Electronic Supplementary Material (ESI) for ChemComm.

Enantioselective Prins Cyclization: BINOL-Derived Phosphoric Acid and CuCl, a Synergistic Catalysis

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SUPPORTING INFORMATION

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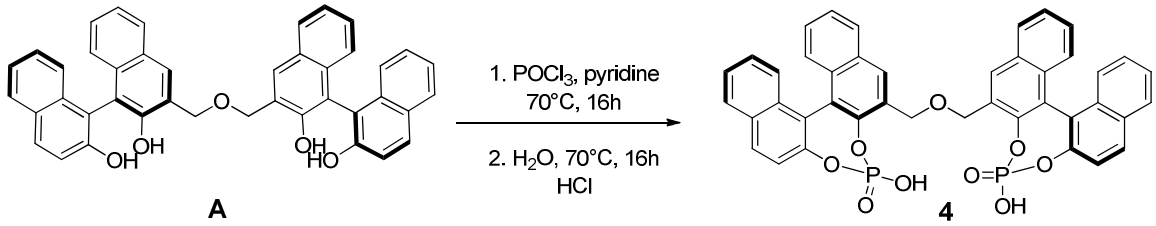
I – General Informations

All the reactions were performed in dried glassware, under argon atmosphere, and sealed with a rubber septum. Reagents were obtained from commercial suppliers and used without further purification unless otherwise noted. - TLC analyses were performed using precoated Merck TLC Silica Gel 60 F_{254} plates. Purifications by column chromatography on silica gel were performed using Merck Silica Gel 60(70-230 mesh) and purifications by preparative thin layer chromatography on silica gel using Merck Silica Gel 60 PF_{254}. Petroleum ether (PE) used for purifications was the low boiling point fraction (40-60 °C). - ^{1}H NMR and ^{13}C spectra were recorded on a Bruker DMX 500 or a Bruker Avance 300 instrument using TMS and CDCl3 respectively as internal standard. Chemical shifts (δ) are reported in parts per million (ppm) relatively to TMS and residual solvent as an internal standards. The following abbreviations are used for multiplicities: s, singlet; d, doublet; t, triplet; dd, doublet of doublets; td, triplet of doublets; m, multiplet. Carbon multiplicities were determined by Jmod experiments. Coupling constants (*J*) are reported in Hertz (Hz). - HRMS analyses were obtained using a Waters Q-TOF 2 or a Micromass ZABSpec TOF or a Bruker Micro-TOF Q II or a LTQ Orbitrap XL instrument for ESI. X-ray crystallographic data were collected on an APEXII crystal diffractometer. Optical rotations were recorded on a Perkin Elmer Model 341 polarimeter. Melting points were obtained on a hot bench. Analytical high-performance liquid chromatography (HPLC) was performed on a Shimadzu Prominence equipped with diode array UV detectors, using Daicel Chiralpak IA and IC. – The catalyst and the homoallylic alcohol were prepared according to the same procedure as previously described in the literature.

II - Preparation and NMR data of the catalyst 4[1]



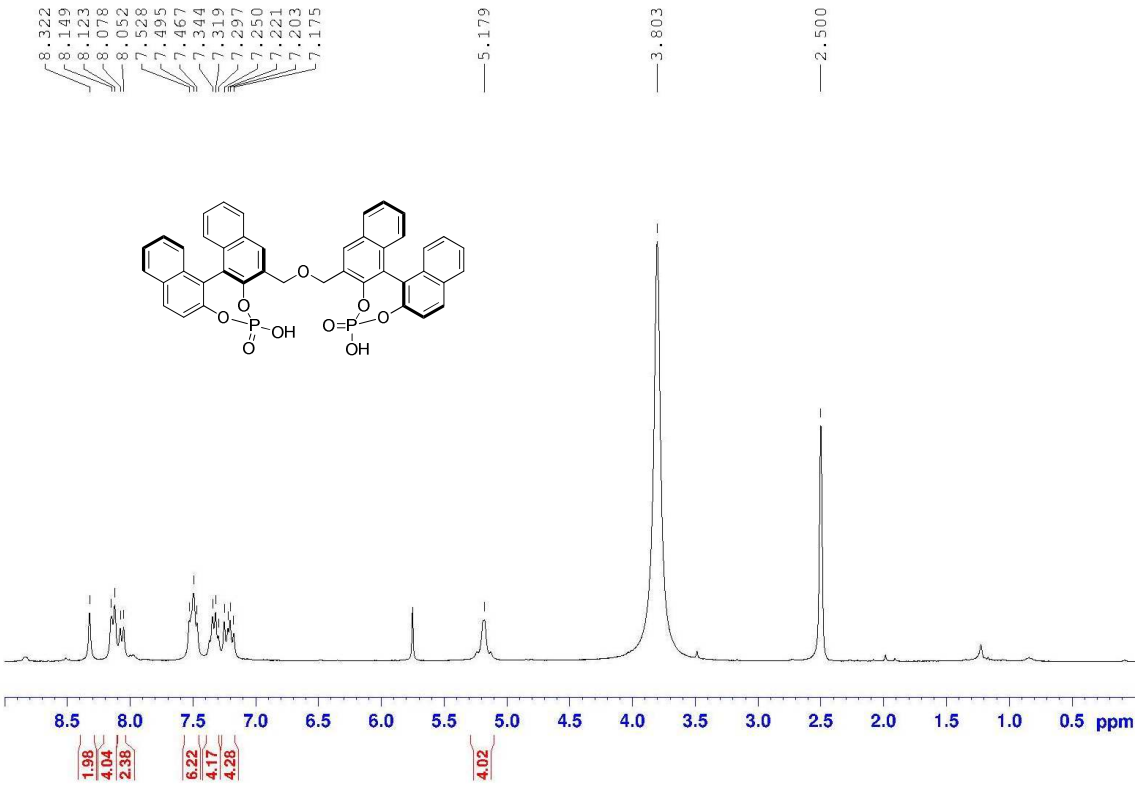
In a flame-dried round-bottom flask under Ar atmosphere, **A**[2] (1.0 mmol) was dissolved in 12 mL of pyridine and $POCl_3$ (3 eq) was added at 0°C. The mixture was stirred at 70 °C for 16 h, then H_2O (2 mL) was added at r.t. and the resulting suspension was stirred additional 24 h at 70 °C. CH_2Cl_2 (50 mL) was added and the organic phase was washed with 6N HCl (50 mL). The aqueous phase was extracted with CH_2Cl_2 (30 mL), then the combined organic phases were washed again with 6N HCl (30 mL), dried over anhydrous $MgSO_4$, finally the solvent was removed *in vacuo*. The resulting crude product was purified by column chromatography (CH_2Cl_2/MeOH : 10/1) to yield a white solid which was dissolved in CH_2Cl_2 (20 mL) and washed with 6N HCl (10 mL). The organic phase was dried over anhydrous $MgSO_4$ and the solvent was removed *in vacuo* to give pure **4** as a white solid (656 mg, 89% yield).

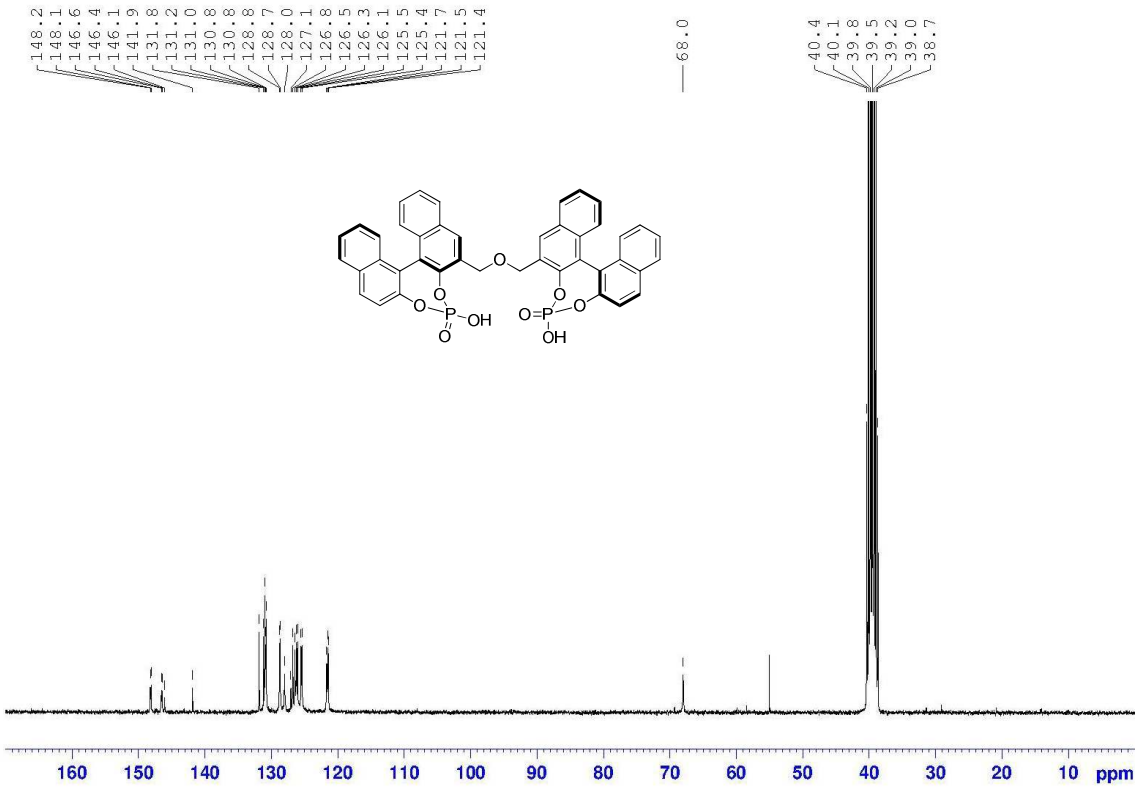
^{1}H NMR (300 MHz, DMSO) δ = 8.32 (s, 2H), 8.13 (d, *J* = 7.8 Hz, 4H), 8.06 (d, *J* = 7.8 Hz, 2H), 7.52-7.46 (m, 6H), 7.34-7.29 (m, 4H), 7.25-7.17 (m, 4H), 5.17 (s, 4H) ppm;

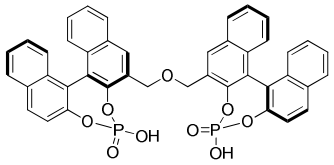
^{13}C NMR (75 MHz, DMSO) δ = 148.2, 148.1, 146.6, 146.4, 146.1, 141.9, 131.8, 131.2, 131.0, 130.8, 130.8, 128.8, 128.7, 128.0, 127.1, 126.8, 126.5, 126.3, 126.1, 125.5, 125.4, 121.7, 121.5, 121.4, 68.0 (CH_2) ppm ppm.

^{31}P NMR (202 MHz, DMSO) δ = 1.98 ppm

[1] Chen, X.-H.; Zhang, W.-Q.; Gong, L.-Z. *J. Am. Chem. Soc.* **2008**, *130*, 5652.
[2] Matsunaga, S.; Das, J.; Roels, J.; Vogl, E. M.; Yamamoto, N.; Iida, T.; Yamaguchi, K.; Shibasaki, M. *J. Am. Chem. Soc.* **2000**, *122*, 2252.


8.322
8.149
8.123
8.078
8.052
7.528
7.495
7.467
7.344
7.319
7.297
7.250
7.221
7.203
7.175
5.179
3.803
2.500
OH
OH
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
1.98
4.04
2.38
6.22
4.17
4.28
4.02

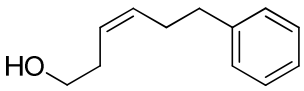

148.2
148.1
146.6
146.4
146.1
141.9
131.8
131.2
131.0
130.8
130.8
128.8
128.7
128.0
127.1
126.8
126.5
126.3
126.1
125.5
125.4
121.7
121.5
121.4
68.0
40.4
40.1
39.8
39.5
39.2
39.0
38.7
OH
OH
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


O
O
O
P
OH
O
O
O=P
O
OH

1.98
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
f1 (ppm)

III - NMR data of the homoallylic alcohol (*Z*)-1

(*Z*)-6-phenylhex-3-en-1-ol (*Z*)-1

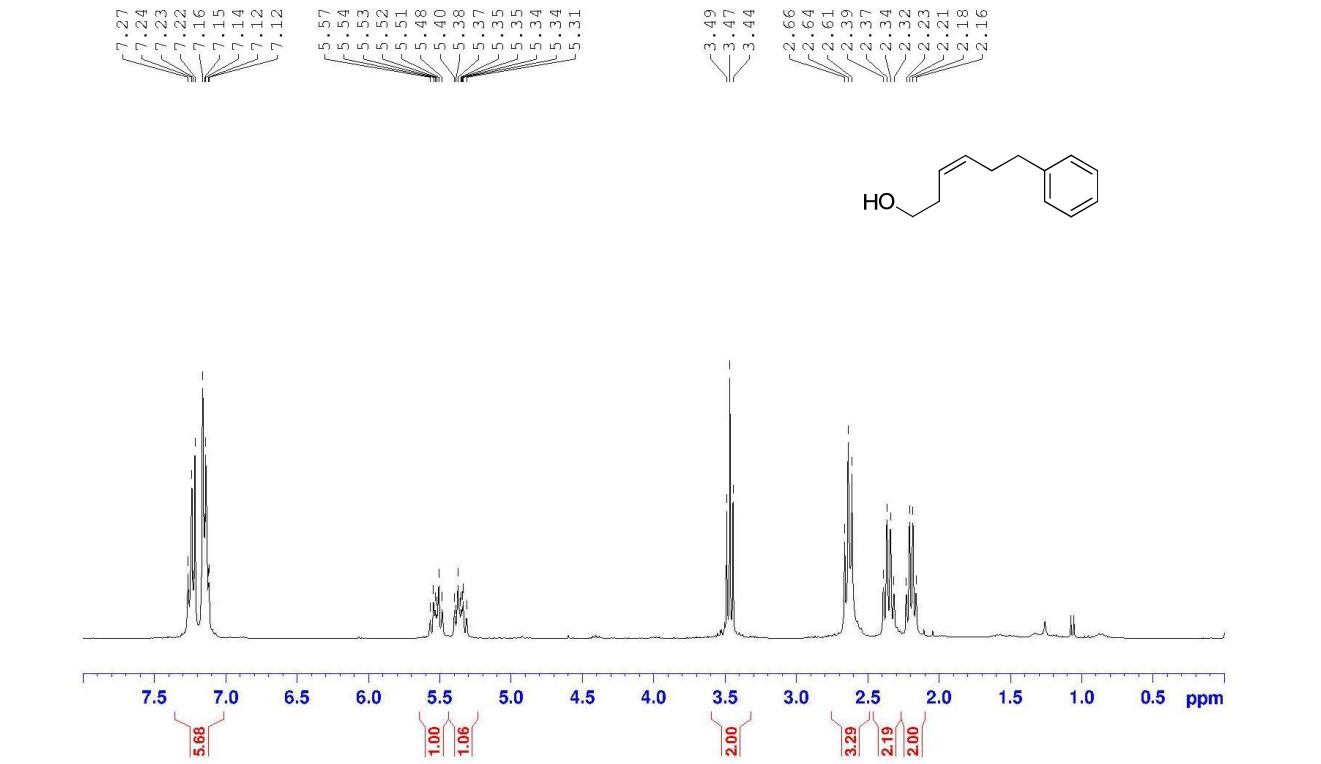


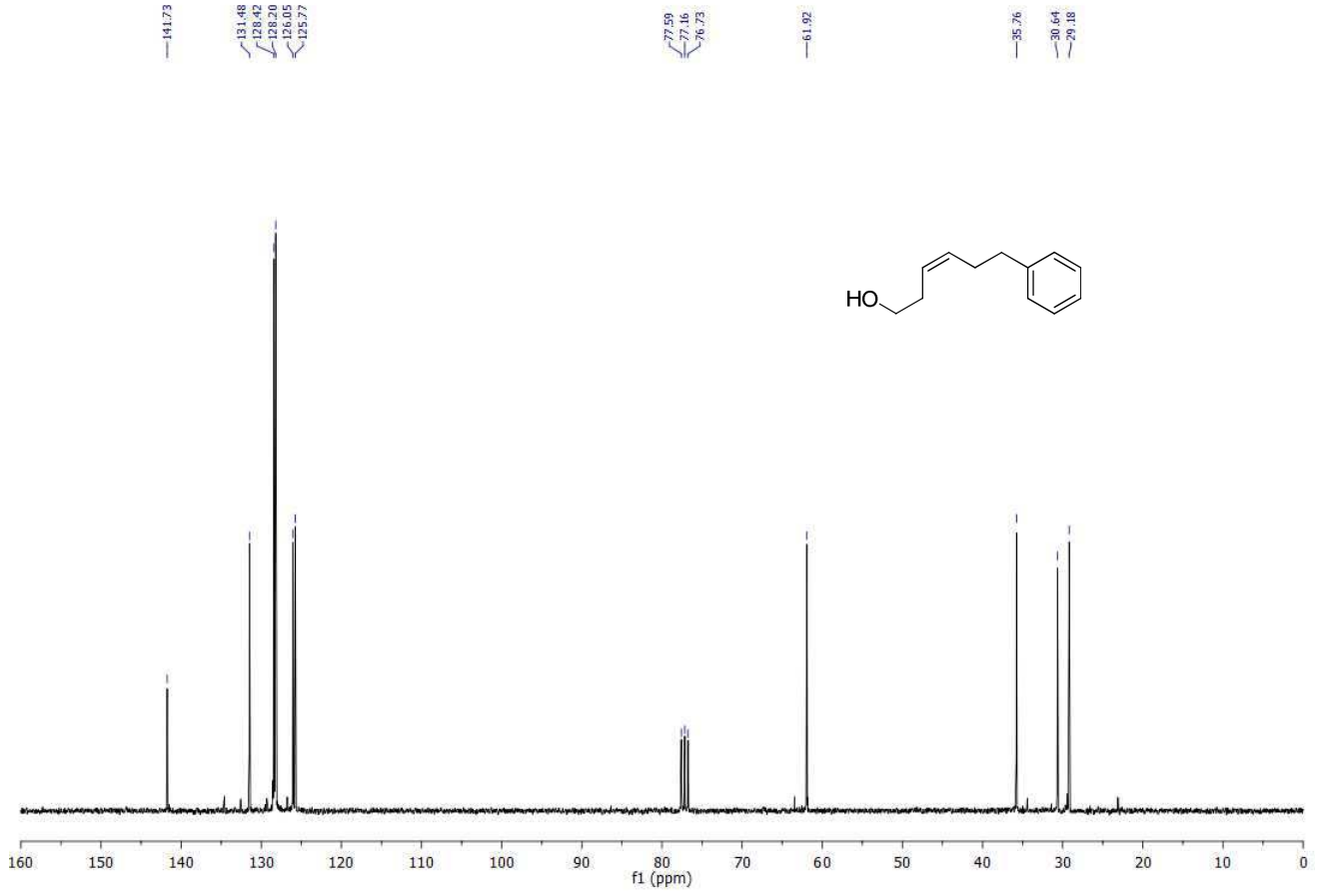
The title compound was obtained in 90% yield as a colorless liquid according to the literature.[3]

^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.26-7.11 (m, 5H), 5.56-5.48 (m, 1H), 5.39-5.31 (m, 1H), 3.46 (t, *J* = 6.6 Hz, 2H), 2.63 (t, *J* = 7.5 Hz, 2H), 2.39-2.31 (m, 2H), 2.22-2.16 (m, 2H) ppm;

^{13}C NMR (75 MHz, $CDCl_3$) δ = 141.7 (C), 131.4 (CH), 128.4 (2 × CH), 128.2 (2 × CH), 126.0 (CH), 125.7 (CH), 61.9 (CH_2), 35.7 (CH_2), 30.6 (CH_2), 29.1 (CH_2) ppm.

[3] Subba Reddy, B. V.; Borkar, P. ; Yadav, J. S.; Sridhar, B.; Grée. R. *J. Org. Chem.* **2011**, *76*, 7677.


7.27
7.24
7.23
7.22
7.16
7.15
7.14
7.12
7.12
5.57
5.54
5.53
5.52
5.51
5.48
5.40
5.38
5.37
5.35
5.35
5.34
5.34
5.31
3.49
3.47
3.44
2.66
2.64
2.61
2.39
2.37
2.34
2.32
2.23
2.21
2.18
2.16
HO
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
5.68
1.00
1.06
2.00
3.29
2.19
2.00


141.73
131.48
128.42
128.20
126.05
125.77
77.59
77.16
76.73
61.92
35.76
30.64
29.18
HO
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

IV – Optimization studies: Lewis Acid variation

Entry	Lewis Acid	time	Yield (%)	e.r
1	$Cu(OTf)_2$	22h	24	80:20
2	TMSOTf	22h	59	50:50
3	$Zn(OTf)_2$	5days	26	50:50
4	$Ni(OTf)_2$	22h	70	50:50
5	AgOTf	22h	57	50:50
6	LiOTf	40h	61	50:50
7	$Bi(OTf)_3$	22h	26	50:50
8	$MgCl_2$	5days	-	-
9	$MgBr_2$	5days	-	-
10	CuCl	22h	70	80:20
11	CuBr	40h	39	79:21
12	CuI	5days	17	75:25
13	$CuCl_2$	22h	65	79:21

V - Optimization studies: solvent effect

Entry	solvent	time	Yield (%)	e.r.
1	DCE	22h	70	80:20
2	DCM[a]	22h	69	77:23
3	$CHCl_3$	40h	38	70:30
4	CCl_4	40h	31	62:38
5	toluene	40h	52	58:42
6	EtOAc	40h	34	75:25
7	Et_2O[a]	22h	41	75:25
8	DIPE	40h	48	75:25
9	THF	5days	-	-
10	dioxane	5days	-	-

[a] Sealed vial

VI – General procedure for the racemic tandem Prins/Friedel-Crafts cyclization.

To a stirring solution of homoallylic alcohol **(*Z*)-1** (1 eq, 0.1 mmol) and aldehyde (1.2 eq, 0.12 mmol) in dry dichloromethane DCM (0.1 M, 1 mL) was added trifluoromethane sulfonic acid TfOH (0.3 eq, 0.03 mmol). The obtained mixture was stirred under an argon atmosphere at room temperature for 16 h. Solvent was removed under reduced pressure and purification of the residue over silica gel (Petroleum Ether/Diethyl Ether : 5/2) provided the desired product as single diastereomer between 52% and 92% yield.

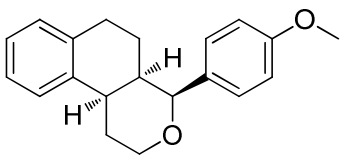
VII – General procedure for the enantioselective tandem Prins/Friedel-Crafts cyclization.

In a flame-dried tube under argon atmosphere catalyst **4** (0.1 eq, 0.01 mmol, 7mg), CuCl (0.1 eq, 0.01 mmol, 1mg) were charged together with dry dichloroethane DCE (0.1 M, 1 mL). To this suspension the homoallylic alcohol **(*Z*)-1** (1 eq, 0.1 mmol) and the aldehyde (1.2 eq, 0.12 mmol) were added. The mixture was stirred under an argon atmosphere at 40 °C for 22 h and then the solvent was removed under reduced pressure. The resulting crude product was purified over silica gel (Petroleum Ether/Diethyl Ether : 5/2) providing the desired product **5** as single diastereomer.

VIII - ^{1}H, ^{13}C NMR data and HPLC data of compounds 5

(4*S*,4a*R*,10b*R*)-4-(4-methoxyphenyl)-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene

5a



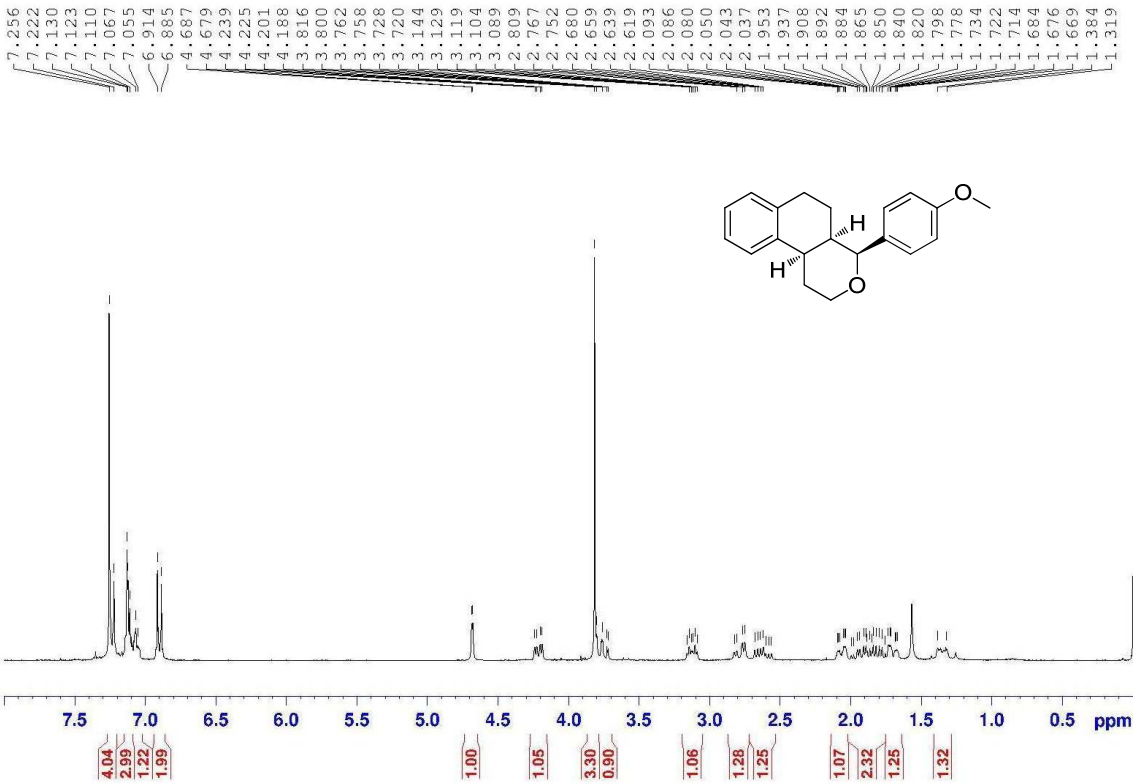
Obtained as a white solid,
16 mg, 70% yield, dr > 95:5;
M.p. 135-138 °C;
$[\alpha]^{23}_{D}$ -1.7 (c 1.0, $CHCl_3$);

IR (neat, cm^{-1}) 2941, 2837, 1510, 1245, 1170, 1095, 1084, 1025, 834, 765, 743, 546;
ESI-HRMS calculated for $C_{20}H_{23}O_2$ $[M+H]^+$ 295.16981, found 295.1699;

Chiral HPLC (Chiralpak IA, Heptane/*i*PrOH = 99/1, flow rate = 1.0 mL/min, 272 nm): major isomer: t_R = 8.8 min, minor isomer: t_R = 13.5 min, 79:21 e.r.;

^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.24 (d, *J* = 8.7 Hz, 2H), 7.13-7.05 (m, 4H), 6.90 (d, *J* = 8.7 Hz, 2H), 4.68 (d, *J* = 2.4 Hz, 1H), 4.21 (dd, *J* = 11.4, 4.2 Hz, 1H), 3.81 (s, 3H), 3.80-3.72 (m, 1H), 3.16-3.08 (m, 1H), 2.79 (dd, *J* = 17.1, 4.2 Hz, 1H), 2.68-2.56 (m, 1H), 2.09-2.03 (m, 1H), 1.99-1.75 (m, 2H), 1.73-1.66 (m, 1H), 1.38-1.31 (m, 1H) ppm;

^{13}C NMR (75 MHz, $CDCl_3$) δ = 158.4 (C), 141.0 (C), 136.2 (C), 133.6 (C), 129.1 (CH), 128.7 (CH), 126.7 (2 × CH), 126.1 (CH), 125.8 (CH), 113.5 (2 × CH), 81.5 (CH), 68.9 (CH_2), 55.3 (CH_3), 39.9 (CH), 39.6 (CH), 31.5 (CH_2), 29.4 (CH_2), 16.8 (CH_2) ppm.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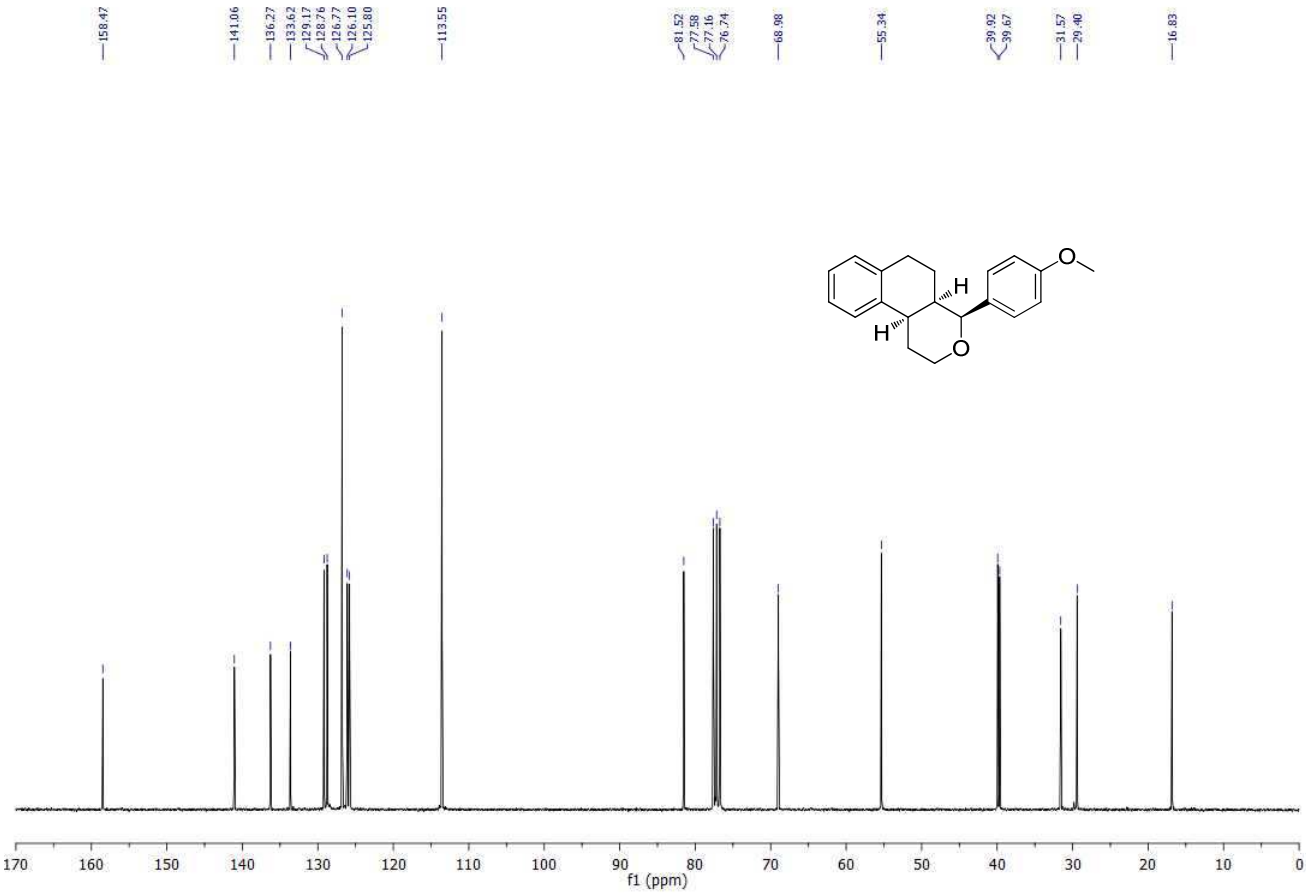
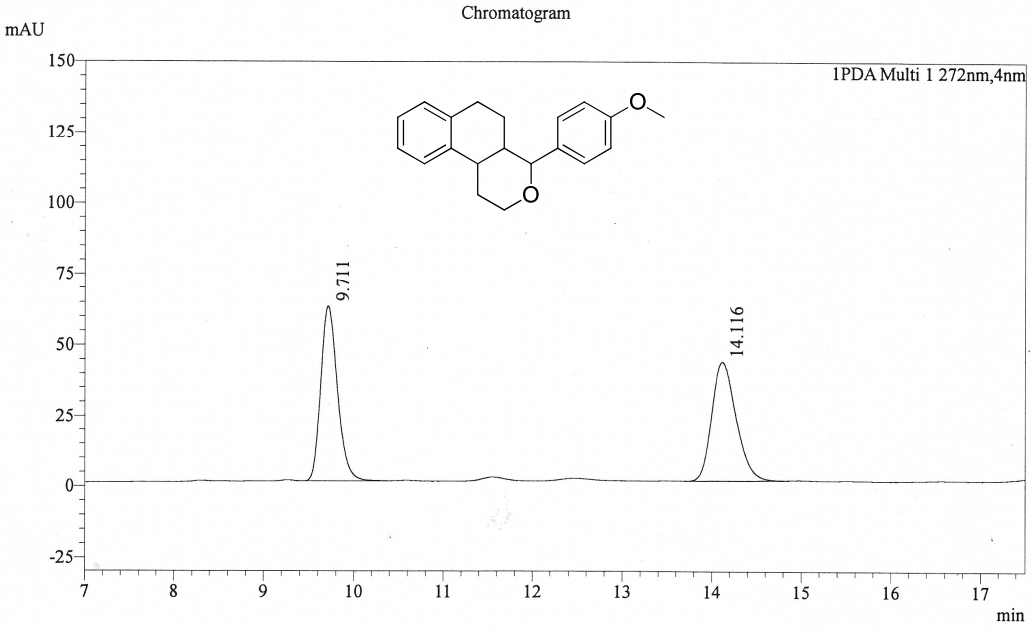
7.130
7.123
7.110
7.067
7.055
6.914
6.885
4.687
4.679
4.239
4.225
4.201
4.188
3.816
3.800
3.762
3.758
3.728
3.720
3.144
3.129
3.119
3.104
3.089
2.809
2.767
2.752
2.680
2.659
2.639
2.619
2.093
2.086
2.080
2.050
2.043
2.037
1.953
1.937
1.908
1.892
1.884
1.865
1.850
1.840
1.820
1.798
1.778
1.734
1.722
1.714
1.684
1.676
1.669
1.384
1.319
O
H
H
O
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
4.04
2.99
1.22
1.99
1.00
1.05
3.30
0.90
1.06
1.28
1.25
1.07
2.32
1.25
1.32


158.47
141.06
136.27
133.62
129.17
128.76
126.77
126.10
125.80
113.55
81.52
77.58
77.16
76.74
68.98
55.34
39.92
39.67
31.57
29.40
16.83
O
H
H
O
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

Chiralpak IA, Heptane/Isopropanol = 99/1, 1mL/min, 272nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
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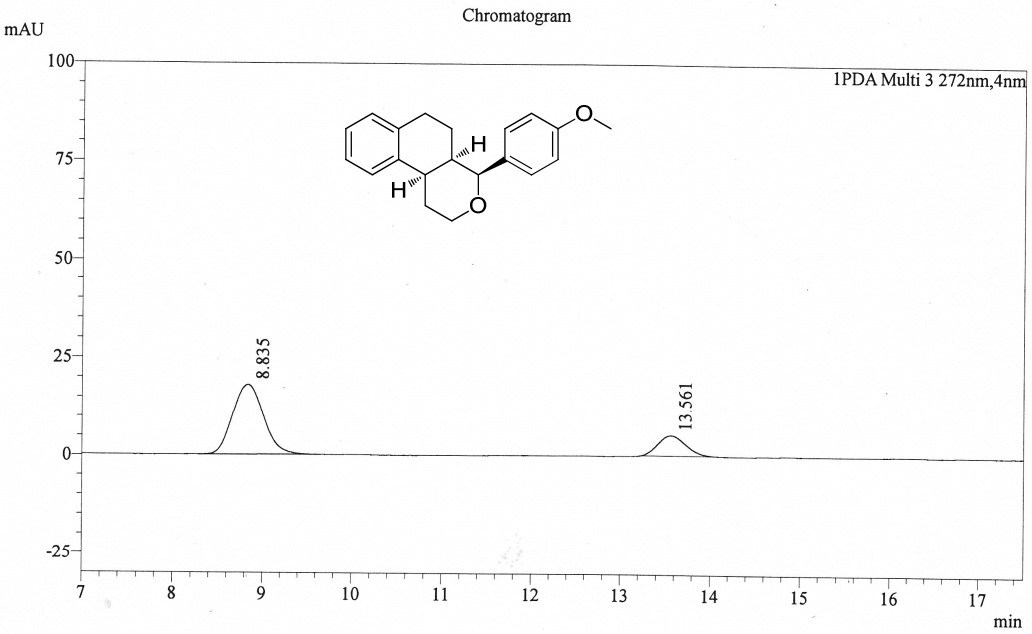
2	14.116	42268	801910	50.043
Total		104109	1602450	100.000

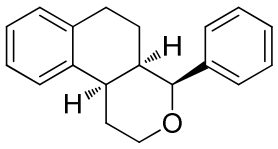


Peak Table

PDA Ch3 272nm

Peak#	Ret. Time	Height	Area	Area%
1	8.835	17944	430621	79.271
2	13.561	5188	112603	20.729
Total		23132	543224	100.000

(4*S*,4a*R*,10b*R*)-4-phenyl-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene 5b

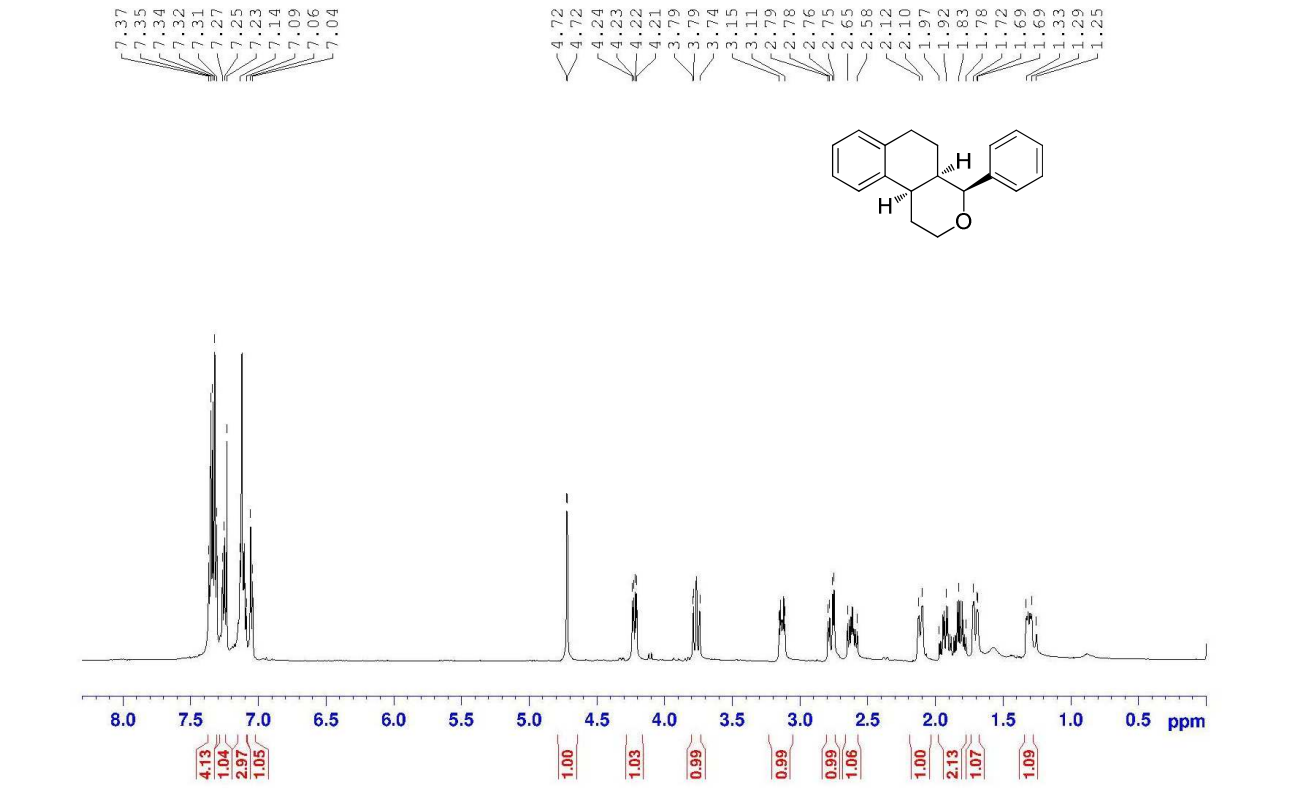


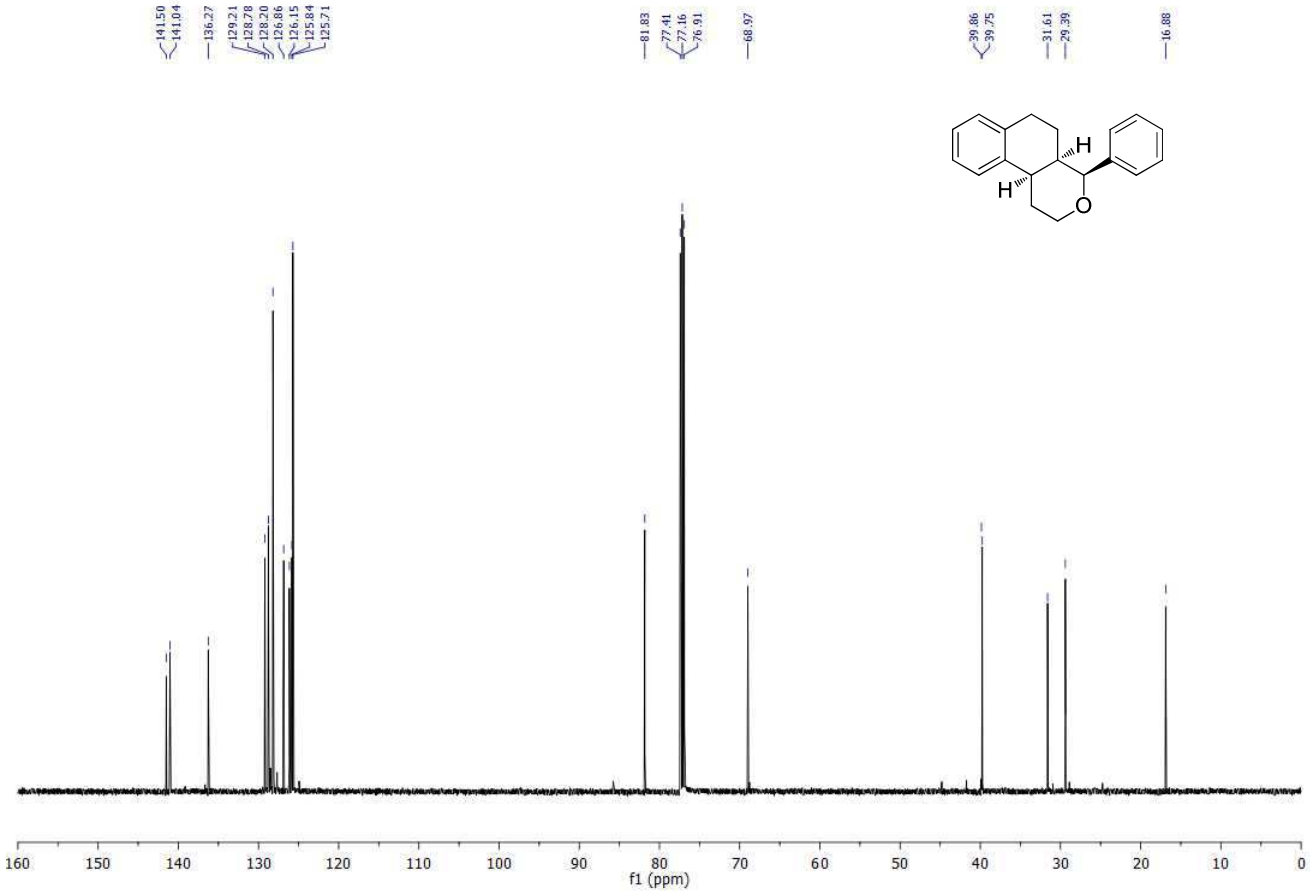
Obtained as a colorless oil,
19 mg, 73% yield, dr > 95:5;
$[\alpha]^{23}_{D}$ -4.8 (c 1.0, $CHCl_3$);

IR (neat, cm^{-1}) 2941, 1490, 1449, 1258, 1098, 1076, 759, 737, 701;
ESI-HRMS calculated for $C_{19}H_{21}O$ $[M+H]^+$ 265.15924, found 265.1581;
Chiral HPLC (Chiralpak IC, Heptane/*i*PrOH = 99/1, flow rate = 0.5 mL/min, 272 nm): major isomer: t_R = 11.0 min, minor isomer: t_R = 12.7 min, 80:20 e.r.;

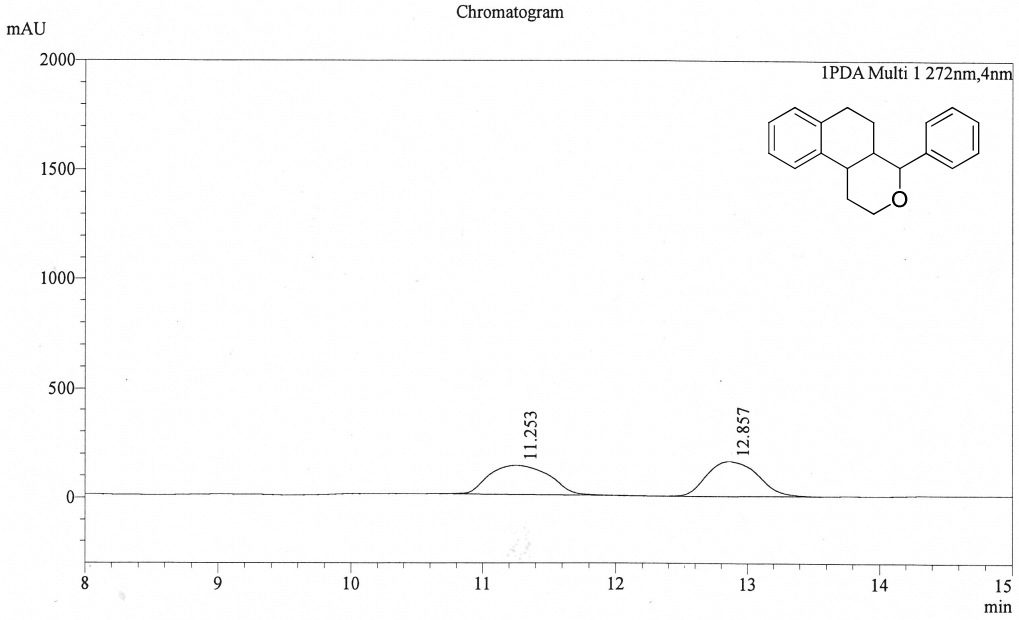
^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.37-7.31 (m, 4H), 7.27-7.23 (m, 1H), 7.14-7.09 (m, 3H), 7.05 (d, *J* = 7.1 Hz, 1H), 4.72 (d, *J* = 2.1 Hz, 1H), 4.22 (dd, *J* = 11.3, 4.6 Hz, 1H), 3.79-3.74 (m, 1H), 3.15-3.11 (m, 1H), 2.77 (dd, *J* = 17.0, 5.5 Hz, 1H), 2.65-2.58 (m, 1H), 2.11 (dd, *J* = 7.4, 5.5 Hz, 1H), 1.97-1.78 (m, 2H), 1.72-1.69 (m, 1H), 1.33-1.25 (m, 1H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 141.5 (C), 141.0 (C), 136.2 (C), 129.2 (CH), 128.7 (CH), 128.2 (2 × CH), 126.8 (CH), 126.1 (CH), 125.8 (CH), 125.7 (2 × CH), 81.8 (CH), 68.9 (CH_2), 39.8 (CH), 39.7 (CH), 31.6 (CH_2), 29.3 (CH_2), 16.8 (CH_2) ppm.


7.37
7.35
7.34
7.32
7.31
7.27
7.25
7.23
7.14
7.09
7.06
7.04
4.72
4.72
4.24
4.23
4.22
4.21
3.79
3.79
3.74
3.15
3.11
2.79
2.78
2.76
2.75
2.65
2.58
2.12
2.10
1.97
1.92
1.83
1.78
1.72
1.69
1.69
1.33
1.29
1.25
H
H
O
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
4.13
1.04
2.97
1.05
1.00
1.03
0.99
0.99
0.99
1.06
1.00
2.13
1.07
1.09


141.50
141.04
136.27
129.21
128.78
128.20
126.86
126.15
125.84
125.71
81.83
77.41
77.16
76.91
68.97
39.86
39.75
31.61
29.39
16.88
H
H
O
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

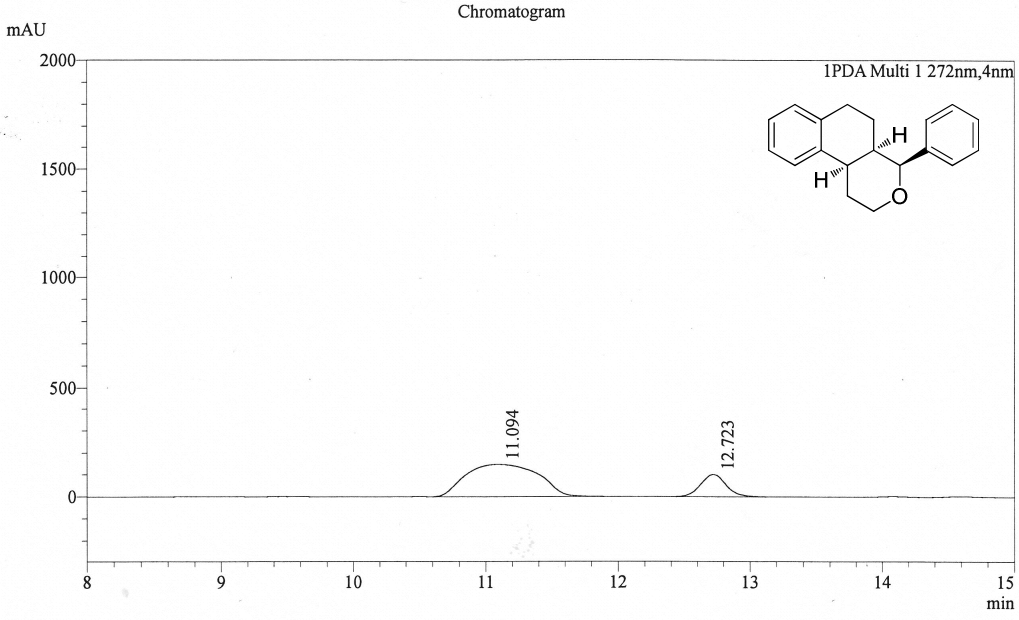
Chiralpak IC, Heptane/*i*PrOH = 99/1, 0.5 mL/min, 272 nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	11.253	132558	4239132	49.376
2	12.857	159317	4346298	50.624
Total		291876	8585430	100.000



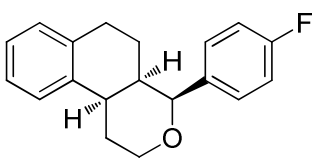
Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	11.094	148089	5676939	80.085
2	12.723	102519	1411663	19.915
Total		250608	7088603	100.000

(4*S*,4a*R*,10b*R*)-4-(4-fluorophenyl)-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene

5c

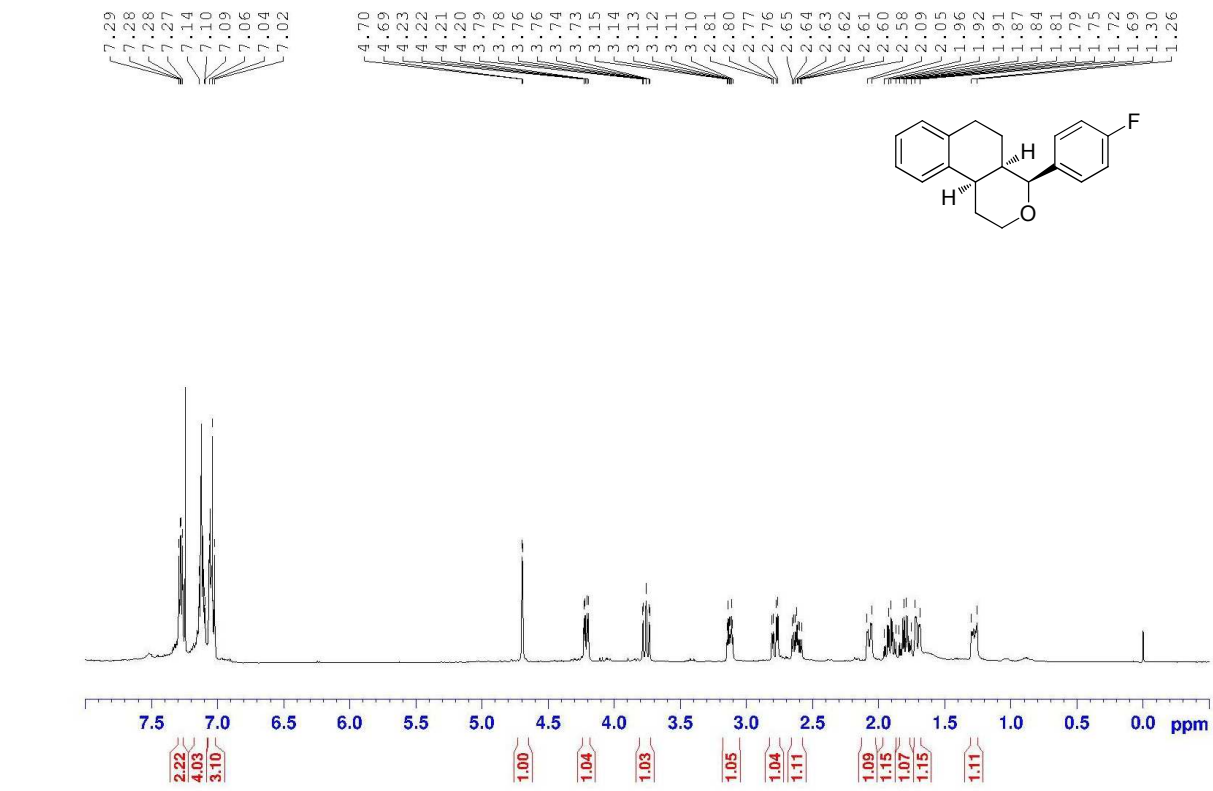


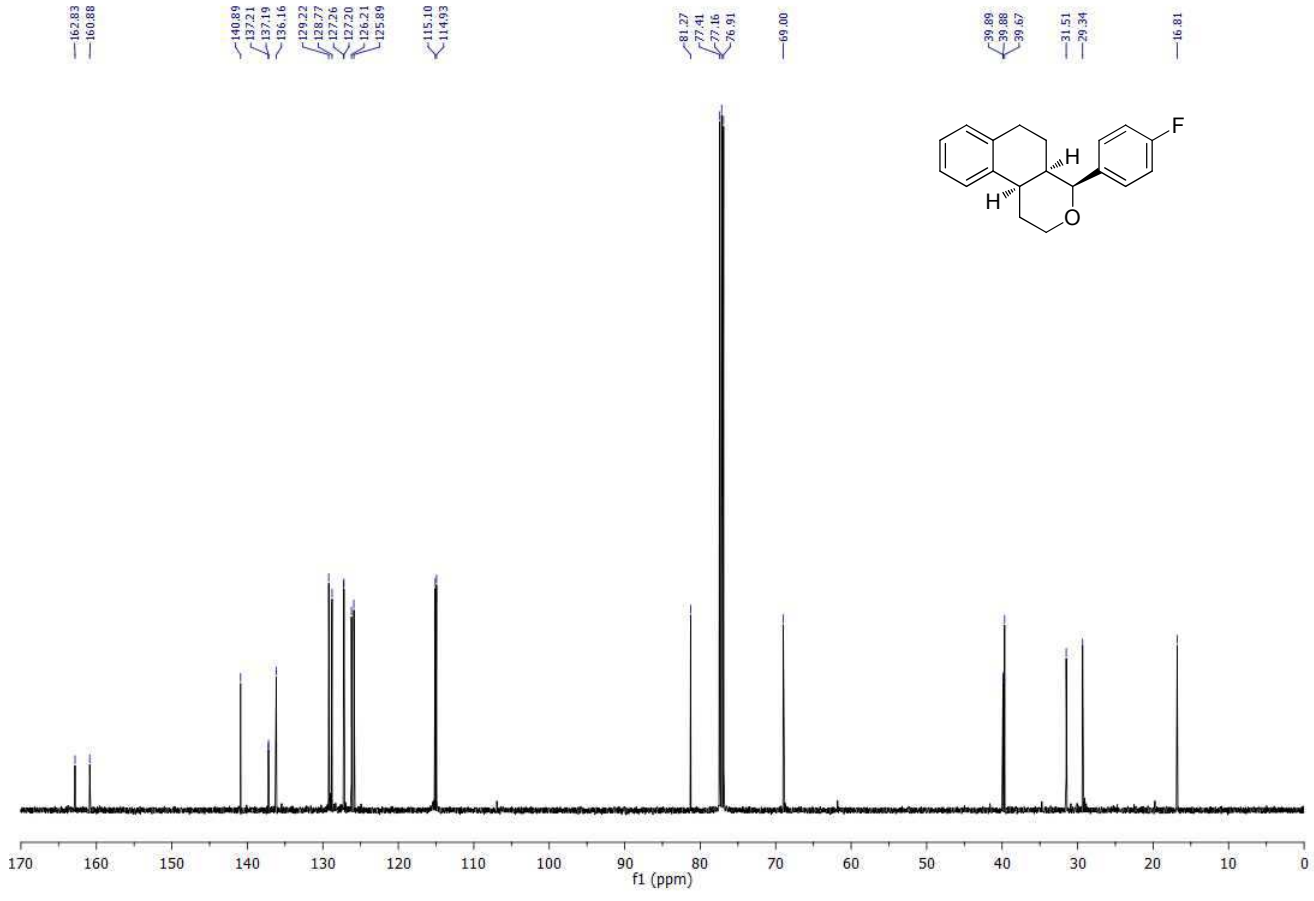
Obtained as a white solid,
19 mg, 68% yield, dr > 95:5;
M.p. 78-81 °C;
$[\alpha]^{23}_{D}$ -2.6 (c 1.0, $CHCl_3$);

IR (neat, cm^{-1}) 2942, 1602, 1508, 1220, 1155, 1086, 837, 764, 744, 544;
ESI-HRMS calculated for $C_{19}H_{20}FO$ $[M+H]^+$ 283.14982, found 283.1497;
Chiral HPLC (Chiralpak IA, Heptane/*i*PrOH = 99.5/0.5, flow rate = 0.8 mL/min, 272 nm): major isomer: t_R = 8.0 min, minor isomer: t_R = 9.2 min, 76:24 e.r.;

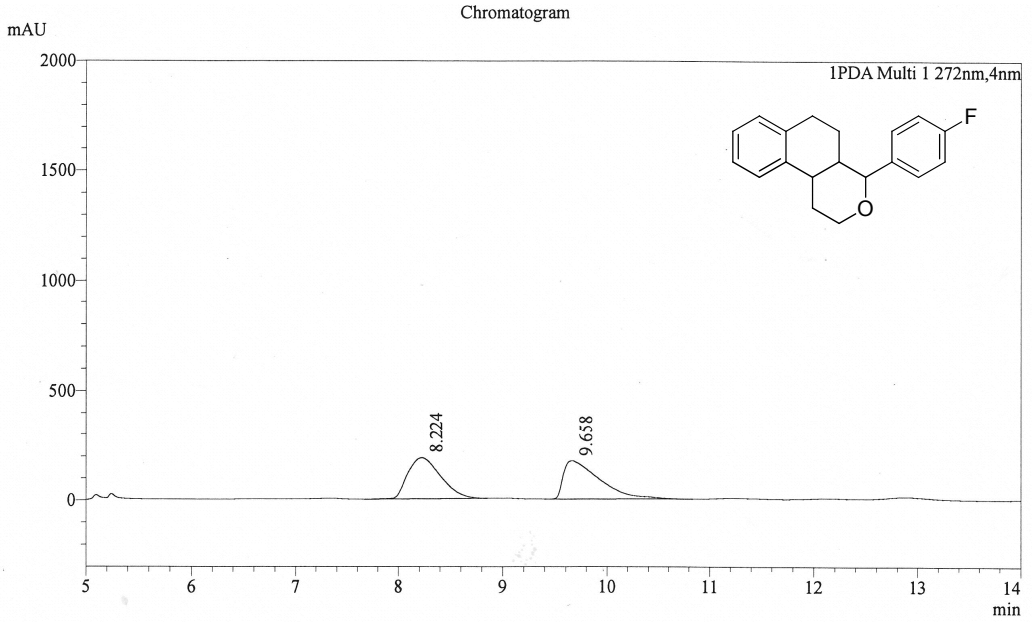
^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.29-7.27 (m, 2H), 7.14-7.09 (m, 4H), 7.06-7.02 (m, 3H), 4.70 (d, *J* = 1.9 Hz, 1H), 4.21 (dd, *J* = 11.4, 4.4 Hz, 1H), 3.76 (td, *J* = 12.8, 2.4 Hz, 1H), 3.12 (dt, *J* = 12.2, 4.4 Hz, 1H), 2.78 (dd, *J* = 17.0, 4.9 Hz, 1H), 2.65-2.58 (m, 1H), 2.09-2.05 (m, 1H), 1.96-1.87 (m, 1H), 1.84-1.75 (m, 1H), 1.72-1.69 (m, 1H), 1.30-1.26 (m, 1H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 161.8 (d, *J* = 250 Hz, C), 140.8 (C), 137.2 (d, *J* = 3 Hz, C), 136.1 (C), 129.2 (CH), 128.7 (CH), 127.2 (d, *J* = 8 Hz 2 × CH), 126.2 (CH), 125.8 (CH), 115.5 (d, *J* = 21 Hz, 2 × CH), 81.2 (CH), 69.0 (CH_2), 39.8 (d, *J* = 2 Hz, CH), 39.6 (CH), 31.5 (CH_2), 29.3 (CH_2), 16.8 (CH_2) ppm.


7.29
7.28
7.28
7.27
7.14
7.10
7.09
7.06
7.04
7.02
4.70
4.69
4.23
4.22
4.21
4.20
3.79
3.78
3.76
3.76
3.74
3.73
3.15
3.14
3.13
3.12
3.11
3.10
2.81
2.80
2.77
2.76
2.65
2.64
2.63
2.62
2.61
2.60
2.58
2.09
2.05
1.96
1.92
1.91
1.87
1.84
1.81
1.79
1.75
1.72
1.69
1.30
1.26
F
H
H
O
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.22
4.03
3.10
1.00
1.04
1.03
1.05
1.04
1.11
1.09
1.15
1.07
1.15
1.11


162.83
160.88
140.89
137.21
137.19
136.16
129.22
128.77
127.26
127.20
126.21
125.89
115.10
114.93
81.27
77.41
77.16
76.91
69.00
39.89
39.88
39.67
31.51
29.34
16.81
F
H
H
O
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

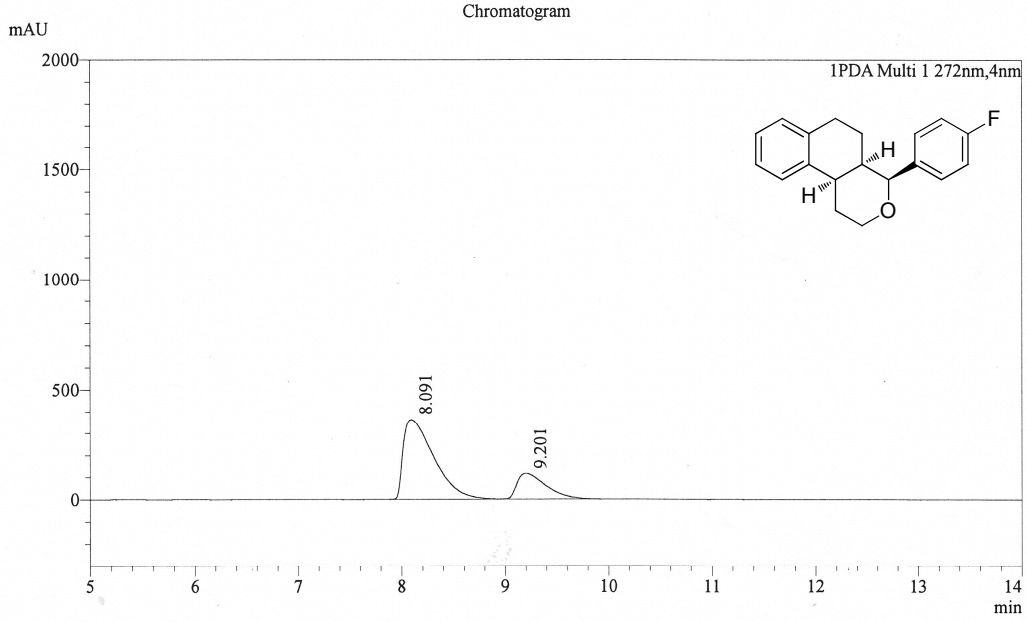
Chiralpak IA, Heptane/*i*PrOH = 99.5/0.5, 0.8 mL/min, 272 nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	8.224	187912	4122275	49.255
2	9.658	174655	4247059	50.745
Total		362567	8369334	100.000



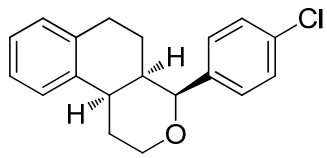
Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	8.091	362295	7428370	76.475
2	9.201	116859	2285093	23.525
Total		479154	9713464	100.000

(4*S*,4a*R*,10b*R*)-4-(4-chlorophenyl)-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene

5d

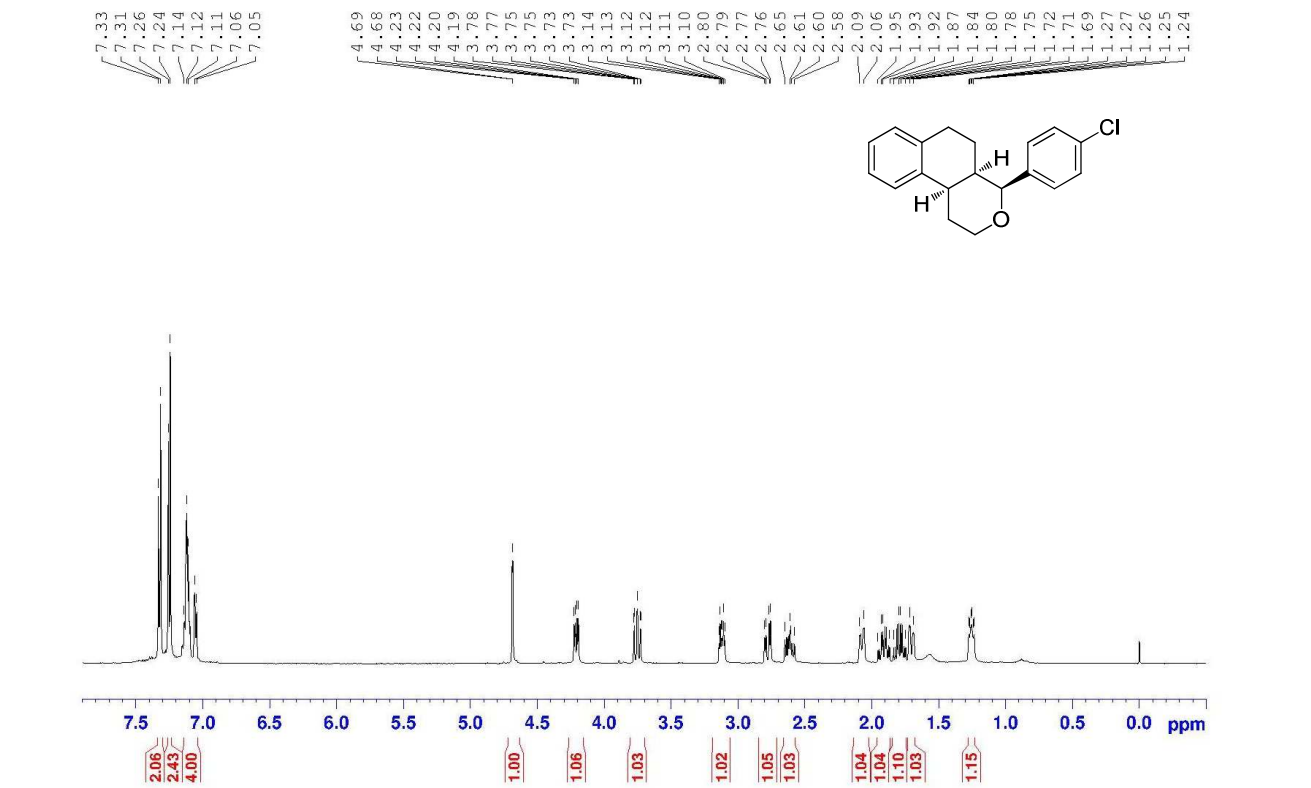


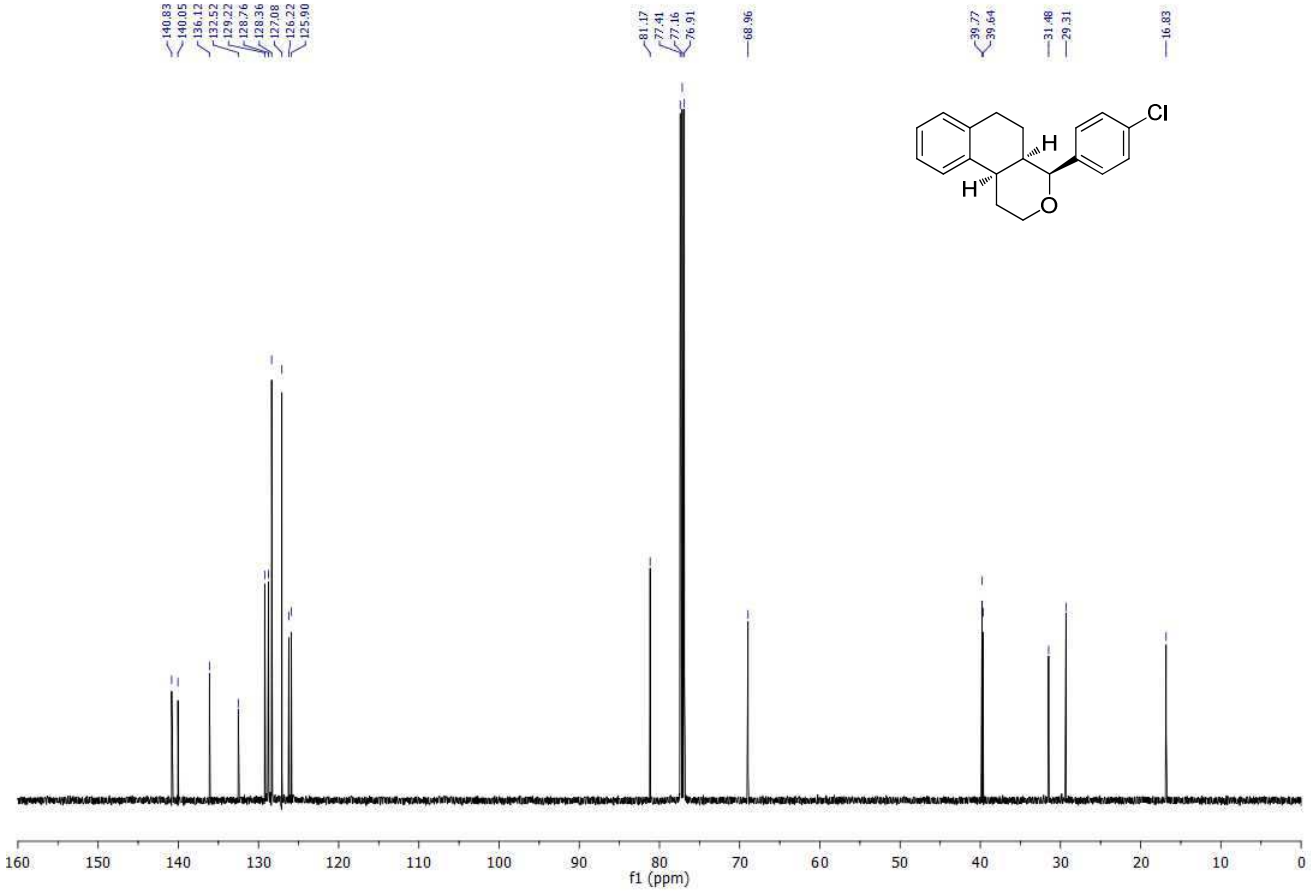
Obtained as a white solid,
21 mg, 76% yield, dr > 95:5;
M.p. 90-93 °C;
$[\alpha]^{23}_{D}$ -1.9 (c 1.0, $CHCl_3$);

IR (neat, cm^{-1}) 2940, 1489, 1258, 1085, 1013, 836, 763, 743, 731;
ESI-HRMS calculated for $C_{19}H_{18}ClO$ $[M-H]^+$ 297.10462, found 297.1048;
Chiral HPLC (Chiralpak IA, Heptane/*i*PrOH = 99.5/0.5, flow rate = 0.8 mL/min, 272 nm): major isomer: t_R = 8.3 min, minor isomer: t_R = 10.0 min, 76:24 e.r.;

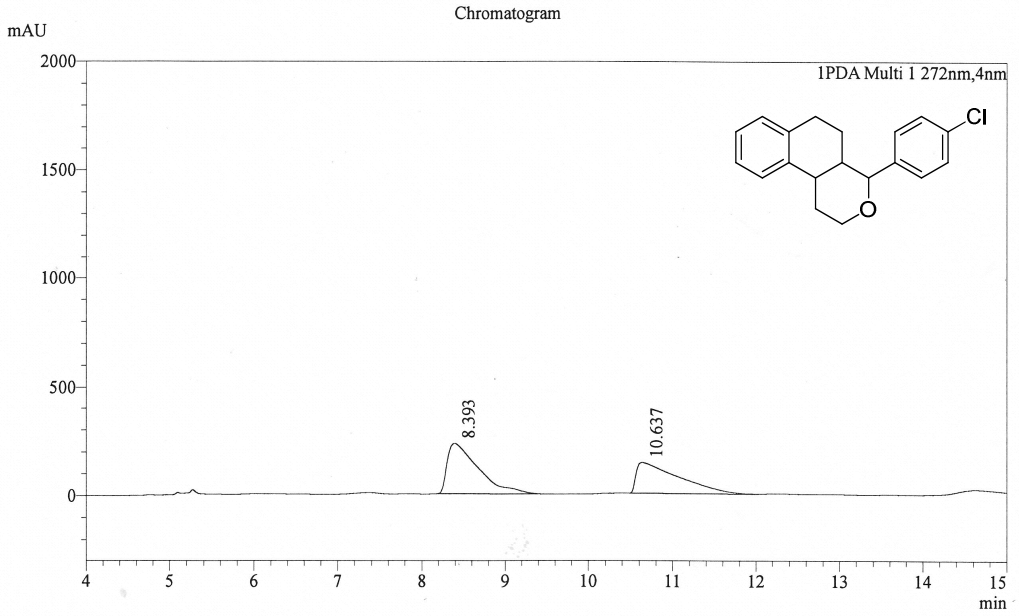
^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.32 (d, *J* = 7.5 Hz, 2H), 7.25 (d, *J* = 7.5 Hz, 2H), 7.14-7.05 (m, 4H), 4.69 (d, *J* = 2.3 Hz, 1H), 4.21 (dd, *J* = 11.4, 4.4 Hz, 1H), 3.75 (td, *J* = 12.8, 2.3 Hz, 1H), 3.12 (dt, *J* = 12.8, 4.4 Hz, 1H), 2.78 (dd, *J* = 17.1, 5.0 Hz, 1H), 2.65-2.58 (m, 1H), 2.09-2.06 (m, 1H), 1.95-1.87 (m, 1H), 1.84-1.72 (m, 1H), 1.71-1.69 (m, 1H), 1.27-1.24 (m, 1H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 140.8 (C), 140.0 (C), 136.1 (C), 132.5 (C), 129.2 (CH), 128.7 (CH), 128.3 (2 × CH), 127.0 (2 × CH), 126.2 (CH), 125.9 (CH), 81.1 (CH), 68.9 (CH_2), 39.7 (CH), 39.6 (CH), 31.4 (CH_2), 29.3 (CH_2), 16.8 (CH_2) ppm.


7.33
7.31
7.26
7.24
7.14
7.12
7.11
7.06
7.05
4.69
4.68
4.23
4.22
4.20
4.19
3.78
3.77
3.75
3.75
3.73
3.73
3.14
3.13
3.12
3.12
3.11
3.10
2.80
2.79
2.77
2.76
2.65
2.61
2.60
2.58
2.09
2.06
1.95
1.93
1.92
1.87
1.84
1.80
1.78
1.75
1.72
1.71
1.69
1.27
1.27
1.26
1.25
1.24
Cl
H
H
O
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.06
2.43
4.00
1.00
1.06
1.03
1.02
1.05
1.03
1.04
1.04
1.10
1.03
1.15


140.83
140.05
136.12
132.52
129.22
128.76
128.36
127.08
126.22
125.90
81.17
77.41
77.16
76.91
68.96
39.77
39.64
31.48
29.31
16.83
Cl
H
H
O
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

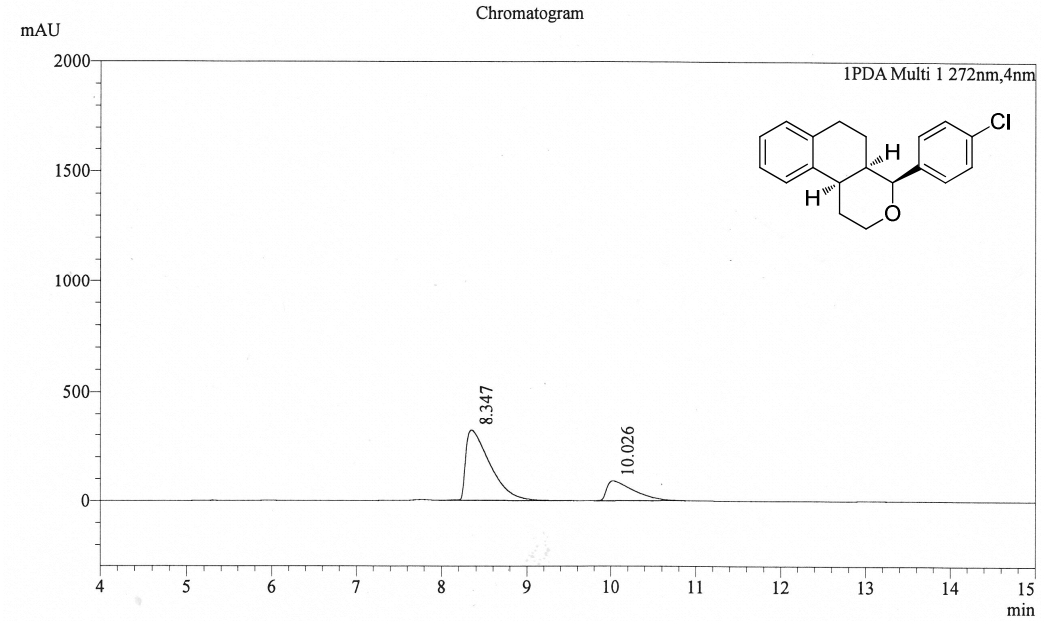
Chiralpak IA, Heptane/*i*PrOH = 99.5/0.5, 0.8 mL/min, 272 nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	8.393	229885	6016231	54.603
2	10.637	141659	5001842	45.397
Total		371544	11018073	100.000



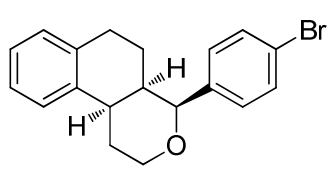
Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	8.347	321322	6319292	76.113
2	10.026	89893	1983203	23.887
Total		411216	8302495	100.000

(4*S*,4a*R*,10b*R*)-4-(4-bromophenyl)-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene

5e



Obtained as a white solid,

21 mg, 62% yield, dr > 95:5;

M.p. 116-119 °C;

$[\alpha]^{23}_{D}$ -1.8 (c 0.5, $CHCl_3$);

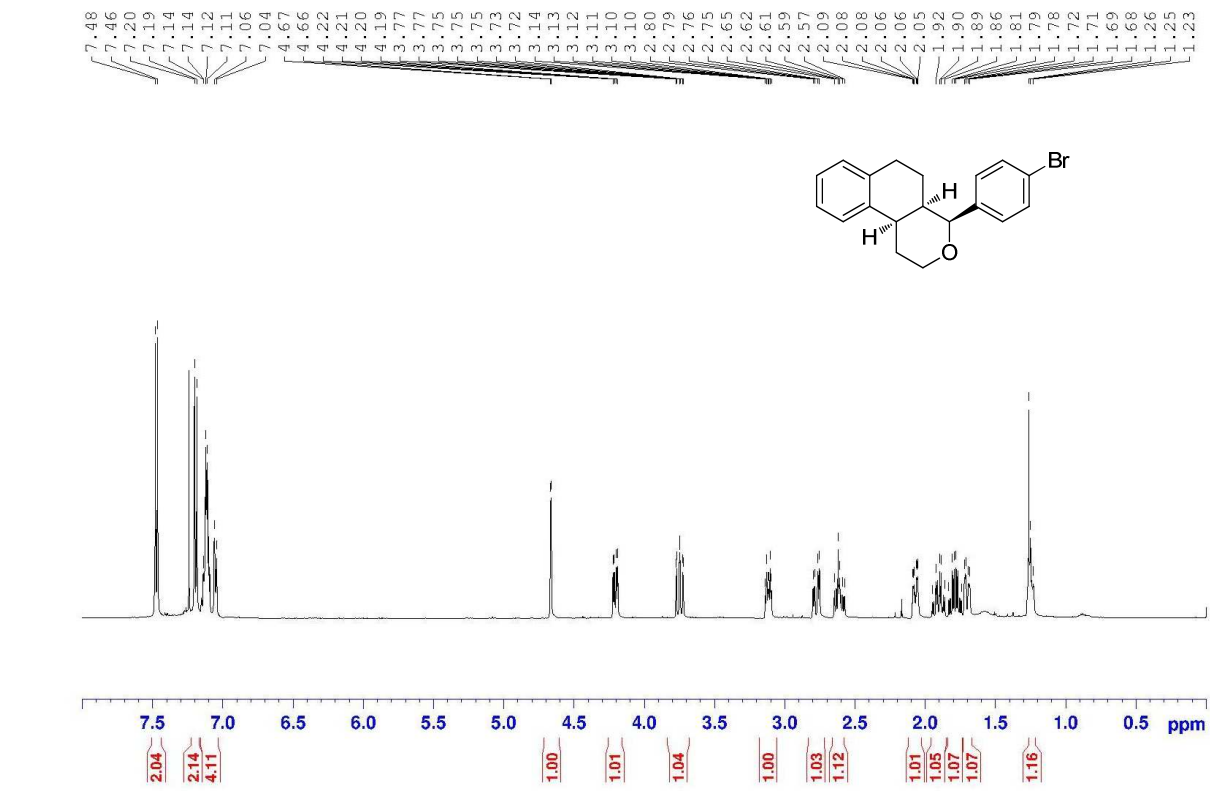
IR (neat, cm^{-1}) 2941, 2840, 1486, 1085, 1072, 1009, 764, 742, 727;

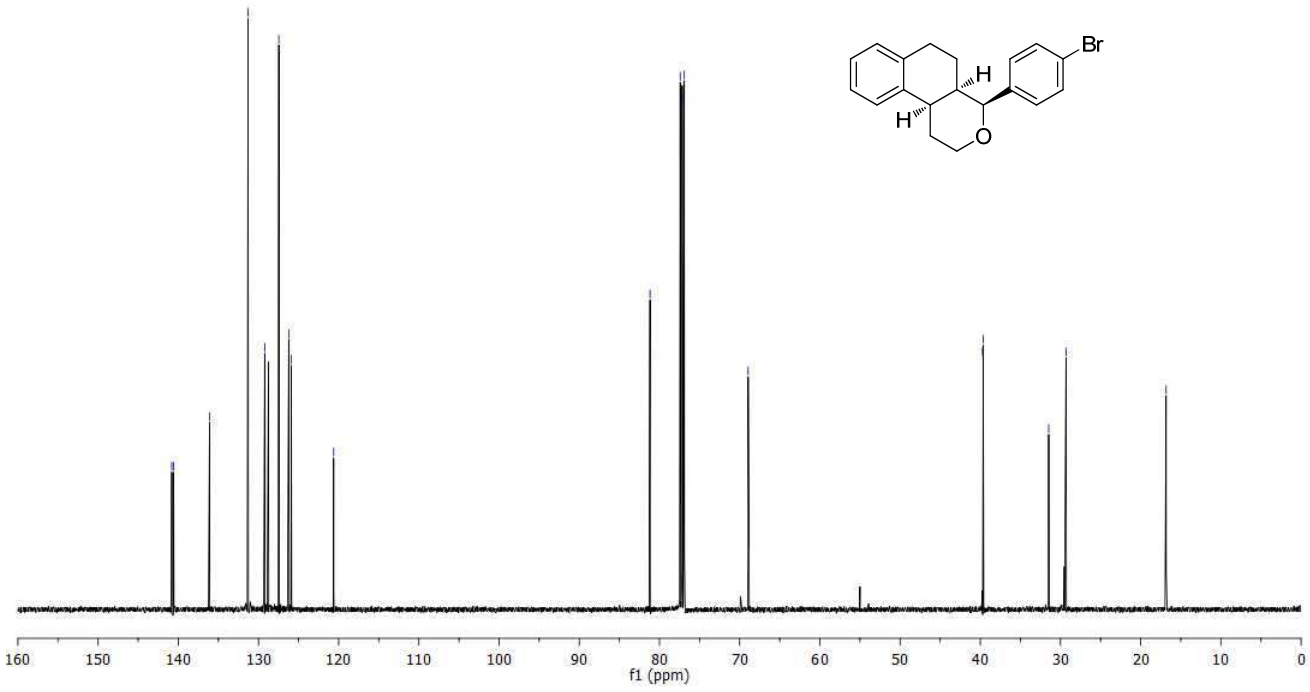
ESI-HRMS calculated for $C_{19}H_{18}BrO$ $[M-H]^+$ 341.0541, found 341.0545;

Chiral HPLC (Chiralpak IC, Heptane/*i*PrOH = 99/1, flow rate = 0.5 mL/min, 254 nm): major isomer: t_R = 10.8 min, minor isomer: t_R = 12.1 min, 80:20 e.r.;

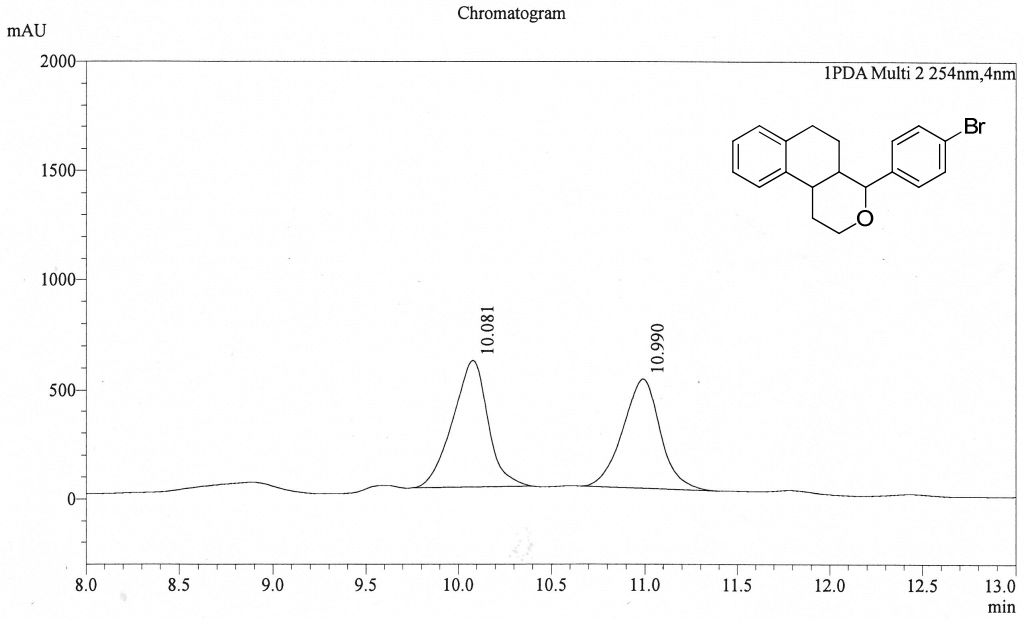
^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.47 (d, *J* = 8.5 Hz, 2H), 7.18 (d, *J* = 8.5 Hz, 2H), 7.14-7.04 (m, 4H), 4.67 (d, *J* = 2.4 Hz, 1H), 4.21 (dd, *J* = 11.4, 4.1 Hz, 1H), 3.75 (ddd, *J* = 12.7, 11.4, 2.4 Hz, 1H), 3.12 (dt, *J* = 12.7, 4.5 Hz, 1H), 2.78 (dd, *J* = 17.1, 4.5 Hz, 1H), 2.68-2.53 (m, 1H), 2.15-2.01 (m, 1H), 1.95-1.85 (m, 1H), 1.83-1.74 (m, 1H), 1.72-1.68 (m, 1H), 1.31-1.17 (m, 1H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 140.8 (C), 140.5 (C), 136.1 (C), 131.2 (2 × CH), 129.2 (CH), 128.7 (CH), 127.4 (2 × CH), 126.3 (CH), 125.9 (CH), 120.6 (C), 81.1 (CH), 68.9 (CH_2), 39.7 (CH), 39.6 (CH), 31.4 (CH_2), 29.3 (CH_2), 16.8 (CH_2) ppm.


7.48
7.46
7.20
7.19
7.14
7.14
7.12
7.11
7.06
7.04
4.67
4.66
4.22
4.21
4.20
4.19
3.77
3.77
3.75
3.75
3.75
3.73
3.72
3.14
3.13
3.12
3.11
3.10
3.10
2.80
2.79
2.76
2.75
2.65
2.62
2.61
2.59
2.57
2.09
2.08
2.08
2.06
2.06
2.05
1.92
1.90
1.89
1.86
1.81
1.79
1.78
1.72
1.71
1.69
1.68
1.26
1.25
1.23
Br
H
H
O
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.04
2.14
4.11
1.00
1.01
1.04
1.00
1.03
1.12
1.01
1.05
1.07
1.07
1.16


140.81
140.58
136.10
131.29
129.22
128.75
127.46
126.23
125.90
120.63
81.18
77.41
77.16
76.91
68.94
39.72
39.63
31.47
29.31
16.83
Br
H
H
O
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

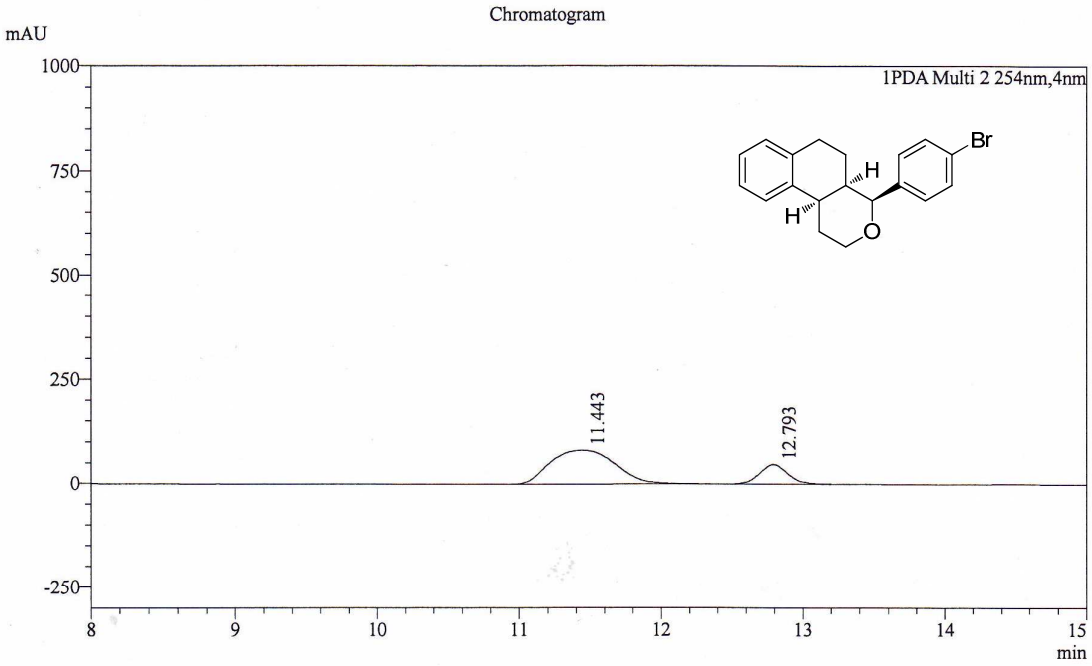
Chiralpak IC Heptane/*i*PrOH = 99/1, 0.5 mL/min, 254 nm



Peak Table

PDA Ch2 254nm

Peak#	Ret. Time	Height	Area	Area%
1	10.081	579997	7697840	52.387
2	10.990	501916	6996326	47.613
Total		1081914	14694166	100.000

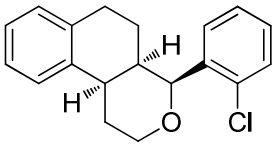


Peak Table

PDA Ch2 254nm

Peak#	Ret. Time	Height	Area	Area%
1	11.443	82007	2624817	79.569
2	12.793	47902	673987	20.431
Total		129909	3298804	100.000

(4*S*,4a*R*,10b*R*)-4-(2-chlorophenyl)-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene 5f

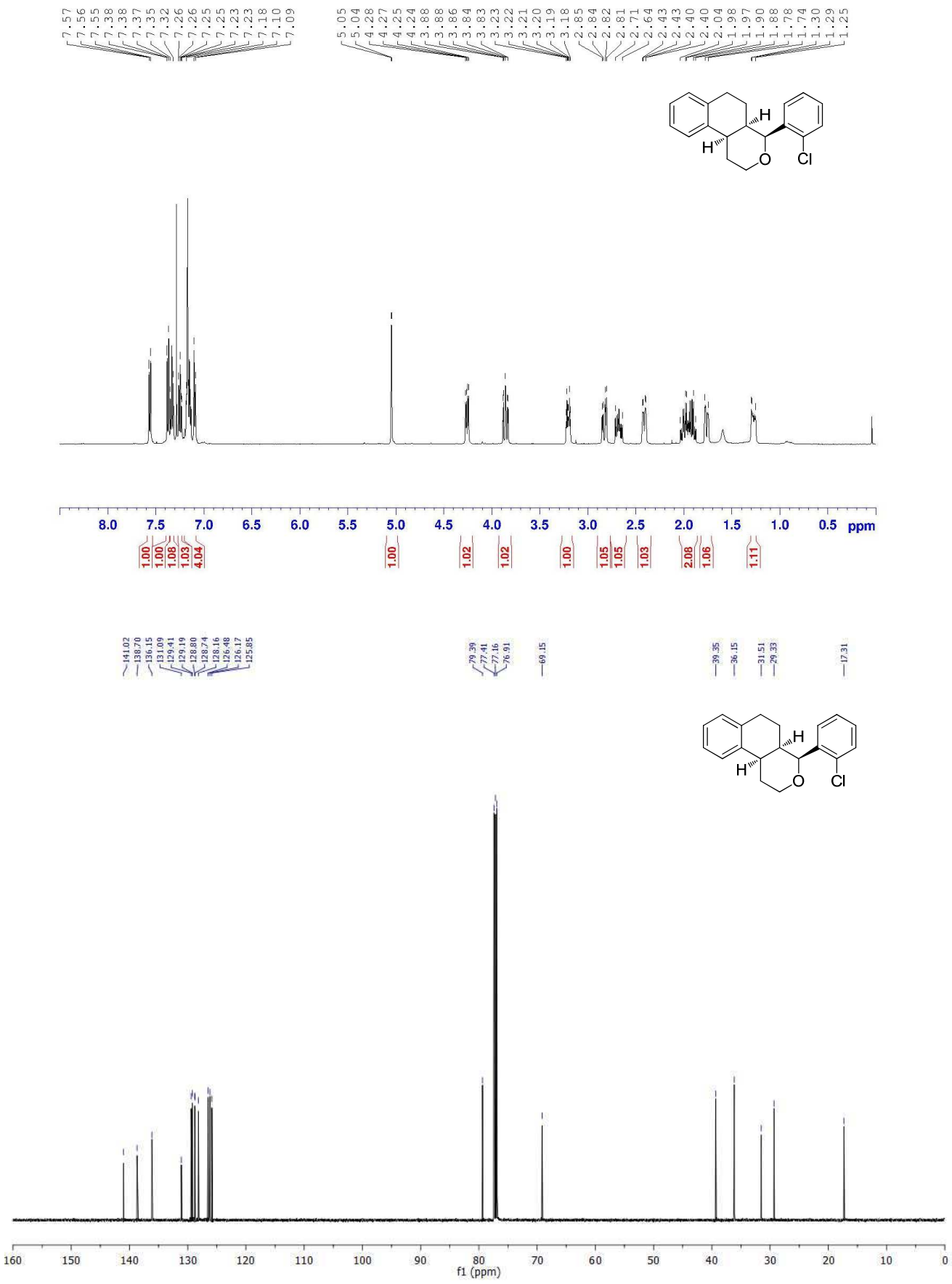


Obtained as a white solid,
18 mg, 62% yield, dr > 95:5;
M.p. 110-113 °C;
$[\alpha]^{23}_{D}$ +1.3 (c 1.4, $CHCl_3$);

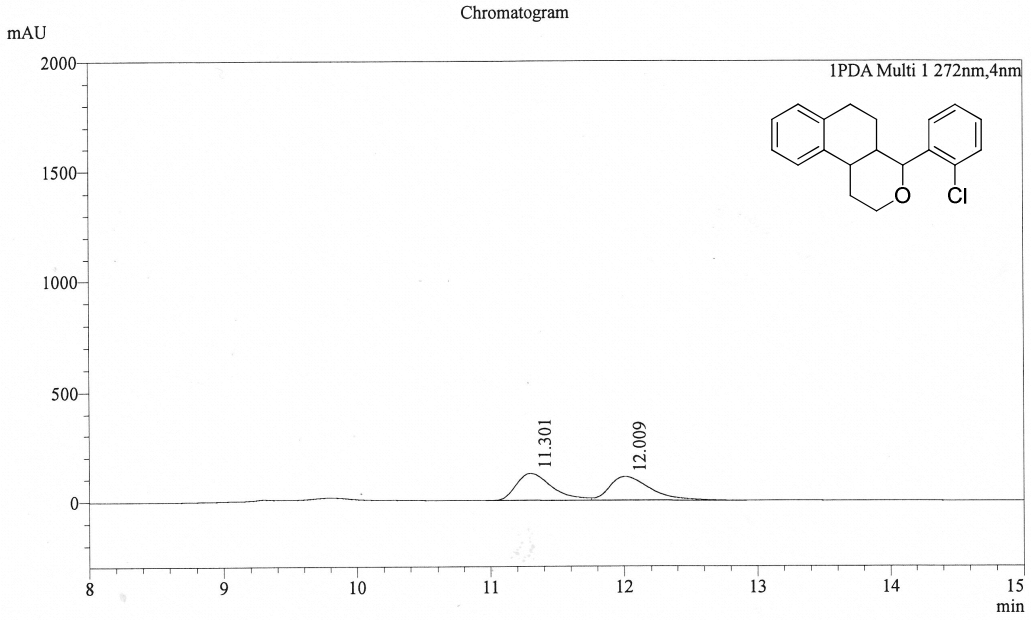
IR (neat, cm^{-1}) 2939, 2841, 1436, 1137, 1096, 1084, 1032, 1018, 759, 743, 705;
ESI-HRMS calculated for $C_{19}H_{20}ClO$ $[M+H]^+$ 299.12027, found 299.1187;
Chiral HPLC (Chiralpak IC, Heptane/*i*PrOH = 99/1, flow rate = 0.4 mL/min, 272 nm): major isomer: t_R = 11.2 min, minor isomer: t_R = 11.9 min, 72:28 e.r.;

^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.56 (dd, *J* = 7.7, 1.4 Hz, 1H), 7.38 (dd, *J* = 7.9, 1.1 Hz, 1H), 7.35-7.32 (m, 1H), 7.25 (td, *J* = 7.7, 1.4 Hz, 1H), 7.18-7.09 (m, 4H), 5.04 (d, *J* = 2.3 Hz, 1H), 4.26 (dd, *J* = 11.4, 4.5 Hz, 1H), 3.86 (td, *J* = 12.8, 2.4 Hz, 1H), 3.21 (dt, *J* = 12.3, 4.5 Hz, 1H), 2.83 (dd, *J* = 17.1, 5.1 Hz, 1H), 2.71-2.64 (m, 1H), 2.43-2.40 (m, 1H), 2.04-1.88 (m, 2H), 1.78-1.74 (m, 1H), 1.30-1.25 (m, 1H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 141.0 (C), 138.7 (C), 136.1 (C), 131.0 (C), 129.4 (CH), 129.1 (CH), 128.8 (CH), 128.7 (CH), 128.1 (CH), 126.4 (CH), 126.1 (CH), 125.8 (CH), 79.3 (CH), 69.1 (CH_2), 39.5 (CH), 36.1 (CH), 31.5 (CH_2), 29.3 (CH_2), 17.3 (CH_2) ppm.


7.57 7.56 7.55 7.38 7.38 7.37 7.35 7.32 7.26 7.26 7.25 7.25 7.23 7.23 7.18 7.10 7.09
5.05 5.04 4.28 4.27 4.25 4.24 3.88 3.88 3.86 3.84 3.83 3.23 3.22 3.21 3.20 3.19 3.18 2.85 2.84 2.82 2.81 2.71 2.64 2.43 2.43 2.40 2.40 2.04 1.98 1.97 1.90 1.88 1.78 1.74 1.30 1.29 1.25
H
H
O
Cl
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
1.00 1.00 1.08 1.03 4.04 1.00 1.02 1.02 1.00 1.05 1.05 1.03 2.08 1.06 1.11
141.02 138.70 136.15 131.09 129.41 129.19 128.80 128.74 128.16 126.48 126.17 125.85
79.39 77.41 77.16 76.91 69.15 39.35 36.15 31.51 29.33 17.31
H
H
O
Cl
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

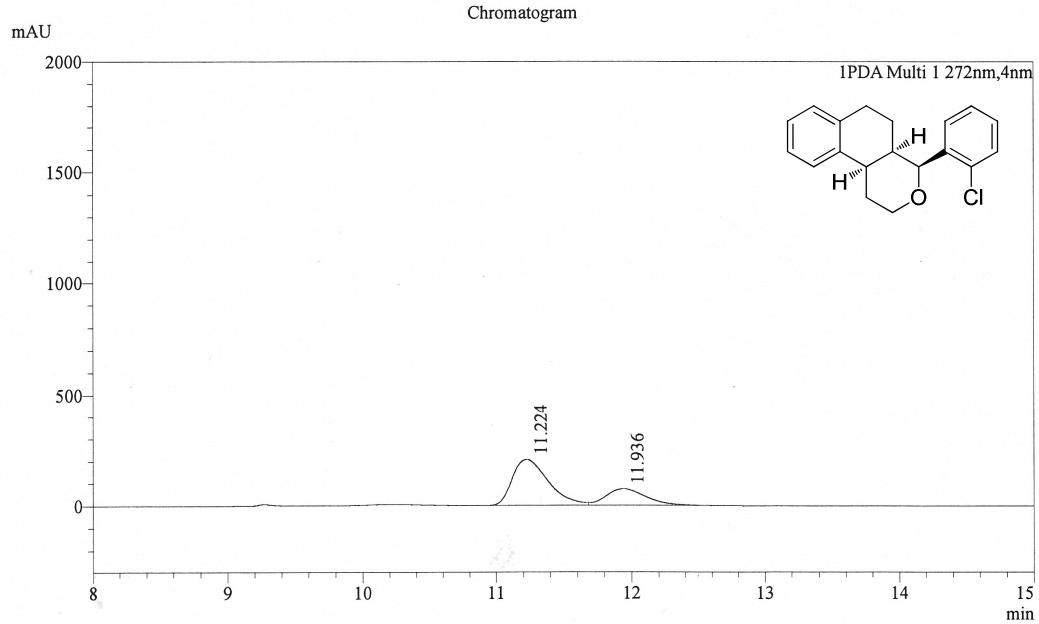
Chiralpak IC, Heptane/*i*PrOH = 99/1, 0.4 mL/min, 272 nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	11.301	122333	2279519	50.141
2	12.009	107505	2266731	49.859
Total		229838	4546250	100.000

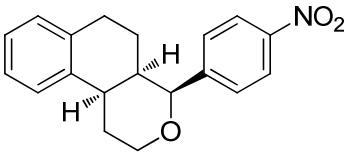


Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	11.224	207032	3842130	71.528
2	11.936	74245	1529393	28.472
Total		281277	5371523	100.000

(4*S*,4a*R*,10b*R*)-4-(4-nitrophenyl)-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene 5g

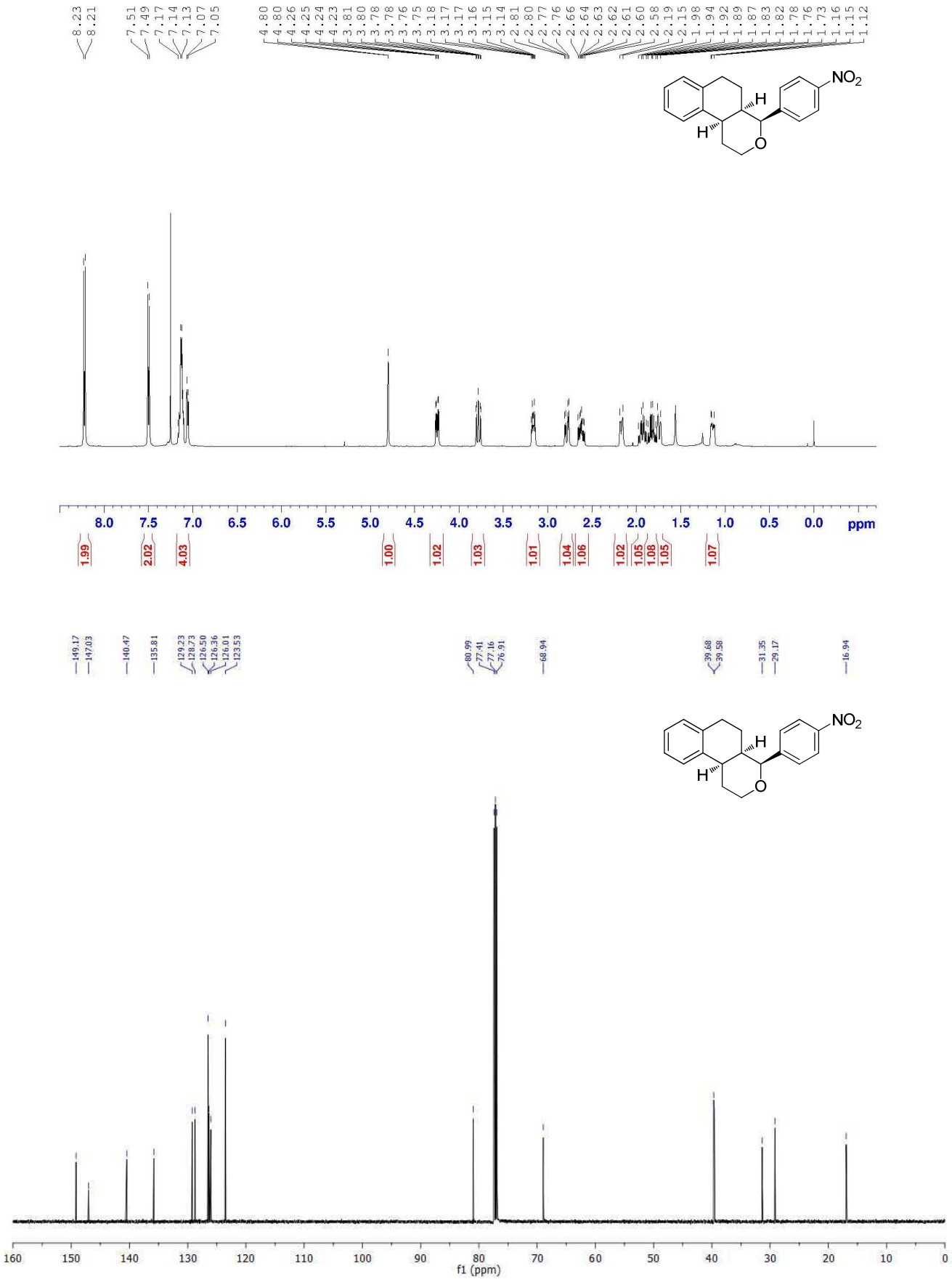


Obtained as a yellow solid,
19 mg, 63% yield, dr > 95:5;
M.p. 185-188 °C;
$[\alpha]^{23}_{D}$ -0.8 (c 0.7, $CHCl_3$);

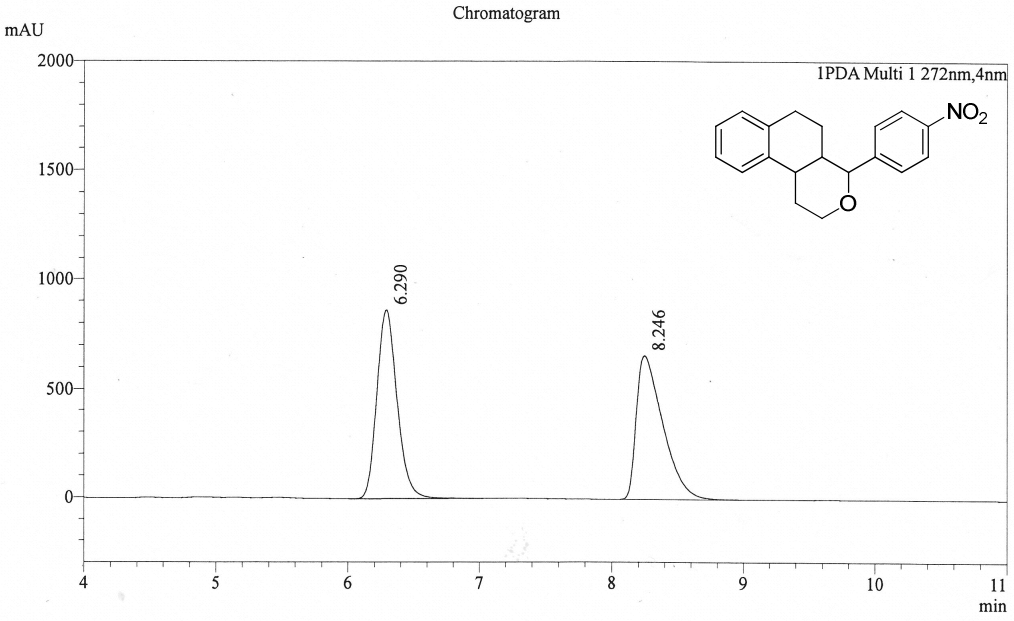
IR (neat, cm^{-1}) 2938, 2848, 1513, 1340, 1097, 1087, 874, 759, 738, 710;
ESI-HRMS calculated for $C_{19}H_{20}NO_3$ $[M+H]^+$ 310.14432, found 310.1440;
Chiral HPLC (Chiralpak IA, Heptane/*i*PrOH = 90/10, flow rate = 1 mL/min, 272 nm): major isomer: t_R = 6.3 min, minor isomer: t_R = 8.3 min, 67:33 e.r.;

^{1}H NMR (500 MHz, $CDCl_3$) δ = 8.22 (d, *J* = 8.5 Hz, 2H), 7.50 (d, *J* = 8.5 Hz, 2H), 7.17-7.05 (m, 4H), 4.80 (d, *J* = 2.4 Hz, 1H), 4.25 (dd, *J* = 11.5, 4.3 Hz, 1H), 3.81-3.75 (m, 1H), 3.17 (dt, *J* = 12.1, 4.3 Hz, 1H), 2.79 (dd, *J* = 17.1, 5.0 Hz, 1H), 2.66-2.58 (m, 1H), 2.19-2.15 (m, 1H), 1.98-1.89 (m, 1H), 1.87-1.78 (m, 1H), 1.76-1.73 (m, 1H), 1.16-1.12 (m, 1H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 149.1 (C), 147.3 (C), 140.4 (C), 135.8 (C), 129.2 (CH), 128.7 (CH), 126.5 (2 × CH), 126.3 (CH), 126.0 (CH), 123.5 (2 × CH), 80.9 (CH), 68.9 (CH_2), 39.6 (CH), 39.5 (CH), 31.3 (CH_2), 29.1 (CH_2), 16.9 (CH_2) ppm.


8.23
8.21
7.51
7.49
7.17
7.14
7.13
7.07
7.05
4.80
4.80
4.26
4.25
4.24
4.23
3.81
3.80
3.78
3.78
3.76
3.75
3.18
3.17
3.17
3.16
3.15
3.14
2.81
2.80
2.77
2.76
2.66
2.64
2.63
2.62
2.61
2.60
2.58
2.19
2.15
1.98
1.94
1.92
1.89
1.87
1.83
1.82
1.78
1.76
1.73
1.16
1.15
1.12
NO2
H
H
O
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.99
2.02
4.03
1.00
1.02
1.03
1.01
1.04
1.06
1.02
1.05
1.08
1.05
1.07
149.17
147.03
140.47
135.81
129.23
128.73
126.50
126.36
126.01
123.53
80.99
77.41
77.16
76.91
68.94
39.68
39.58
31.35
29.17
16.94
NO2
H
H
O
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

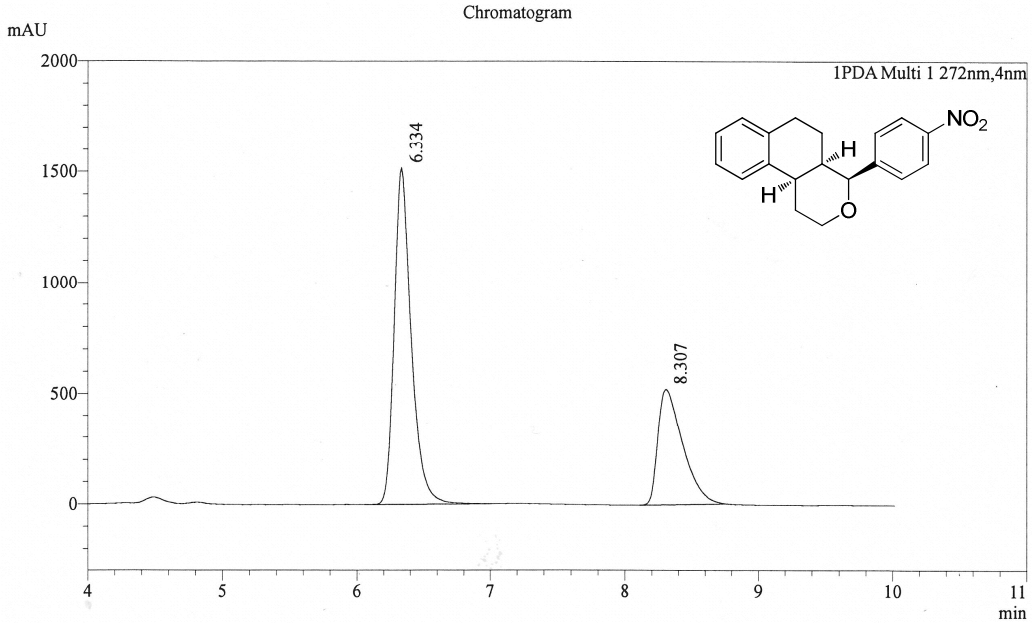
Chiralpak IA, Heptane/*i*PrOH = 99.0/10.0, 1 mL/min, 272 nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	6.290	865463	9323679	50.018
2	8.246	662801	9316861	49.982
Total		1528264	18640539	100.000



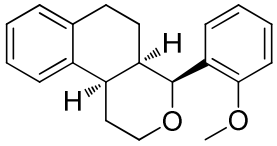
Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	6.334	1517671	13529053	66.615
2	8.307	523751	6780258	33.385
Total		2041421	20309312	100.000

(4*S*,4a*R*,10b*R*)-4-(2-methoxyphenyl)-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene

5h



Obtained as a white solid,

22 mg, 76% yield, dr > 95:5;

M.p. 112-115 °C;

$[\alpha]^{23}_{D}$ +6.3 (c 0.9, $CHCl_3$);

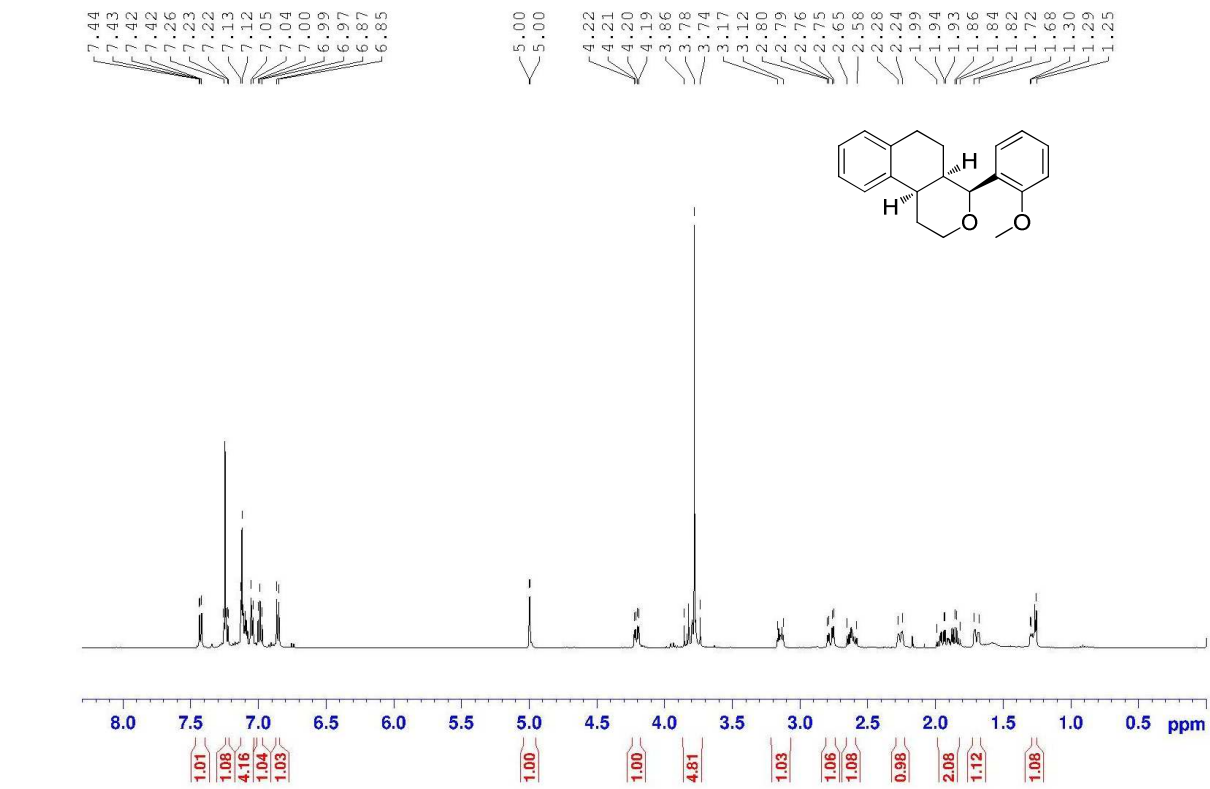
IR (neat, cm^{-1}) 2938, 2835, 1490, 1461, 1237, 1090, 1045, 1025, 750, 734;

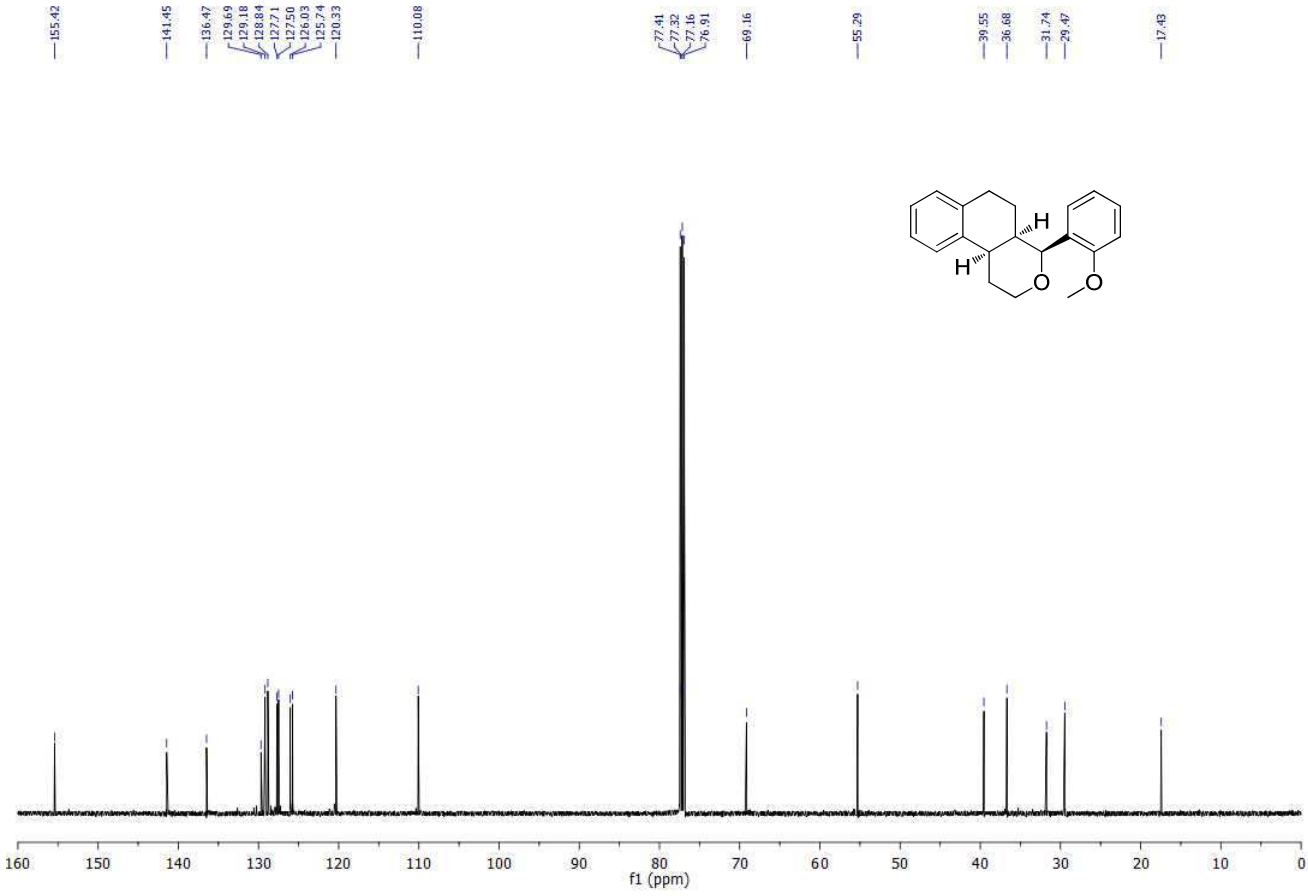
ESI-HRMS calculated for $C_{20}H_{23}O_2$ $[M+H]^+$ 295.16981, found 295.1697;

Chiral HPLC (Chiralpak IA, Heptane/*i*PrOH = 99.5/0.5, flow rate = 0.8 mL/min, 272 nm): minor isomer: t_R = 7.5 min, major isomer: t_R = 9.3 min, 41:59 e.r.;

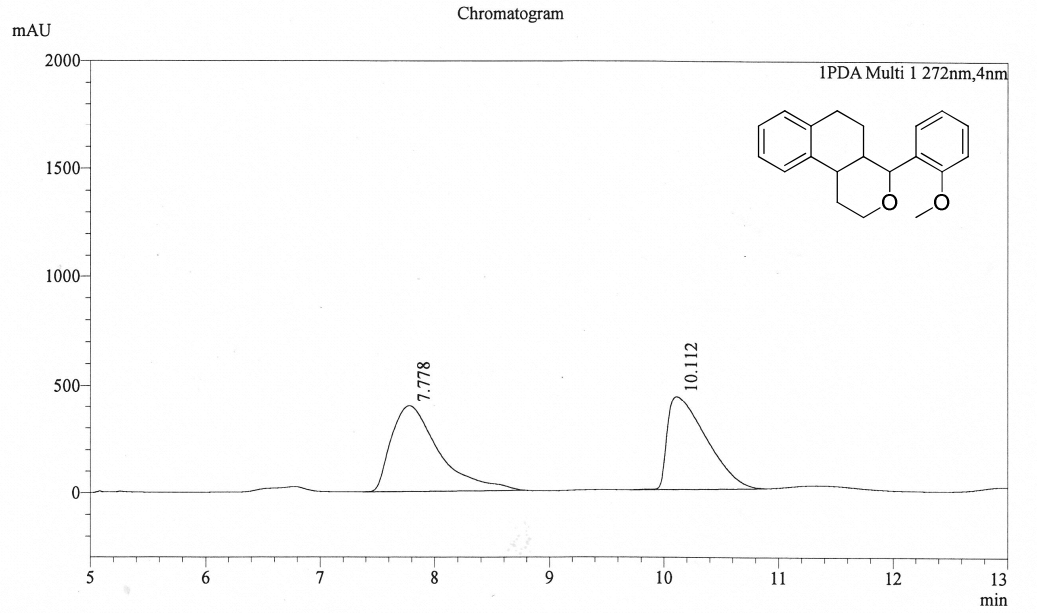
^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.43 (dd, *J* = 7.5, 1.3 Hz, 1H), 7.26-7.22 (m, 1H), 7.13-7.04 (m, 4H), 6.99 (t, *J* = 7.5 Hz, 1H), 6.86 (d, *J* = 8.1 Hz, 1H), 5.00 (d, *J* = 2.1 Hz, 1H), 4.21 (dd, *J* = 11.4, 4.4 Hz, 1H), 3.86-3.74 (m, 1H), 3.78 (s, 3H), 3.17-3.12 (m, 1H), 2.77 (dd, *J* = 17.1, 4.4 Hz, 1H), 2.65-2.58 (m, 1H), 2.28-2.24 (m, 1H), 1.99-1.82 (m, 2H), 1.72-1.68 (m, 1H), 1.30-1.25 (m, 1H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 155.4 (C), 141.5 (C), 136.4 (C), 129.6 (C), 129.1 (CH), 128.8 (CH), 127.7 (CH), 127.5 (CH), 126.0 (CH), 125.7 (CH), 120.3 (CH), 110.0 (CH), 77.3 (CH), 69.1 (CH_2), 55.2 (CH_3), 39.5 (CH), 36.6 (CH), 31.7 (CH_2), 29.4 (CH_2), 17.4 (CH_2) ppm.


7.44
7.43
7.42
7.42
7.26
7.23
7.22
7.13
7.12
7.05
7.04
7.00
6.99
6.97
6.87
6.85
5.00
5.00
4.22
4.21
4.20
4.19
3.86
3.78
3.74
3.17
3.12
2.80
2.79
2.76
2.75
2.65
2.58
2.28
2.24
1.99
1.94
1.93
1.86
1.84
1.82
1.72
1.68
1.30
1.29
1.25
H
H
O
O
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.01
1.08
4.16
1.04
1.03
1.00
1.00
4.81
1.03
1.06
1.08
0.98
2.08
1.12
1.08


155.42
141.45
136.47
129.69
129.18
128.84
127.71
127.50
126.03
125.74
120.33
110.08
77.41
77.32
77.16
76.91
69.16
55.29
39.55
36.68
31.74
29.47
17.43
H
H
O
O
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

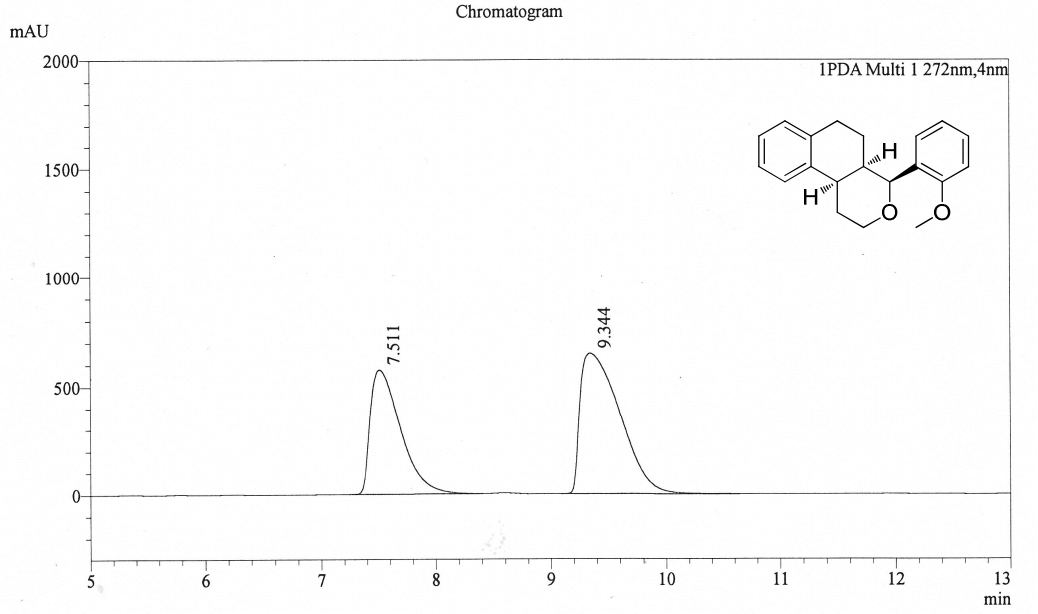
Chiralpak IA, Heptane/*i*PrOH = 99.5/0.5, 0.8 mL/min, 272 nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	7.778	397542	11496384	53.091
2	10.112	434986	10157657	46.909
Total		832528	21654041	100.000

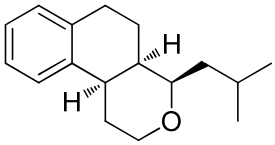


Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	7.511	574612	10667723	40.764
2	9.344	647273	15501789	59.236
Total		1221885	26169511	100.000

(4*R*,4a*R*,10b*R*)-4-isobutyl-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene 5i

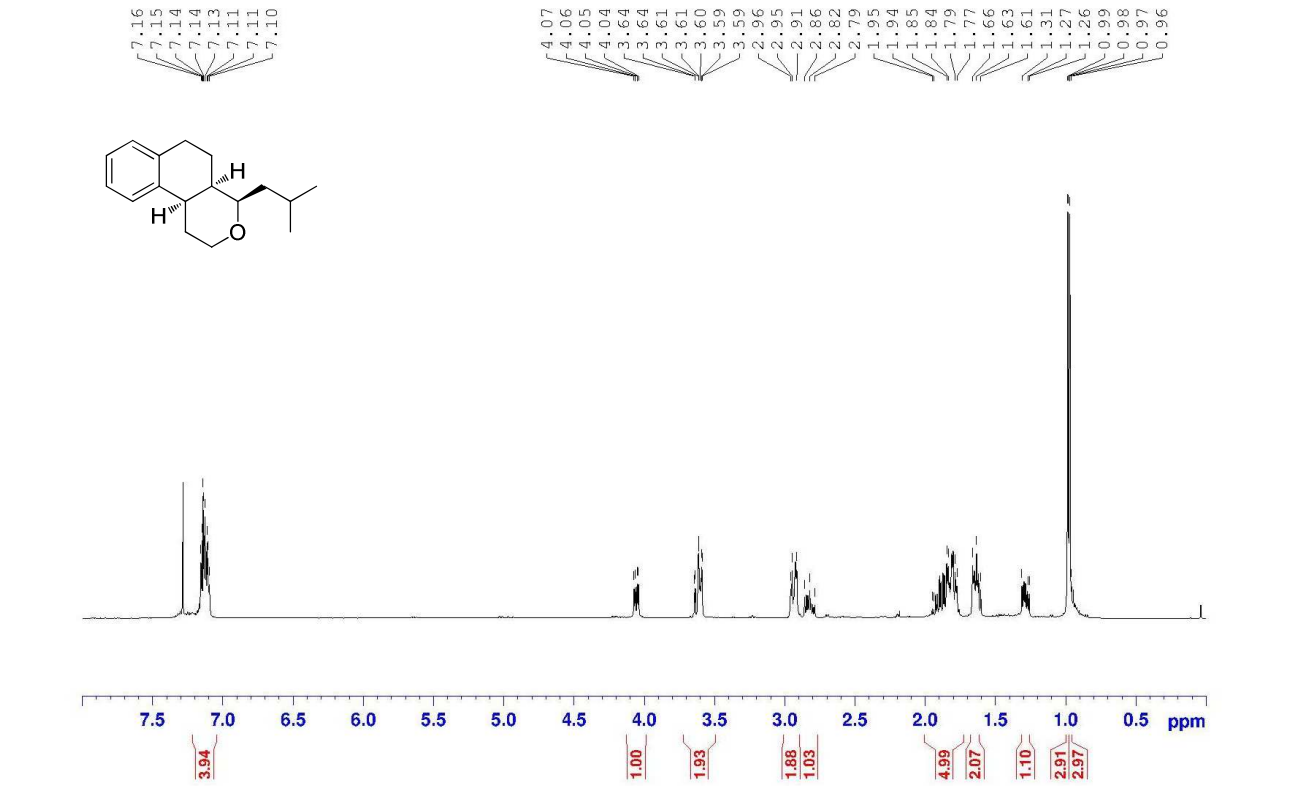


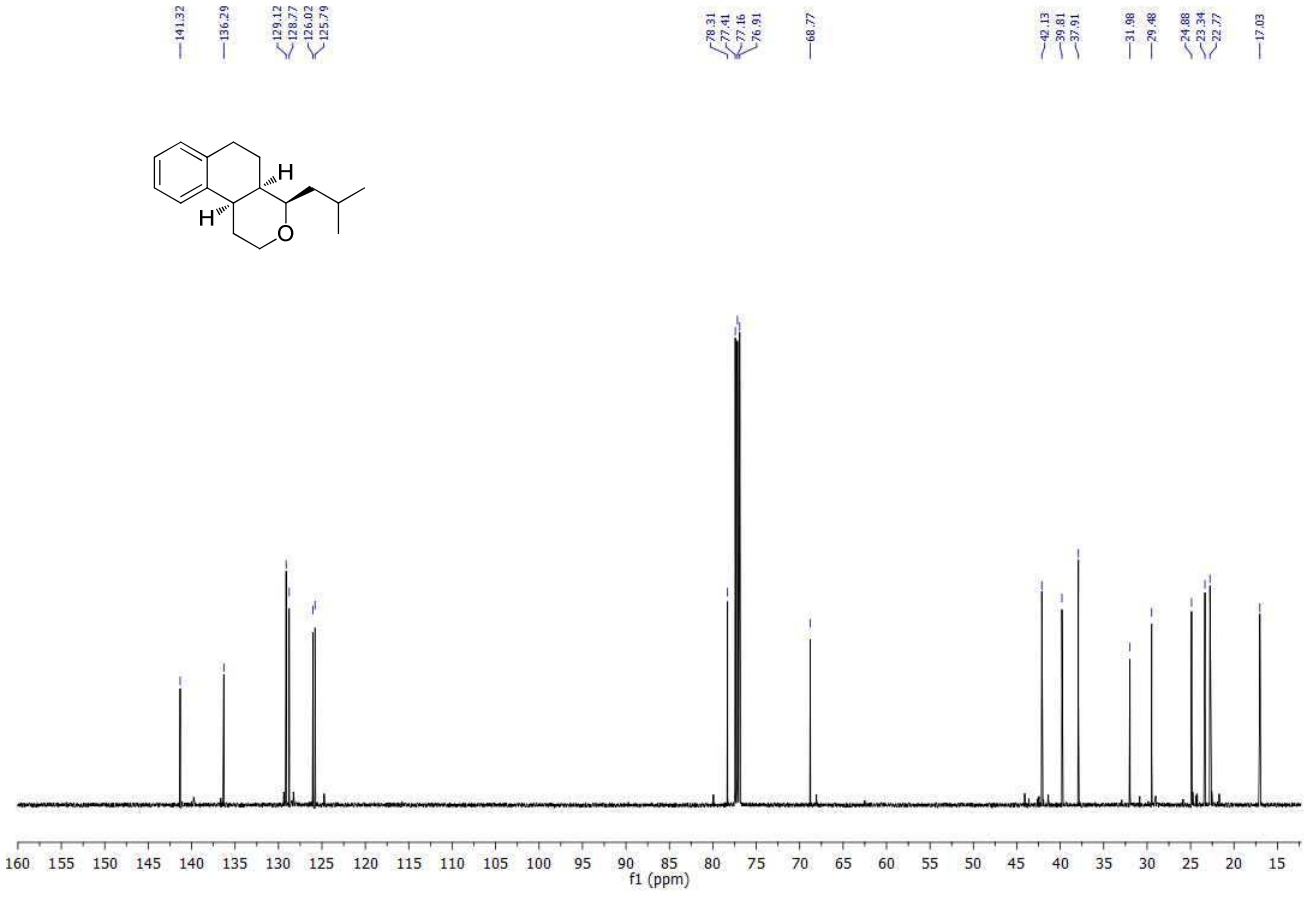
Obtained as a colorless liquid,
15 mg, 63% yield, dr > 95:5;
[α]$^{23}_{D}$ +2.6 (c 1.2, $CHCl_3$);

IR (neat, cm^{-1}) 2950, 2867, 1463, 1368, 1098, 1086, 764, 741;
ESI-HRMS calculated for $C_{17}H_{25}O$ $[M+H]^+$ 245.19054, found 245.1905;
Chiral HPLC (Chiralpak IC, Heptane/*i*PrOH = 99.5/0.5, flow rate = 0.2 mL/min, 272 nm): minor isomer: t_R = 22.4 min, major isomer: t_R = 23.3 min, 35:65 e.r.;

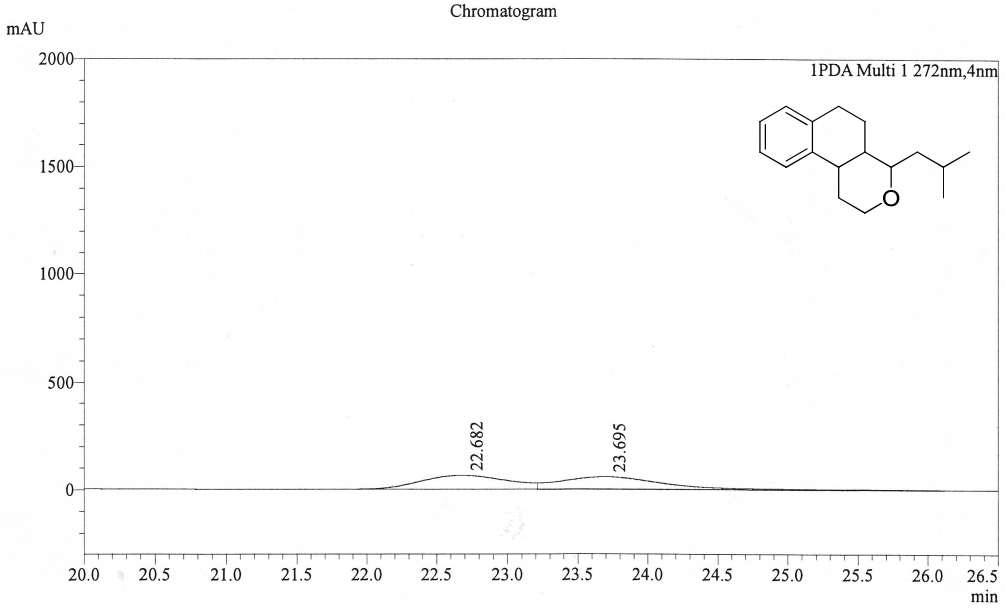
^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.16-7.10 (m, 4H), 4.05 (dd, *J* = 11.3, 4.3 Hz, 1H), 3.64-3.59 (m, 2H), 2.96-2.91 (m, 2H), 2.86-2.79 (m, 1H), 1.95-1.77 (m, 5H), 1.66-1.61 (m, 2H), 1.31-1.26 (m, 1H), 0.98 (d, *J* = 1.1 Hz, 3H), 0.96 (d, *J* = 1.1 Hz, 3H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 141.3 (C), 136.2 (C), 129.1 (CH), 128.7 (CH), 128.1 (CH), 126.0 (CH), 125.7 (CH), 78.3 (CH), 68.7 (CH_2), 42.1 (CH_2), 39.8 (CH), 37.9 (CH), 31.9 (CH_2), 29.4 (CH_2), 24.8 (CH), 23.3 (CH_3), 22.7 (CH_3), 17.0 (CH_2) ppm.


7.16
7.15
7.14
7.14
7.13
7.11
7.11
7.10
4.07
4.06
4.05
4.04
3.64
3.64
3.61
3.61
3.60
3.59
3.59
2.96
2.95
2.91
2.86
2.82
2.79
1.95
1.94
1.85
1.84
1.79
1.77
1.66
1.63
1.61
1.31
1.27
1.26
0.99
0.98
0.97
0.96
H
H
O
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.94
1.00
1.93
1.88
1.03
4.99
2.07
1.10
2.91
2.97


141.32
136.29
129.12
128.77
126.02
125.79
78.31
77.41
77.16
76.91
68.77
42.13
39.81
37.91
31.98
29.48
24.88
23.34
22.77
17.03
H
H
O
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
f1 (ppm)

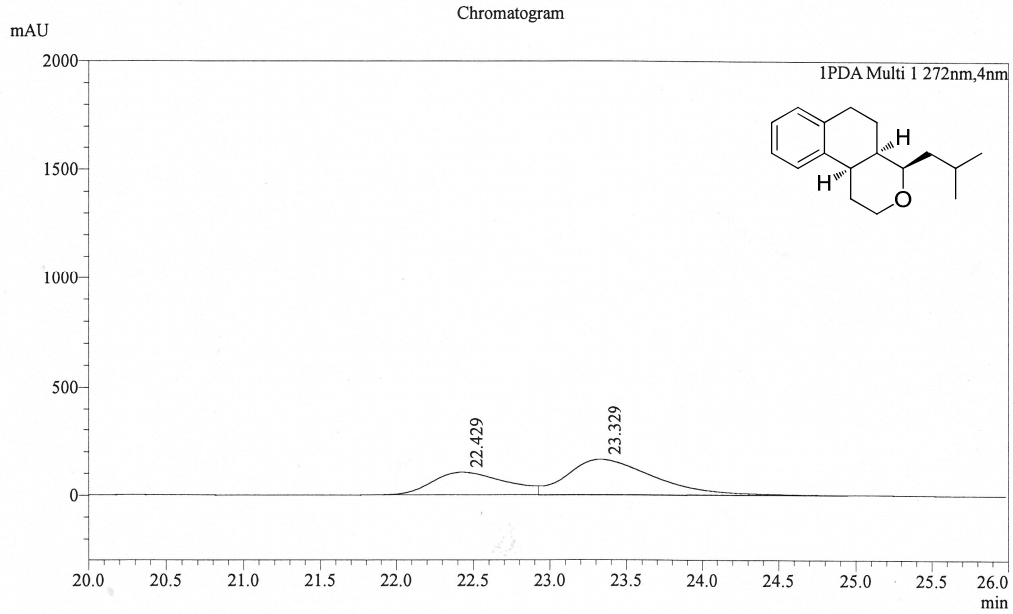
Chiralpak IC, Heptane/*i*PrOH = 99.5/0.5, 0.2 mL/min, 272 nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	22.682	63819	2749846	48.152
2	23.695	56695	2960922	51.848
Total		120514	5710768	100.000

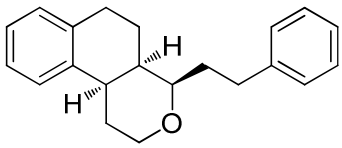


Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	22.429	104374	3487382	35.149
2	23.329	163020	6434464	64.851
Total		267395	9921846	100.000

(4*R*,4a*R*,10b*R*)-4-phenethyl-2,4,4a,5,6,10b-hexahydro-1H-benzo[f]isochromene 5j

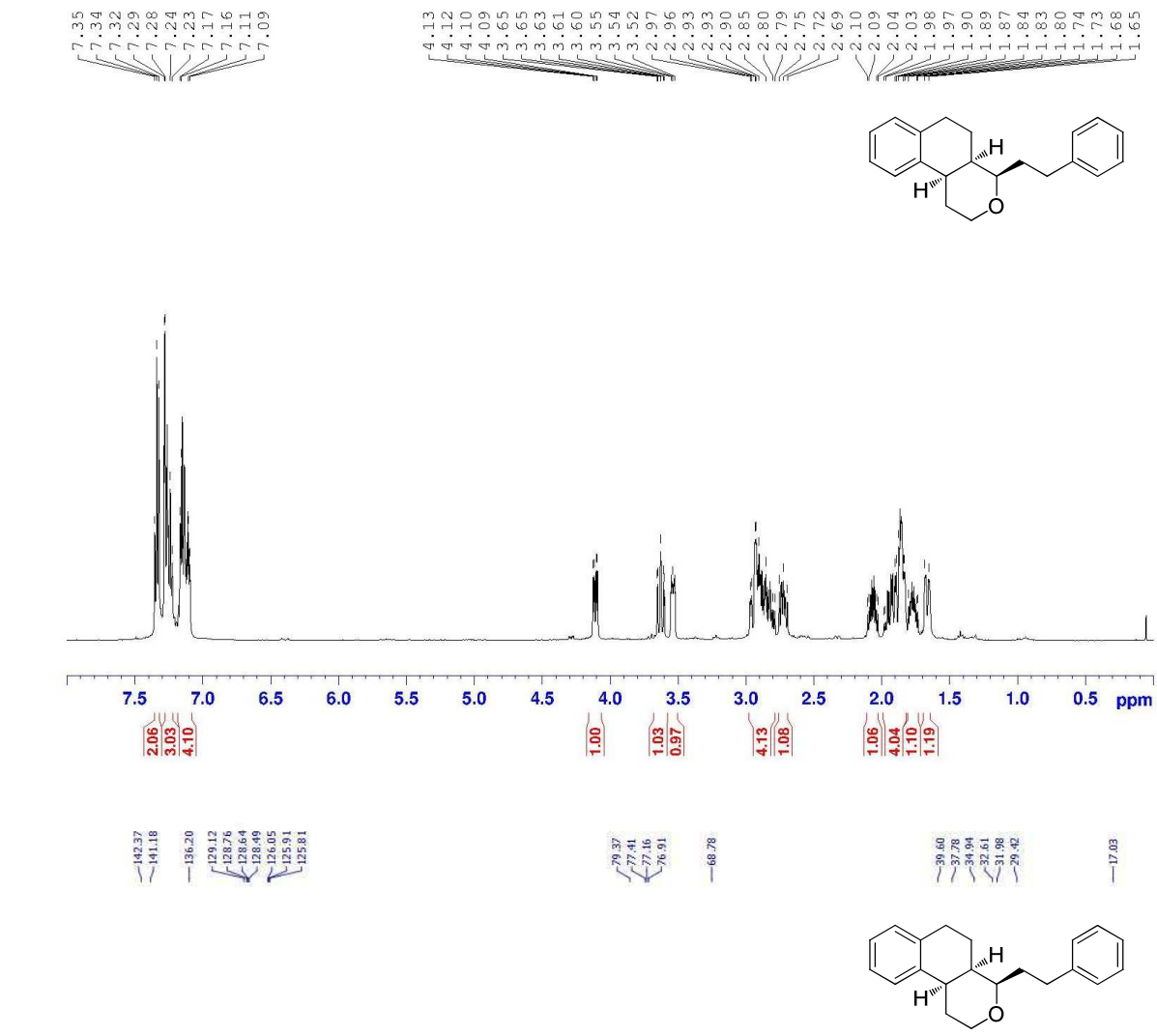


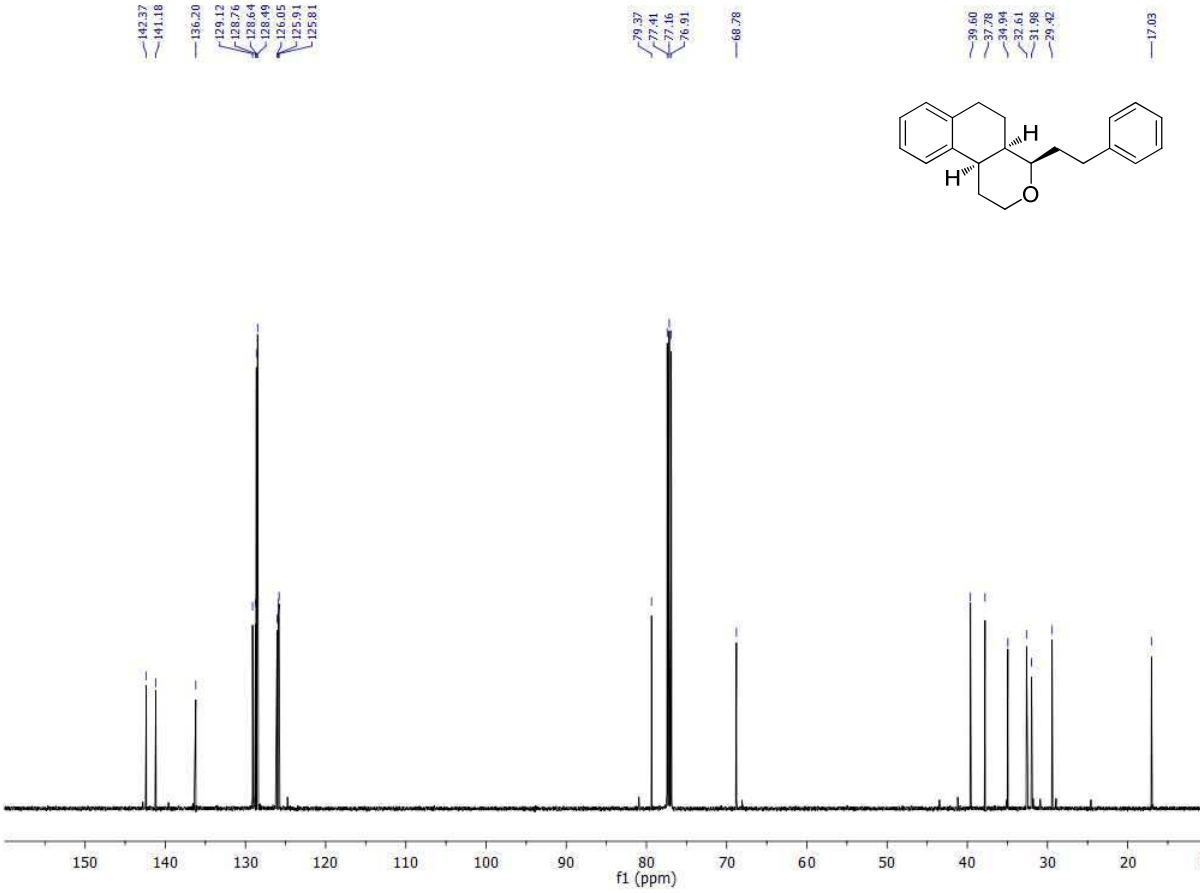
Obtained as a white solid,
21 mg, 72% yield, dr > 95:5;
M.p. 96-99 °C;
[α]$^{23}_{D}$ +0.4 (c 1.1, $CHCl_3$);

IR (neat, cm^{-1}) 3024, 2939, 1736, 1493, 1453, 1369, 1085, 740, 698;
ESI-HRMS calculated for $C_{21}H_{25}O$ $[M+H]^+$ 293.19054, found 293.1901;
Chiral HPLC (Chiralpak IC, Heptane/*i*PrOH = 99/1, flow rate = 0.3 mL/min, 272 nm): minor isomer: t_R = 21.9 min, major isomer: t_R = 22.6 min, 40:60 e.r.;

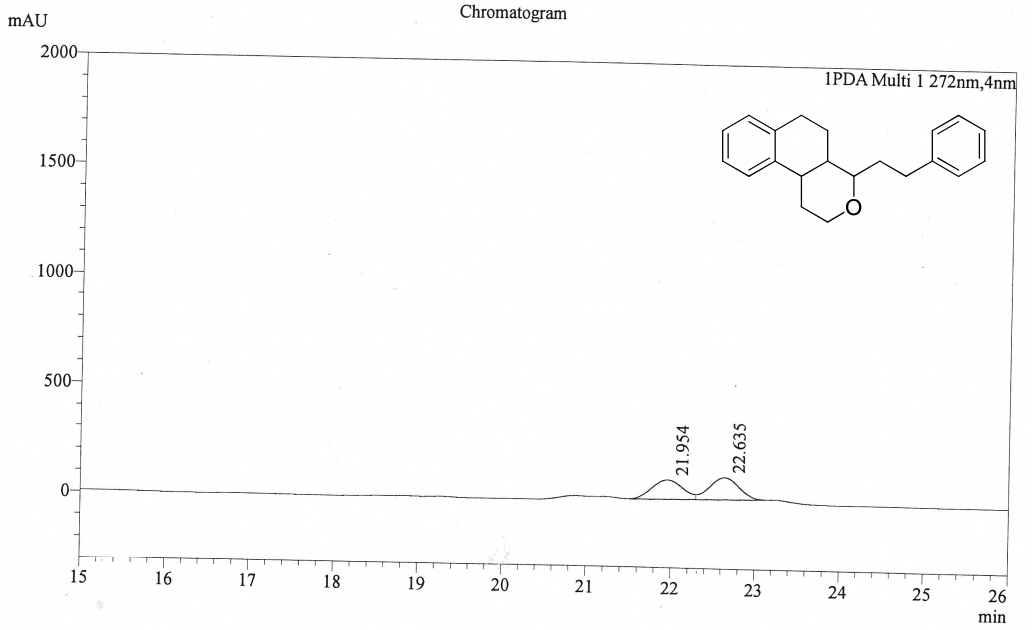
^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.34 (t, *J* = 7.5 Hz, 2H), 7.29-7.23 (m, 3H), 7.17-7.09 (m, 4H), 4.11 (dd, *J* = 11.2, 4.4 Hz, 1H), 3.65-3.60 (m, 1H), 3.55-3.52 (m, 1H), 2.97-2.79 (m, 4H), 2.75-2.69 (m, 1H), 2.10-2.03 (m, 1H), 1.98-1.83 (m, 4H), 1.80-1.73 (m, 1H), 1.68-1.65 (m, 1H) ppm;

^{13}C NMR (125 MHz, $CDCl_3$) δ = 142.3 (C), 141.1 (C), 136.2 (C), 129.1 (CH), 128.7 (CH), 128.6 (2 × CH), 128.4 (2 × CH), 126.0 (CH), 125.9 (CH), 125.8 (CH), 79.3 (CH), 68.7 (CH_2), 39.6 (CH), 37.7 (CH), 34.9 (CH_2), 32.6 (CH_2), 31.9 (CH_2), 29.4 (CH_2), 17.0 (CH_2) ppm.


7.35
7.34
7.32
7.29
7.28
7.24
7.23
7.17
7.16
7.11
7.09
4.13
4.12
4.10
4.09
3.65
3.65
3.63
3.61
3.60
3.55
3.54
3.52
2.97
2.96
2.93
2.93
2.90
2.85
2.80
2.79
2.75
2.72
2.69
2.10
2.09
2.04
2.03
1.98
1.97
1.90
1.89
1.87
1.84
1.83
1.80
1.74
1.73
1.68
1.65
H
H
O
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.06
3.03
4.10
1.00
1.03
0.97
4.13
1.08
1.06
4.04
1.10
1.19


142.37
141.18
136.20
129.12
128.76
128.64
128.49
126.05
125.91
125.81
79.37
77.41
77.16
76.91
68.78
39.60
37.78
34.94
32.61
31.98
29.42
17.03
H
H
O
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

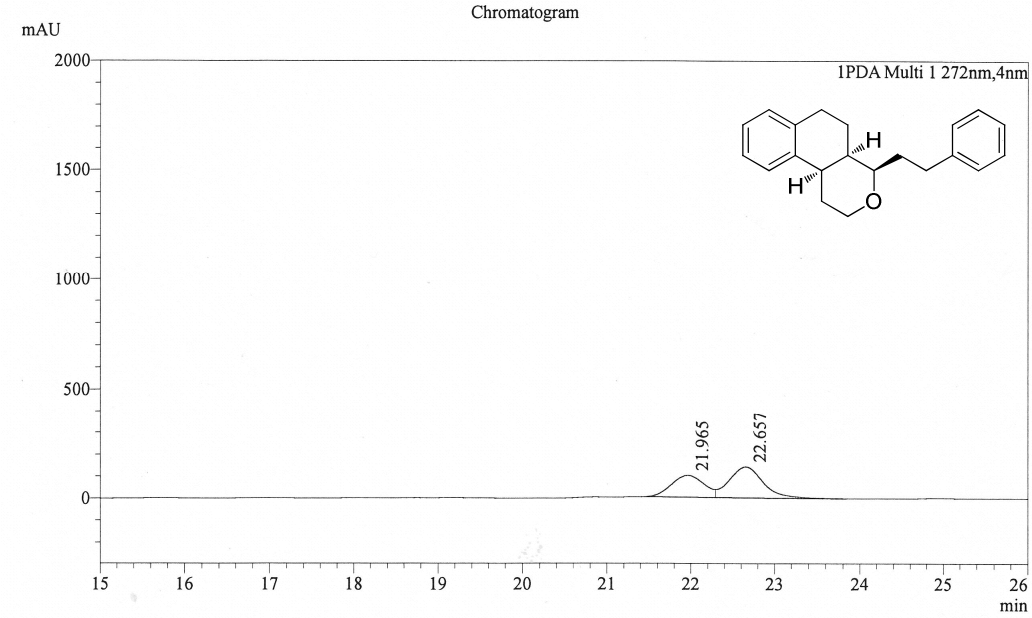
Chiralpak IC, Heptane/*i*PrOH = 99/1, 0.3 mL/min, 272 nm



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	21.954	87463	2206590	47.527
2	22.635	100138	2436241	52.473
Total		187601	4642831	100.000



Peak Table

PDA Ch1 272nm

Peak#	Ret. Time	Height	Area	Area%
1	21.965	99588	2714597	40.345
2	22.657	141773	4013835	59.655
Total		241362	6728432	100.000

IX - X-ray data for 5e

The crystal structure presented herein was solved from a colourless plate suitable to X-ray single crystal diffraction, obtained by slow diffusion of heptane in a dichloromethane solution.

Results for *compound 5e*: (C_{19} H_{19} Br O); M = 343.25. APEXII, Bruker-AXS diffractometer, Mo-Kα radiation (λ = 0.71073 Å), T = 150(2) K; orthorhombic *P* 2_1 2_1 2_1 (I.T.#19), a = 9.8879(6), b = 12.4088(9), c = 13.0415(9) Å, V = 1600.15(19) $Å^3$.Z = 4, d = 1.425 $g.cm^{-3}$, μ = 2.565 mm^{-1}. The structure was solved by direct methods using the *SIR97* program [1], and then refined with full-matrix least-square methods based on F^2 (*SHELXL-97*) [2] with the aid of the *WINGX* [3] program. All non-hydrogen atoms were refined with anisotropic atomic displacement parameters. H atoms were finally included in their calculated positions. A final refinement on F^2 with 3674 unique intensities and 190 parameters converged at ω$R(F^2)$ = 0.0663 ($R(F)$ = 0.0333) for 3181 observed reflections with $I > 2\sigma(I)$.

The scattering contribution from the bromide atom was exploited to assign the absolute configuration of the chiral centres, C7 (S), C11 (R), C12 (R), unambiguously from the value of the Flack parameter, [4] 0.000(7).

[1] A. Altomare, M. C. Burla, M. Camalli, G. Cascarano, C. Giacovazzo, A. Guagliardi, A. G. G. Moliterni, G. Polidori, R. Spagna, *J. Appl. Cryst.* (**1999**) *32*, 115-119.
[2] Sheldrick G.M., *Acta Cryst.* A64 (**2008**), 112-122.
[3] L. J. Farrugia, *J. Appl. Cryst.*, **2012**, *45*, 849-854.
[4] Flack, H. D. (**1983**) *Acta Crystallogr* A39, 876-881.

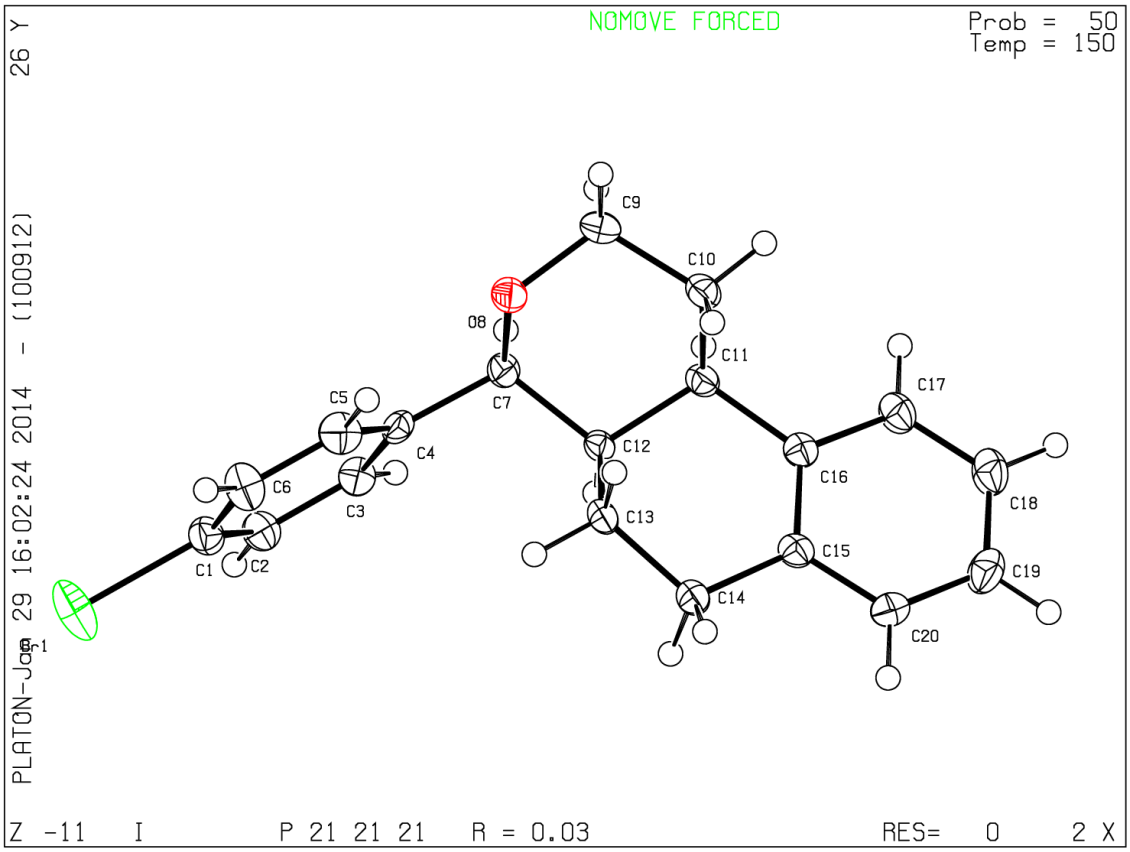


Figure ORTEP plot of (**5e**). Ellipsoids are drawn at the 50% probability.