Supplementary Information

Concise Enantioselective Synthesis of the Antimitotic (+)-2,3,9-Trimethoxypterocarpan via Asymmetric Transfer Hydrogenation

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Characterization of compounds

Table S1. Comparison of ^{1}H NMR data between natural product (–)-**1** and synthetic samples of the racemate and compound (+)-**1**

δ_H (–)-**1**[a,b]	δ_H (±)-**1**[b,c]	δ_H (+)-**1**[d,e]
Not reported	3.53 (m, 1H)	3.54 (ddd, *J* 11.1, 6.6, 4.6 Hz, 1H)
Not reported	3.59 (t, *J* 10.8 Hz, 1H)	3.63 – 3.57 (m, 1H)
3.78 (s, 3H)	3.77 (s, 3H)	3.77 (s, 3H)
3.86 (s, 3H)	3.86 (s, 3H)	3.86 (s, 3H)
3.91 (s, 3H)	3.90 (s, 3H)	3.90 (s, 3H)
Not reported	4.24 (m, 1H)	4.26-4.21 (m, 1H)
Not reported	5.49 (d, *J* 6.8 Hz, 1H)	5.50 (d, *J* 6.7 Hz)
6.44 (q, *J* 8.8 and 2.5 Hz, 1H) 6.45 (d, *J* 2.5 Hz, 1H)	6.45 (m, 2H)	6.48-6.44 (m, 2H)
6.47 (s, 1H)	6.49 (s, 1H)	6.49 (s, 1H)
6.97 (s, 1H)	6.98 (s, 1H)	6.98 (s, 1H)
7.12 (d, *J* 8.8 Hz, 1H)	7.13 (d, *J* 9.2 Hz, 1H)	7.13 (d, *J* 8.9 Hz, 1H)

[a]Data derived from reference 1; [b]spectrum recorded at 90 MHz in $CDCl_3$; [c]data derived from reference 2; [d]compound prepared during the current study; [e]spectrum recorded at 400 MHz in $CDCl_3$.

Table S2. Comparison of ^{13}C NMR data between synthetic compounds (±)-**1** and (+)-**1** synthesized in this work

δ_C (±)-**1**[a,b]	δ_C (+)-**1**[b,c]	$\Delta\delta_C$
39.8 (CH)	39.8	0
55.6 (CH_3)	55.6	0
56.0 (CH_3)	56.0	0
56.4 (CH_3)	56.4	0
66.8 (CH_2)	66.8	0
78.9 (CH)	78.9	0
97.0 (CH)	97.0	0
100.9 (CH)	100.9	0
106.4 (CH)	106.5	0.1
110.7 (C)	110.8	0.1
112.3 (CH)	112.3	0
119.2 (C)	119.2	0
124.9 (CH)	124.9	0
144.4 (C)	144.4	0
150.0 (C)	150.0	0
150.7 (C)	150.7	0
160.7 (C)	160.7	0
161.2 (C)	161.3	0.1

[a]Data derived from reference 2; [b]spectrum recorded at 90 MHz in $CDCl_3$; [c]compound prepared during the current study; [d]spectrum recorded at 126 MHz in $CDCl_3$.

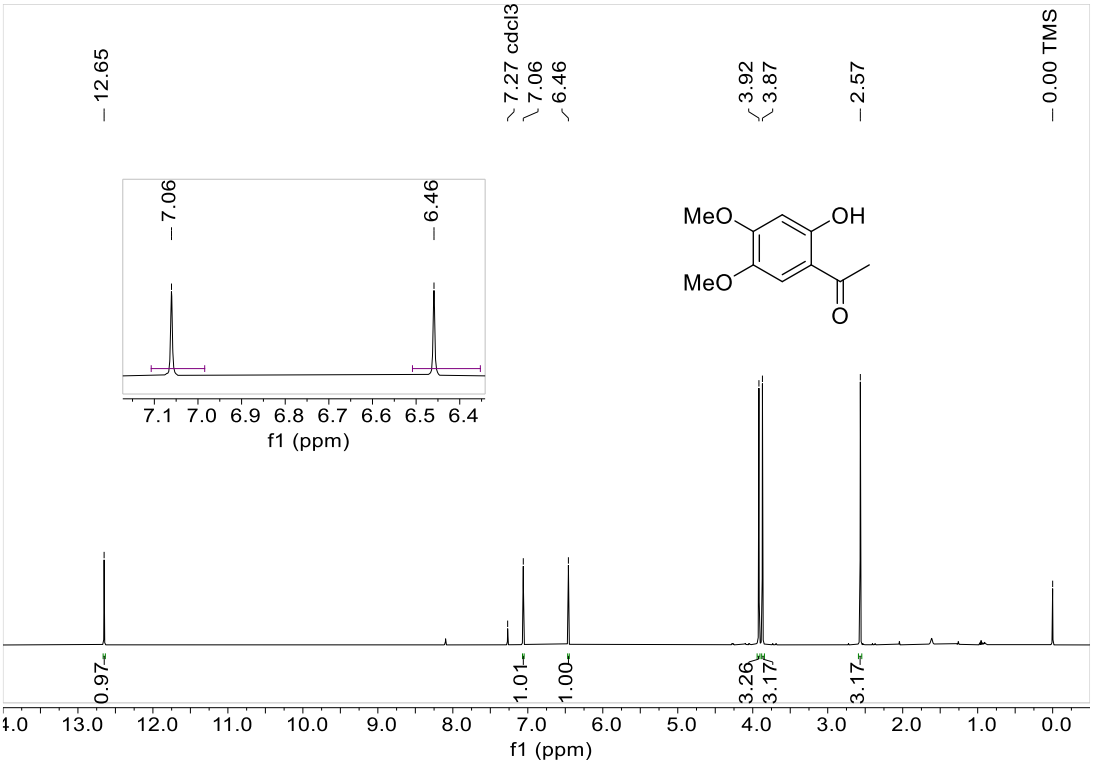


Figure S1. ^1H NMR spectrum (400 MHz, $CDCl_3$) of compound **12**.

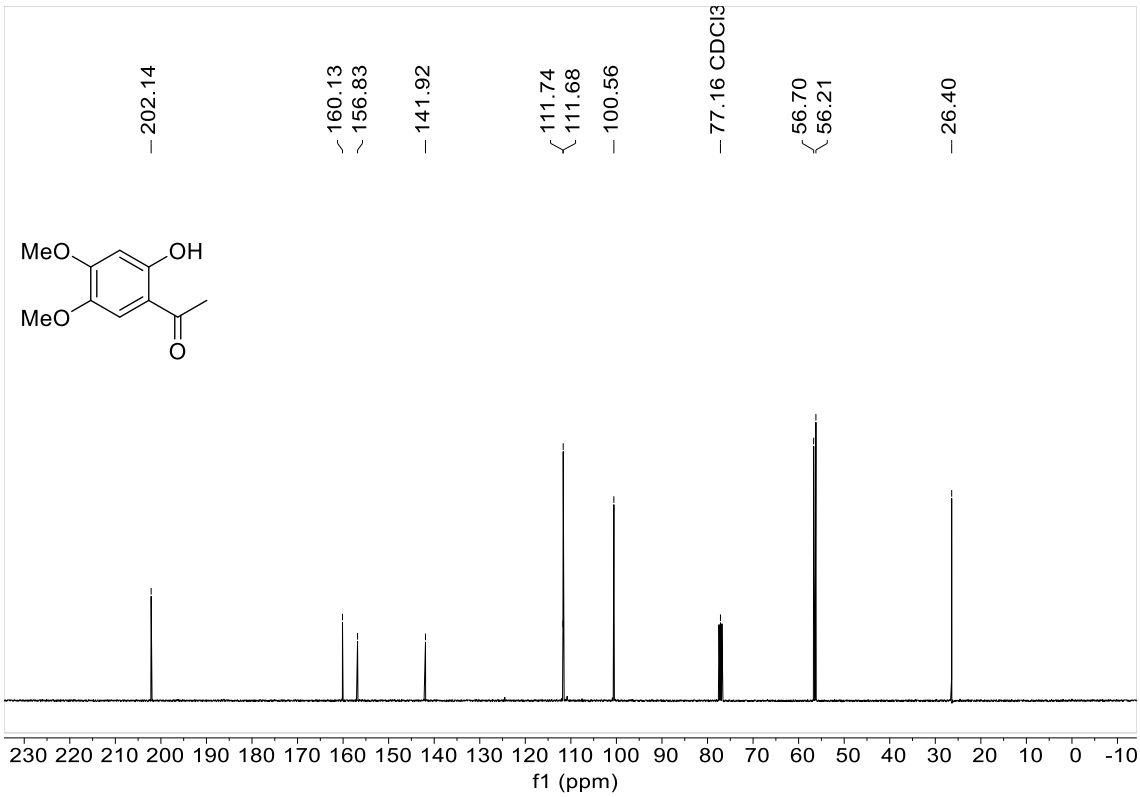


Figure S2. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **12**.

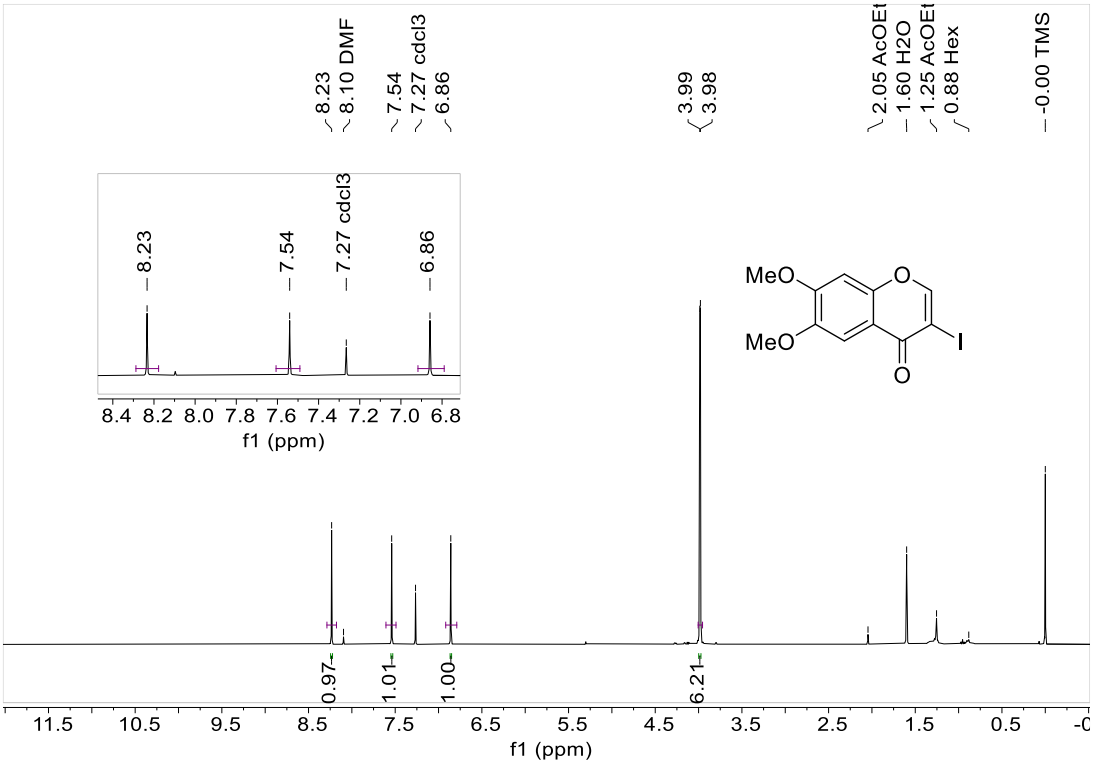


Figure S3. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **10**.

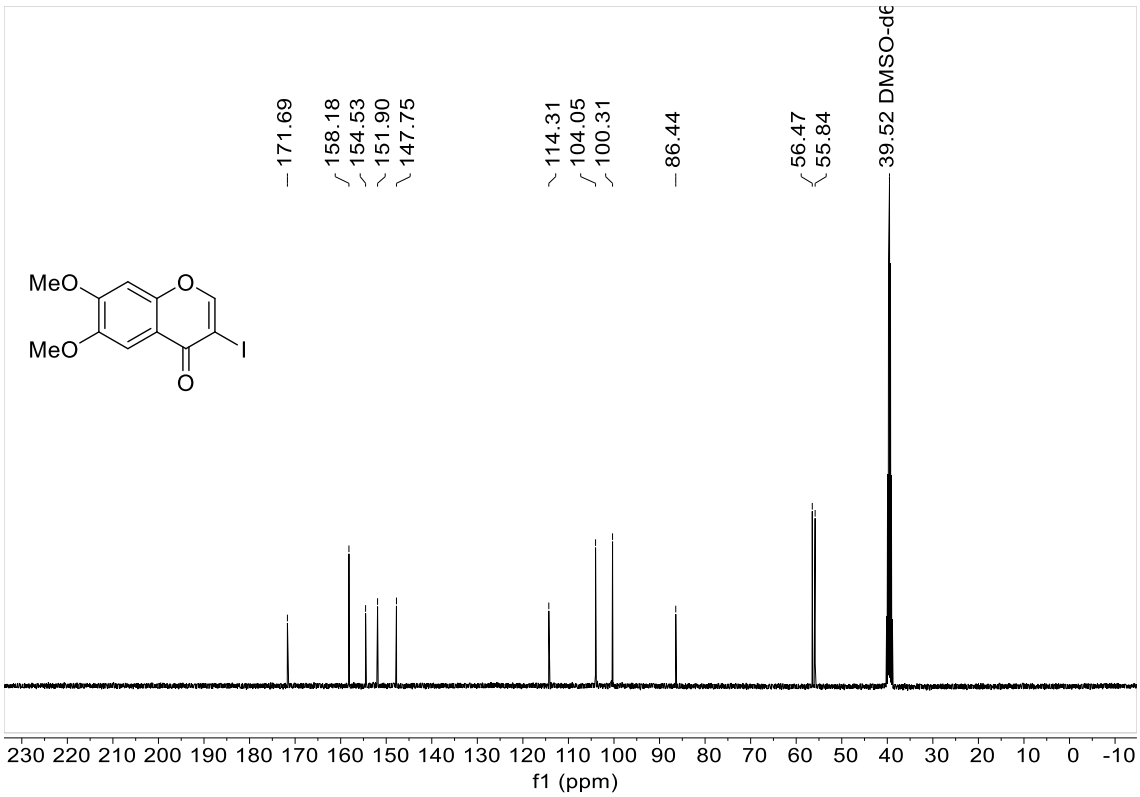


Figure S4. ^{13}C NMR spectrum (101 MHz, DMSO-d_6) of compound **10**.

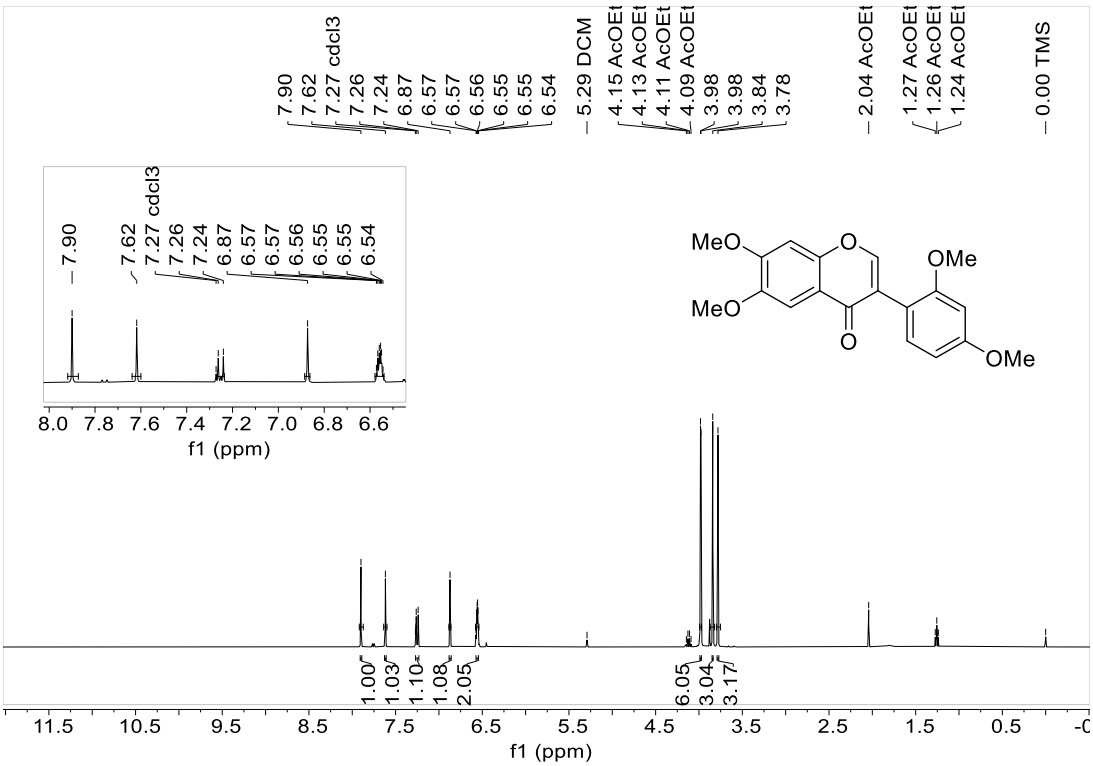


Figure S5. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **15**.

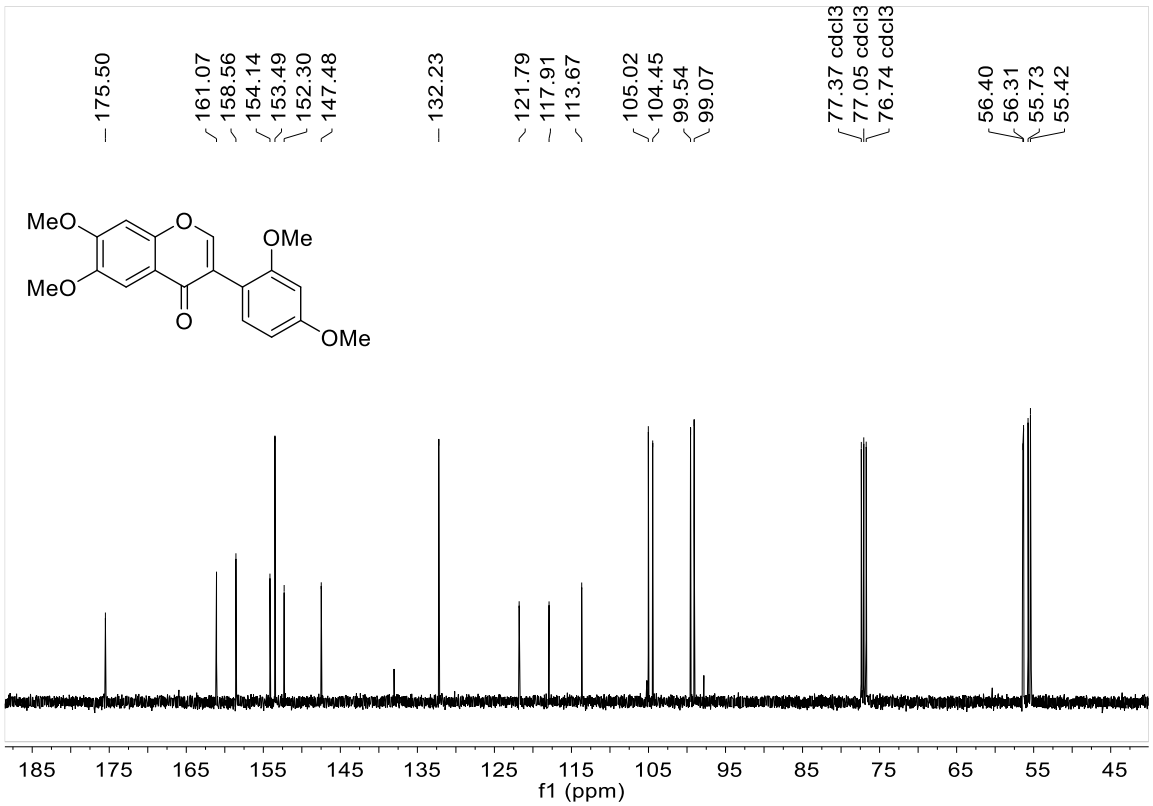


Figure S6. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **15**.

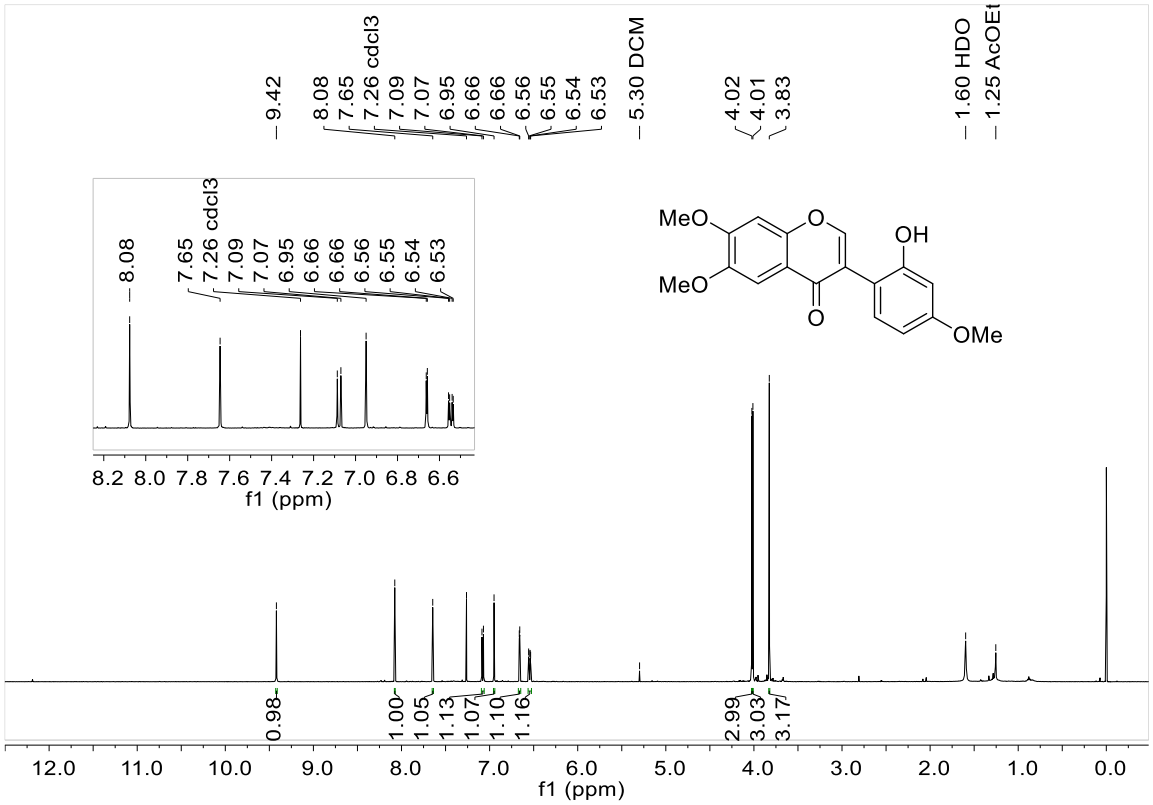


Figure S7. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **9**.

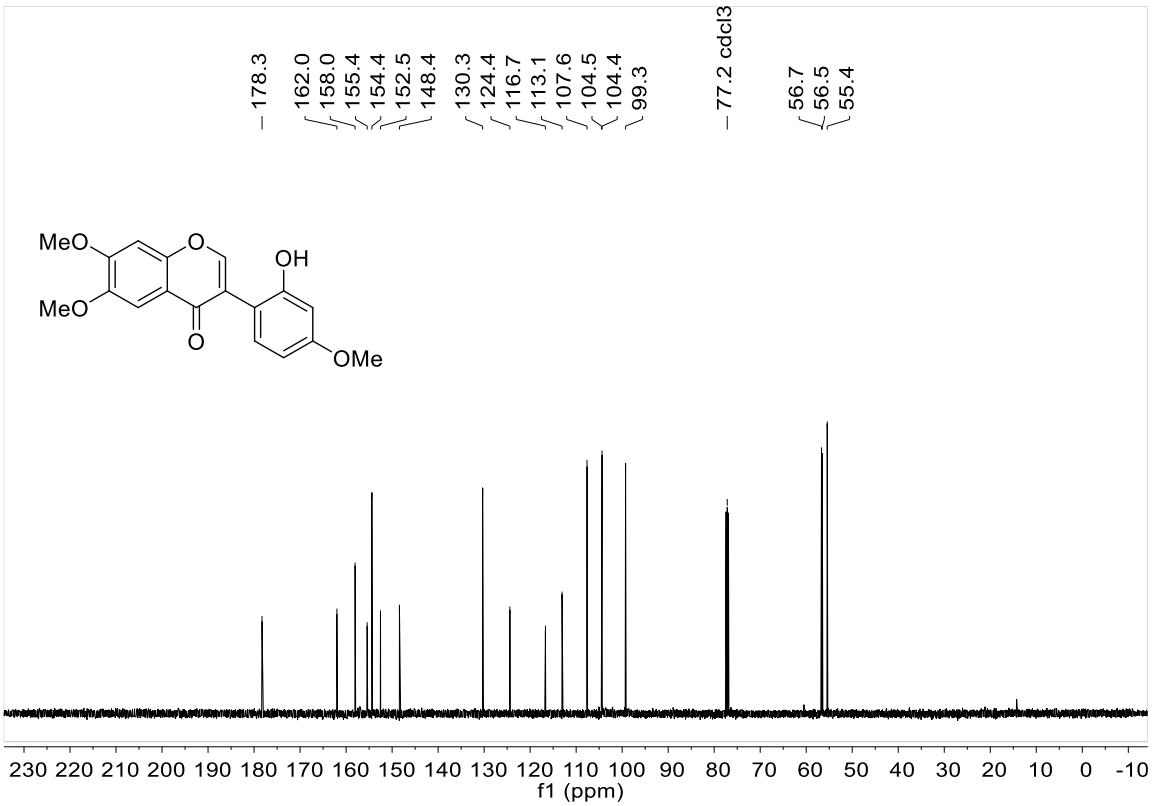


Figure S8. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **9**.

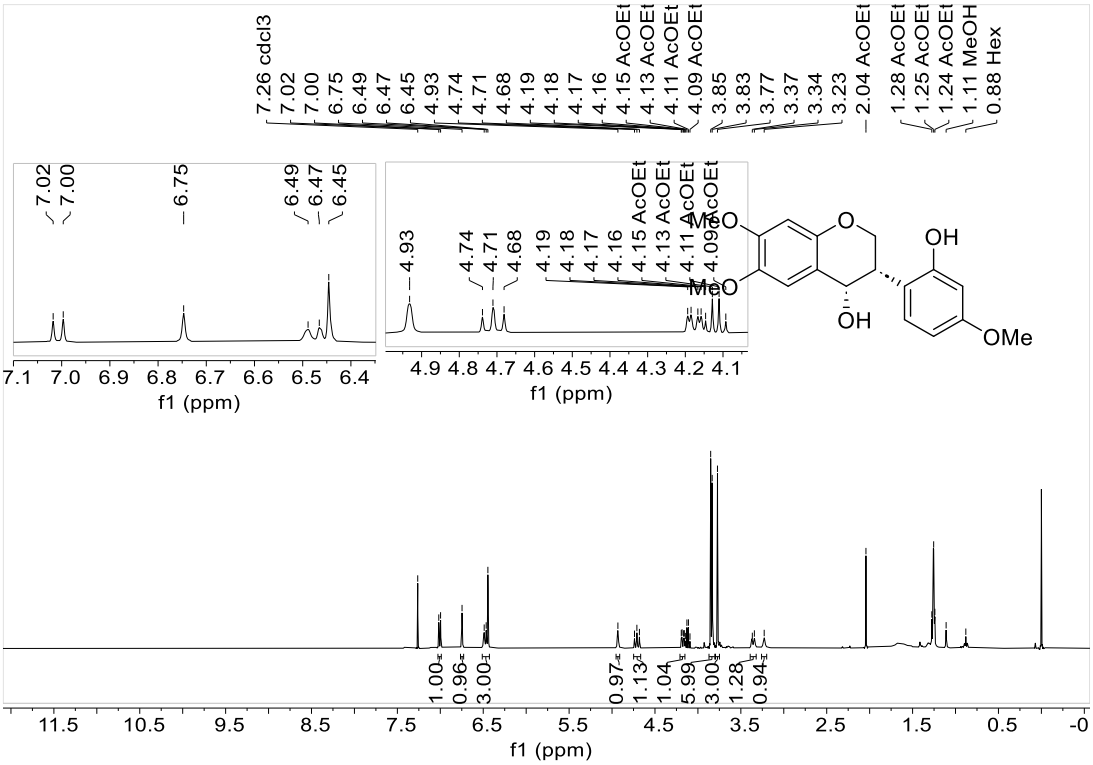


Figure S9. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **8**.

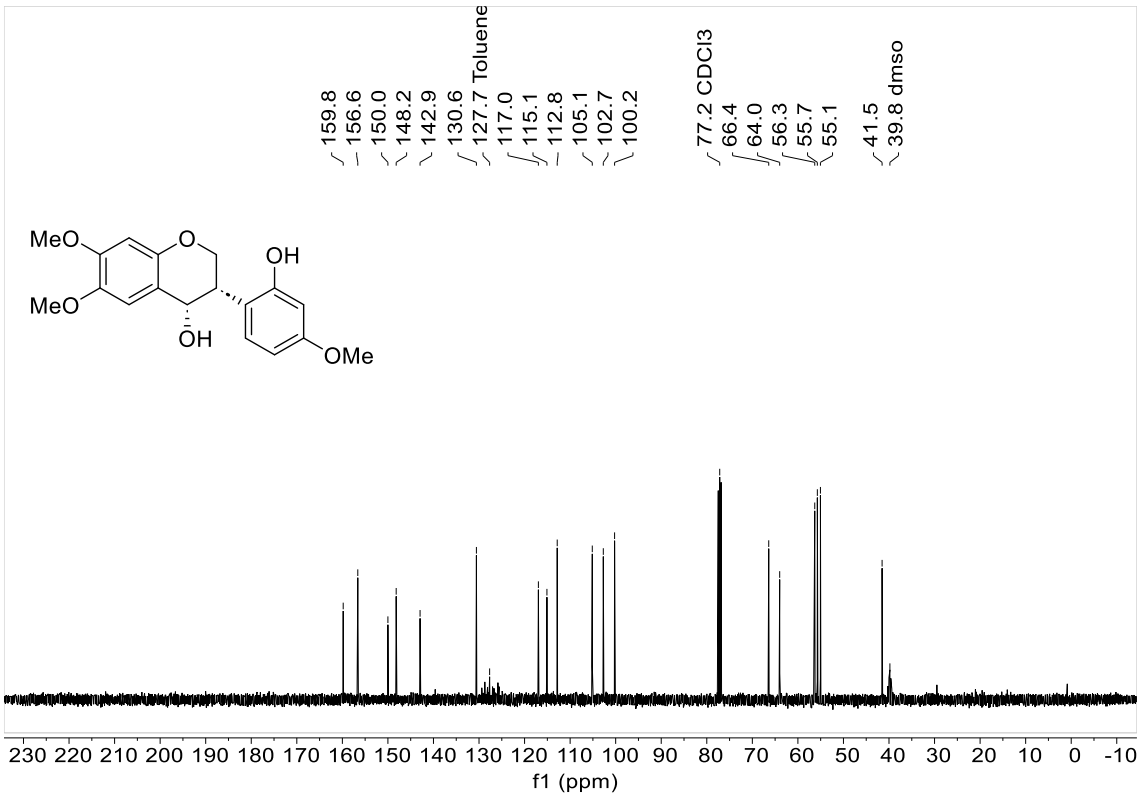


Figure S10. ^{13}C NMR spectrum (101 MHz, $CDCl_3$) of compound **8**.

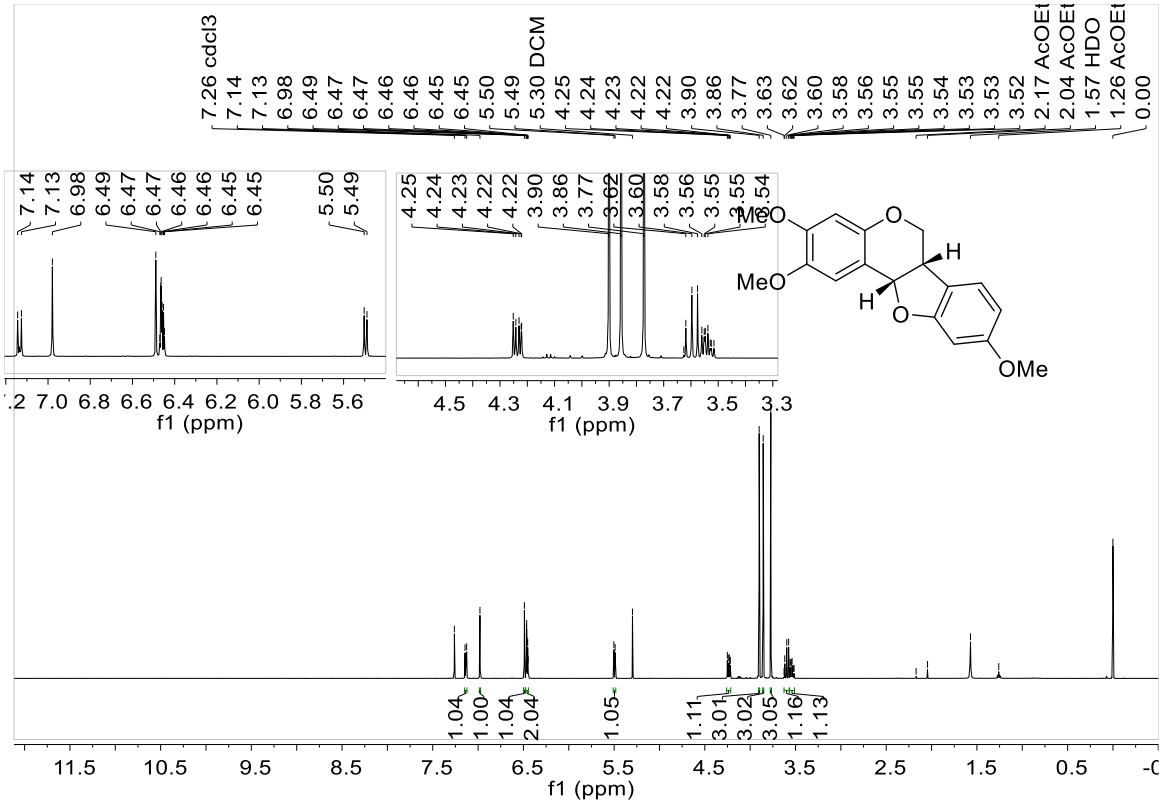


Figure S11. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **1**.

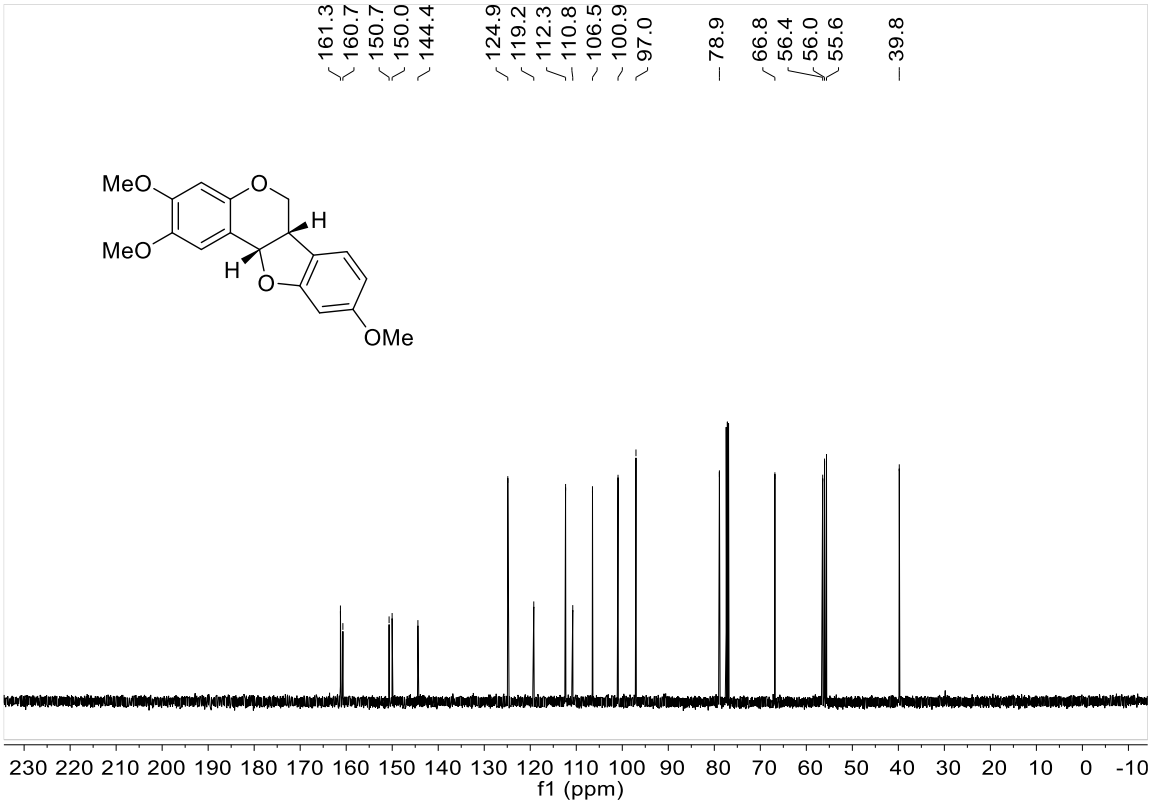


Figure S12. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **1**.

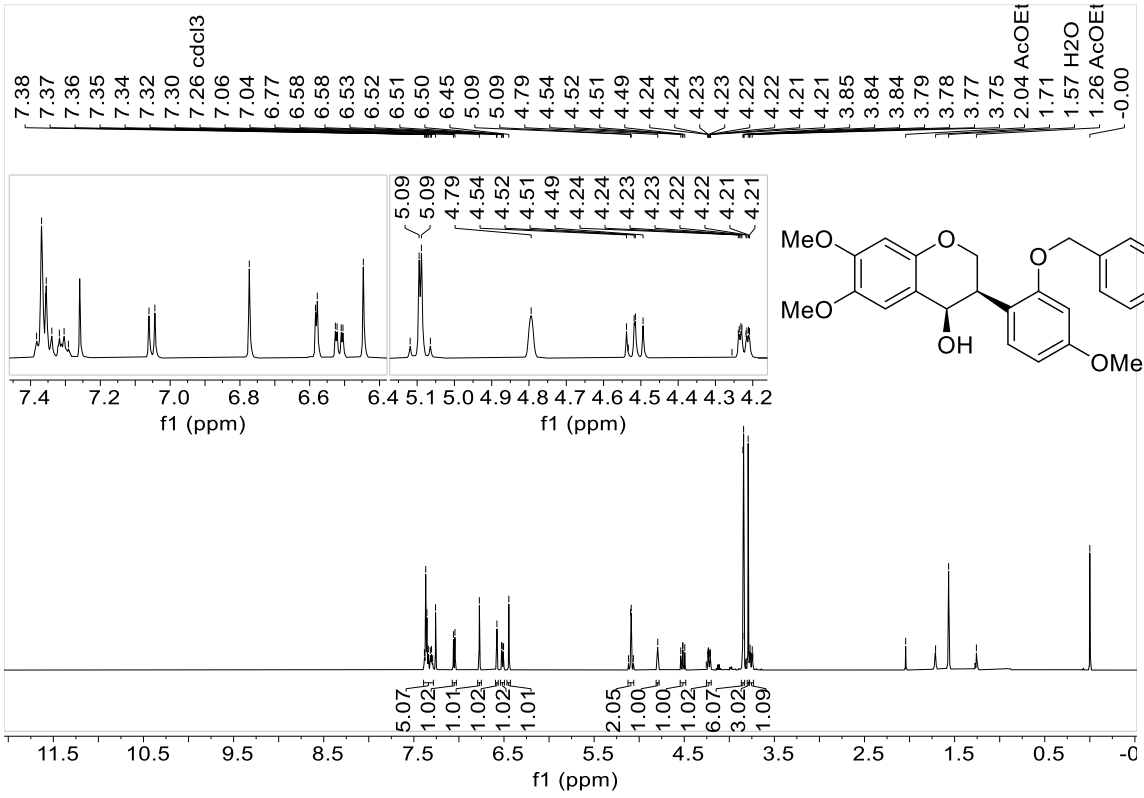


Figure S13. ^{1}H NMR spectrum (500 MHz, $CDCl_3$) of compound **16**.

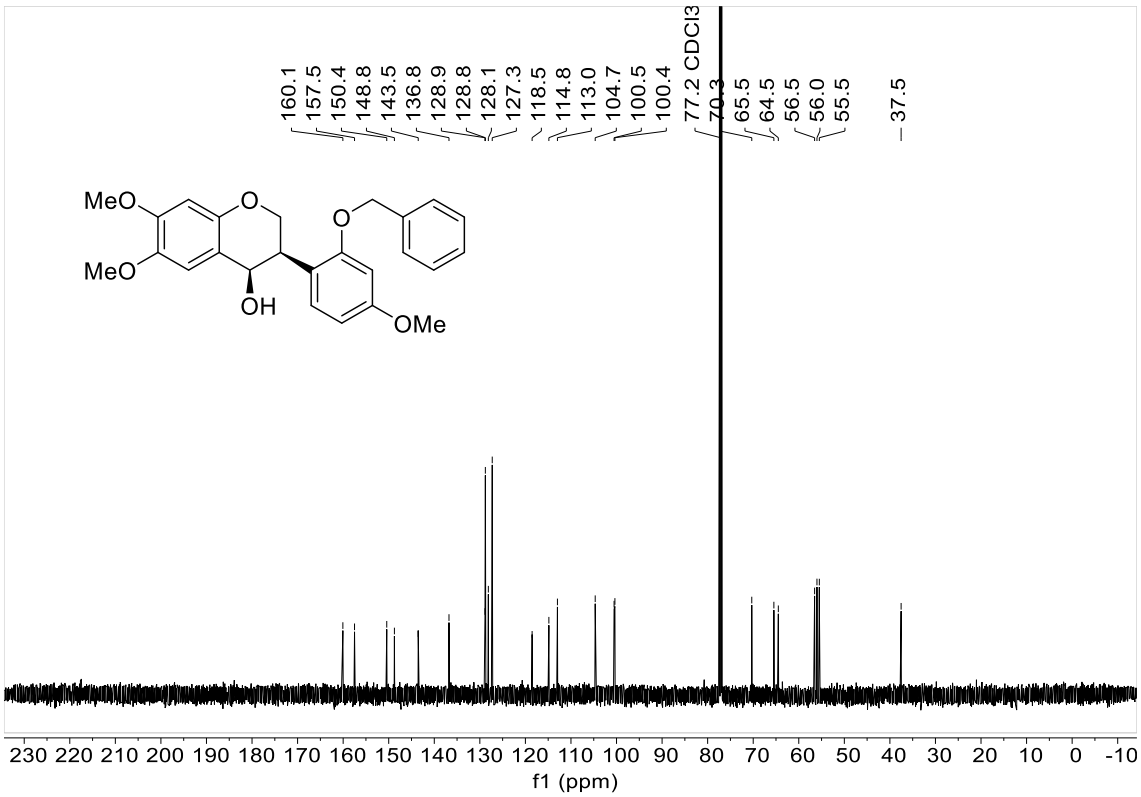


Figure S14. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **16**.

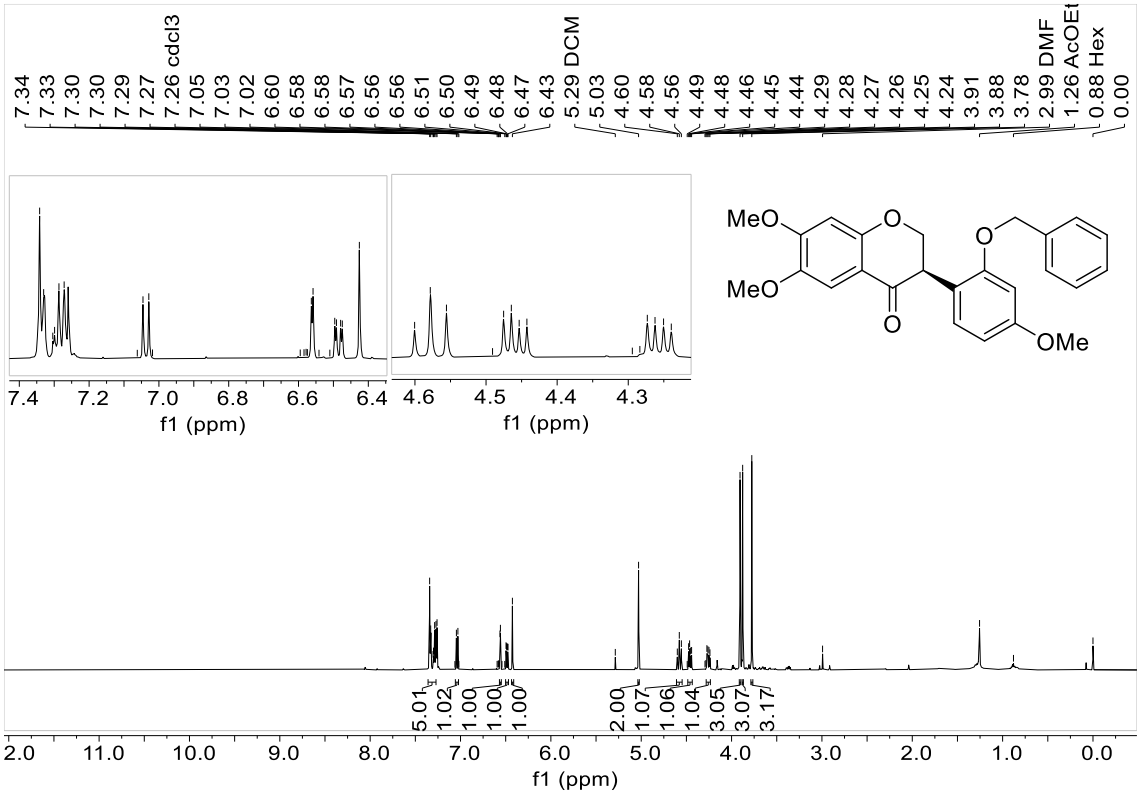


Figure S15. ^{1}H NMR spectrum (500 MHz, $CDCl_3$) of compound **18**.

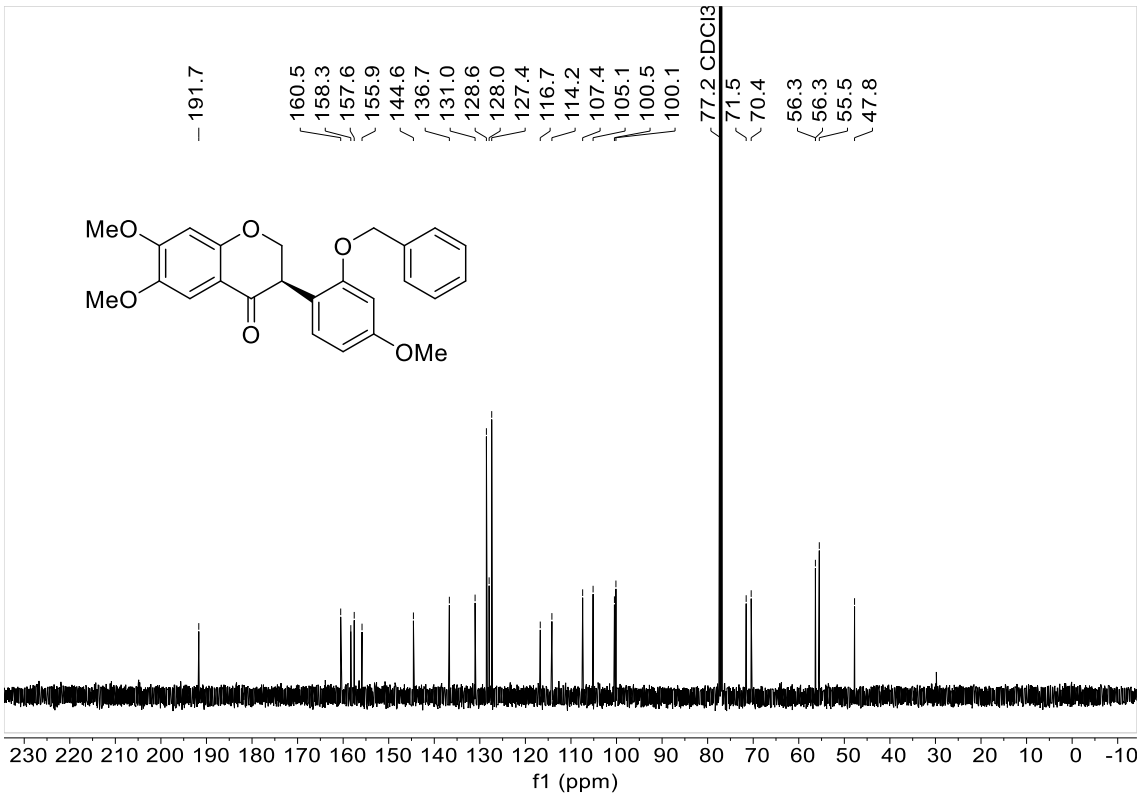


Figure S16. ^{13}C NMR spectrum (126 MHz, $CDCl_3$) of compound **18**.

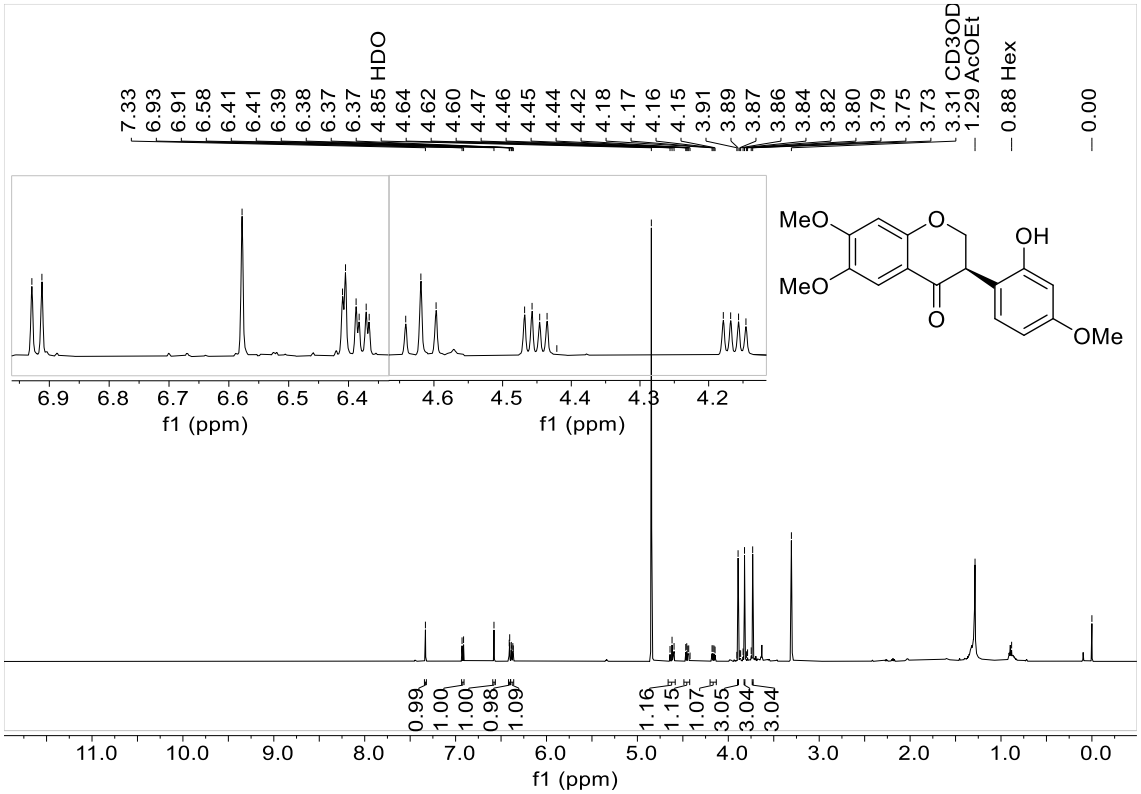


Figure S17. ^{1}H NMR spectrum (500 MHz, CD_3OD) of compound **17**.

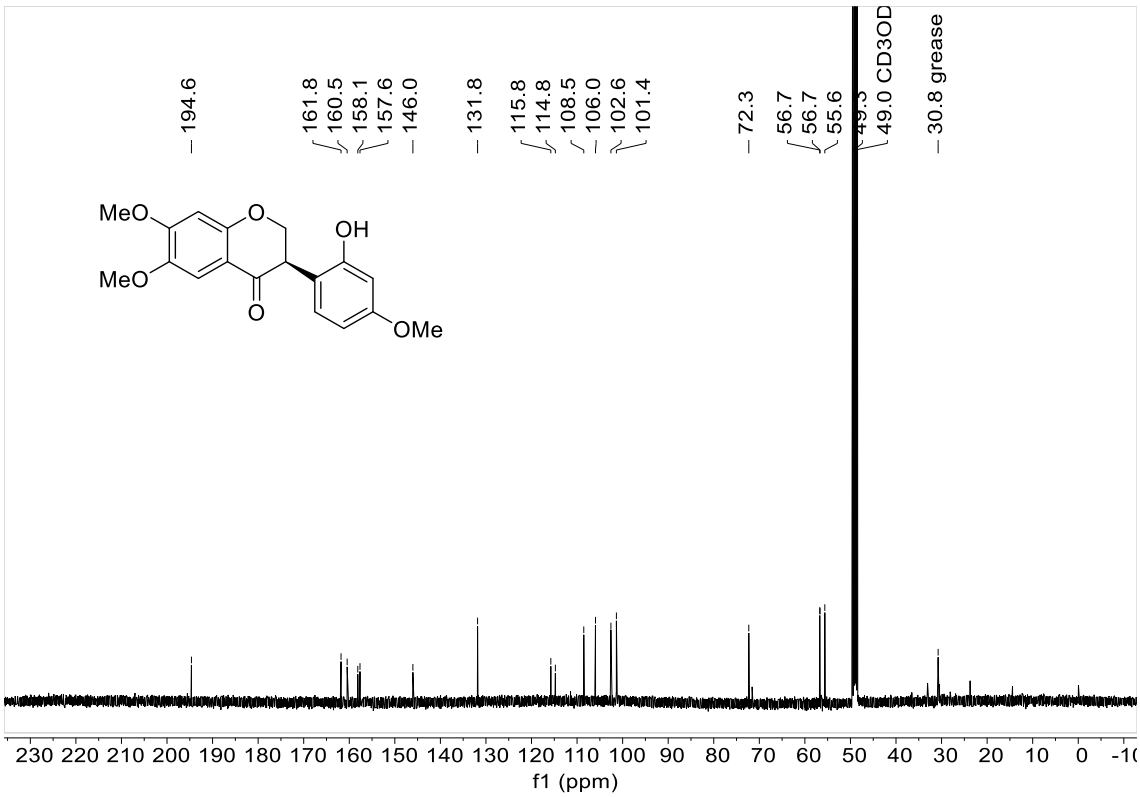
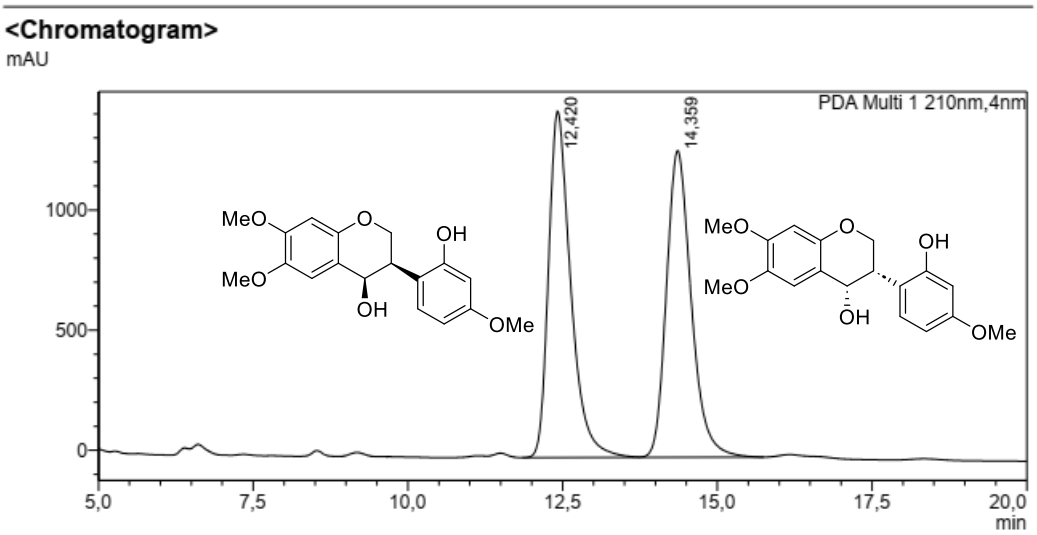


Figure S18. ^{13}C NMR spectrum (126 MHz, CD_3OD) of compound **17**.

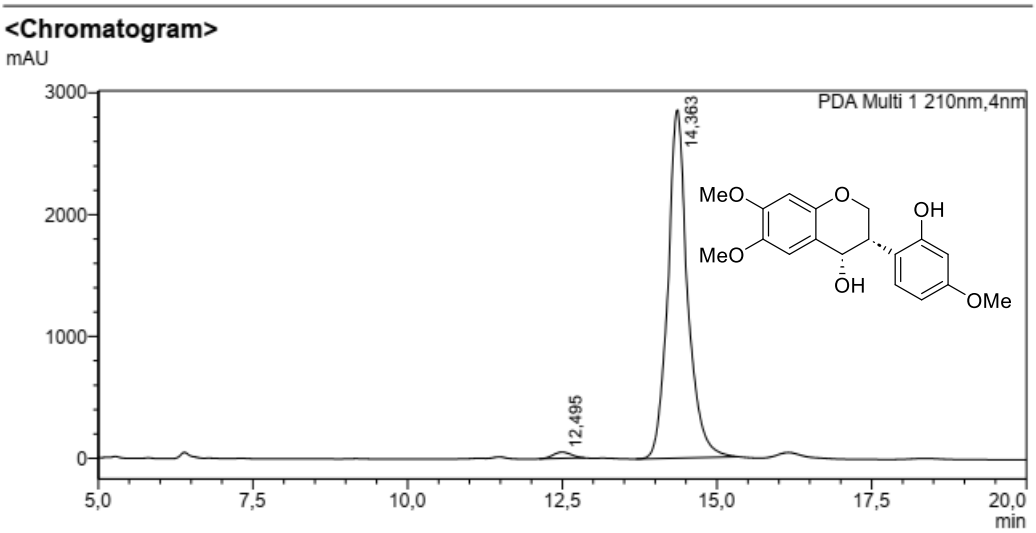


<Peak Table>

PDA Ch1 210nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	0,661	407172	6121	0,225	0,566
2	12,420	36029935	1441632	52,915	50,050
3	14,359	35550175	1276699	46,861	49,384
Total		71987282	2724453	100,000	100,000

Figure S19. HPLC Chromatogram of compound (*rac*)-**8**.

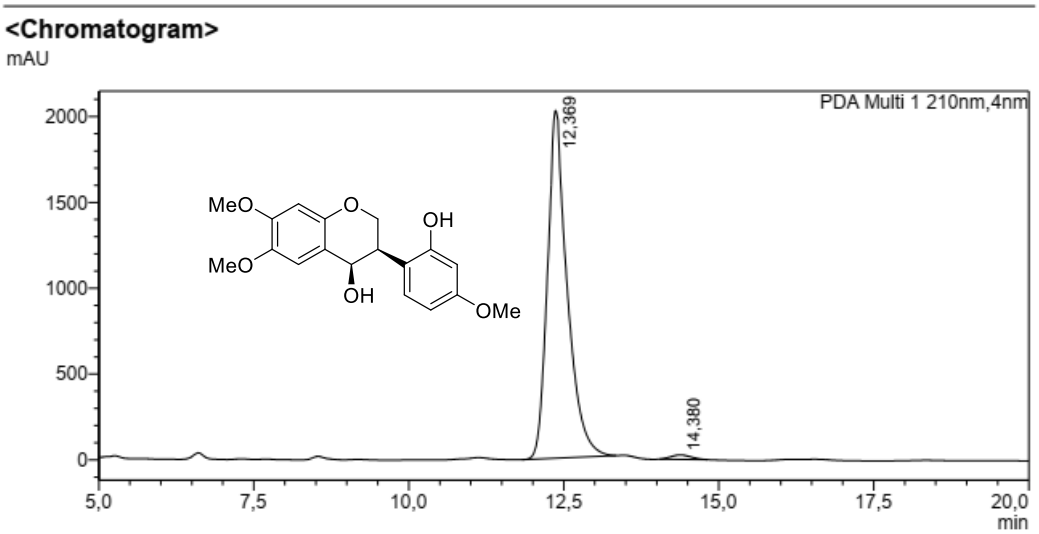


<Peak Table>

PDA Ch1 210nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	12,495	1030400	51276	1,764	1,598
2	14,363	63463749	2854766	98,236	98,402
Total		64494149	2906041	100,000	100,000

Figure S20. HPLC Chromatogram of compound (3*S*,4*S*)-**8**. HPLC method: Chiralpak IA column, *n*-hexane/isopropyl alcohol 70:30, 1 mL min^{-1}, 28 °C, t_{Rmaj} = 14.3 min, t_{Rmin} = 12.4 min, 210 nm.

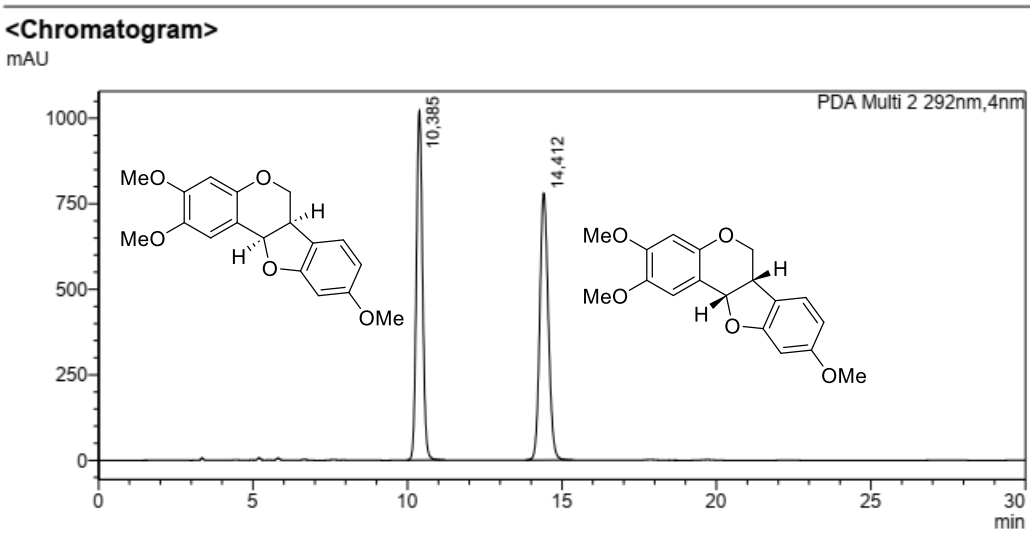


<Peak Table>

PDA Ch1 210nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	12,369	44793277	2024273	98,769	98,744
2	14,380	569918	25221	1,231	1,256
Total		45363195	2049494	100,000	100,000

Figure S21. HPLC Chromatogram of compound (3*R*,4*R*)-**8**. HPLC method: Chiralpak IA column, *n*-hexane/isopropyl alcohol 70:30, 1 mL min^{-1}, 28 °C, t_{Rmaj} = 12.3 min, t_{Rmin} = 14.3 min, 210 nm.

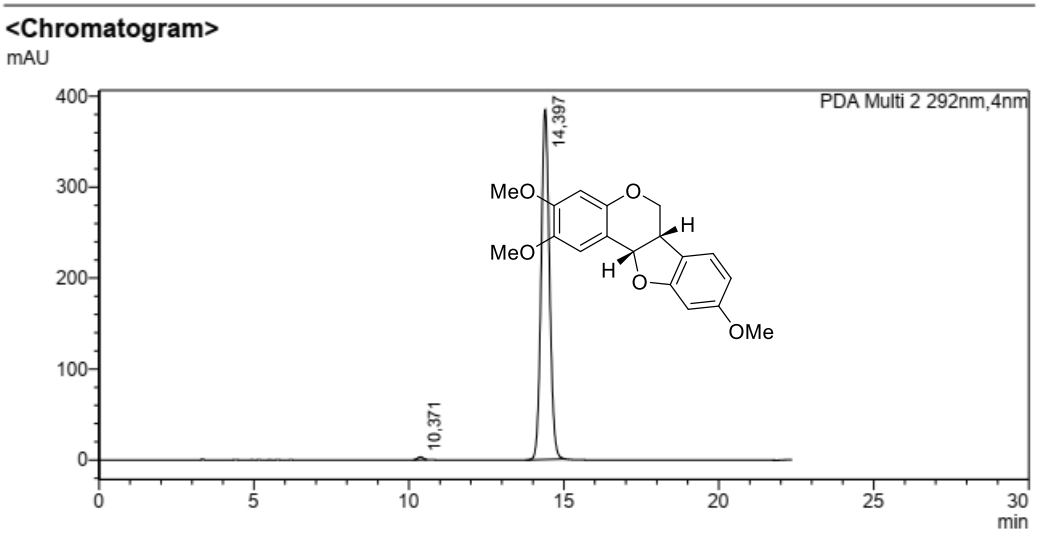


<Peak Table>

PDA Ch2 292nm

Peak#	Ret. Time	Area	Height	Area%
1	10,385	14197910	1021420	48,710
2	14,412	14949967	780260	51,290
Total		29147877	1801680	100,000

Figure S22. HPLC Chromatogram of compound (*rac*)-**1**.



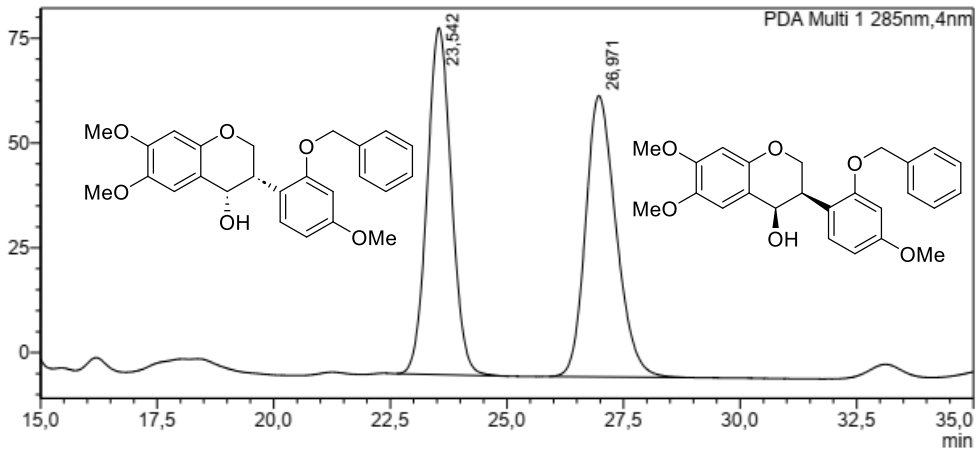
<Peak Table>

PDA Ch2 292nm

Peak#	Ret. Time	Area	Height	Area%
1	10,371	37258	3077	0,516
2	14,397	7189040	384369	99,484
Total		7226298	387445	100,000

Figure S23. HPLC Chromatogram of compound (6a*S*,11a*S*)-**1**. HPLC method: Chiralpak IA column, *n*-hexane/isopropyl alcohol 80:20, 1 mL min^{-1}, 28 °C, t_{Rmaj} = 14.0 min, t_{Rmin} = 10.3 min, 292 nm.

<Chromatogram>



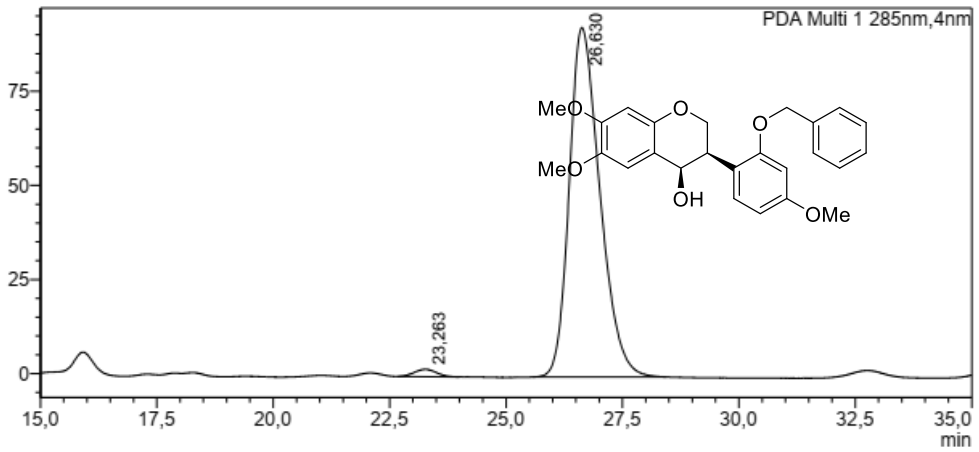
<Peak Table>

PDA Ch1 285nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	23,542	2985357	82748	55,235	49,480
2	26,971	3048081	67063	44,765	50,520
Total		6033438	149811	100,000	100,000

Figure S24. HPLC Chromatogram of compound (*rac*)-**16**.

<Chromatogram>

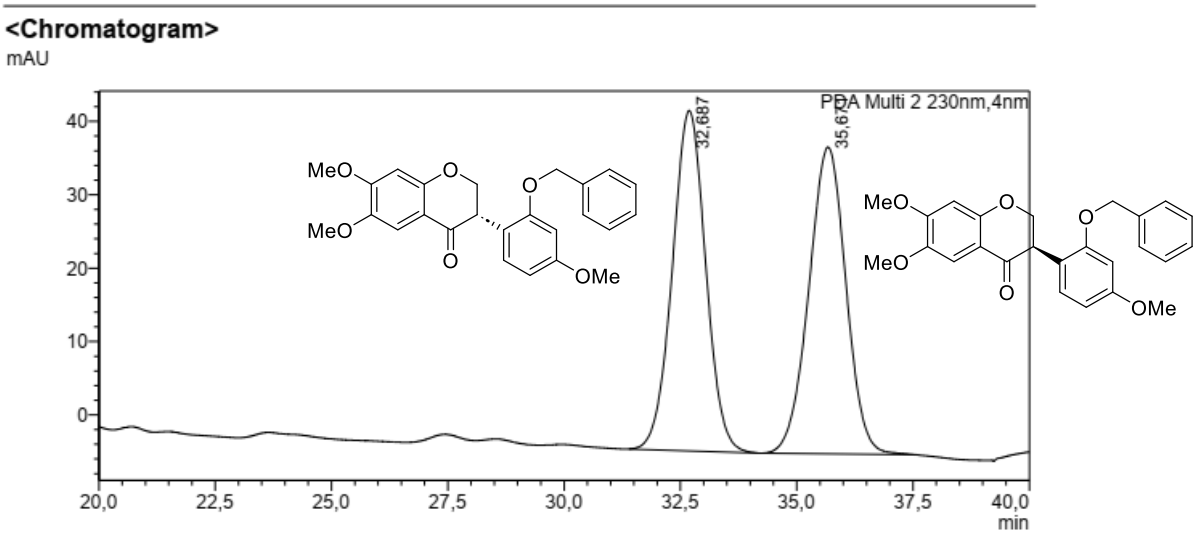


<Peak Table>

PDA Ch1 285nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	23,263	64714	1956	2,064	1,497
2	26,630	4256878	92834	97,936	98,503
Total		4321593	94790	100,000	100,000

Figure S25. HPLC Chromatogram of compound (3*R*,4*R*)-**16**. HPLC method: Chiralpak IA column, *n*-hexane/ethanol 70:30, 1 mL min^{-1}, 28 °C, t_{Rmaj} = 26.6 min, t_{Rmin} = 23.2 min, 285 nm.

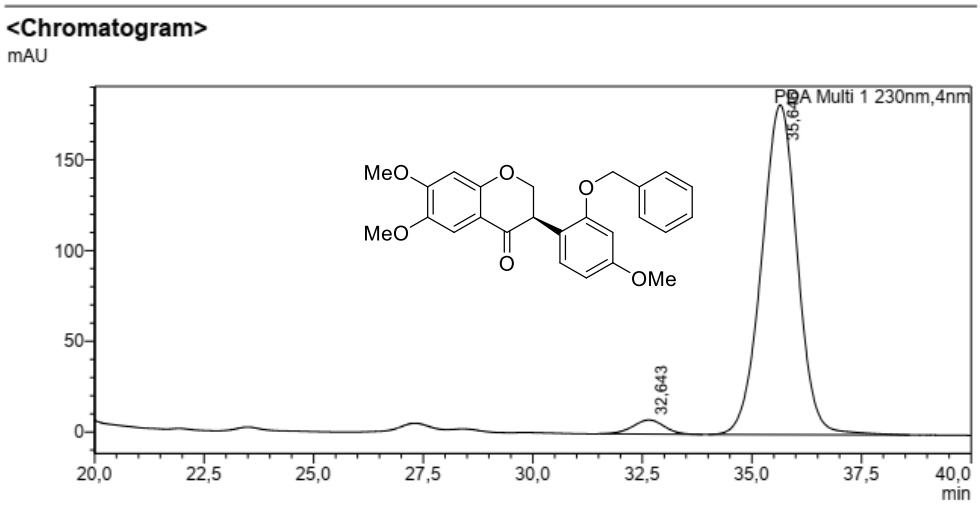


<Peak Table>

PDA Ch2 230nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	32,687	2314242	46373	52,597	49,926
2	35,671	2321120	41795	47,403	50,074
Total		4635361	88168	100,000	100,000

Figure S26. HPLC Chromatogram of compound (*rac*)-**18**.

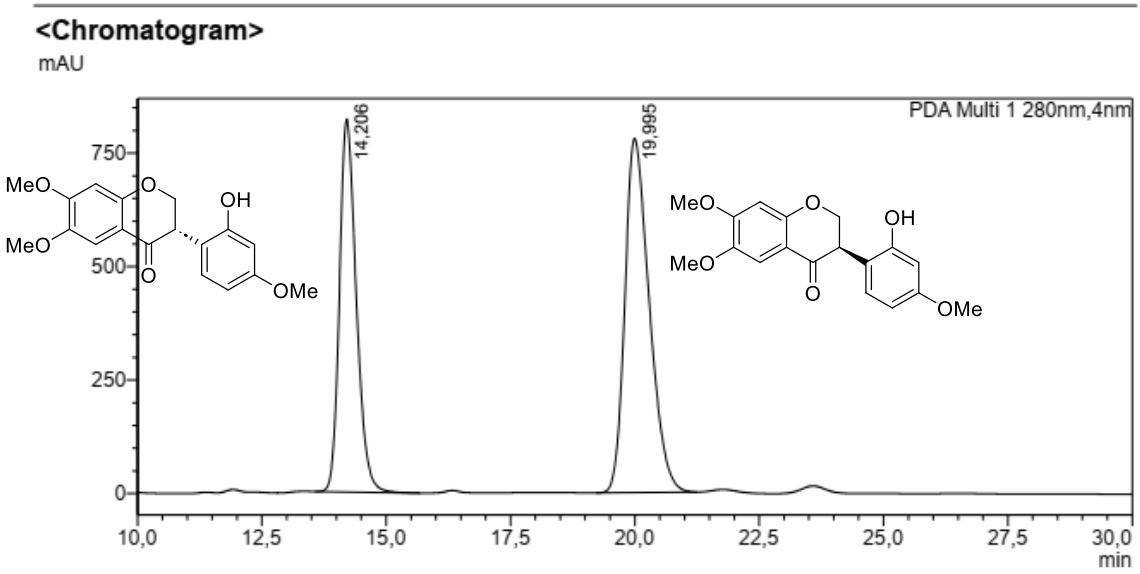


<Peak Table>

PDA Ch1 230nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	32,643	391788	7803	4,117	3,665
2	35,646	10297623	181739	95,883	96,335
Total		10689411	189542	100,000	100,000

Figure S27. HPLC Chromatogram of compound (3*R*)-**18**. HPLC method: Chiralpak IA column, *n*-hexane/ethanol 70:30, 1 mL min^{-1}, 28 °C, t_{Rmaj} = 35.6 min, t_{Rmin} = 32.6 min, 230 nm.

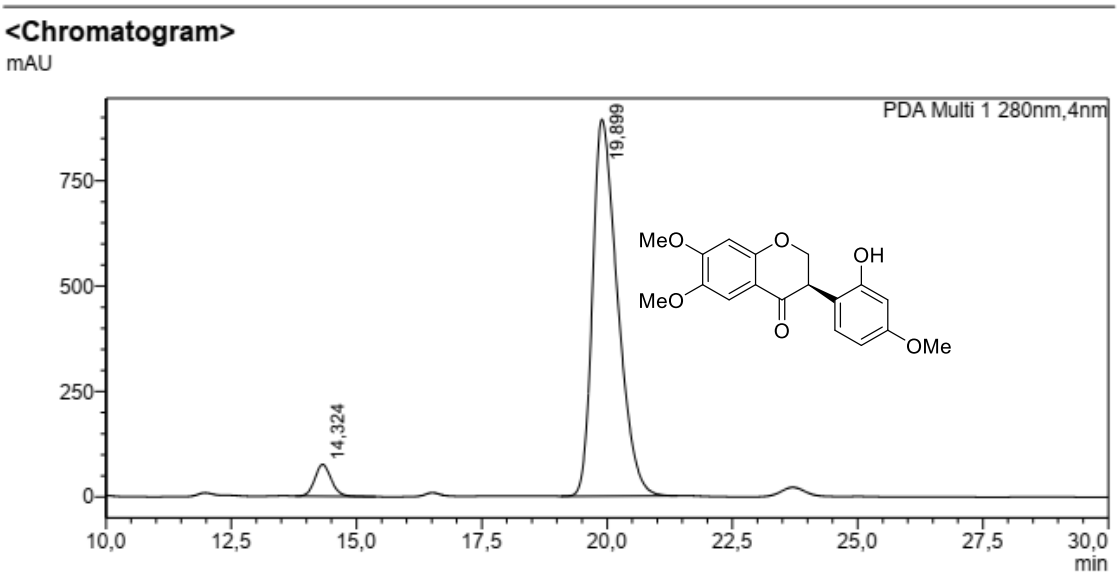


<Peak Table>

PDA Ch1 280nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	14,206	19294307	821021	51,273	42,044
2	19,995	26596788	780263	48,727	57,956
Total		45891095	1601284	100,000	100,000

Figure S28. HPLC Chromatogram of compound (*rac*)-**17**.



<Peak Table>

PDA Ch1 280nm

Peak#	Ret. Time	Area	Height	Height%	Area%
1	14,324	1744267	75700	7,813	5,331
2	19,899	30976859	893236	92,187	94,669
Total		32721126	968937	100,000	100,000

Figure S29. HPLC Chromatogram of compound (3*R*)-**17**. HPLC method: Chiralpak IA column, *n*-hexane/ethanol 70:30, 1 mL min^{-1}, 28 °C, t_{Rmaj} = 19.8 min, t_{Rmin} = 14.3 min, 280 nm.

References

1. Pueppke, S. G.; VanEtten, H. D.; *J. Chem. Soc. Perkin Trans. 1* **1975**, 946. [Crossref]

2. Farias, K.; da Costa, R. F.; Meira, A. S.; Diniz-Filho, J.; Bezerra, E. M.; Freire, V. N.; Guest, P.; Nikahd, M.; Ma, X.; Gardiner, M. G.; Banwell, M. G.; de Oliveira, M. C. F.; de Moraes, M. O.; Pessoa, C. Ó.; *ACS Med. Chem. Lett.* **2020**, *11*, 1274. [Crossref]