Supplementary Material (ESI) for Organic & Biomolecular Chemistry

Enantioselective organocatalytic Michael-hemiketalization catalyzed by a *trans*-bifunctional indane thiourea catalyst

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Supporting Information

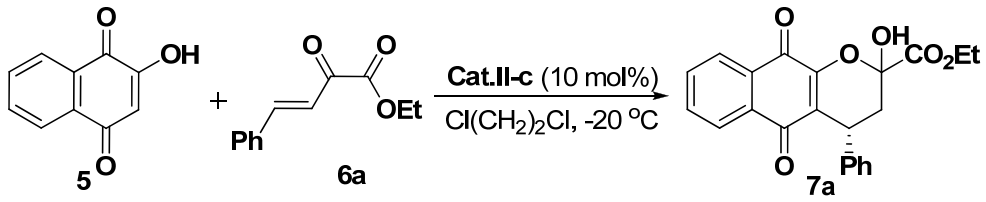
Contents:

1. General information

Chemicals and solvents were purchased from commercial suppliers and used as received. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker ACF300 (300 MHz) or AMX500 (500 MHz) spectrometer. Chemical shifts were reported in parts per million (ppm), and the residual solvent peak was used as an internal reference: proton (chloroform δ 7.26), carbon (chloroform δ 77.0) or tetramethylsilane (TMS δ 0.00) was used as a reference. Multiplicity was indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), dd (doublet of doublet), bs (broad singlet). Coupling constants were reported in Hertz (Hz). Low resolution mass spectra were obtained on a Finnigan/MAT LCQ spectrometer in ESI mode, and a Finnigan/MAT 95XL-T mass spectrometer in EI mode. All high resolution mass spectra were obtained on a Finnigan/MAT 95XL-T mass spectrometer. For thin layer chromatography (TLC), Merck pre-coated TLC plates (Merck 60 F254) were used, and compounds were visualized with a UV light at 254 nm. Further visualization was achieved by staining with $KMnO_4$ solution, or ninhydrin followed by heating using a heat gun. Flash chromatography separations were performed on Merck 60 (0.040-0.063 mm) mesh silica gel. The enantiomeric excesses of products were determined by chiral phase HPLC analysis. Optical rotations were recorded on Jasco DIP-1000 polarimeter.

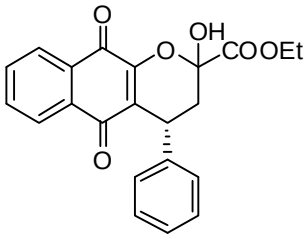
2. Catalyst synthesis and representative reaction procedure for Michael addition reaction

a) Synthesis of Catalyst II-c: Please check the Supporting Information of our published paper: Y. J. Gao, Q. Ren, H. Wu, M. G. Li, J. Wang, *Chem. Commun.* **2010**, DOI: 10.1039/c0cc03489d.



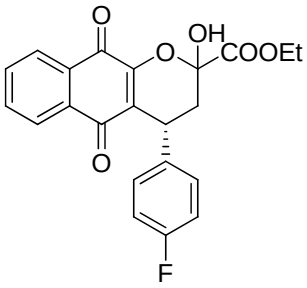
b) General procedure: To a solution of 2-hydroxynaphthalene-1,4-dione **5** (17.5 mg, 0.1 mmol) in 0.45 mL of DCE was added (*E*)-Ethyl 2-oxo-4-phenylbut-3-enoate **6a** (23 mg, 0.11 mmol) at –20 ^{o}C, followed by adding of 50 μL of pre-cooled catalyst **II-c** solution (4.2 mg in 50 μL of DCE, 0.01 mmol). The mixture was stirred at –20 ^{o}C for 24 h. The crude product was purified by column chromatography on silica gel, eluted by hexane/EtOAc= 2:1 to afford 36.7 mg (97% yield) of the desired product **7a** as yellow solid.

3. Analytical data of Michael addition reaction products

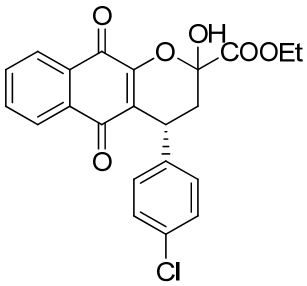


(4*R*)-Ethyl 2-hydroxy-5,10-dioxo-4-phenyl-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7a) (Table 3, entry 1). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.15-8.08 (m, 1H), 8.03-8.0 (m, 0.44 H), 7.90 (dt, *J* = 6.6, 3.0 Hz, 0.48 H), 7.75-7.63 (m, 2.3H), 7.47 (d, *J* = 7.3 Hz, 0.6 H), 7.33-7.18 (m, 4.4 H), 5.01-4.95 (m, 0.74 H), 4.72 (s, 0.16 H), 4.45 (dd, *J* = 7.6, 3.5 Hz, 0.19 H), 4.38-4.25 (m, 2.5 H), 4.15 (dd, *J* = 19.2, 9.8 Hz, 0.32 H), 3.67 (dd, *J* = 19.2, 5.7 Hz, 0.30 H), 2.74 (dd, *J* = 14.3, 7.7 Hz, 0.19 H), 2.46-2.36 (m, 1.27 H), 1.32 (dd, *J* = 9.0, 5.5 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 192.66, 183.97, 183.24, 183.12, 181.50, 179.30, 178.98, 168.19, 160.68, 153.56, 153.06, 152.57, 142.84, 141.94, 140.99, 135.11, 134.22,

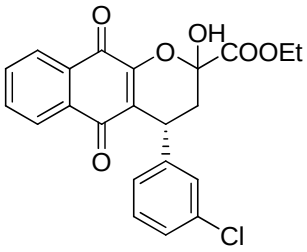
134.15, 133.34, 133.17, 132.96, 132.76, 132.07, 131.89, 130.94, 130.83, 129.07, 128.76, 128.57, 128.33, 128.16, 127.57, 127.22, 127.07, 126.93, 126.68, 126.58, 126.49, 126.43, 126.39, 126.21, 126.05, 125.10, 123.73, 122.98, 95.96, 95.23, 63.54, 63.44, 62.48, 42.24, 37.83, 35.74, 35.28, 34.74, 33.54, 13.93, 13.89; HRMS (ESI) calcd for $C_{22}H_{18}NaO_6$ (M + Na^+) 401.1001, found 401.0999; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 15.37 min, t_{minor} = 20.34 min, *ee* = 96%; $[\alpha]^{25}_D$ = +26.7 (*c* =1.13 in $CHCl_3$).



(4*R*)-Ethyl 4-(4-fluorophenyl)-2-hydroxy-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene -2-carboxylate (7b) (Table 3, entry 2). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 (d, *J* = 94.9 Hz, 2H), 7.69 (d, *J* = 22.1 Hz, 2H), 7.44 (bs, 0.67 H), 7.24 (d, *J* = 23.6 Hz, 1.21 H), 6.98 (bs, 2H), 4.92 (d, *J* = 49.2 Hz, 0.73 H), 4.69 (bs, 0.19 H), 4.32 (t, *J* = 25.7 Hz, 2.63 H), 4.11-4.07 (m, 0.36 H), 3.67 (d, *J* = 14.8 Hz, 0.33 H), 2.72 (bs, 0.19 H), 2.38 (bs, 1 H), 1.34 (t, *J* = 7.1 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 183.15, 183.13, 181.41, 179.21, 168.11, 162.52, 160.75, 160.70, 160.57, 153.06, 138.47, 135.18, 134.24, 133.25, 132.07, 130.85, 129.77, 129.18, 128.74, 126.39, 126.25, 115.74, 115.57, 115.27, 95.21, 63.62, 62.53, 42.31, 37.82, 35.07, 34.09, 29.67, 13.93; HRMS (ESI) calcd for $C_{22}H_{17}FNaO_6$ (M + Na^+) 419.0907, found 419.0895; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 10.88 min, t_{minor} = 15.99 min, *ee* = 96%; $[\alpha]^{25}_D$ = +27.7 (*c* = 1.37 in $CHCl_3$).

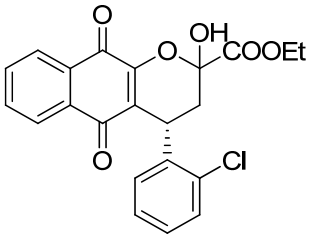


(4*R*)-Ethyl 4-(4-chlorophenyl)-2-hydroxy-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7c) (Table 3, entry 3). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.15-8.01 (m, 1.5 H), 7.92-7.90 (m, 0.48 H), 7.75-7.67 (m, 2 H), 7.40 (t, *J* = 8.2 Hz, 0.69 H), 7.24 (ddd, *J* = 29.3, 18.3, 8.0 Hz, 3.58 H), 4.86 (d, *J* = 109.7 Hz, 1 H), 4.40-4.24 (m, 2.74 H), 4.07 (dd, *J* = 19.5, 9.5 Hz, 0.32 H), 3.68 (dd, *J* = 18.9, 5.7 Hz, 0.31 H), 2.72 (dd, *J* = 14.0, 7.7 Hz, 0.22 H), 2.42-2.30 (m, 1.22 H), 1.34 (t, *J* = 7.1 Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 183.37, 179.74, 153.11, 140.67, 134.58, 133.28, 132.49, 132.19, 130.37, 129.01, 128.77, 126.64, 126.30, 123.78, 63.31, 34.29, 13.92; HRMS (ESI) calcd for $C_{22}H_{17}ClNaO_6$ (M + Na^+) 435.0611, found 435.0598; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 10.77 min, t_{minor} = 15.66 min, *ee* = 97%; $[\alpha]^{25}_{D}$ = +18.7 (*c* =1.37 in $CHCl_3$).

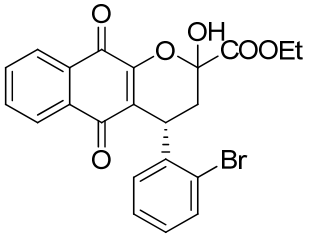


(4*R*)-Ethyl 4-(3-chlorophenyl)-2-hydroxy-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7d) (Table 3, entry 3). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.14-7.91 (m, 2 H), 7.70 (d, *J* = 23.3 Hz, 2 H), 7.40 (d, *J* = 51.7 Hz, 0.68 H), 7.22-7.14 (m, 3.22 H), 4.99 (d, *J* = 20.5 Hz, 0.77 H), 4.79 (s, 0.18 H), 4.40-4.23 (m, 2.69 H), 4.13-4.05 (m, 0.35 H), 3.67 (d, *J* = 14.5 Hz, 0.31H), 2.71 (d, *J* = 6.9 Hz, 0.19 H), 2.37 (dt, *J* = 25.9, 10.2 Hz, 1.16 H), 1.34 (t, *J* = 7.1 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 192.28, 182.98, 179.11, 168.02, 153.24, 144.93, 135.19, 134.23, 133.29, 131.99, 130.84, 130.00, 128.28, 127.28, 127.13, 126.95, 126.43, 126.29, 125.61, 124.28, 95.19, 63.62, 62.55, 41.95, 37.60, 35.43, 35.41, 34.90, 34.56, 13.91; HRMS (ESI) calcd for $C_{22}H_{17}ClNaO_6$ (M + Na^+) 435.0611, found 435.0601; HPLC

(Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 11.07 min, t_{minor} = 13.40 min, *ee* = 97%; $[\alpha]^{25}_{D}$ = +7.1 (*c* = 1.47 in $CHCl_3$).

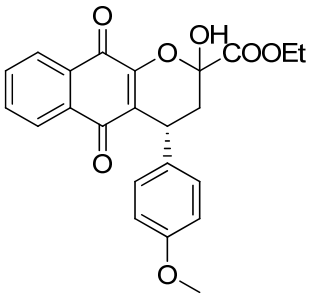


(4*S*)-Ethyl 4-(2-chlorophenyl)-2-hydroxy-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7e) (Table 3, entry 3). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.11-7.92 (m, 2 H), 7.68 (s, 2 H), 7.40 (d, *J* = 6.0 Hz, 1 H), 7.13 (d, *J* = 32.8 Hz, 3 H), 4.94-4.74 (m, 2 H), 4.36-4.33 (m, 2 H), 2.69 (s, 0.35 H), 2.42 (d, *J* = 65.3 Hz, 1.39 H), 1.34 (t, *J* = 6.6 Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 182.89, 179.14, 168.07, 154.00, 153.33, 140.21, 138.83, 134.23, 133.27, 131.89, 130.90, 129.90, 129.60, 127.96, 127.25, 126.44, 126.32, 124.75, 95.91, 95.31, 63.58, 35.11, 32.50, 30.86, 29.66, 13.92; HRMS (ESI) calcd for $C_{22}H_{17}ClNaO_6$ (M + Na^+) 435.0611, found 435.0611; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 13.36 min, t_{minor} = 16.31 min, *ee* = 95%; $[\alpha]^{25}_{D}$ = +29.6 (*c* = 1.33 in $CHCl_3$).

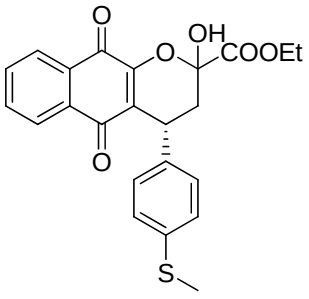


(4*S*)-Ethyl 4-(2-bromophenyl)-2-hydroxy-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7f) (Table 3, entry 6). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.04 (dd, *J* = 85.6, 26.6 Hz, 2 H), 7.70-7.58 (m, 3 H), 7.19-7.07 (m, 3 H), 4.87-4.72 (m, 2H), 4.34 (dd, *J* = 15.9, 7.4 Hz, 2 H), 2.55 (dt, *J* = 212.8, 59.1 Hz, 2 H), 1.34 (t, *J* = 6.3 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 182.81, 179.10, 168.03, 154.00, 140.46, 134.19, 133.40, 133.26, 132.91, 131.95, 130.91, 129.72, 128.26, 128.18, 127.92, 126.97, 126.43, 126.30, 124.86, 123.79, 122.63, 95.96, 95.31, 63.61, 60.37, 33.46, 32.76, 21.00, 13.93; HRMS (ESI) calcd

for $C_{22}H_{17}BrNaO_6$ (M + Na^+) 479.0106, found 479.0101; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 14.23 min, t_{minor} = 16.53 min, *ee* = 94%; $[\alpha]^{25}_D$ = +13.3 (*c* = 0.87 in $CHCl_3$).

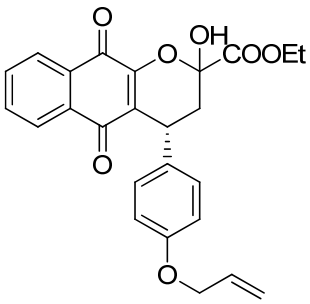


(4*R*)-Ethyl 2-hydroxy-4-(4-methoxyphenyl)-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7g) (Table 3, entry 7). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.14-7.90 (m, 2 H), 7.68 (d, *J* = 24.9 Hz, 2 H), 7.39 (d, *J* = 7.6 Hz, 0.69 H), 7.16 (d, *J* = 7.9 Hz, 1.26 H), 6.85-6.82 (m, 2 H), 4.86 (d, *J* = 88.3 Hz, 0.85 H), 4.39-4.23 (m, 2.59 H), 4.09 (dd, *J* = 18.8, 9.3 Hz, 0.35 H), 3.76 (d, *J* = 10.7 Hz, 3 H), 3.65 (d, *J* = 19.2 Hz, 0.41 H), 2.69 (d, *J* = 7.3 Hz, 0.18 H), 2.39 (d, *J* = 7.9 Hz, 1 H), 1.33 (t, *J* = 6.9 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 192.78, 184.03, 183.21, 181.56, 179.33, 168.21, 160.77, 158.47, 158.23, 152.89, 152.40, 135.05, 134.72, 134.10, 133.29, 133.11, 132.92, 132.80, 132.14, 130.85, 129.22, 128.61, 128.22, 127.03, 126.36, 126.17, 126.00, 125.32, 124.03, 123.27, 114.19, 113.95, 113.79, 96.02, 95.34, 63.45, 63.37, 62.42, 55.16, 42.44, 37.92, 35.37, 35.00, 33.92, 32.81, 13.91; HRMS (ESI) calcd for $C_{23}H_{20}NaO_7$ (M + Na^+) 431.1107, found 431.1101; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 23.49 min, t_{minor} = 44.30 min, *ee* = 90%; $[\alpha]^{25}_D$ = +58.7 (*c* = 1.37 in $CHCl_3$).

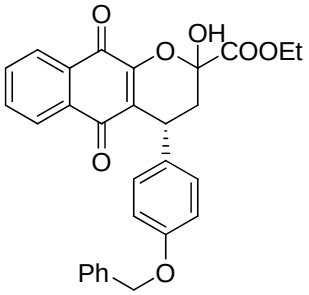


(4*R*)-Ethyl 2-hydroxy-4-(4-(methylthio)phenyl)-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene

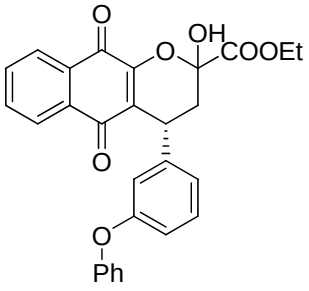
-2-carboxylate (7h) (Table 3, entry 8). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.03 (dd, *J* = 74.2, 37.4 Hz, 2 H), 7.68 (d, *J* = 23.0 Hz, 2 H), 7.39-7.17 (m, 4 H), 5.04 (d, *J* = 83.9 Hz, 1 H), 4.38-4.09 (m, 3 H), 3.67 (d, *J* = 17.0 Hz, 0.27 H), 2.71 (bs, 0.19 H), 2.45-2.36 (m, 4 H), 1.32 (bs, 3 H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 183.11, 179.26, 168.09, 153.04, 139.68, 136.51, 134.19, 133.15, 130.79, 127.74, 127.05, 126.35, 126.17, 124.89, 95.26, 63.47, 42.07, 37.73, 35.14, 34.21, 15.85, 13.88; HRMS (ESI) calcd for $C_{23}H_{20}NaO_6S$ (M + Na^+) 447.0878, found 447.0873; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 19.14 min, t_{minor} = 31.89 min, *ee* = 93%; $[\alpha]^{25}_{D}$ = +52.9 (*c* = 1.43 in $CHCl_3$).



(4*R*)-ethyl 4-(4-(allyloxy)phenyl)-2-hydroxy-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7i) (Table 3, entry 9). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.16-7.90 (m, 1.66 H), 7.92-7.91 (m, 0.42 H), 7.75-7.58 (m, 2.34 H), 7.38 (d, *J* = 8.5 Hz, 0.73 H), 7.16 (d, *J* = 8.2 Hz, 1 H), 6.87-6.82 (m, 2 H), 6.03 (dt, *J* = 24.3, 9.6 Hz, 1 H), 5.32 (ddd, *J* = 27.4, 24.3, 10.7 Hz, 2 H), 4.94 (dd, *J* = 9.6, 5.8 Hz, 0.29 H), 4.74 (s, 0.35 H), 4.45-4.22 (m, 4.56 H), 4.10 (dd, *J* = 19.1, 9.6 Hz, 0.34 H), 3.64 (dd, *J* = 19.2, 6.0 Hz, 0.35 H), 2.38 (d, *J* = 9.5 Hz, 1 H), 1.34 (t, *J* = 7.1 Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 192.79, 184.06, 183.24, 181.60, 179.36, 168.27, 157.55, 157.35, 152.89, 152.35, 135.11, 134.91, 134.15, 133.36, 133.28, 133.17, 132.98, 132.16, 131.72, 130.87, 130.70, 129.25, 128.63, 128.24, 127.09, 126.40, 126.23, 126.06, 125.40, 124.06, 118.04, 117.62, 115.01, 114.79, 114.58, 114.45, 95.91, 95.25, 68.81, 63.60, 63.48, 62.47, 42.47, 37.89, 35.20, 35.03, 33.94, 32.69, 29.68, 13.95; HRMS (ESI) calcd for $C_{25}H_{22}NaO_7$ (M + Na^+) 457.1263, found 457.1251; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 20.60 min, t_{minor} = 39.69 min, *ee* = 90%; $[\alpha]^{25}_{D}$ = +53.9 (*c* = 1.5 in $CHCl_3$).

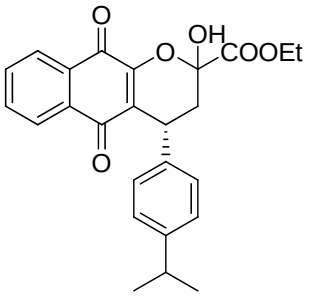


(4*R*)-Ethyl 4-(4-(benzyloxy)phenyl)-2-hydroxy-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7j) (Table 3, entry 10). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.15-7.90 (m, 2 H), 7.74-7.63 (m, 2.59 H), 7.43-7.28 (m, 6.20 H), 7.17-7.15 (m, 1.62 H), 6.93-6.88 (m, 2 H), 5.02-4.93 (m, 3 H), 4.41-4.23 (m, 2.76 H), 4.10 (dd, *J* = 19.1, 9.6 Hz, 0.35 H), 3.64 (dd, *J* = 19.2, 6.0 Hz, 0.32 H), 2.73-2.68 (m, 0.19 H), 2.43-2.37 (m, 1 H), 1.35-1.31(m, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 192.78, 184.04, 183.22, 181.57, 179.32, 168.23, 160.77, 157.76, 157.56, 152.91, 152.39, 137.05, 135.07, 135.02, 134.19, 134.12, 133.35, 133.31, 133.14, 132.94, 132.83, 132.16, 130.87, 129.28, 129.12, 128.90, 128.66, 128.54, 128.52, 128.38, 128.27, 128.11, 127.92, 127.88, 127.48, 127.40, 127.24, 127.06, 126.49, 126.38, 126.20, 126.03, 125.32, 124.01, 115.09, 114.90, 114.67, 95.98, 95.31, 70.01, 63.51, 63.42, 62.43, 42.46, 37.91, 35.29, 35.04, 33.95, 32.78, 13.93, 13.91; HRMS (ESI) calcd for $C_{29}H_{24}NaO_7$ (M + Na^+) 507.1420, found 507.1414; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 24.43 min, t_{minor} = 41.02 min, *ee* = 90%; $[\alpha]^{25}_{D}$ = +42.2 (*c* = 1.53 in $CHCl_3$).

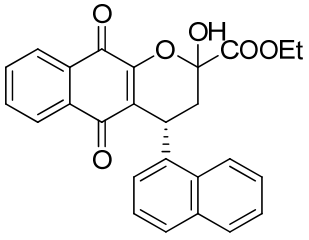


(4*R*)-Ethyl 2-hydroxy-5,10-dioxo-4-(3-phenoxyphenyl)-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7k) (Table 3, entry 11). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 (ddd, *J* = 47.3, 11.5, 7.4 Hz, 2 H), 7.73-7.66 (m, 2 H), 7.31-7.18 (m, 3.55 H), 7.08-6.80 (m, 5.3 H), 4.96 (t, *J* = 64.9 Hz, 1 H), 4.41-4.07 (m, 2.7 H), 4.10 (dd, *J* = 18.8, 9.3 Hz, 0.28 H), 3.66 (dd, *J* = 19.2, 5.0 Hz, 0.27 H), 2.72 (dd, *J* = 13.9, 7.6

Hz, 0.19 H), 2.45-2.33 (m, 1.26 H), 1.33 (t, J = 7.1 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 183.19, 179.16, 168.10, 157.01, 153.01, 144.89, 134.16, 133.15, 129.63, 126.22, 123.16, 118.75, 116.90, 95.24, 63.45, 42.08, 37.67, 34.63, 29.64, 13.90; HRMS (ESI) calcd for $C_{28}H_{22}NaO_7$ (M + Na^+) 493.1263, found 493.1258; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 14.18 min, t_{minor} = 17.62 min, *ee* = 96%; $[\alpha]^{25}_D$ = +11.7 (c = 1.73 in $CHCl_3$).

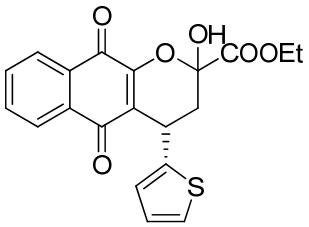


(4*R*)-Ethyl 2-hydroxy-4-(4-isopropylphenyl)-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7l) (Table 3, entry 12). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.09-7.91 (m, 2 H), 7.68 (d, J = 20.8 Hz, 2 H), 7.38 (s, 1 H), 7.15 (bs, 3 H), 4.81 (d, J = 154.8 Hz, 1 H), 4.42-4.14 (m, 2.89 H), 3.64 (d, J = 15.8 Hz, 0.31 H), 2.78 (d, J = 72.2 Hz, 1 H), 2.40 (d, J = 8.2 Hz, 1 H), 1.32 (bs, 3 H), 1.22 (bs, 6 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 192.81, 184.01, 183.14, 181.59, 179.35, 168.25, 160.76, 152.98, 147.47, 147.00, 139.96, 138.28, 135.05, 134.09, 133.11, 132.91, 132.17, 130.89, 129.13, 128.08, 127.40, 127.11, 126.79, 126.62, 126.40, 126.19, 126.02, 125.35, 123.95, 104.97, 95.34, 63.46, 62.42, 42.41, 37.94, 35.44, 34.32, 33.61, 23.87, 13.91; HRMS (ESI) calcd for $C_{25}H_{24}NaO_6$ (M + Na^+) 443.1471, found 443.1465; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 14.02 min, t_{minor} = 18.78 min, *ee* = 94%; $[\alpha]^{25}_D$ = +39.6 (c = 1.0 in $CHCl_3$).

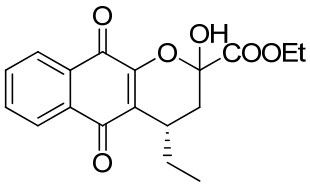


(4*R*)-Ethyl 2-hydroxy-4-(naphthalen-1-yl)-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7m) (Table 3, entry 13). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28-7.07 (m, 11 H), 5.71 (s, 0.13 H),

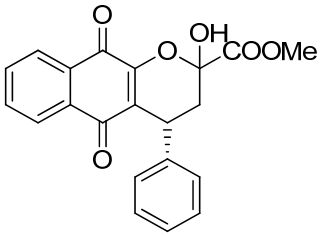
5.02 (d, J = 96.2 Hz, 1 H), 4.54 (bs, 0.20 H), 4.23-4.13 (m, 2 H), 3.63 (d, J = 16.7 Hz, 0.14 H), 2.80 (dd, J = 13.7, 8.0 Hz, 0.23 H), 2.53-2.39 (m, 1 H), 1.21 (ddd, J = 14.5, 10.6, 6.3 Hz, 3 H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 192.63, 183.10, 183.00, 179.25, 178.94, 168.15, 154.00, 139.31, 136.93, 135.14, 134.23, 134.15, 133.36, 133.21, 132.97, 132.08, 131.95, 131.00, 130.92, 130.53, 129.41, 129.13, 127.72, 127.53, 127.22, 126.47, 126.42, 126.29, 126.09, 125.73, 125.52, 125.42, 125.28, 125.07, 123.40, 122.58, 95.96, 95.53, 63.44, 62.49, 60.38, 42.95, 36.94, 33.40, 31.95, 29.65, 21.00, 14.15, 13.92, 13.80; HRMS (ESI) calcd for $C_{26}H_{20}NaO_6$ (M + Na^+) 451.1158, found 451.1152; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 21.03 min, t_{minor} = 29.86 min, *ee* = 91%; $[\alpha]^{25}_D$ = +45.2 (c = 1.5 in $CHCl_3$).



(4*S*)-Ethyl 2-hydroxy-5,10-dioxo-4-(thiophen-2-yl)-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7n) (Table 3, entry 14). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.18-8.04 (m, 1.62 H), 7.97-7.95 (m, 0.27 H), 7.71 (ddd, J = 29.0, 15.3, 6.9 Hz, 2.42 H), 7.14 (d, J = 5.0 Hz, 0.81 H), 7.06 (d, J = 3.5 Hz, 0.53 H), 6.94-6.88 (m, 1.25 H), 5.29 (dd, J = 9.5, 6.0 Hz, 0.46 H), 4.86-4.62 (m, 0.77 H), 4.33 (ddd, J = 21.4, 10.6, 5.2 Hz, 2 H), 4.12 (dd, J = 19.1, 9.3 Hz, 0.55 H), 3.77 (dd, J = 19.2, 6.0 Hz, 0.51 H), 2.73 (dd, J = 14.5, 7.3 Hz, 0.16 H), 2.59-2.48 (m, 0.73 H), 1.34 (t, J = 7.1 Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 192.16, 183.61, 183.08, 181.45, 160.53, 152.46, 143.49, 135.22, 134.25, 133.43, 133.23, 133.07, 132.73, 130.79, 129.12, 128.77, 127.15, 126.81, 126.64, 126.56, 126.43, 126.28, 126.16, 125.40, 125.14, 124.89, 124.46, 124.25, 123.78, 123.54, 122.97, 95.64, 95.26, 63.64, 62.56, 43.43, 38.24, 34.94, 30.94, 29.88, 28.36, 13.93; HRMS (ESI) calcd for $C_{20}H_{16}NaO_6S$ (M + Na^+) 407.0565, found 407.0560; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 19.84 min, t_{minor} = 26.87 min, *ee* = 95%; $[\alpha]^{25}_D$ = +52.6 (c =1.17 in $CHCl_3$).

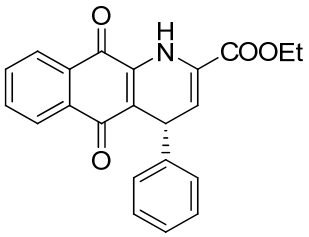


(4*S*)-Ethyl 4-ethyl-2-hydroxy-5,10-dioxo-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7o) (Table 3, entry 15). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.09 (dd, *J* = 20.8, 9.8 Hz, 2 H), 7.76-7.66 (m, 2 H), 4.68 (d, *J* = 84.2 Hz, 0.55 H), 4.40-4.26 (m, 2H), 3.63 (bs, 0.47 H), 3.50 (dd, *J* = 18.0, 8.8 Hz, 0.49 H), 3.30 (dd, *J* = 18.1, 5.5 Hz, 0.50 H), 3.10-2.98 (m, 0.57 H), 2.33-2.15 (m, 1.39 H), 1.90-1.61 (m, 4.47 H), 1.35 (ddd, *J* = 46.0, 25.4, 18.3 Hz, 3.83 H), 1.05 (t, *J* = 7.4 Hz, 1.17 H), 0.96-0.84 (m, 2.52 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 193.49, 184.26, 183.85, 181.27, 179.19, 169.00, 160.91, 153.19, 151.68, 135.03, 134.02, 133.18, 133.09, 132.90, 132.08, 130.91, 129.23, 127.03, 126.57, 126.29, 126.23, 126.07, 125.74, 124.34, 95.96, 63.47, 62.38, 42.30, 32.97, 32.21, 29.21, 28.79, 27.73, 25.79, 25.23, 24.97, 13.94, 12.13, 11.94, 10.65; HRMS (ESI) calcd for $C_{18}H_{18}NaO_6$ (M + Na^+) 353.1001, found 353.0996; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 10.50 min, t_{minor} = 12.10 min, *ee* = 98%; $[\alpha]^{25}_{D}$ = +18.5 (*c* = 1.17 in $CHCl_3$).

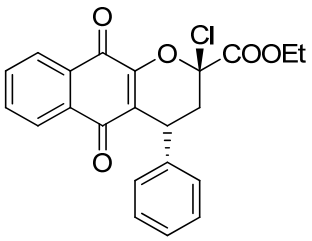


(4*R*)-Methyl 2-hydroxy-5,10-dioxo-4-phenyl-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (7p) (Table 3, entry 16). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.03 (dd, *J* = 77.6, 37.5 Hz, 2 H), 7.68 (d, *J* = 23.6 Hz, 2 H), 7.46 (bs, 0.67 H), 7.30-7.22 (m, 4.4 H), 4.89 (d, *J* = 117.6 Hz, 1 H), 4.43-4.11 (m, 1 H), 3.86 (d, *J* = 15.1 Hz, 3 H), 3.67 (d, *J* = 16.4 Hz, 0.28 H), 2.72 (bs, 0.18 H), 2.46-2.37 (m, 1.22 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 192.20, 183.98, 183.09, 181.46, 179.31, 168.60, 152.94, 142.65, 140.95, 135.09, 134.17, 133.33, 133.16, 132.95, 132.73, 132.05, 130.78, 129.05, 128.72, 128.56, 128.34, 128.12, 127.53, 127.20, 127.05, 126.91, 126.67, 126.39, 126.21, 126.04, 125.02, 123.65, 95.39, 53.79, 52.94, 42.32, 37.86, 35.69, 35.46, 34.64, 33.58, 29.62; HRMS (ESI) calcd for $C_{21}H_{16}NaO_6$ (M + Na^+) 387.0845, found 387.0839; HPLC

(Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{major} = 12.76 min, t_{minor} = 18.37 min, *ee* = 96%; $[\alpha]^{25}_{D}$ = +28.7 (*c* = 1.17 in $CHCl_3$).



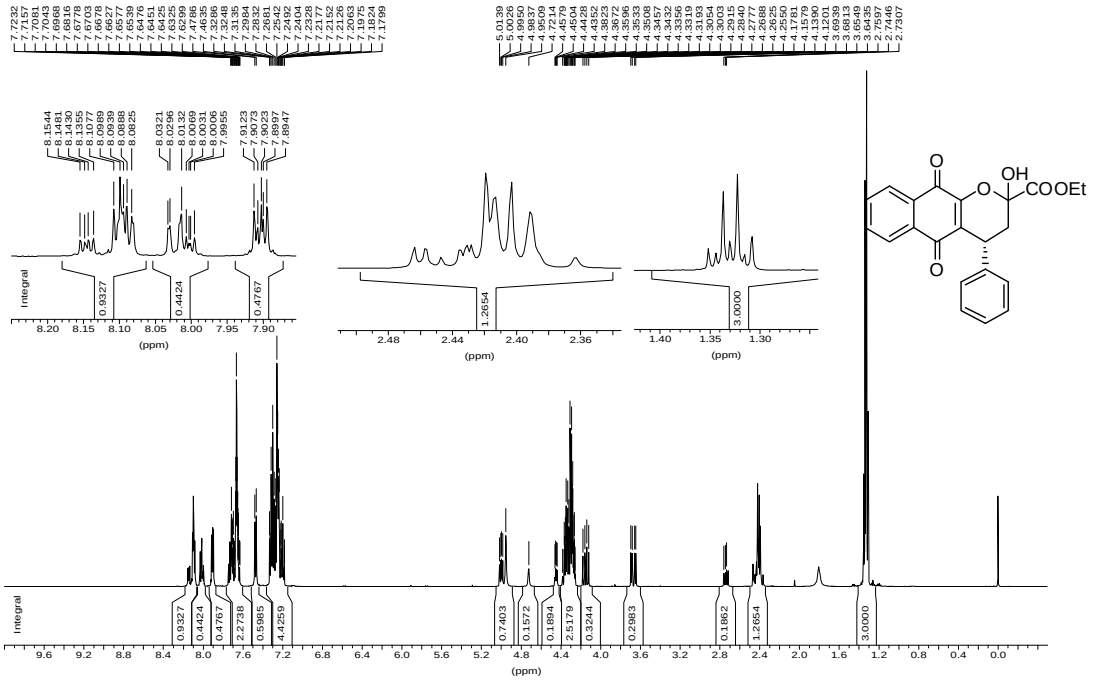
(*R*)-Ethyl 5,10-dioxo-4-phenyl-1,4,5,10-tetrahydrobenzo[g]quinoline-2-carboxylate (9). A solution of **7a** (38 mg, 0.1 mmol) and ammonium acetate (77 mg, 1.0 mmol) in ethanol (0.5 mL) was heated at 70 ℃ for 30 min. The solvent was evaporated and the mixture was purified by column chromatography on silica gel, eluted by hexane/EtOAc= 10:1 to provide **9** as a red solid (15 mg, 42% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.07 (dd, *J* = 7.6, 0.9 Hz, 1 H), 8.00 (dd, *J* = 7.7, 1.1 Hz, 1 H), 7.70-7.61 (m, 3 H), 7.36 (dd, *J* = 8.2, 0.9 Hz, 2 H), 7.31 (dd, *J* = 10.4, 5.0 Hz, 2 H), 7.21 (dd, *J* = 10.2, 4.3 Hz, 1 H), 6.18 (dd, *J* = 5.4, 1.9 Hz, 1 H), 5.05 (d, *J* = 5.4 Hz, 1 H), 4.38-4.27 (m, 2 H), 1.34 (t, *J* = 7.1 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 182.48, 180.11, 162.13, 144.91, 138.86, 134.69, 132.96, 132.49, 130.36, 128.77, 128.25, 127.22, 126.49, 126.30, 126.10, 115.44, 113.69, 62.04, 38.50, 14.13; HRMS (ESI) calcd for $C_{22}H_{17}NNaO_4$ (M + Na^+) 382.1055, found 382.1050; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{minor} = 20.62 min, t_{major} = 26.70 min, *ee* = 75%; $[\alpha]^{25}_{D}$ = +180.7 (*c* = 0.27 in $CHCl_3$).

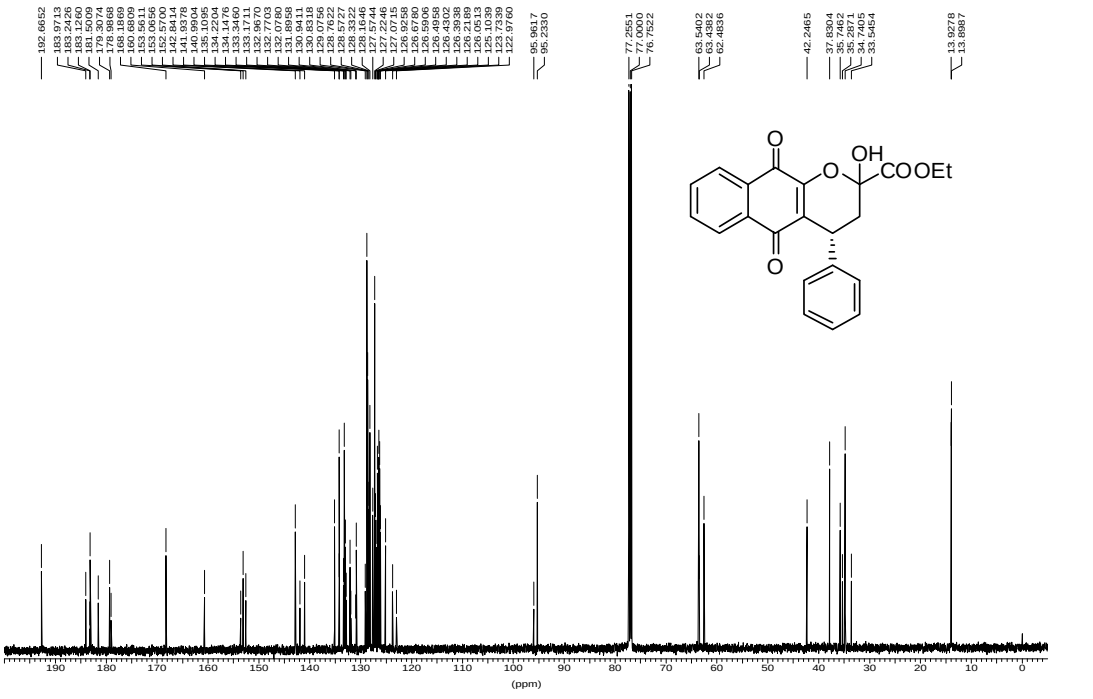


(2*R*,4*R*)-Ethyl 2-chloro-5,10-dioxo-4-phenyl-3,4,5,10-tetrahydro-2H-benzo[g]chromene-2-carboxylate (10). To a solution of **7a** (76 mg, 0.2 mmol) in DCM (1 mL) were added triethylamine (0.1 mL) and methanesulfonyl chloride (0.05 mL) at room temperature. After 12 h, the mixture was purified by column chromatography on silica gel, eluted by hexane/EtOAc= 7:1 to provide **10** as yellow oil (32 mg, 40 % yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.20-8.18 (m, 1 H), 7.80-7.98 (m, 1 H), 7.76-7.70 (m, 2 H), 7.31-7.28 (m, 2 H), 7.23 (dd, *J* = 7.1, 5.2 Hz, 3 H), 4.38-4.30 (m, 3 H), 3.00 (dd, *J* = 14.7, 7.7 Hz, 1 H), 2.83 (dd,

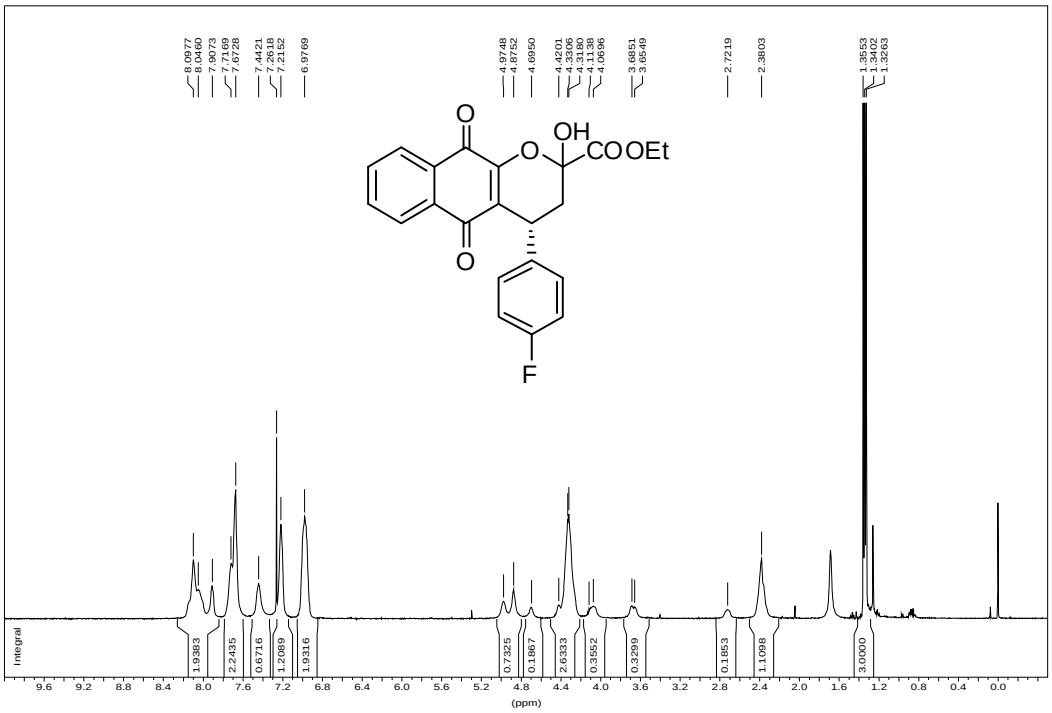
J = 14.7, 6.1 Hz, 1 H), 1.34 (t, J = 7.3 Hz, 3 H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 182.91, 177.67, 165.40, 153.12, 141.28, 134.37, 133.69, 131.84, 130.85, 128.65, 127.51, 126.92, 126.64, 126.62, 123.77, 91.46, 63.62, 40.77, 34.96, 13.89; HRMS (ESI) calcd for $C_{22}H_{17}ClNaO_5$ (M + Na^+) 419.0662, found 419.0659; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_{minor} = 32.20 min, t_{major} = 37.06 min, *ee* = 94%; $[\alpha]^{25}_D$ = +149.7 (c = 0.33 in $CHCl_3$).

Compound **7a**





Compound **7b**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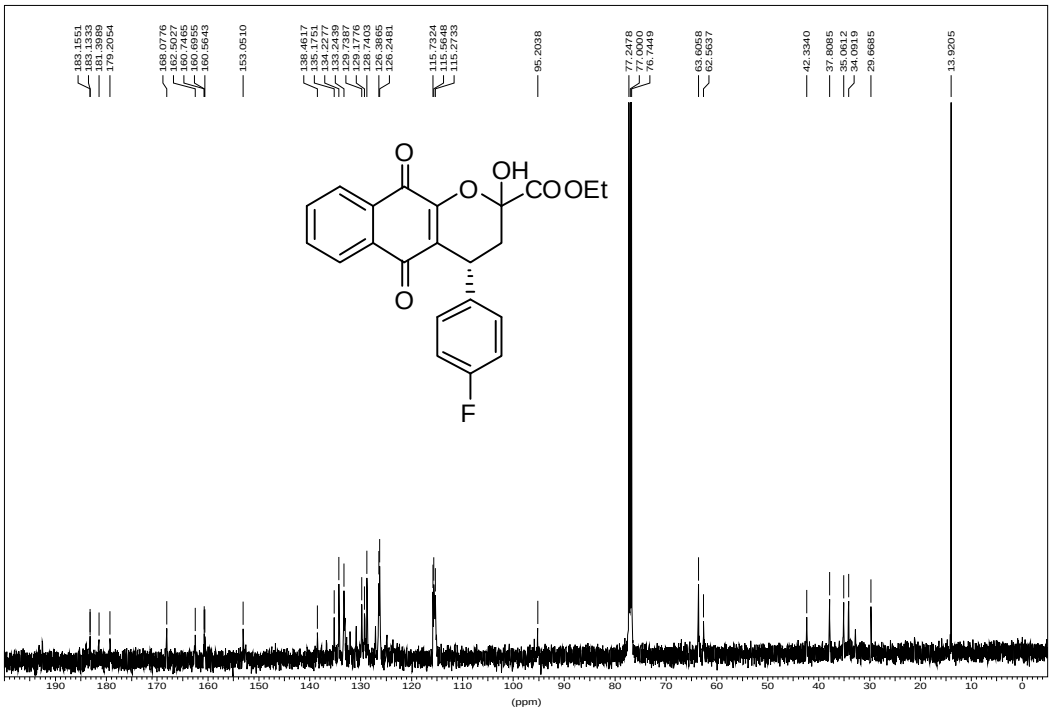
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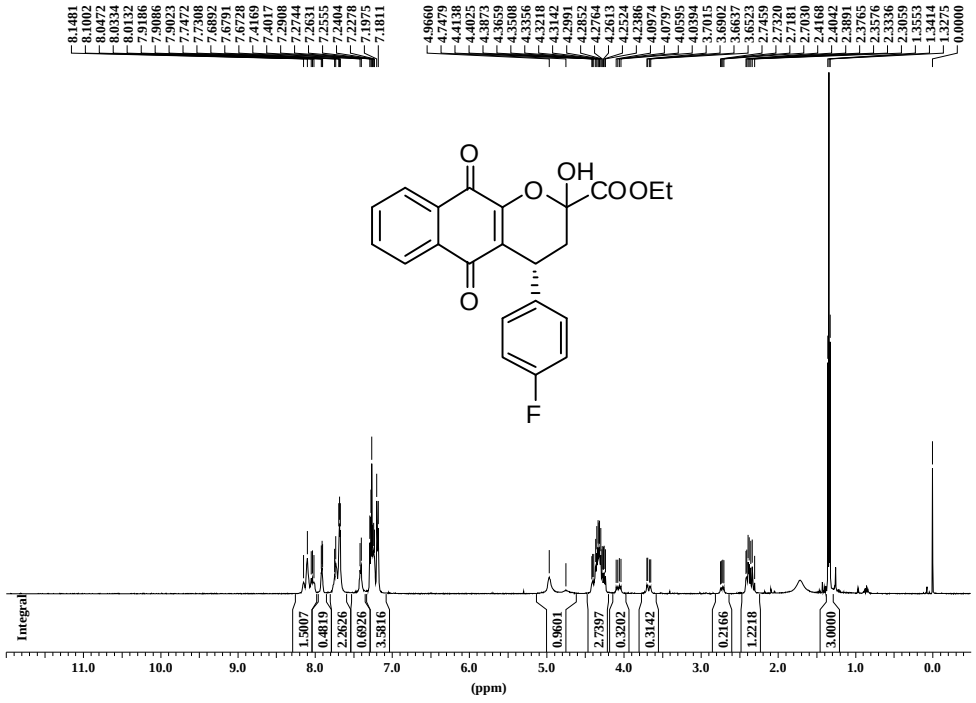
Compound **7c**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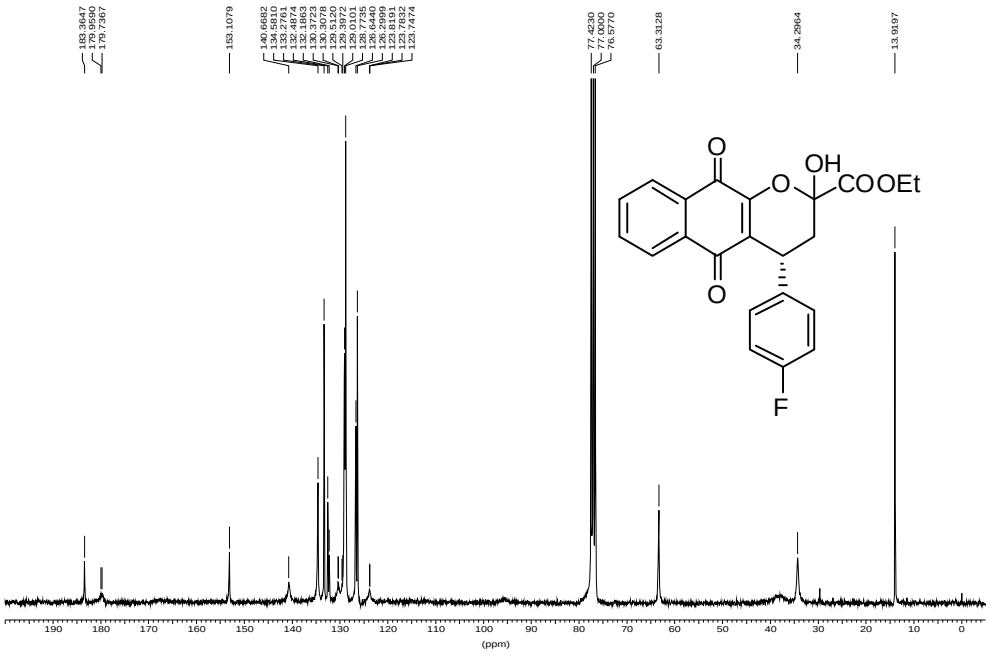
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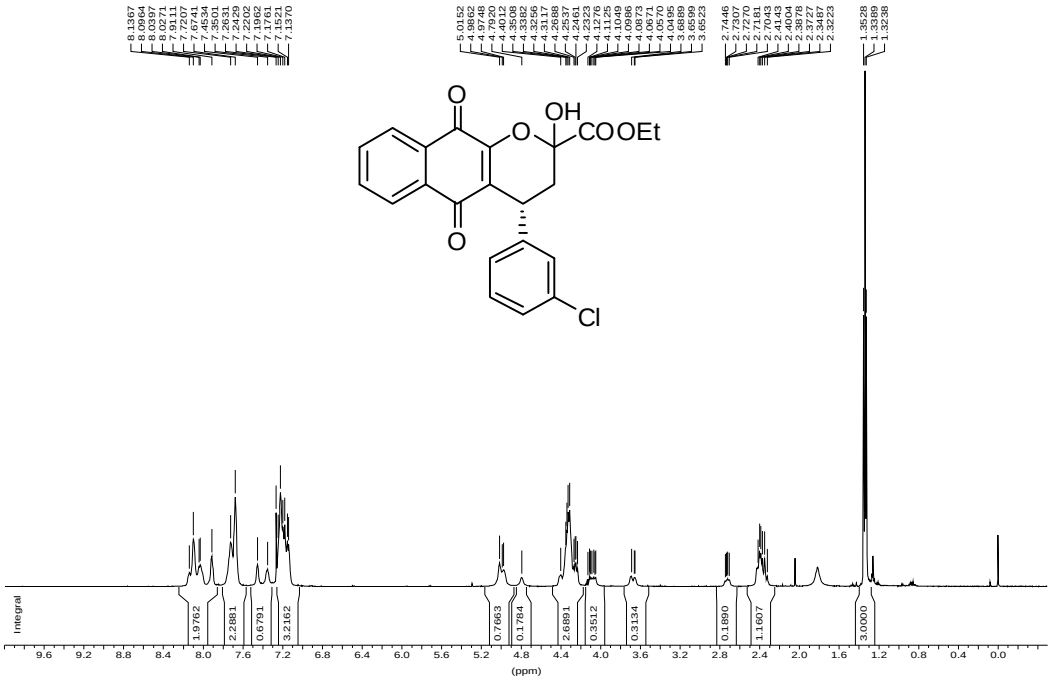
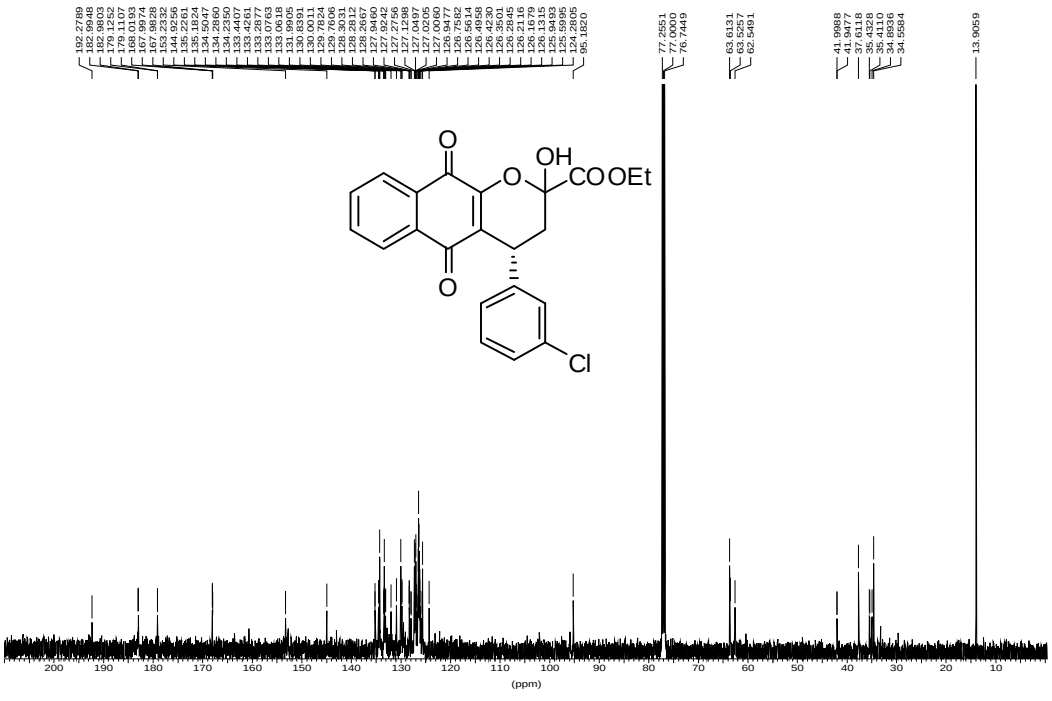
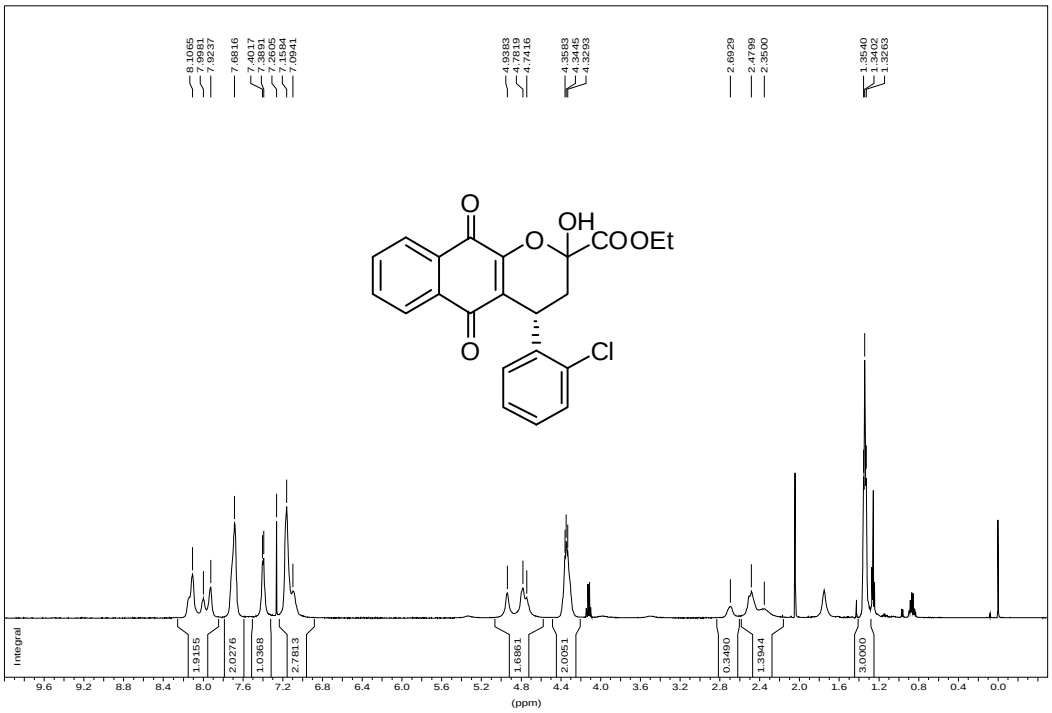
123.7832
123.7474
77.4630
77.0460
76.5770
63.3128
34.2964
13.9197
O
OH
O
COOEt
O
F
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
(ppm)

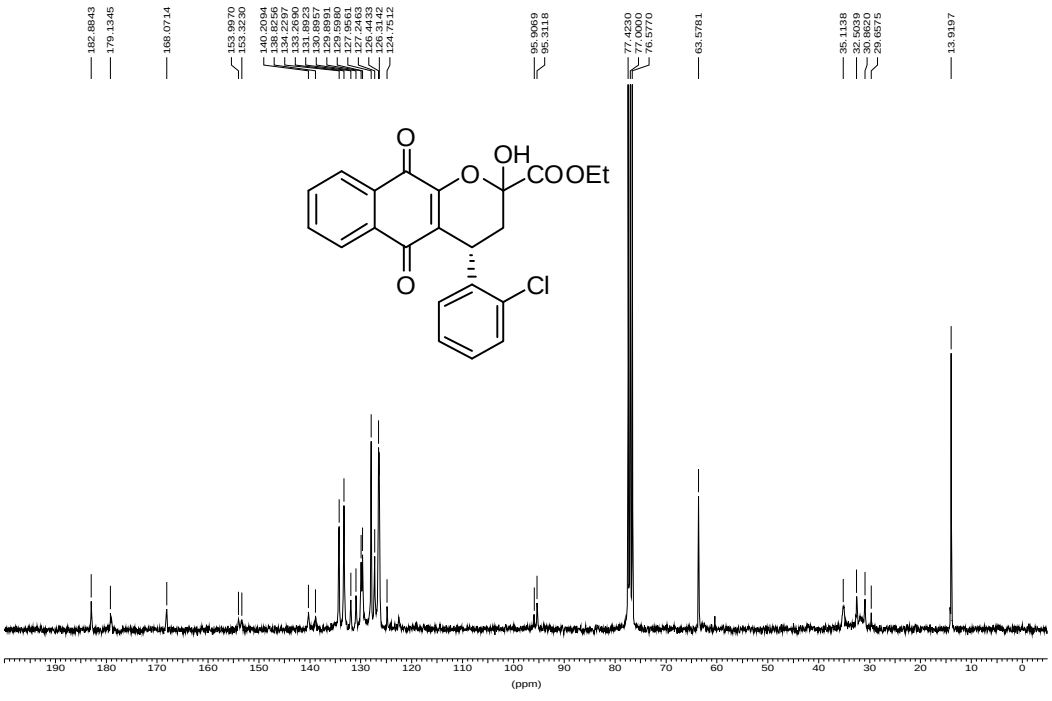
Compound **7d**


8.1367
8.0964
8.0597
8.0271
7.9111
7.7207
7.6744
7.4534
7.3501
7.2631
7.2439
7.2202
7.1962
7.1761
7.1521
7.1370
5.0152
4.9862
4.9748
4.7920
4.4012
4.3508
4.3382
4.3256
4.3117
4.2588
4.2537
4.2461
4.2293
4.1276
4.1125
4.1049
4.0998
4.0873
4.0671
4.0570
4.0485
3.6889
3.6599
3.6523
2.7446
2.7307
2.7270
2.7181
2.7043
2.4143
2.4004
2.3878
2.3777
2.3497
2.3223
1.3528
1.3389
1.3238
O
OH
O
COOEt
O
Cl
Integral
1.9762
2.2881
0.6791
3.2162
0.7663
0.1784
2.6891
0.3512
0.3134
0.1980
1.1607
3.0000
9.6 9.2 8.8 8.4 8.0 7.6 7.2 6.8 6.4 6.0 5.6 5.2 4.8 4.4 4.0 3.6 3.2 2.8 2.4 2.0 1.6 1.2 0.8 0.4 0.0
(ppm)

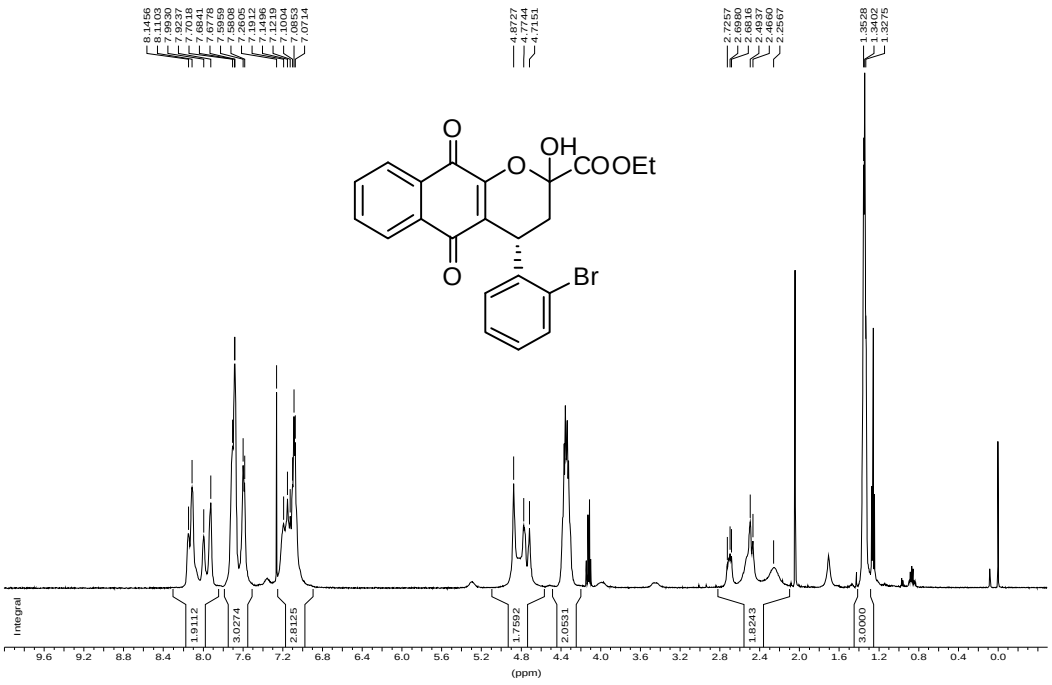

192.2789
182.9948
182.9803
179.1752
179.1107
168.0193
167.9974
167.3938
157.2832
144.9256
135.2261
135.1524
134.5047
134.2860
134.2350
133.4407
133.4261
133.2877
133.0763
133.0618
131.9805
130.8391
130.0011
129.7924
129.7606
128.3031
128.2812
128.2667
127.9460
127.9242
127.2756
127.2139
127.1997
127.0205
127.0060
126.7942
126.7482
126.5614
126.4958
126.4230
126.3501
126.2845
126.2116
126.1679
126.1315
125.9493
125.5995
124.2805
95.1820
77.2551
77.0000
76.7449
63.6131
55.5557
62.5491
41.9988
41.9477
37.6118
35.4328
35.4111
34.8936
34.5584
13.9059
O
OH
O
COOEt
O
Cl
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
(ppm)

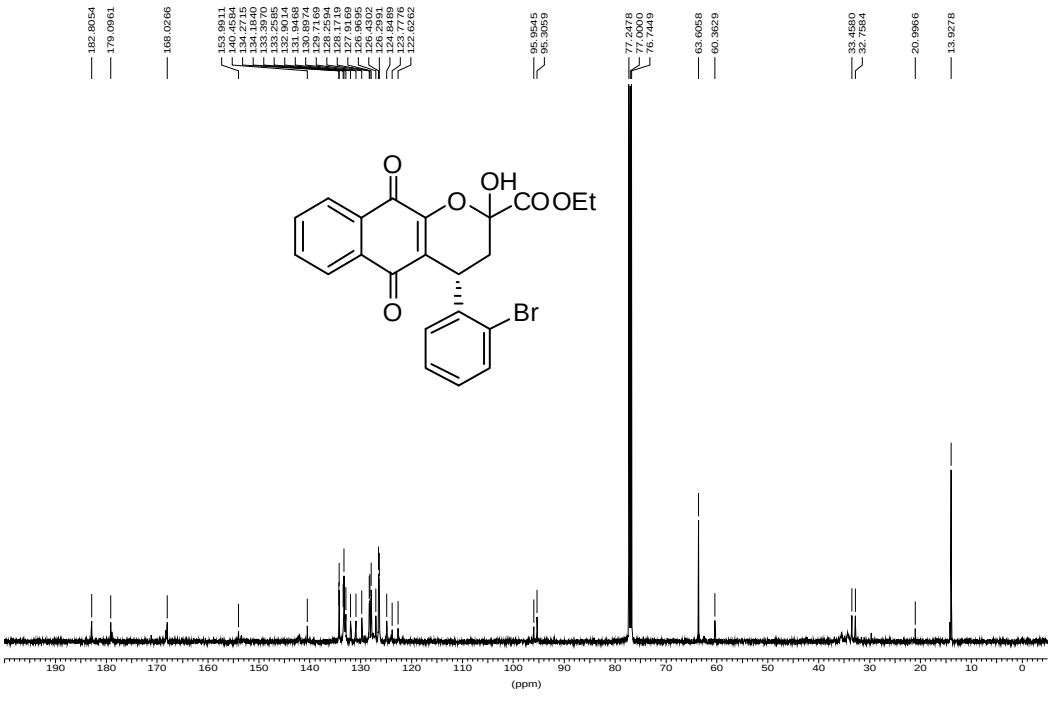
Compound **7e**


8.1065
7.9981
7.9237
7.6816
7.4017
7.3891
7.2605
7.1584
7.0941
4.9383
4.7919
4.7416
4.3583
4.3445
4.3293
2.6929
2.4799
2.3500
1.3540
1.3402
1.3263
O
OH
O
COOEt
O
Cl
Integral
1.9155
2.0276
1.0368
2.7813
1.6861
2.0051
0.3490
1.3944
3.0000
(ppm)

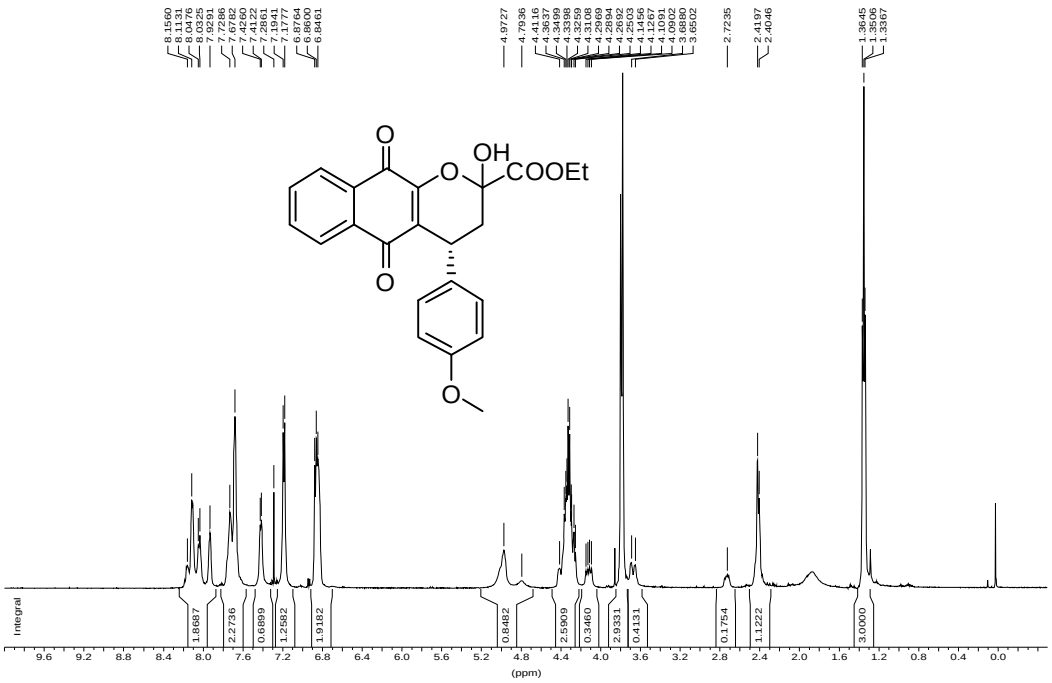

182.8843
179.1345
168.0714
153.9970
153.3230
140.2094
138.8256
134.2297
133.2690
131.8923
130.8957
129.8991
129.5980
127.9561
127.2463
126.4433
126.3142
124.7512
95.9069
95.3118
77.4230
77.0000
76.5770
63.5781
35.1138
32.5039
30.8620
28.6575
13.9197
O
OH
O
COOEt
O
Cl
(ppm)

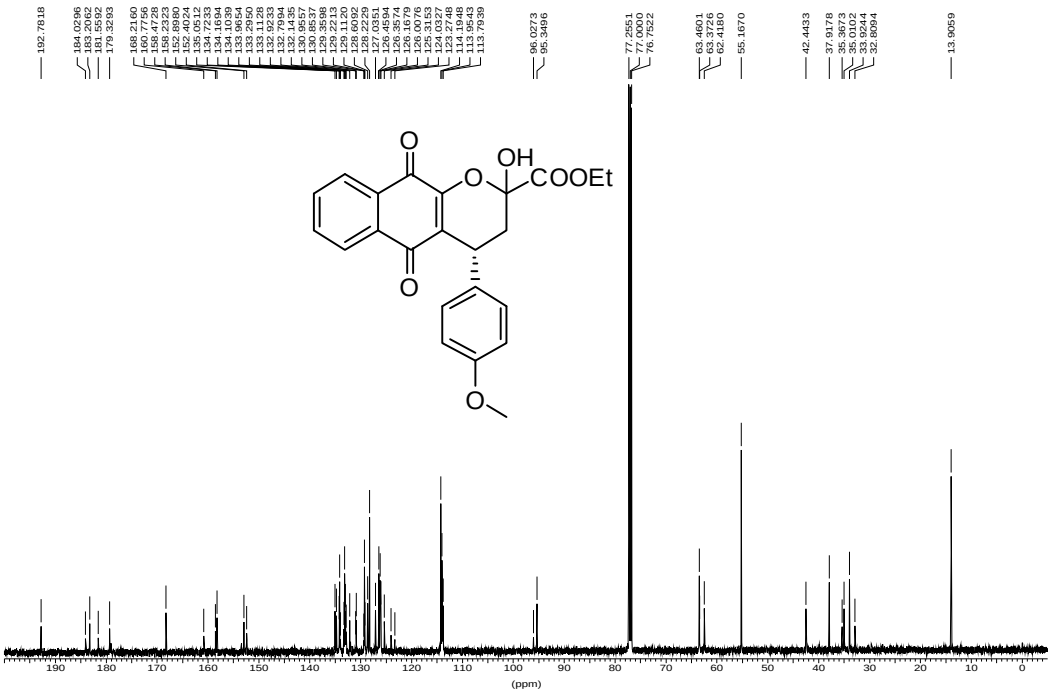
Compound **7f**


8.1456
8.1103
7.9930
7.9637
7.7018
7.6841
7.6778
7.6698
7.5808
7.2605
7.1912
7.1496
7.1219
7.1004
7.0853
7.0714
4.8727
4.7744
4.7151
2.7257
2.6980
2.6816
2.4937
2.4660
2.2567
1.3528
1.3402
1.3275
O
OH
O
COOEt
O
Br
Integral
1.9112
3.0274
2.8125
1.7592
2.0531
1.8243
3.0000
(ppm)

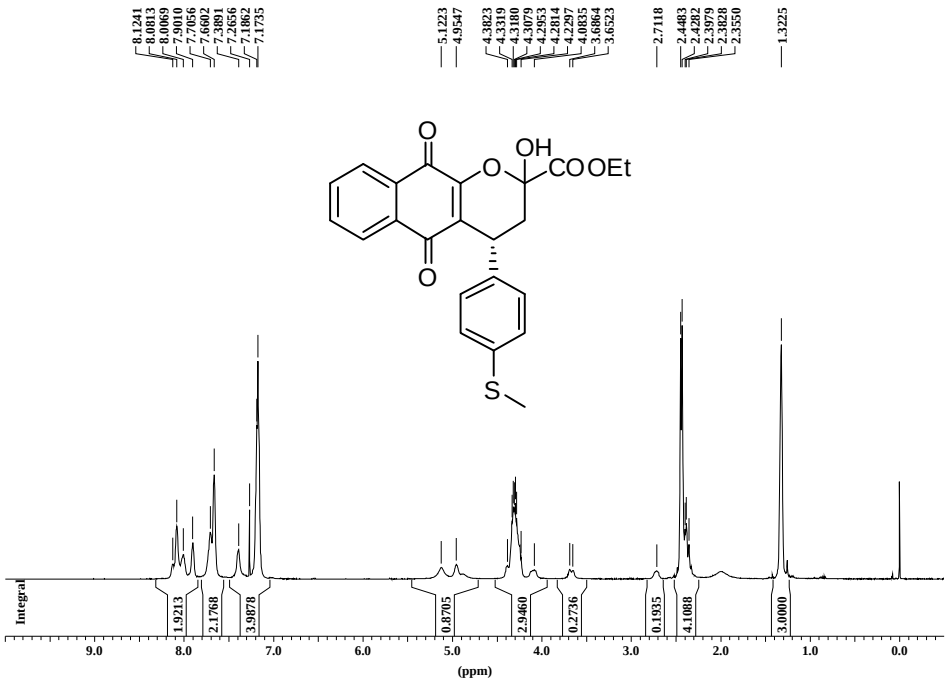

182.8054
179.0961
168.0266
153.9911
140.4584
134.2715
134.1840
133.3970
133.2585
132.9014
131.9468
130.8874
129.7169
128.2594
128.1719
127.7169
126.9695
126.4302
126.2991
124.9499
123.7776
122.6262
95.9545
95.3059
77.2478
77.0000
76.7449
63.6058
60.3629
33.4580
32.7584
20.9966
13.9278
O
OH
O
COOEt
O
Br
(ppm)

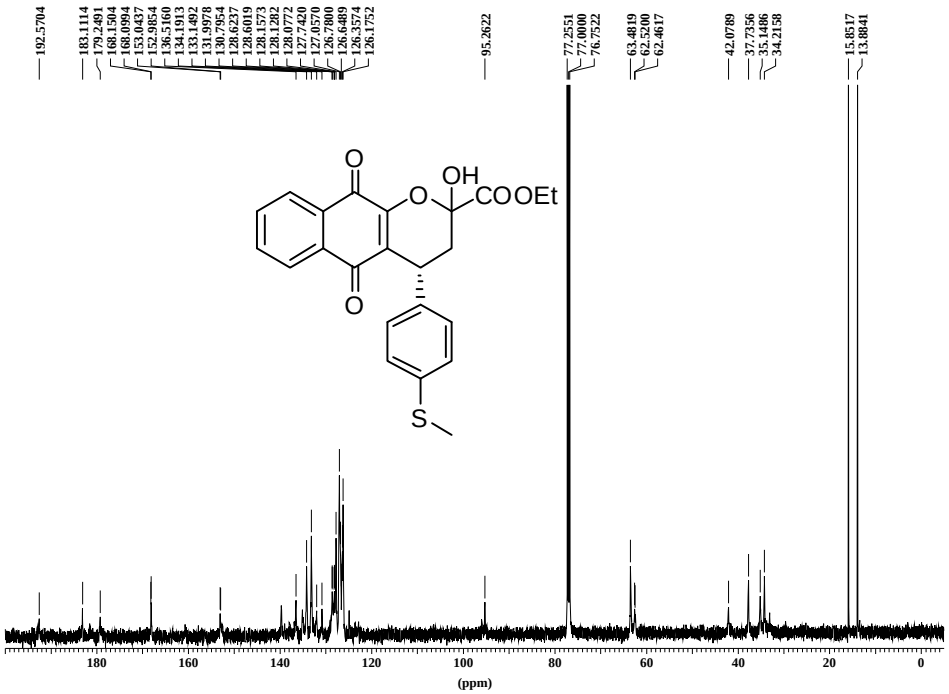
Compound **7g**


8.1560
8.1131
8.0476
8.0325
7.9291
7.7286
7.6782
7.4260
7.4122
7.2961
7.1941
7.1777
6.8764
6.8600
6.6461
4.9727
4.7936
4.4116
4.3637
4.3499
4.3398
4.3259
4.3108
4.2969
4.2894
4.2692
4.2503
4.1456
4.1267
4.1091
4.0902
3.6869
3.6502
2.7235
2.4197
2.4046
1.3645
1.3506
1.3367
O
OH
O
COOEt
O
O
Integral
1.8687
2.2736
0.6899
1.2582
1.9182
0.8482
2.5909
0.3460
2.9331
0.4131
0.1754
1.1222
3.0000
(ppm)


192.7818
184.0296
183.2062
181.5592
179.3293
168.2160
160.7756
158.4728
158.2823
152.8980
152.4024
135.0512
134.4723
134.1694
134.1039
133.9654
133.2990
133.1128
132.9233
132.7994
132.1435
130.9557
130.8537
129.3598
129.2213
129.1120
128.6092
128.2229
127.0851
126.4594
126.3574
126.1679
126.0076
125.3153
124.0327
123.2748
114.1948
113.9543
113.7939
96.0273
95.3496
77.2551
77.0000
76.7522
63.4691
63.3726
62.4180
55.1670
42.4433
37.9178
35.3673
35.0010
33.9244
32.8094
13.9059
O
OH
O
COOEt
O
O
(ppm)

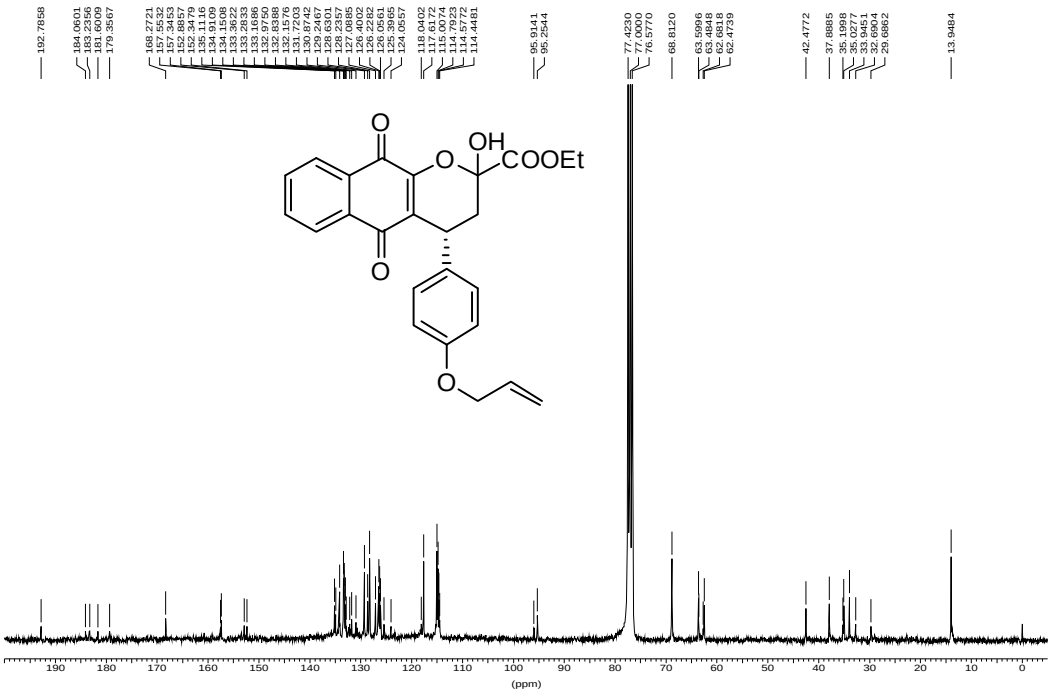
Compound **7h**


8.1241
8.0813
8.0069
7.9010
7.7056
7.6602
7.3891
7.2656
7.1862
7.1735
5.1223
4.9547
4.3823
4.3319
4.3180
4.3079
4.2953
4.2814
4.2297
4.0835
3.6864
3.6523
2.7118
2.4483
2.4282
2.3979
2.3828
2.3550
1.3225
O
OH
O
COOEt
O
S
Integral
1.9213
2.1768
3.9078
0.8705
2.9460
0.2736
0.1935
4.1088
3.0000
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
(ppm)

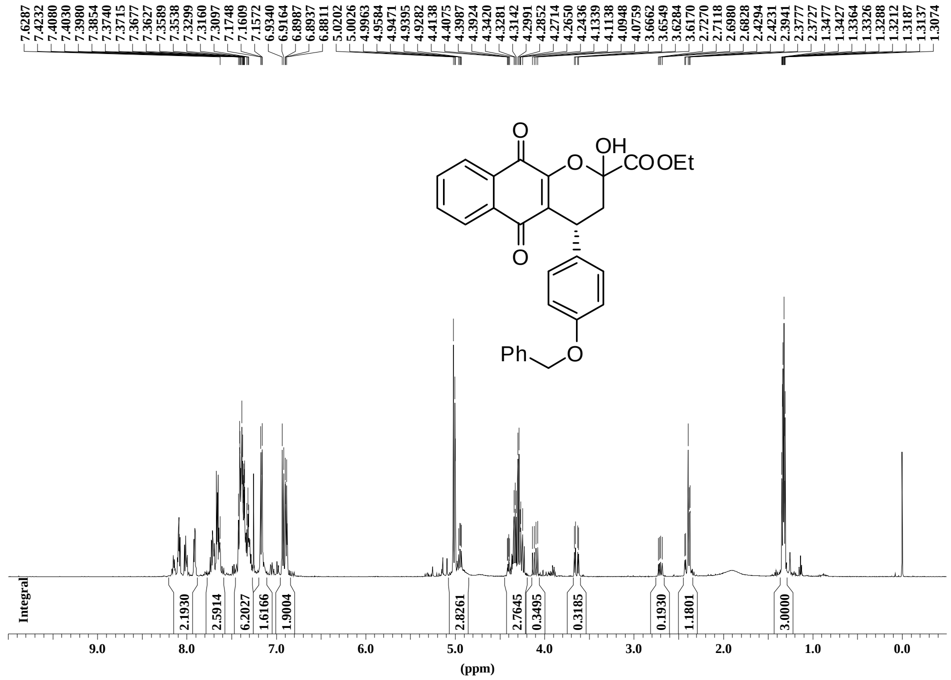

192.5704
183.1114
179.2491
168.1594
160.0994
153.0437
152.9854
136.5160
134.1913
133.1492
131.9978
130.7954
128.6237
128.6019
128.1573
128.1282
128.0772
127.7420
127.0570
126.7800
126.6489
126.3574
126.1752
95.2622
77.2551
77.0000
76.7522
63.4819
62.5200
62.4617
42.0789
37.7356
35.1486
34.2158
15.8517
13.8841
O
OH
O
COOEt
O
S
180
160
140
120
100
80
60
40
20
0
(ppm)

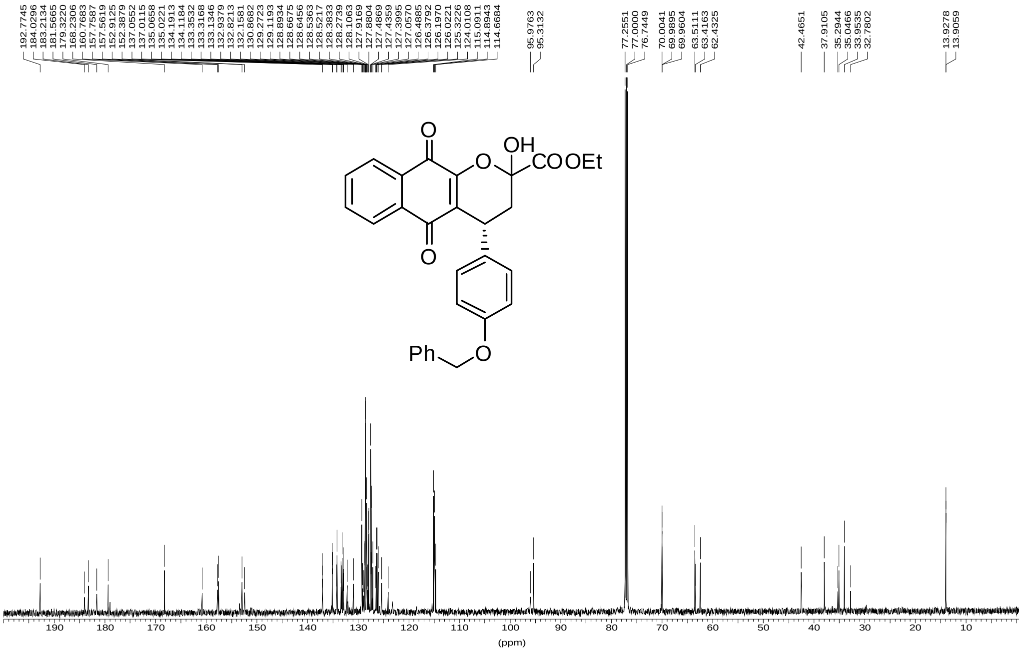
Compound **7i**


OH
COOEt
Integral
1.6561
0.4216
2.3379
0.7335
1.0156
1.6237
0.8976
2.0210
0.2934
0.3531
4.5585
0.3435
0.3545
0.8449
3.0000
(ppm)

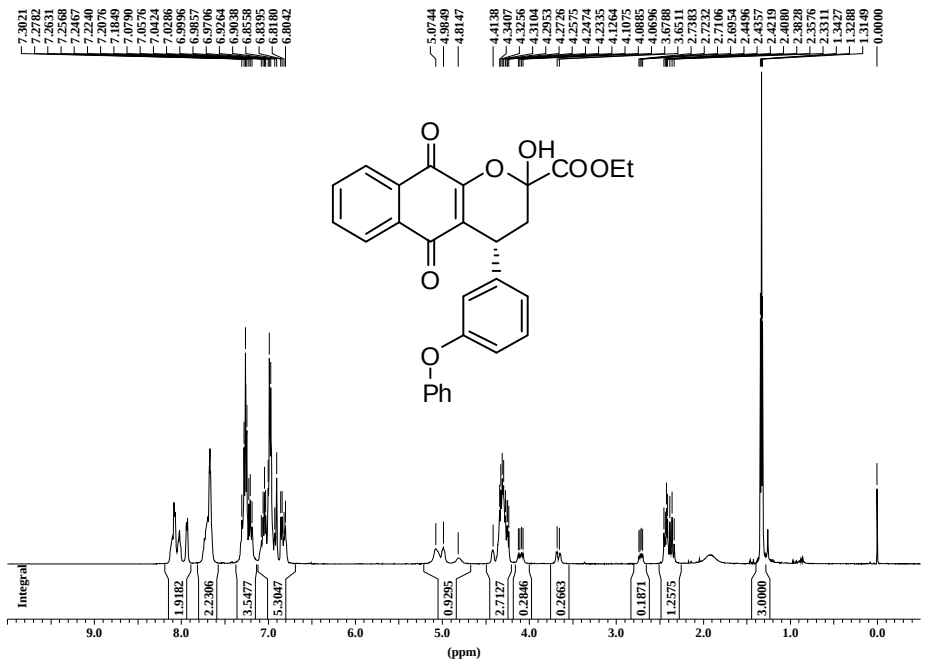

OH
COOEt
(ppm)

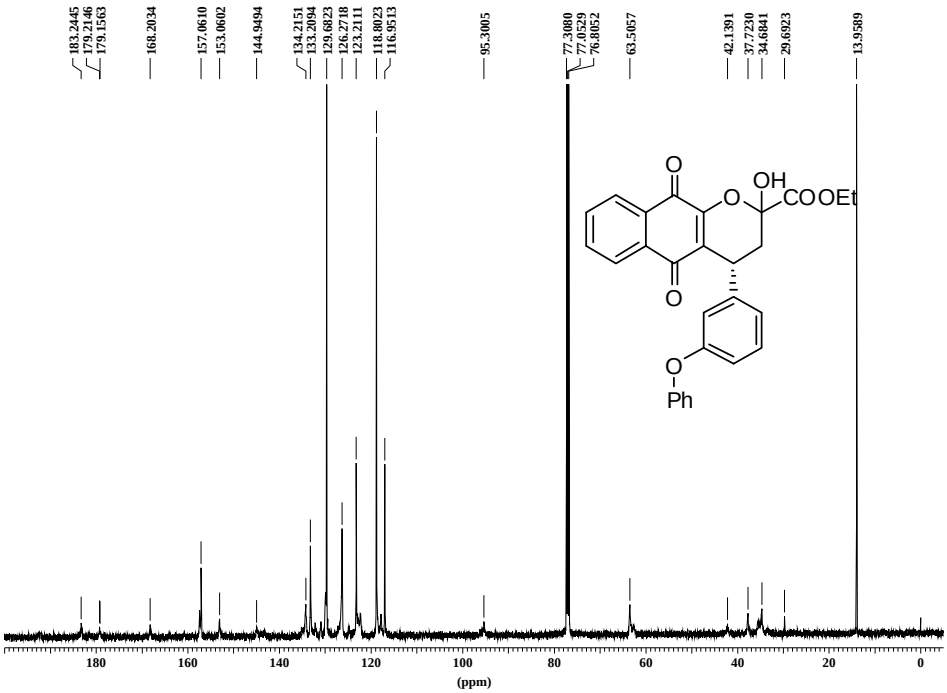
Compound **7j**



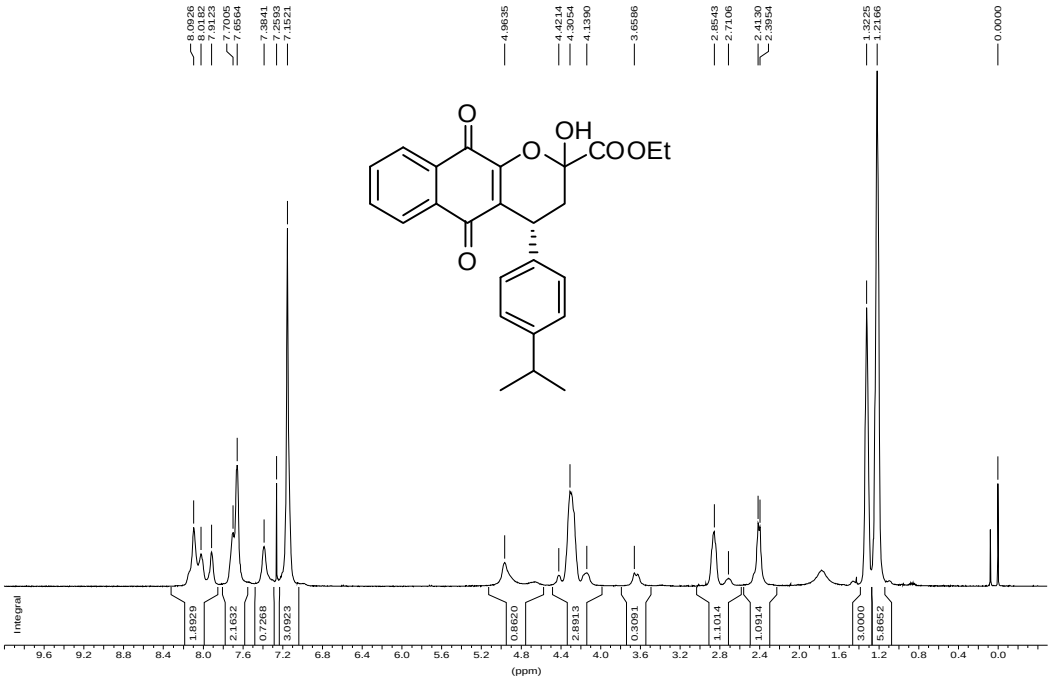


Compound **7k**


7.3021
7.2782
7.2631
7.2568
7.2467
7.2240
7.2076
7.1849
7.0790
7.0576
7.0424
7.0286
6.9996
6.9857
6.9706
6.9264
6.9038
6.8538
6.8395
6.8180
6.8042
5.0744
4.9849
4.8147
4.4138
4.3407
4.3256
4.3104
4.2953
4.2736
4.2575
4.2474
4.2335
4.1264
4.1075
4.0885
4.0696
3.6788
3.6511
2.7383
2.7222
2.7106
2.6954
2.4496
2.4357
2.4219
2.4080
2.3828
2.3576
2.3311
1.3427
1.3288
1.3149
0.0000
O
OH
COOEt
O
O
O
Ph
Integral
1.9182
2.2306
3.5477
5.3047
0.9295
2.7127
0.2846
0.2663
0.1871
1.2575
3.0000
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
(ppm)

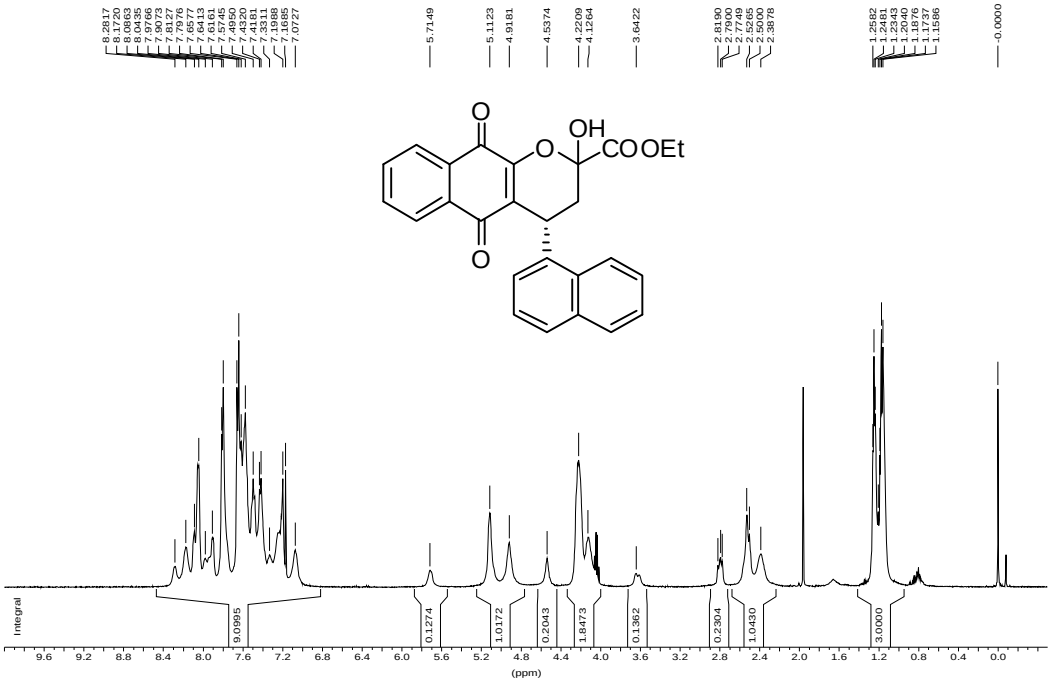

183.2445
179.2146
179.1563
168.2034
157.0610
153.0602
144.9494
134.2151
133.2094
129.6823
126.2718
123.2111
118.8023
116.9513
95.3005
77.3080
77.0529
76.8052
63.5057
42.1391
37.7230
34.6841
29.6923
13.9589
O
OH
COOEt
O
O
Ph
180
160
140
120
100
80
60
40
20
0
(ppm)

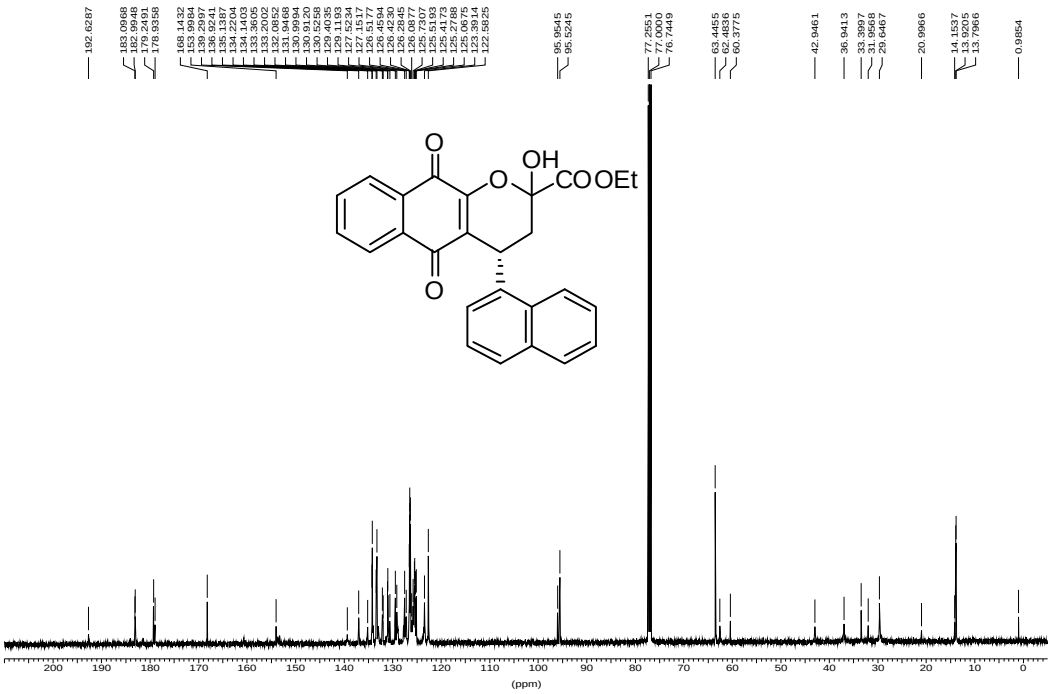
Compound **7l**


8.0926
8.0182
7.9123
7.7005
7.6564
7.3841
7.2593
7.1521
4.9635
4.4214
4.3054
4.1390
3.6586
2.8543
2.7106
2.4130
2.3954
1.3225
1.2166
0.0000
O
OH
O
COOEt
O
Integral
1.8929
2.1632
0.7268
3.0923
0.8620
2.8913
0.3091
1.1014
1.0914
3.0000
5.8652
(ppm)

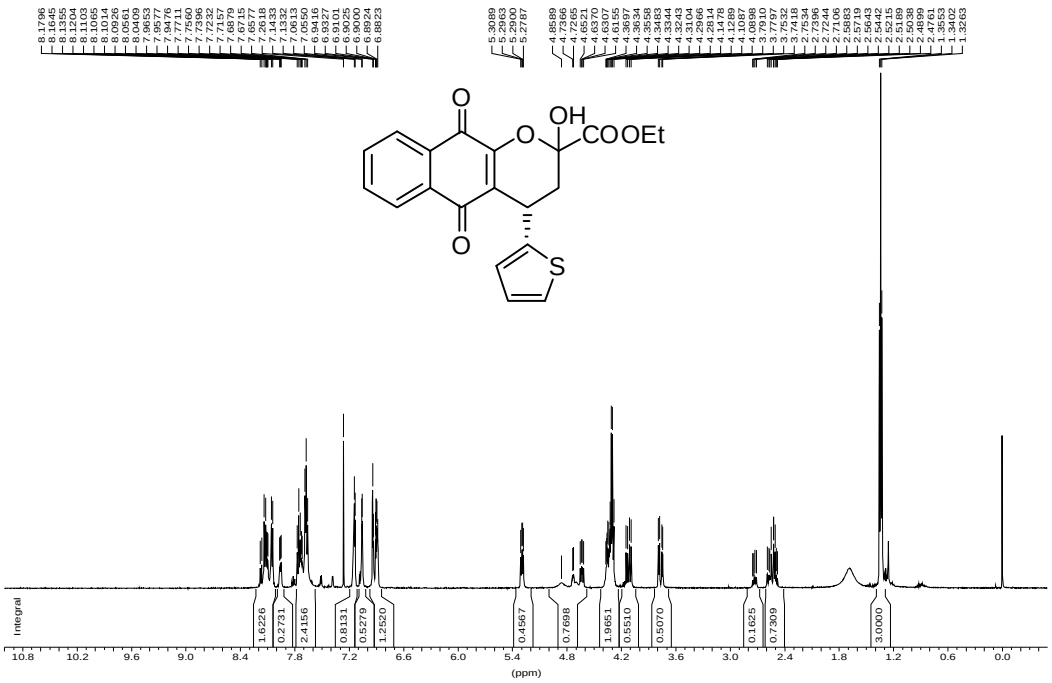

192.8036
184.0078
183.1333
181.5811
179.3436
168.2452
160.7538
152.9781
147.4698
146.9879
139.9483
138.2722
135.6439
134.0893
133.1055
132.9087
132.1777
130.8828
128.0772
127.3995
127.1090
126.7873
126.6124
126.4594
126.3985
126.1898
126.0076
125.3517
95.3350
77.2478
76.9927
76.7449
63.4528
62.4160
42.4068
37.9397
35.4328
34.3773
33.6037
23.8678
13.9132
O
OH
O
COOEt
O
(ppm)

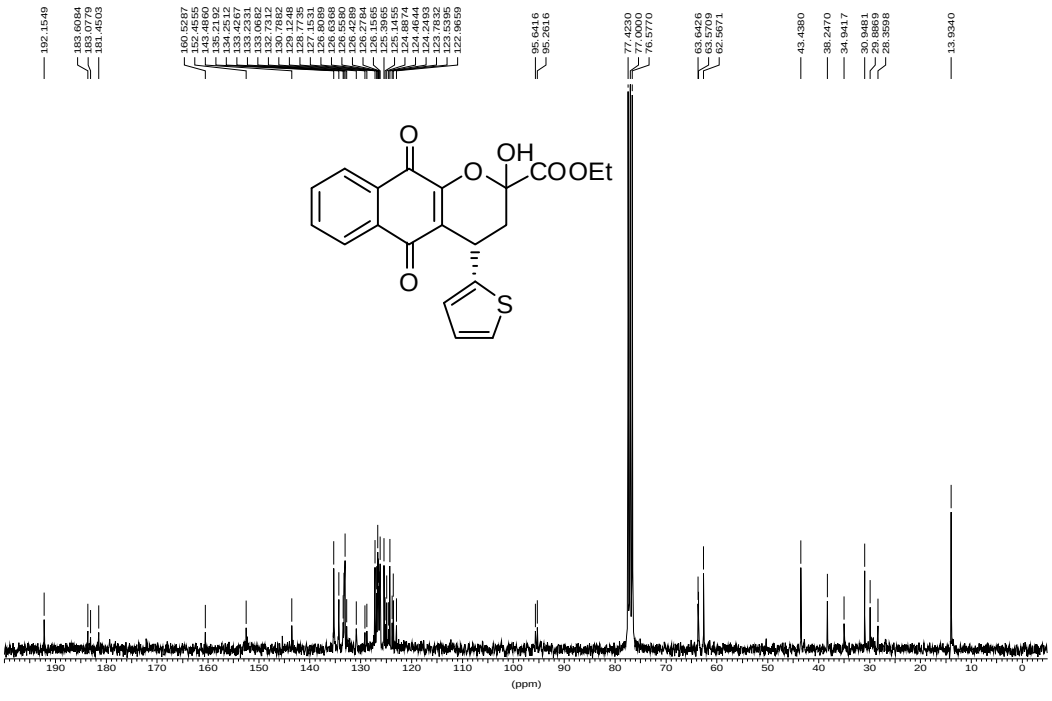
Compound **7m**


8.2817
8.1720
8.0863
8.0435
7.9766
7.9073
7.8127
7.7976
7.6577
7.6413
7.6161
7.5746
7.4950
7.4320
7.4181
7.3911
7.1988
7.1685
7.0727
5.7149
5.1123
4.9181
4.5374
4.2209
4.1264
3.6422
2.8190
2.7900
2.7748
2.5265
2.5000
2.3878
1.2582
1.2481
1.2243
1.2040
1.1876
1.1737
1.1586
-0.0000
O
OH
O
CO OEt
O
Integral
9.0995
0.1274
1.0172
0.2043
1.8473
0.1362
0.2304
1.0430
3.0000
(ppm)

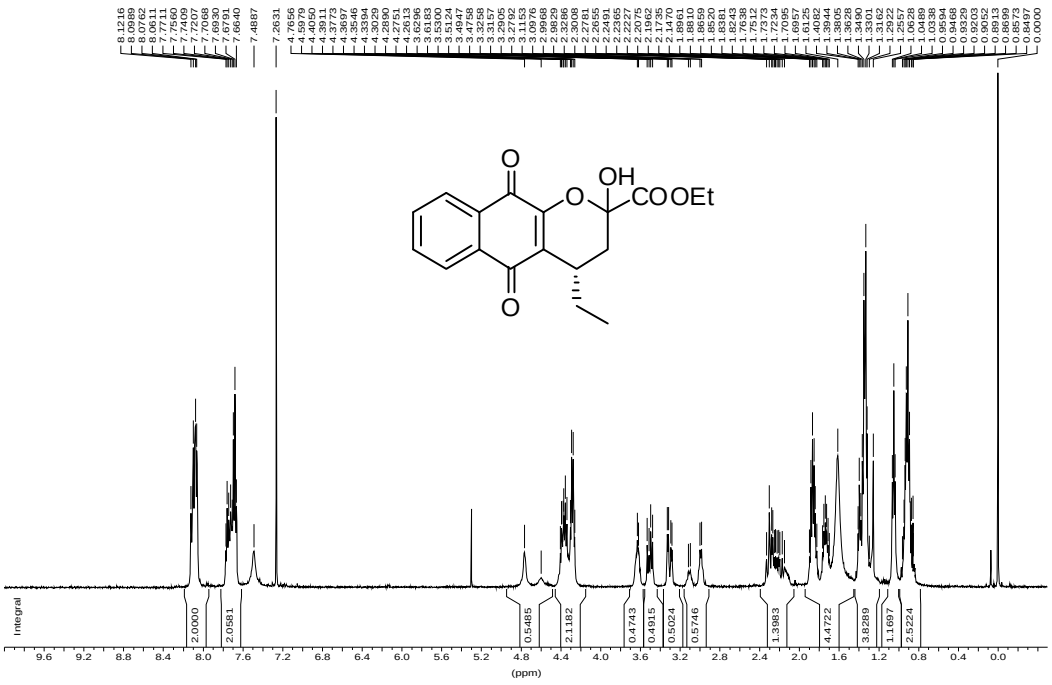

192.6287
183.0968
182.9948
179.2491
178.9358
168.1432
153.9984
139.2997
136.9241
134.2204
134.1403
133.3605
132.2092
132.0852
131.9468
130.9994
130.7530
130.5258
129.4035
129.1193
127.1534
127.1517
126.5177
126.4594
126.3430
126.2845
126.0877
125.7307
125.5193
125.4173
125.2788
125.0675
123.9914
122.5825
95.9545
95.5245
77.2551
77.0000
76.7449
63.4455
62.4466
60.3775
42.9461
36.9413
33.3997
31.9568
29.6467
20.9966
14.1537
13.9205
13.7966
0.9854
O
OH
O
CO OEt
O
(ppm)

Compound **7n**


O
OH
O
COOEt
O
S
Integral
1.6226
0.2731
2.4156
0.8131
0.5279
1.2520
0.4567
0.7698
1.9651
0.5510
0.5070
0.1625
0.7309
3.0000
(ppm)

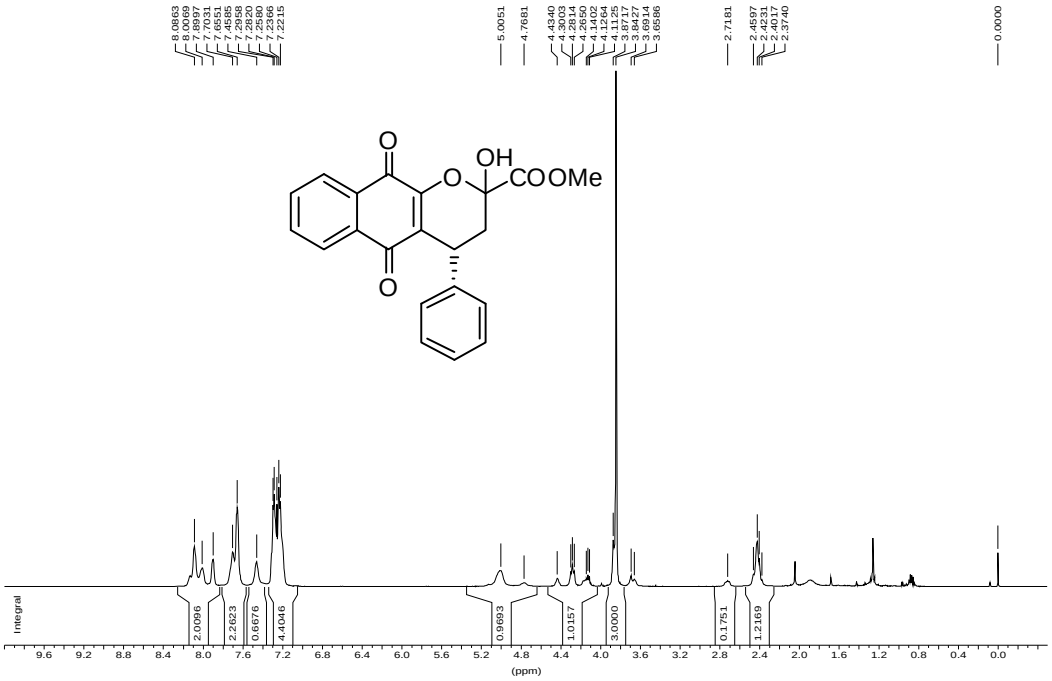

O
OH
O
COOEt
O
S
(ppm)

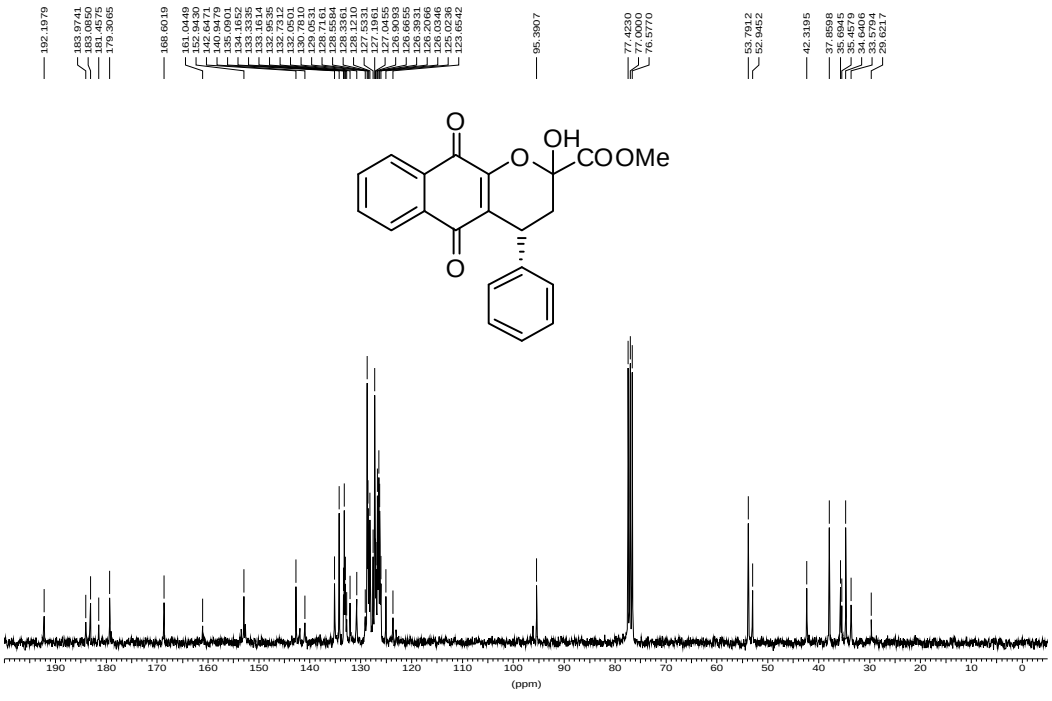
Compound **7o**


O
OH
O
COOEt
O
Integral
2.0000
2.0581
0.5485
2.1182
0.4743
0.4915
0.5024
0.5746
1.3983
4.4722
3.8289
1.1697
2.5224
(ppm)

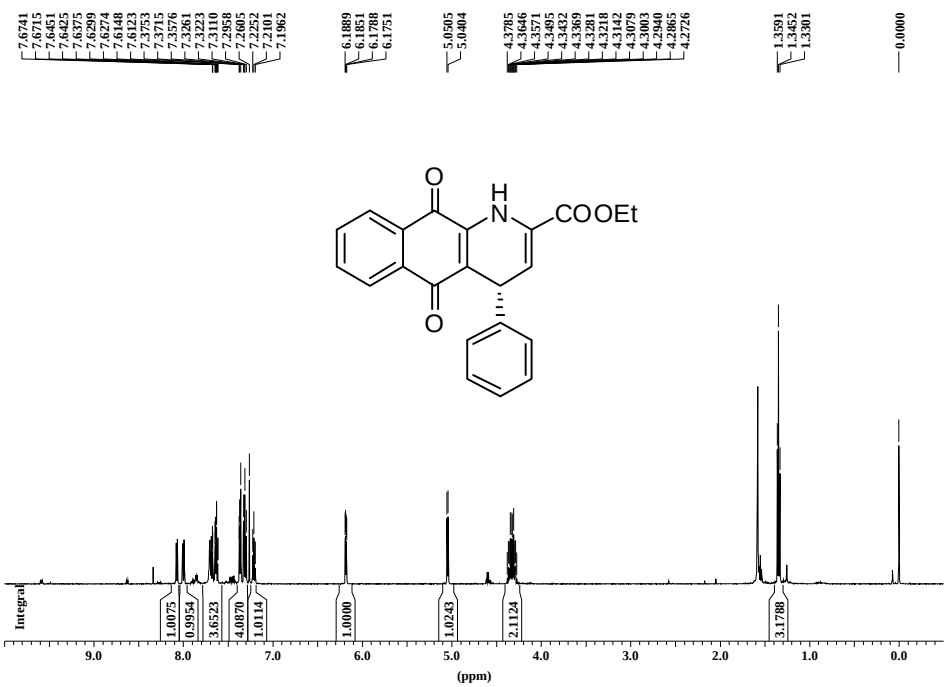

O
OH
O
COOEt
O
(ppm)

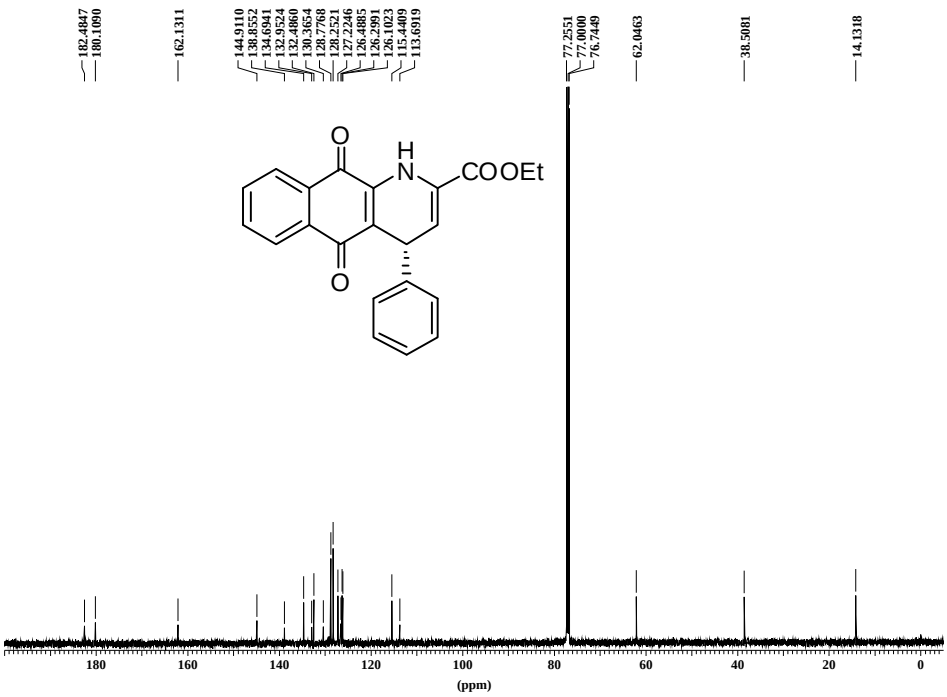
Compound **7p**


8.0863
8.0069
7.8997
7.7031
7.6551
7.4585
7.2958
7.2820
7.2580
7.2366
7.2215
5.0051
4.7681
4.4340
4.3003
4.2814
4.2650
4.1402
4.1264
4.1135
3.8717
3.8427
3.6914
3.6586
2.7181
2.4597
2.4231
2.4017
2.3740
0.0000
O
OH
O
COOMe
O
Integral
2.0096
2.2623
0.6676
4.4046
0.9693
1.0157
3.0000
0.1751
1.2169
9.6 9.2 8.8 8.4 8.0 7.6 7.2 6.8 6.4 6.0 5.6 5.2 4.8 4.4 4.0 3.6 3.2 2.8 2.4 2.0 1.6 1.2 0.8 0.4 0.0
(ppm)

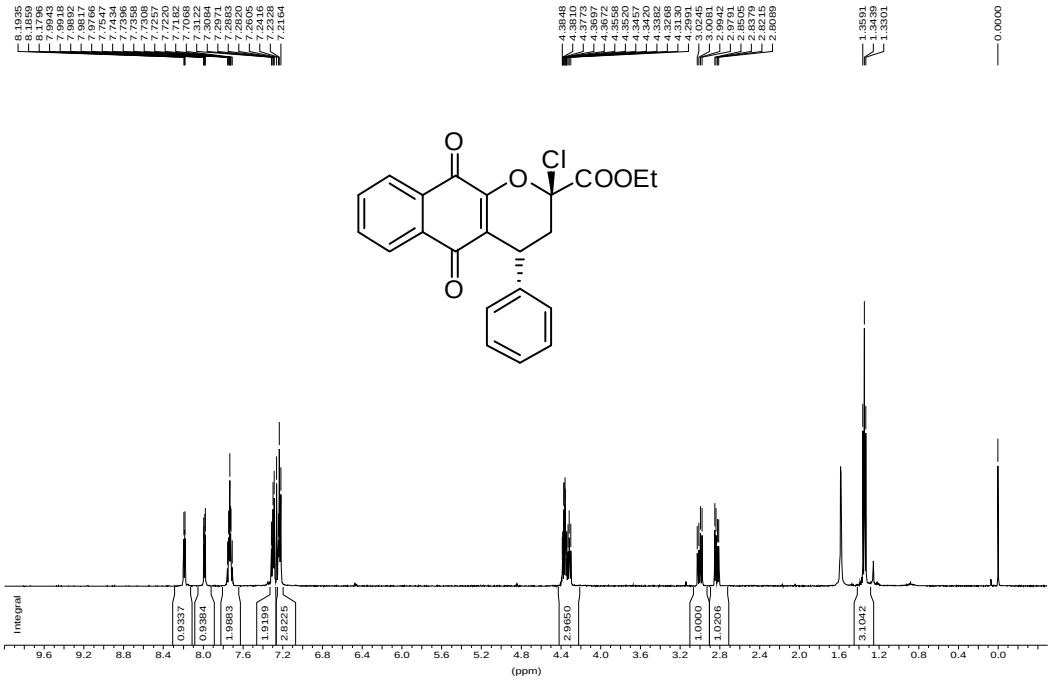

192.1979
183.9741
183.0850
181.4575
179.3065
168.6019
161.0449
152.9430
147.1471
140.9479
135.0901
134.1652
133.3235
133.1614
132.9535
132.7312
132.5701
130.7810
129.0531
128.7161
128.6564
128.3361
128.1210
127.5331
127.1961
127.0455
126.9093
126.6655
126.3931
126.2066
126.0346
125.0236
123.6642
95.3907
77.4230
77.0000
76.5770
53.7912
52.9452
42.3195
37.8598
35.6945
35.4753
34.6406
33.5794
29.6217
O
OH
O
COOMe
O
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
(ppm)

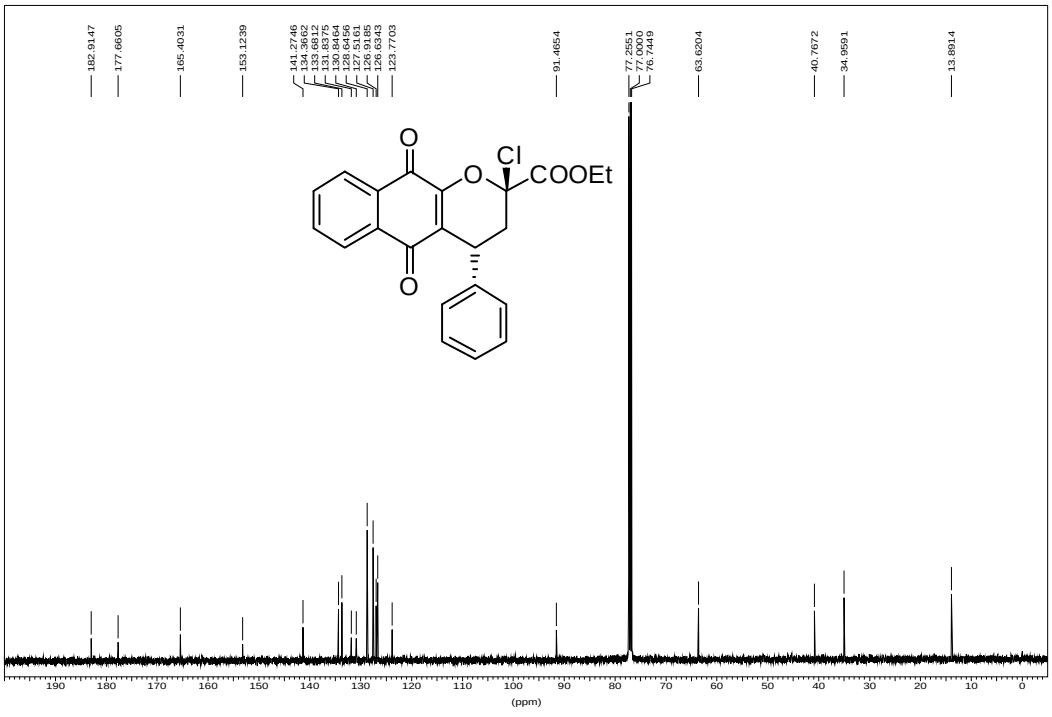
Compound **9**


7.6741
7.6715
7.6451
7.6425
7.6375
7.6299
7.6274
7.6148
7.6123
7.3753
7.3715
7.3576
7.3261
7.3223
7.3110
7.2958
7.2605
7.2552
7.2101
7.1962
6.1889
6.1851
6.1788
6.1751
5.0505
5.0404
4.3785
4.3646
4.3571
4.3495
4.3432
4.3369
4.3291
4.3218
4.3142
4.3078
4.3003
4.2940
4.2865
4.2726
1.3591
1.3452
1.3301
0.0000
O
H
N
COOEt
O
Integral
1.0075
0.9954
3.6523
4.0870
1.0114
1.0000
1.0243
2.1124
3.1788
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
(ppm)


182.4847
180.1090
162.1311
144.9110
138.8552
134.6941
132.9524
132.4860
130.3654
128.7768
128.2521
127.2246
126.4885
126.2991
126.1023
115.4409
113.6919
77.2551
77.0000
76.7449
62.0463
38.5081
14.1318
O
H
N
COOEt
O
180
160
140
120
100
80
60
40
20
0
(ppm)

Compound **10**

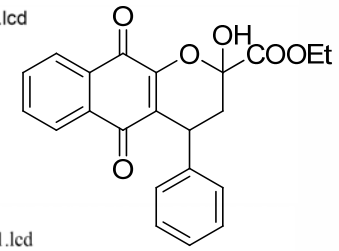

8.1935
8.1859
8.1798
7.9943
7.9918
7.9892
7.9817
7.9766
7.7547
7.7434
7.7298
7.7308
7.7257
7.7220
7.7182
7.7068
7.3122
7.3084
7.2971
7.2883
7.2820
7.2665
7.2416
7.2328
7.2164
4.3848
4.3710
4.3573
4.3697
4.3672
4.3568
4.3520
4.3457
4.3420
4.3382
4.3268
4.3130
4.2991
3.0045
3.0041
2.9942
2.9791
2.8575
2.8370
2.8215
2.8089
1.3591
1.3439
1.3301
0.0000
O
Cl
O
COOEt
O
Integral
0.9337
0.9384
1.9883
1.9199
2.8225
2.9650
1.0000
1.0206
3.1042
(ppm)


182.91.47
177.6605
165.4031
153.1239
141.7746
134.3662
133.6812
131.8375
130.8464
128.8466
127.5161
126.9185
126.6343
123.7703
91.4654
77.2551
77.0000
76.7449
63.6204
40.7672
34.9591
13.8914
O
Cl
O
COOEt
O
(ppm)

Racemic **7a**

==== Shimadzu LCsolution Analysis Report ====

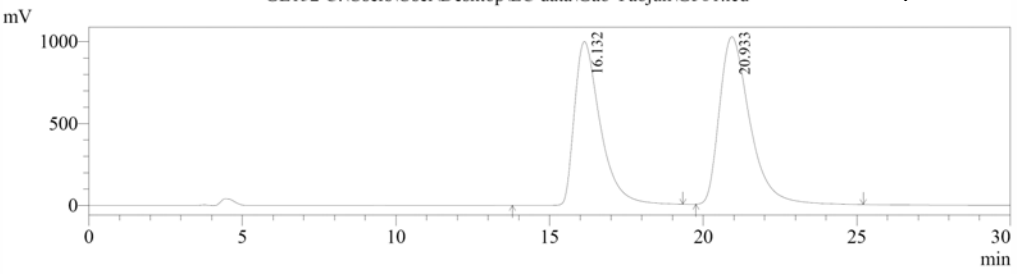
C:\Users\User\Desktop\LC data\Gao Yaojun\G581.lcd



Acquired by : Admin
Sample Name : GE132
Sample ID : GYJ
Data File Name : G581.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA

Chromatogram

GE132 C:\Users\User\Desktop\LC data\Gao Yaojun\G581.lcd



PeakTable

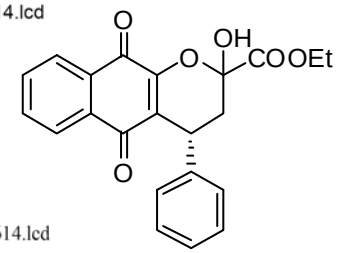
SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.132	58027528	996826	45.200	49.370
2	20.933	70353214	1022275	54.800	50.630
Total		128380742	2019101	100.000	100.000

Enantiomeric enriched **7a**

==== Shimadzu LCsolution Analysis Report ====

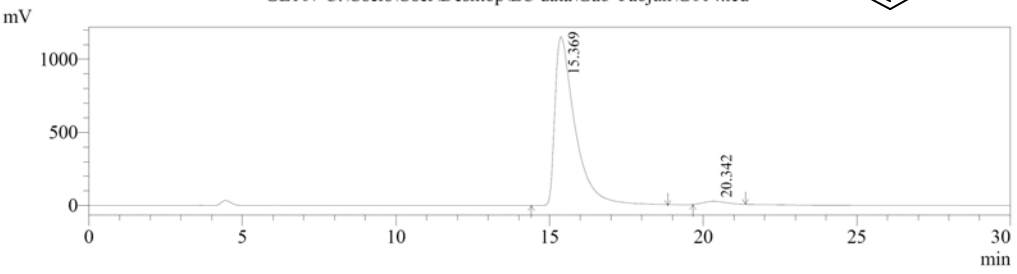
C:\Users\User\Desktop\LC data\Gao Yaojun\G614.lcd



Acquired by : Admin
Sample Name : GE167
Sample ID : GYJ
Data File Name : G614.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA

Chromatogram

GE167 C:\Users\User\Desktop\LC data\Gao Yaojun\G614.lcd



PeakTable

SPD-20A Ch1 254nm

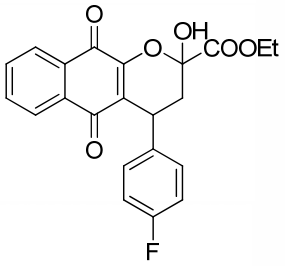
Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.369	53352132	1154616	98.013	98.153
2	20.342	1081728	21728	1.987	1.847
Total		54433860	1176344	100.000	100.000

Racemic **7b**

==== Shimadzu LCsolution Analysis Report ====

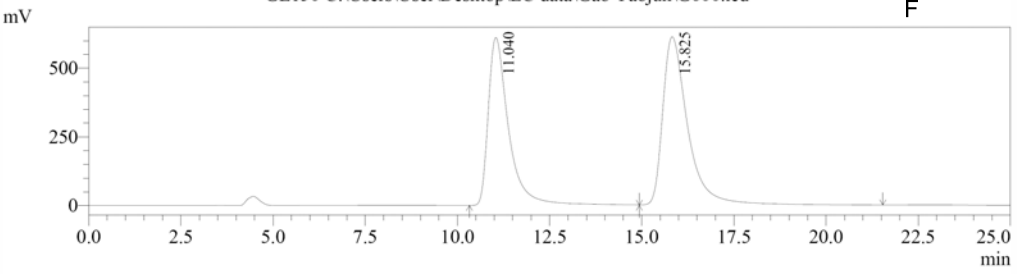
C:\Users\User\Desktop\LC data\Gao Yaojun\G600.lcd

Acquired by : Admin
Sample Name : GE150
Sample ID : GYJ
Data File Name : G600.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram

GE150 C:\Users\User\Desktop\LC data\Gao Yaojun\G600.lcd



PeakTable

SPD-20A Ch1 254nm

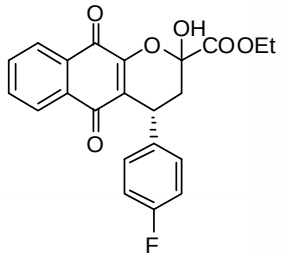
Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.040	23605344	611346	44.770	49.921
2	15.825	29120359	613280	55.230	50.079
Total		52725703	1224626	100.000	100.000

Enantiomeric enriched **7b**

==== Shimadzu LCsolution Analysis Report ====

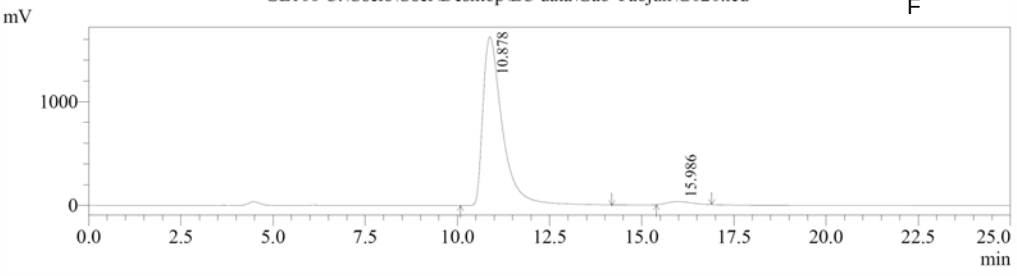
C:\Users\User\Desktop\LC data\Gao Yaojun\G626.lcd

Acquired by : Admin
Sample Name : GE168
Sample ID : GYJ
Data File Name : G626.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram

GE168 C:\Users\User\Desktop\LC data\Gao Yaojun\G626.lcd



PeakTable

SPD-20A Ch1 254nm

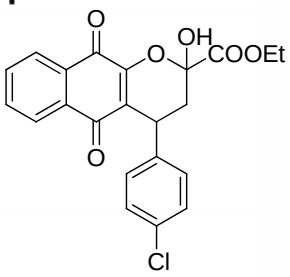
Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.878	60476187	1627729	97.860	98.167
2	15.986	1322655	30392	2.140	1.833
Total		61798842	1658121	100.000	100.000

Racemic **7c**

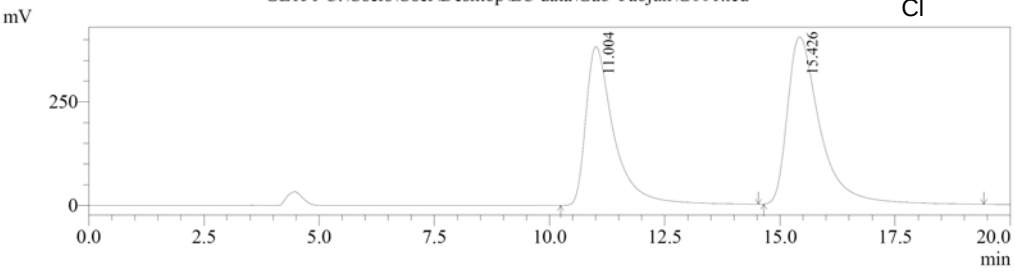
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G601.lcd

Acquired by : Admin
Sample Name : GE151
Sample ID : GYJ
Data File Name : G601.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram
GE151 C:\Users\User\Desktop\LC data\Gao Yaojun\G601.lcd



PeakTable

SPD-20A Ch1 254nm

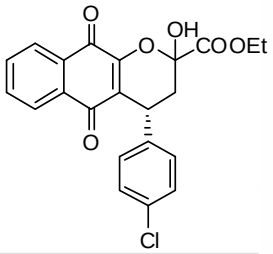
Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.004	16305463	383048	45.113	48.678
2	15.426	19837917	403852	54.887	51.322
Total		36143380	786900	100.000	100.000

Enantiomeric enriched **7c**

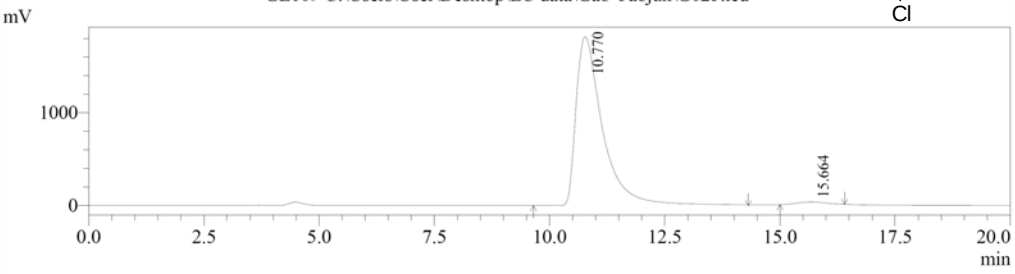
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G625.lcd

Acquired by : Admin
Sample Name : GE169
Sample ID : GYJ
Data File Name : G625.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram
GE169 C:\Users\User\Desktop\LC data\Gao Yaojun\G625.lcd



PeakTable

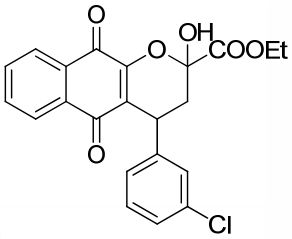
SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.770	73726804	1818805	98.433	98.536
2	15.664	1173414	27019	1.567	1.464
Total		74900218	1845824	100.000	100.000

Racemic **7d**

==== Shimadzu LCsolution Analysis Report ====

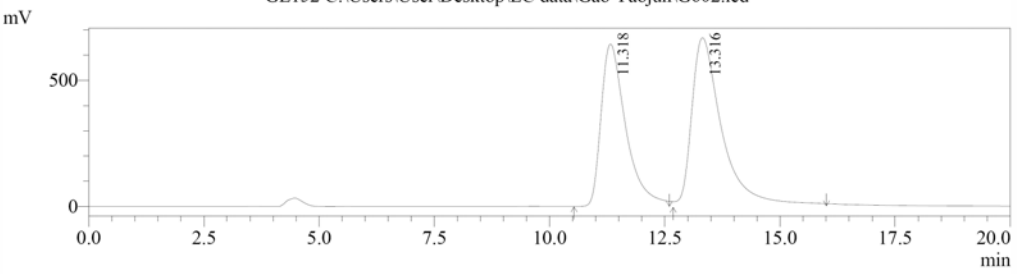
C:\Users\User\Desktop\LC data\Gao Yaojun\G602.lcd



Acquired by : Admin
Sample Name : GE152
Sample ID : GYJ
Data File Name : G602.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA

Chromatogram

GE152 C:\Users\User\Desktop\LC data\Gao Yaojun\G602.lcd



PeakTable

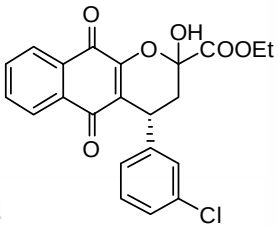
SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.318	24195943	644441	43.754	48.990
2	13.316	31104255	671013	56.246	51.010
Total		55300198	1315455	100.000	100.000

Enantiomeric enriched **7d**

==== Shimadzu LCsolution Analysis Report ====

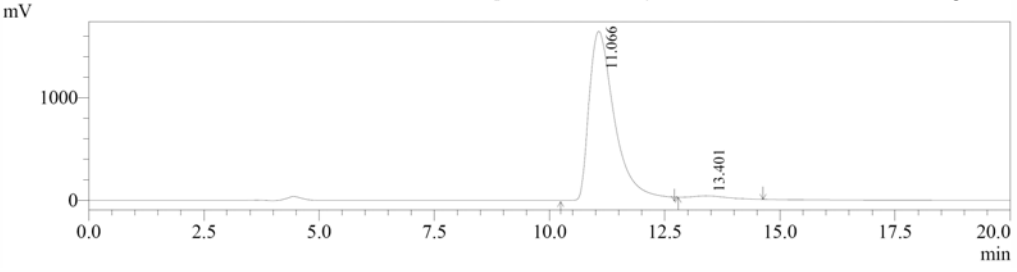
C:\Users\User\Desktop\LC data\Gao Yaojun\G627.lcd



Acquired by : Admin
Sample Name : GE170
Sample ID : GYJ
Data File Name : G627.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA

Chromatogram

GE170 C:\Users\User\Desktop\LC data\Gao Yaojun\G627.lcd



PeakTable

SPD-20A Ch1 254nm

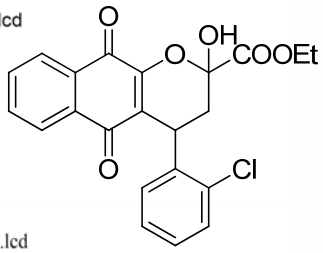
Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.066	65115945	1655410	98.631	98.753
2	13.401	903685	20911	1.369	1.247
Total		66019629	1676321	100.000	100.000

Racemic **7e**

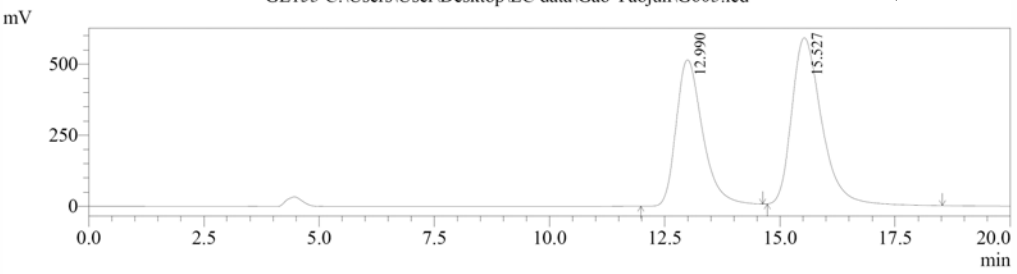
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G603.lcd

Acquired by : Admin
Sample Name : GE153
Sample ID : GYJ
Data File Name : G603.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram
GE153 C:\Users\User\Desktop\LC data\Gao Yaojun\G603.lcd



PeakTable

SPD-20A Ch1 254nm

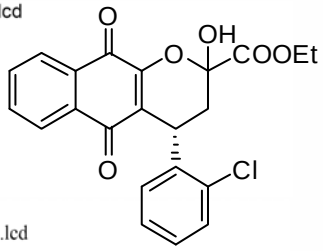
Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.990	20325869	512309	43.568	46.651
2	15.527	26326955	585859	56.432	53.349
Total		46652824	1098168	100.000	100.000

Enantiomeric enriched **7e**

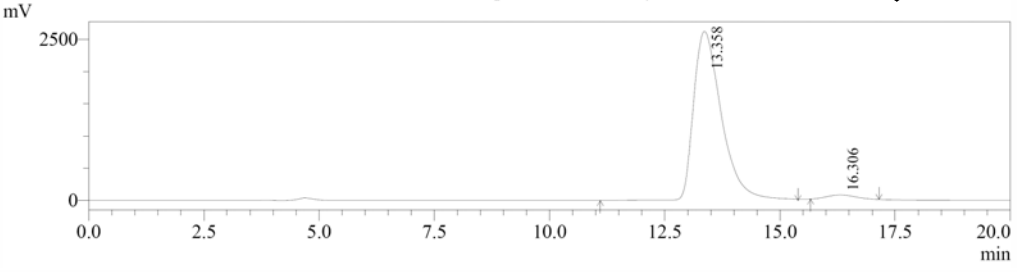
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G628.lcd

Acquired by : Admin
Sample Name : GE171
Sample ID : GYJ
Data File Name : G628.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram
GE171 C:\Users\User\Desktop\LC data\Gao Yaojun\G628.lcd



PeakTable

SPD-20A Ch1 254nm

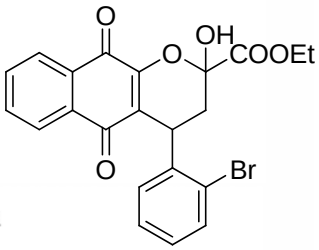
Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.358	111654365	2628505	97.498	97.511
2	16.306	2865352	67094	2.502	2.489
Total		114519717	2695599	100.000	100.000

Racemic **7f**

==== Shimadzu LCsolution Analysis Report ====

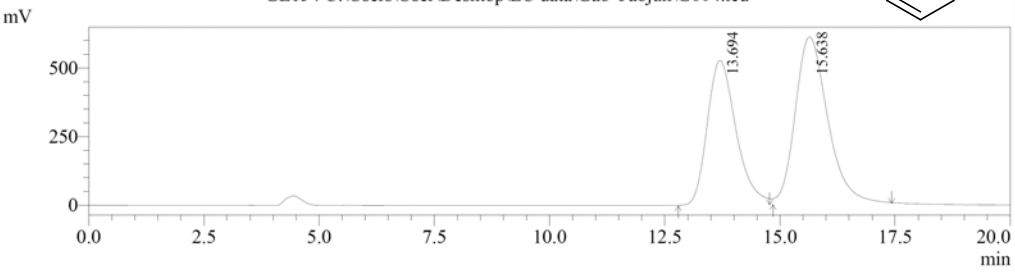
C:\Users\User\Desktop\LC data\Gao Yaojun\G604.lcd

Acquired by : Admin
Sample Name : GE154
Sample ID : GYJ
Data File Name : G604.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram

GE154 C:\Users\User\Desktop\LC data\Gao Yaojun\G604.lcd



PeakTable

SPD-20A Ch1 254nm

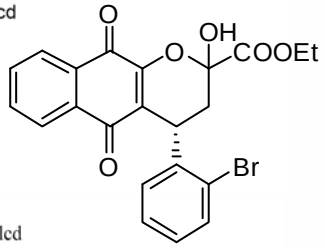
Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.694	23045871	528132	43.485	46.416
2	15.638	29951760	609698	56.515	53.584
Total		52997632	1137830	100.000	100.000

Enantiomeric enriched **7f**

==== Shimadzu LCsolution Analysis Report ====

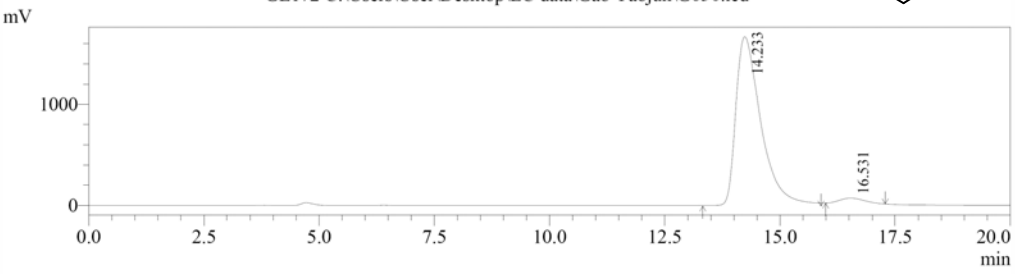
C:\Users\User\Desktop\LC data\Gao Yaojun\G630.lcd

Acquired by : Admin
Sample Name : GE172
Sample ID : GYJ
Data File Name : G630.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram

GE172 C:\Users\User\Desktop\LC data\Gao Yaojun\G630.lcd



PeakTable

SPD-20A Ch1 254nm

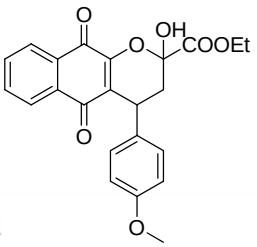
Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.233	64073132	1674220	97.002	96.918
2	16.531	1980596	53243	2.998	3.082
Total		66053728	1727463	100.000	100.000

Racemic **7g**

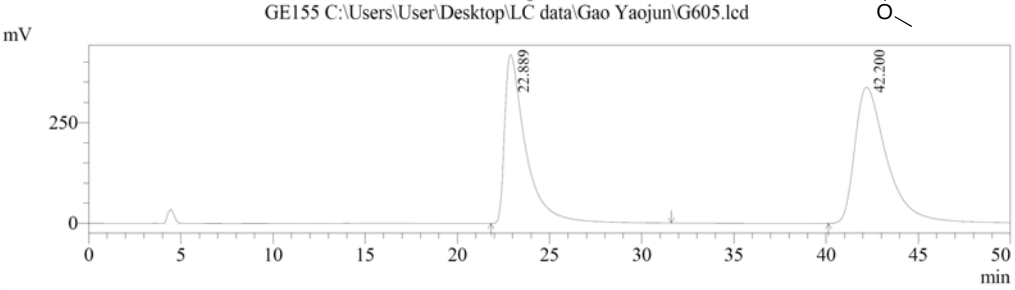
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G605.lcd

Acquired by : Admin
Sample Name : GE155
Sample ID : GYJ
Data File Name : G605.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram
GE155 C:\Users\User\Desktop\LC data\Gao Yaojun\G605.lcd



PeakTable

SPD-20A Ch1 254nm

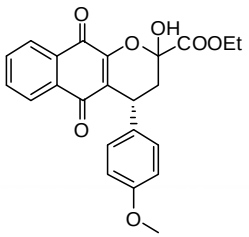
Peak#	Ret. Time	Area	Height	Area %	Height %
1	22.889	33491839	419009	44.797	55.345
2	42.200	41271794	338080	55.203	44.655
Total		74763632	757090	100.000	100.000

Enantiomeric enriched **7g**

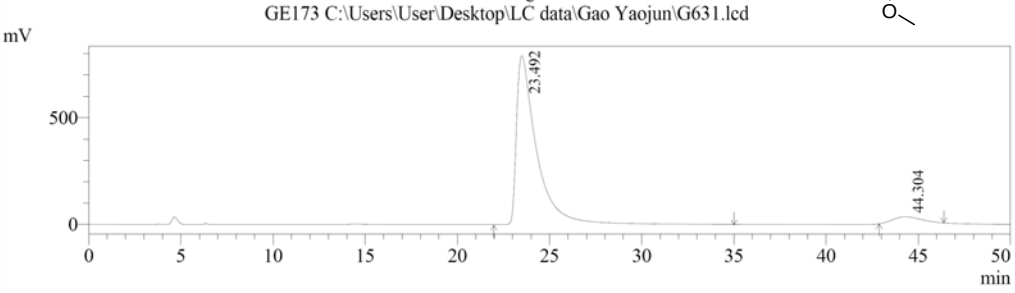
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G631.lcd

Acquired by : Admin
Sample Name : GE173
Sample ID : GYJ
Data File Name : G631.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram
GE173 C:\Users\User\Desktop\LC data\Gao Yaojun\G631.lcd

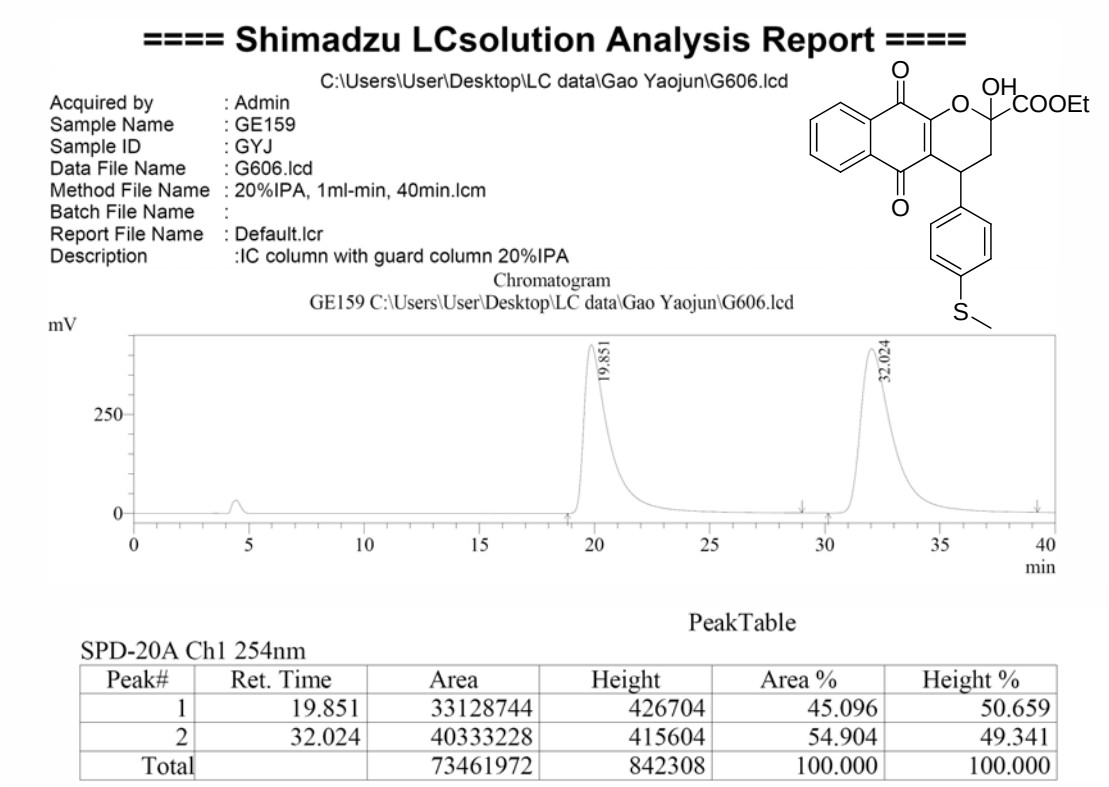


PeakTable

SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.492	62371081	793640	94.973	96.205
2	44.304	3301384	31308	5.027	3.795
Total		65672465	824948	100.000	100.000

Racemic **7h**

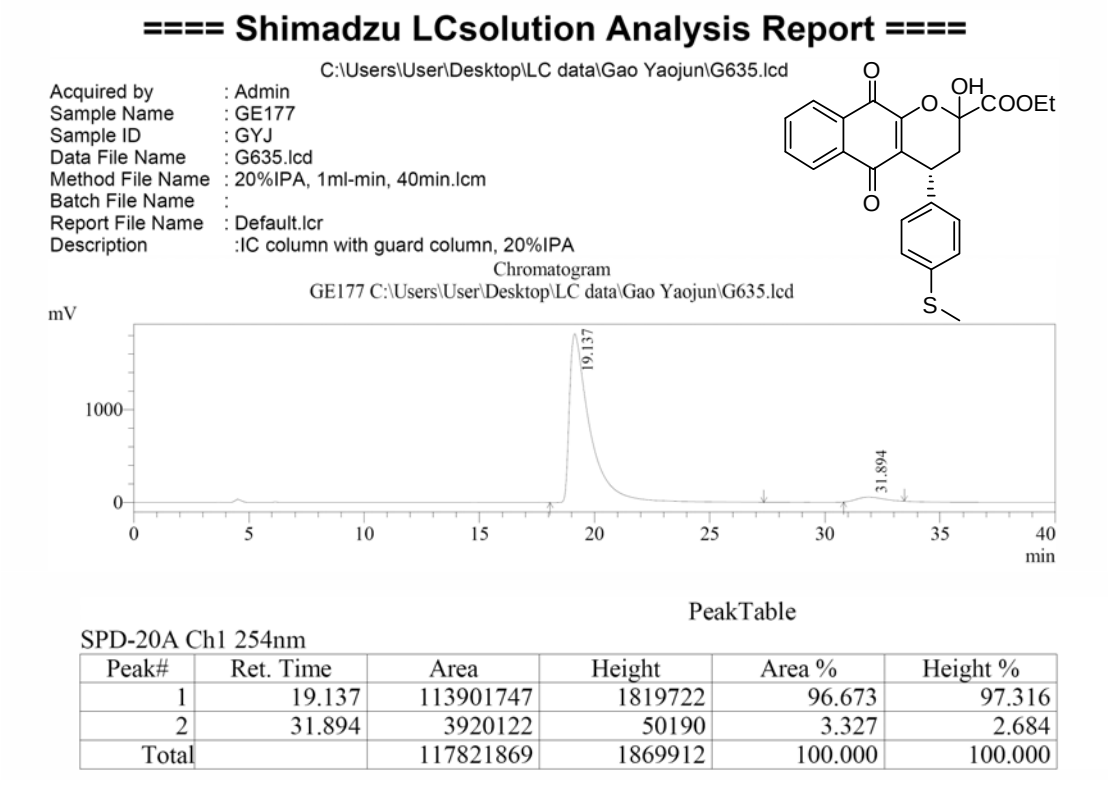


PeakTable

SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.851	33128744	426704	45.096	50.659
2	32.024	40333228	415604	54.904	49.341
Total		73461972	842308	100.000	100.000

Enantiomeric enriched **7h**



PeakTable

SPD-20A Ch1 254nm

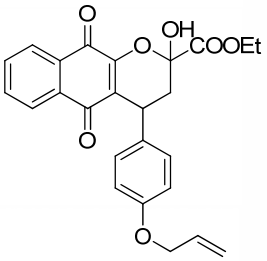
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.137	113901747	1819722	96.673	97.316
2	31.894	3920122	50190	3.327	2.684
Total		117821869	1869912	100.000	100.000

Racemic **7i**

==== Shimadzu LCsolution Analysis Report ====

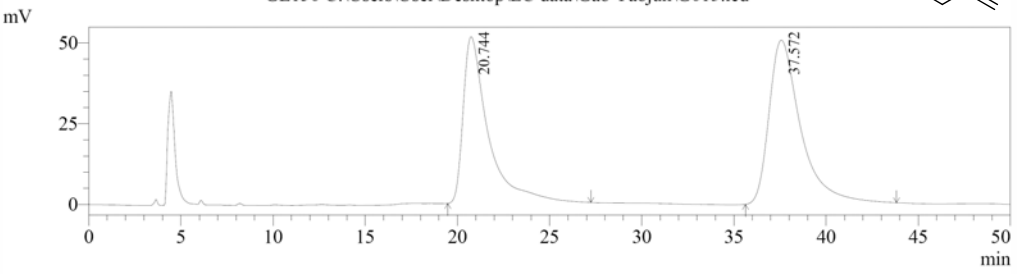
C:\Users\User\Desktop\LC data\Gao Yaojun\G613.lcd

Acquired by : Admin
Sample Name : GE156
Sample ID : GYJ
Data File Name : G613.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram

GE156 C:\Users\User\Desktop\LC data\Gao Yaojun\G613.lcd



PeakTable

SPD-20A Ch1 254nm

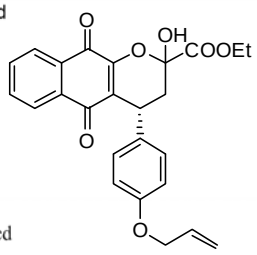
Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.744	4873659	51459	44.616	50.392
2	37.572	6049880	50658	55.384	49.608
Total		10923540	102117	100.000	100.000

Enantiomeric enriched **7i**

==== Shimadzu LCsolution Analysis Report ====

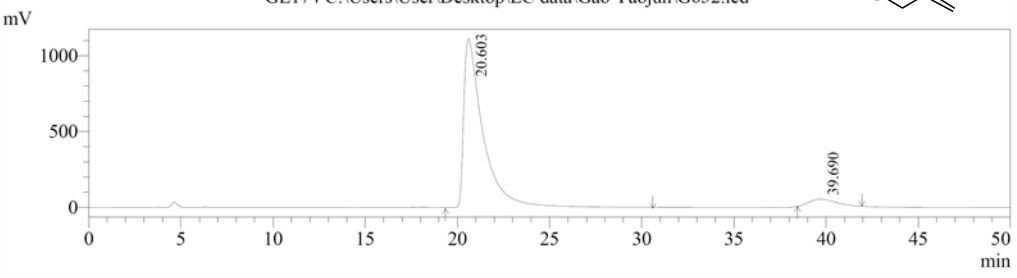
C:\Users\User\Desktop\LC data\Gao Yaojun\G632.lcd

Acquired by : Admin
Sample Name : GE174
Sample ID : GYJ
Data File Name : G632.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram

GE174 C:\Users\User\Desktop\LC data\Gao Yaojun\G632.lcd



PeakTable

SPD-20A Ch1 254nm

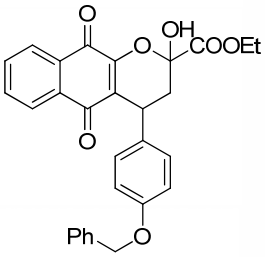
Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.603	85444348	1117877	94.801	96.011
2	39.690	4686167	46439	5.199	3.989
Total		90130515	1164316	100.000	100.000

Racemic **7j**

==== Shimadzu LCsolution Analysis Report ====

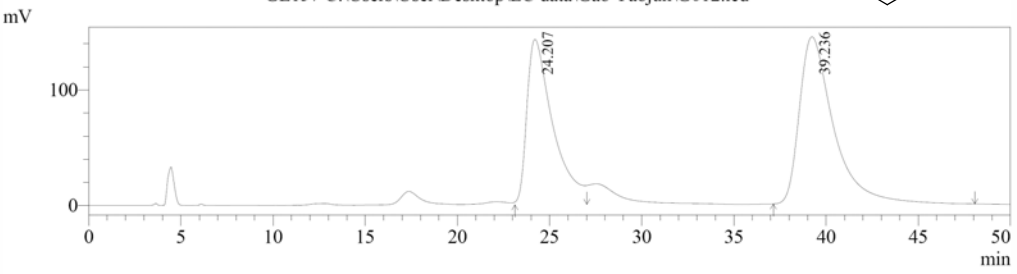
C:\Users\User\Desktop\LC data\Gao Yaojun\G612.lcd

Acquired by : Admin
Sample Name : GE157
Sample ID : GYJ
Data File Name : G612.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram

GE157 C:\Users\User\Desktop\LC data\Gao Yaojun\G612.lcd



PeakTable

SPD-20A Ch1 254nm

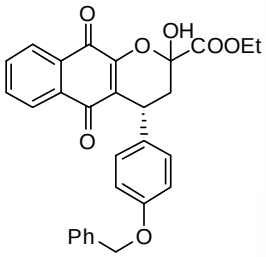
Peak#	Ret. Time	Area	Height	Area %	Height %
1	24.207	14166045	143069	43.031	49.707
2	39.236	18754644	144758	56.969	50.293
Total		32920689	287827	100.000	100.000

Enantiomeric enriched **7j**

==== Shimadzu LCsolution Analysis Report ====

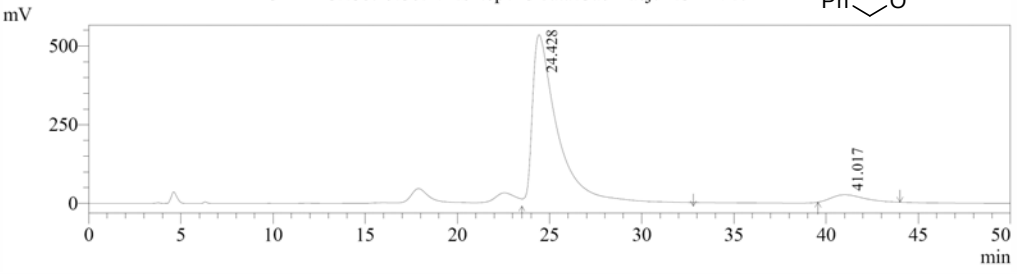
C:\Users\User\Desktop\LC data\Gao Yaojun\G633.lcd

Acquired by : Admin
Sample Name : GE175
Sample ID : GYJ
Data File Name : G633.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram

GE175 C:\Users\User\Desktop\LC data\Gao Yaojun\G633.lcd



PeakTable

SPD-20A Ch1 254nm

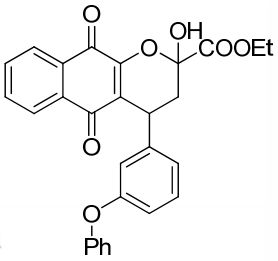
Peak#	Ret. Time	Area	Height	Area %	Height %
1	24.428	55797401	544116	95.147	95.833
2	41.017	2845886	23661	4.853	4.167
Total		58643287	567777	100.000	100.000

Racemic **7k**

==== Shimadzu LCsolution Analysis Report ====

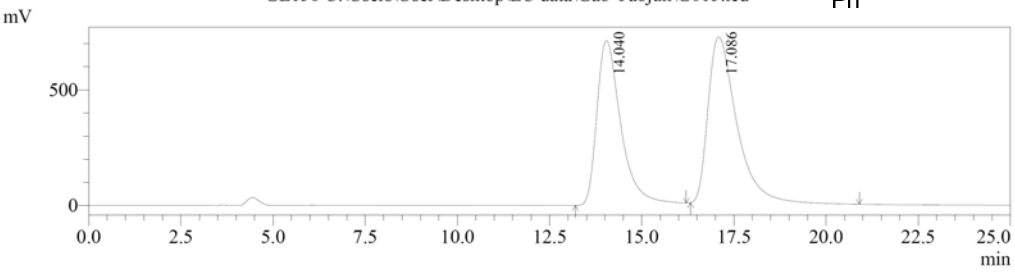
C:\Users\User\Desktop\LC data\Gao Yaojun\G615.lcd

Acquired by : Admin
Sample Name : GE158
Sample ID : GYJ
Data File Name : G615.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram

GE158 C:\Users\User\Desktop\LC data\Gao Yaojun\G615.lcd



PeakTable

SPD-20A Ch1 254nm

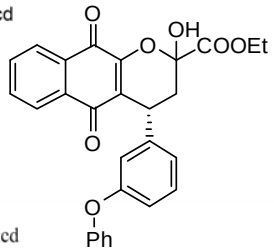
Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.040	31841727	710657	45.040	49.720
2	17.086	38854642	718654	54.960	50.280
Total		70696369	1429311	100.000	100.000

Enantiomeric enriched **7k**

==== Shimadzu LCsolution Analysis Report ====

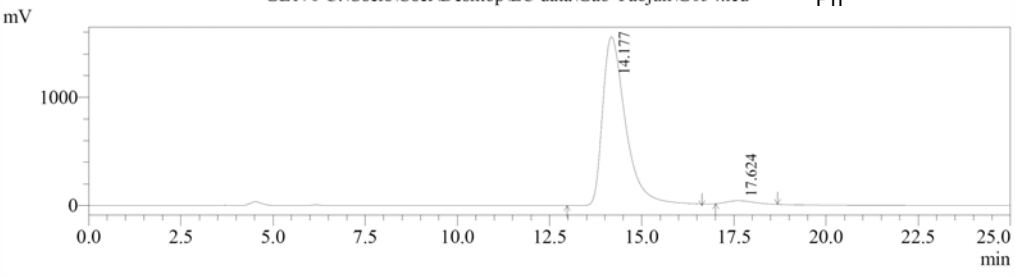
C:\Users\User\Desktop\LC data\Gao Yaojun\G634.lcd

Acquired by : Admin
Sample Name : GE176
Sample ID : GYJ
Data File Name : G634.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram

GE176 C:\Users\User\Desktop\LC data\Gao Yaojun\G634.lcd

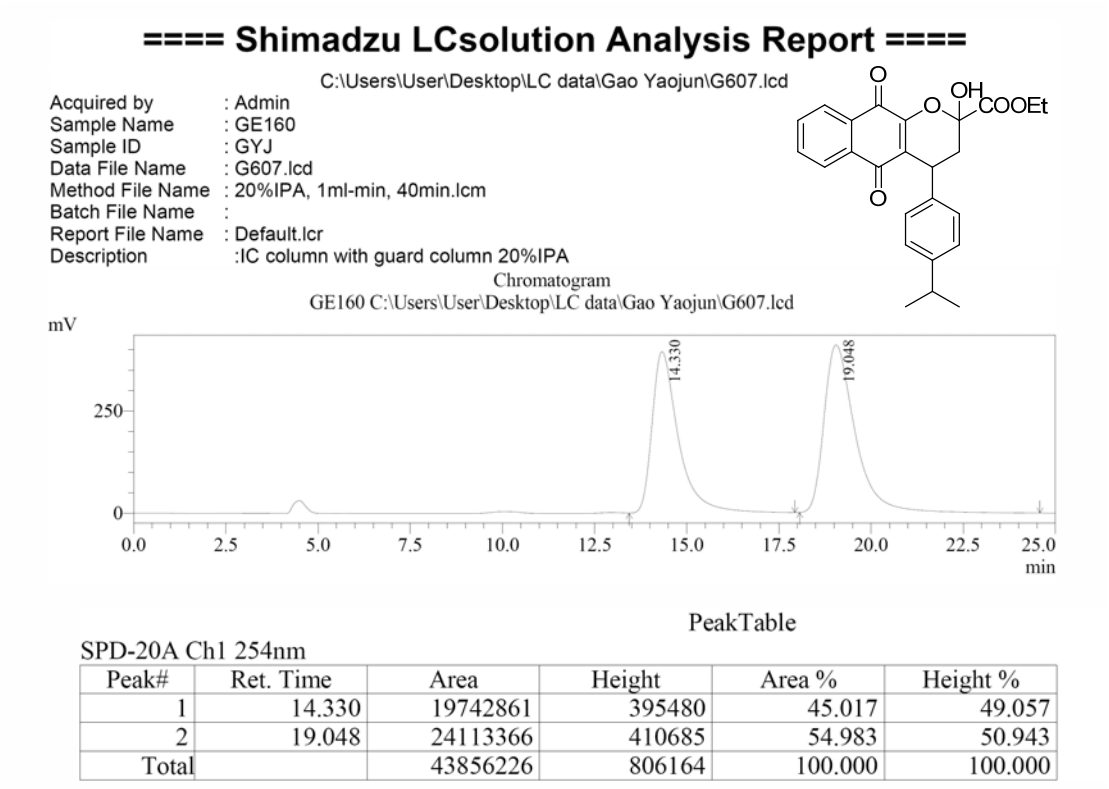


PeakTable

SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.177	68977621	1560348	97.880	98.075
2	17.624	1493834	30631	2.120	1.925
Total		70471455	1590979	100.000	100.000

Racemic **7l**

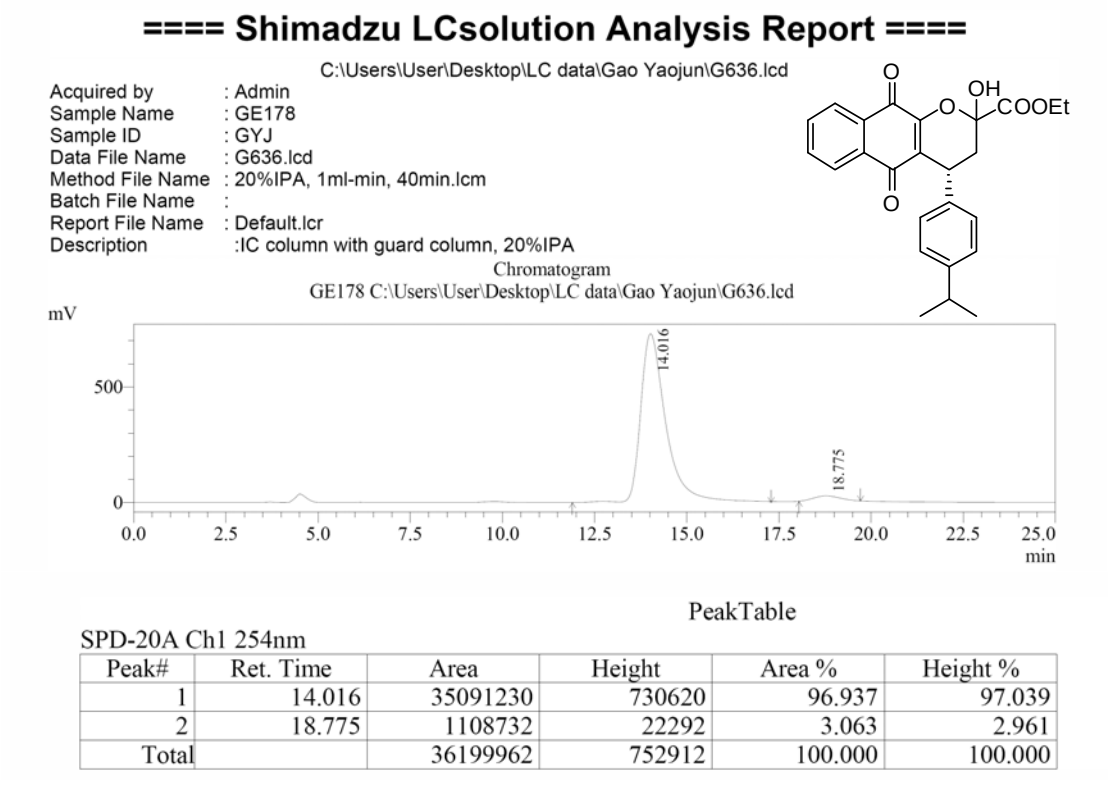


PeakTable

SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.330	19742861	395480	45.017	49.057
2	19.048	24113366	410685	54.983	50.943
Total		43856226	806164	100.000	100.000

Enantiomeric enriched **7l**



PeakTable

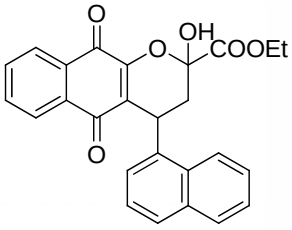
SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.016	35091230	730620	96.937	97.039
2	18.775	1108732	22292	3.063	2.961
Total		36199962	752912	100.000	100.000

Racemic **7m**

==== Shimadzu LCsolution Analysis Report ====

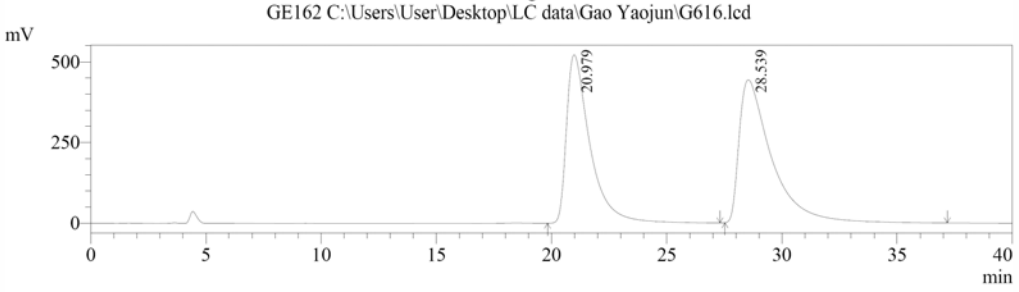
C:\Users\User\Desktop\LC data\Gao Yaojun\G616.lcd



Acquired by : Admin
Sample Name : GE162
Sample ID : GYJ
Data File Name : G616.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA

Chromatogram

GE162 C:\Users\User\Desktop\LC data\Gao Yaojun\G616.lcd



PeakTable

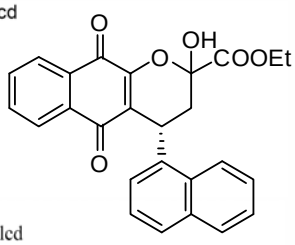
SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.979	37047214	521720	46.046	54.095
2	28.539	43410397	442737	53.954	45.905
Total		80457611	964457	100.000	100.000

Enantiomeric enriched **7m**

==== Shimadzu LCsolution Analysis Report ====

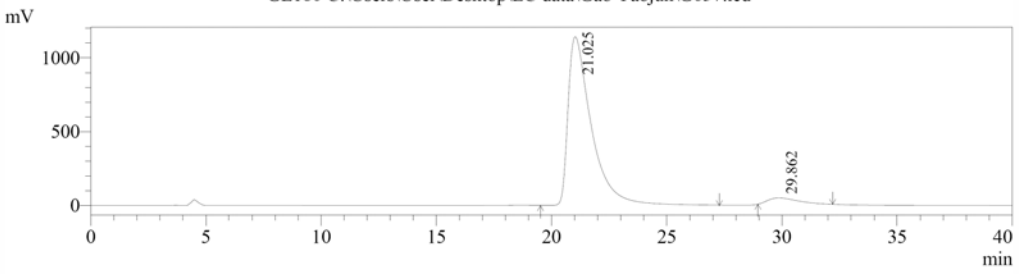
C:\Users\User\Desktop\LC data\Gao Yaojun\G637.lcd



Acquired by : Admin
Sample Name : GE180
Sample ID : GYJ
Data File Name : G637.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA

Chromatogram

GE180 C:\Users\User\Desktop\LC data\Gao Yaojun\G637.lcd



PeakTable

SPD-20A Ch1 254nm

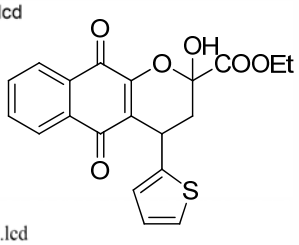
Peak#	Ret. Time	Area	Height	Area %	Height %
1	21.025	81375113	1143288	95.454	96.387
2	29.862	3875268	42850	4.546	3.613
Total		85250381	1186138	100.000	100.000

Racemic **7n**

==== Shimadzu LCsolution Analysis Report ====

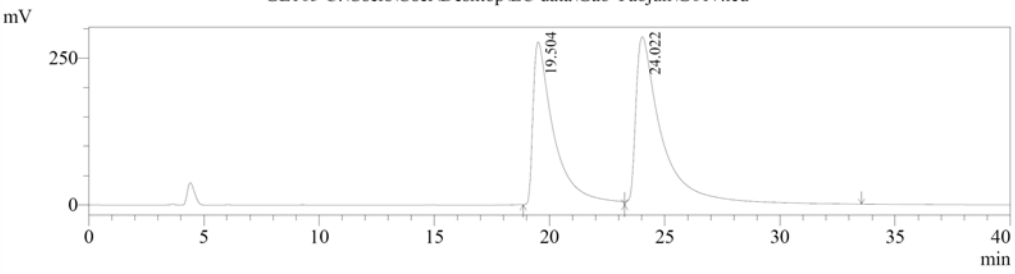
C:\Users\User\Desktop\LC data\Gao Yaojun\G617.lcd

Acquired by : Admin
Sample Name : GE163
Sample ID : GYJ
Data File Name : G617.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram

GE163 C:\Users\User\Desktop\LC data\Gao Yaojun\G617.lcd



PeakTable

SPD-20A Ch1 254nm

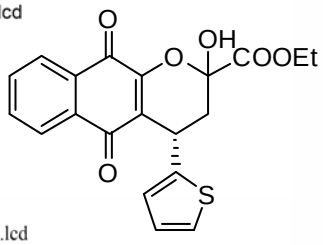
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.504	17648165	277097	43.803	49.259
2	24.022	22641644	285438	56.197	50.741
Total		40289810	562534	100.000	100.000

Enantiomeric enriched **7n**

==== Shimadzu LCsolution Analysis Report ====

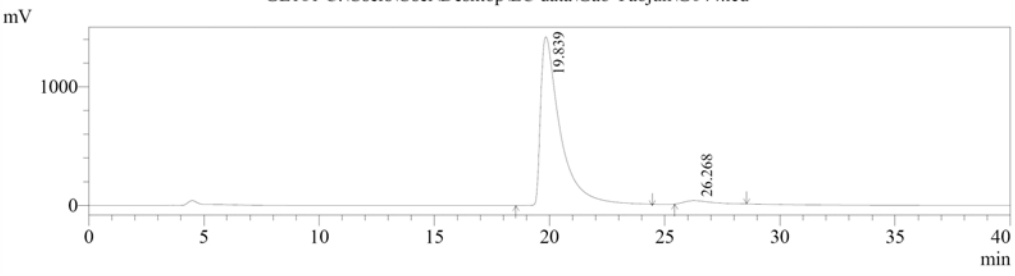
C:\Users\User\Desktop\LC data\Gao Yaojun\G644.lcd

Acquired by : Admin
Sample Name : GE181
Sample ID : GYJ
Data File Name : G644.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :Ic column with guard column,20%IPA



Chromatogram

GE181 C:\Users\User\Desktop\LC data\Gao Yaojun\G644.lcd



PeakTable

SPD-20A Ch1 254nm

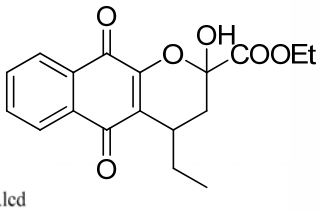
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.839	86108325	1423460	97.458	98.048
2	26.268	2246240	28341	2.542	1.952
Total		88354565	1451801	100.000	100.000

Racemic **7o**

==== Shimadzu LCsolution Analysis Report ====

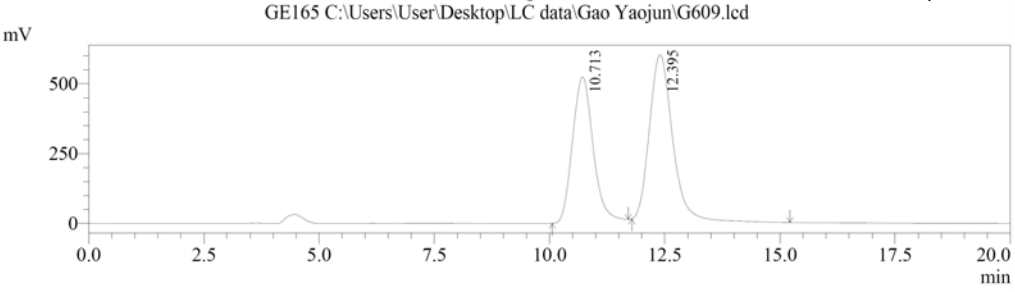
C:\Users\User\Desktop\LC data\Gao Yaojun\G609.lcd

Acquired by : Admin
Sample Name : GE165
Sample ID : GYJ
Data File Name : G609.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column 20%IPA



Chromatogram

GE165 C:\Users\User\Desktop\LC data\Gao Yaojun\G609.lcd



PeakTable

SPD-20A Ch1 254nm

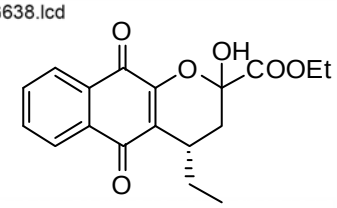
Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.713	15929469	518919	44.102	46.800
2	12.395	20190049	589875	55.898	53.200
Total		36119518	1108795	100.000	100.000

Enantiomeric enriched **7o**

==== Shimadzu LCsolution Analysis Report ====

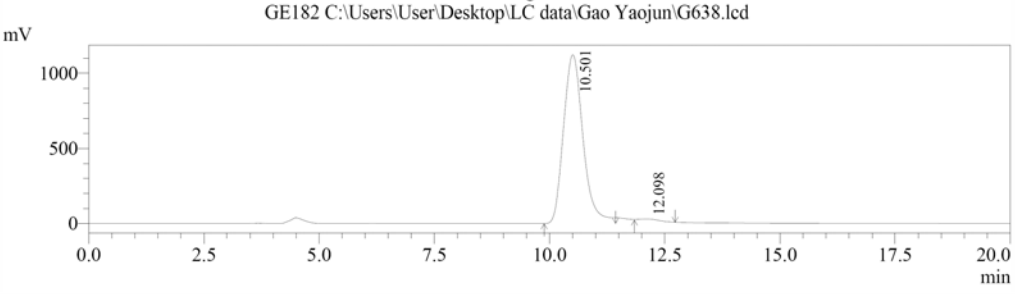
C:\Users\User\Desktop\LC data\Gao Yaojun\G638.lcd

Acquired by : Admin
Sample Name : GE182
Sample ID : GYJ
Data File Name : G638.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column, 20%IPA



Chromatogram

GE182 C:\Users\User\Desktop\LC data\Gao Yaojun\G638.lcd



PeakTable

SPD-20A Ch1 254nm

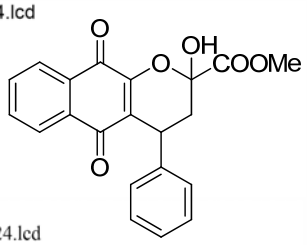
Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.501	33293008	1124834	99.041	98.955
2	12.098	322322	11879	0.959	1.045
Total		33615330	1136713	100.000	100.000

Racemic **7p**

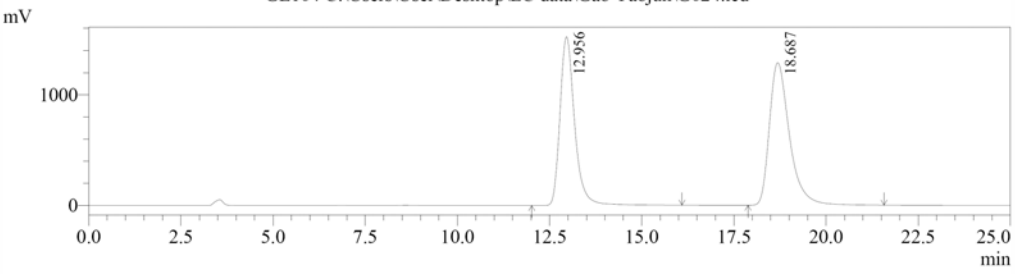
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G624.lcd

Acquired by : Admin
Sample Name : GE164
Sample ID : GYJ
Data File Name : G624.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :AD-H column 20%IPA



Chromatogram
GE164 C:\Users\User\Desktop\LC data\Gao Yaojun\G624.lcd



PeakTable

SPD-20A Ch1 254nm

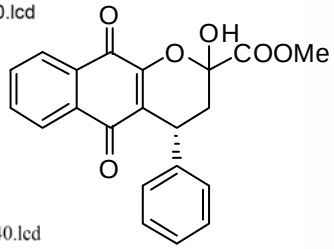
Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.956	42040733	1524027	46.324	54.205
2	18.687	48713087	1287564	53.676	45.795
Total		90753820	2811591	100.000	100.000

Enantiomeric enriched **7p**

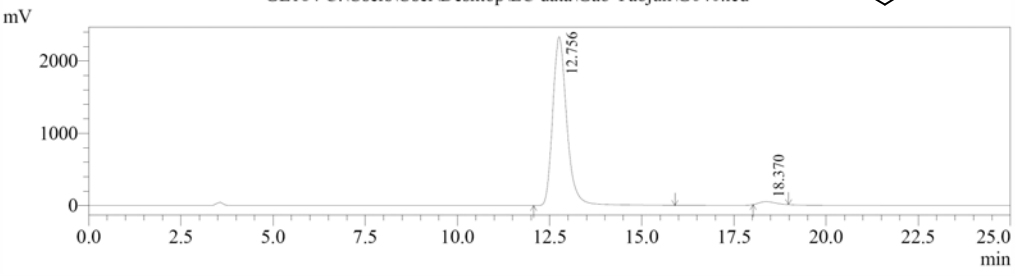
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G640.lcd

Acquired by : Admin
Sample Name : GE184
Sample ID : GYJ
Data File Name : G640.lcd
Method File Name : 20%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :AD-H column, 20%IPA



Chromatogram
GE184 C:\Users\User\Desktop\LC data\Gao Yaojun\G640.lcd

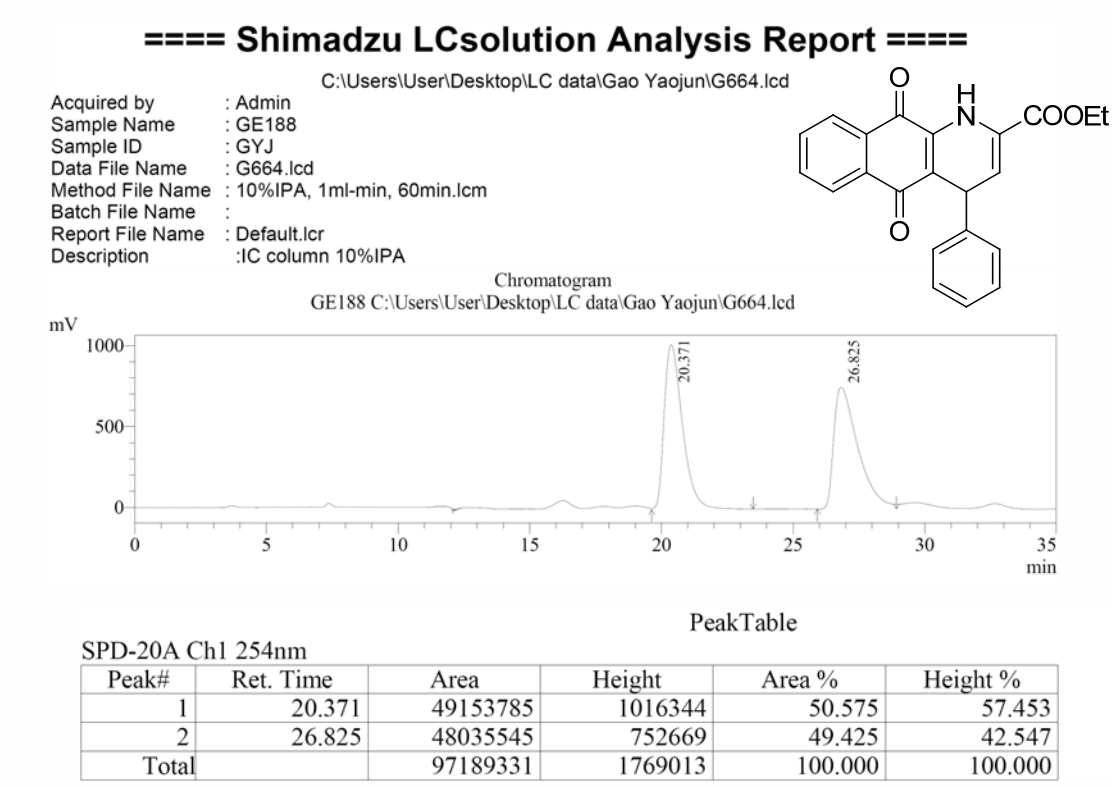


PeakTable

SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.756	62632992	2334627	98.091	98.251
2	18.370	1218921	41571	1.909	1.749
Total		63851912	2376199	100.000	100.000

Racemic **9**

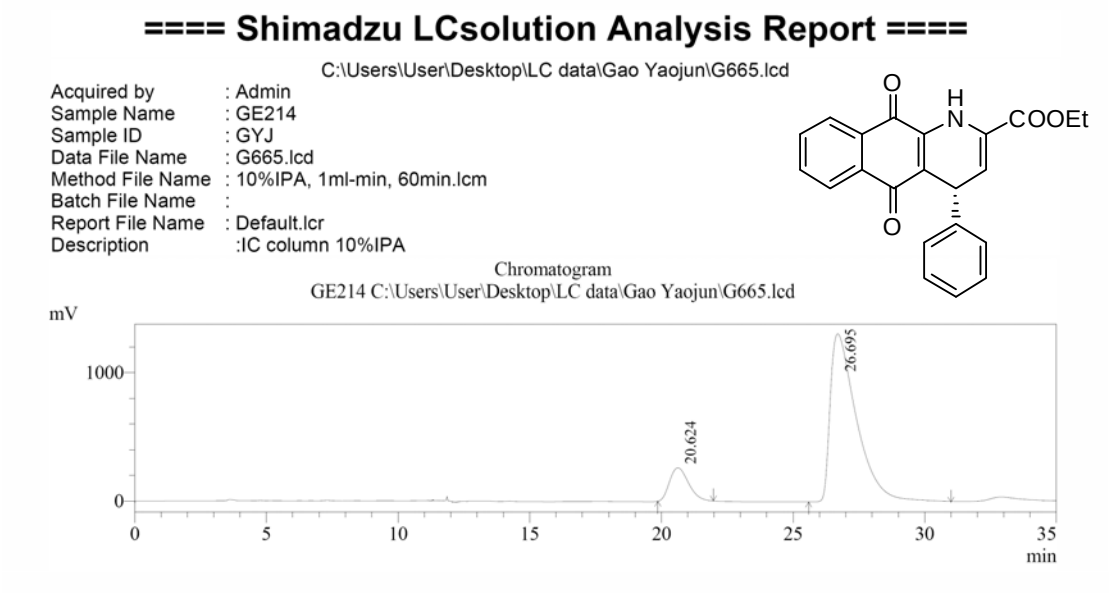


PeakTable

SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.371	49153785	1016344	50.575	57.453
2	26.825	48035545	752669	49.425	42.547
Total		97189331	1769013	100.000	100.000

Enantiomeric enriched **9**



PeakTable

SPD-20A Ch1 254nm

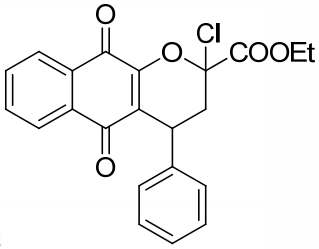
Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.624	13001897	259790	12.404	16.539
2	26.695	91819719	1310939	87.596	83.461
Total		104821616	1570729	100.000	100.000

Racemic **10**

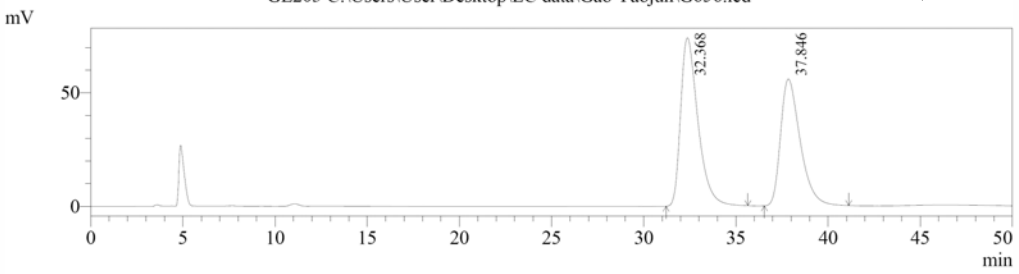
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G656.lcd

Acquired by : Admin
Sample Name : GE203
Sample ID : GYJ
Data File Name : G656.lcd
Method File Name : 10%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with guard column,10%IPA



Chromatogram
GE203 C:\Users\User\Desktop\LC data\Gao Yaojun\G656.lcd



PeakTable

SPD-20A Ch1 254nm

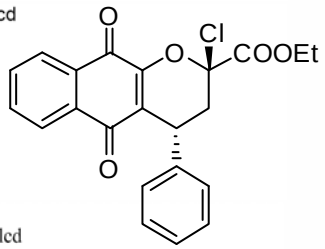
Peak#	Ret. Time	Area	Height	Area %	Height %
1	32.368	4840218	74058	53.989	57.067
2	37.846	4124937	55716	46.011	42.933
Total		8965155	129774	100.000	100.000

Enantiomeric enriched **10**

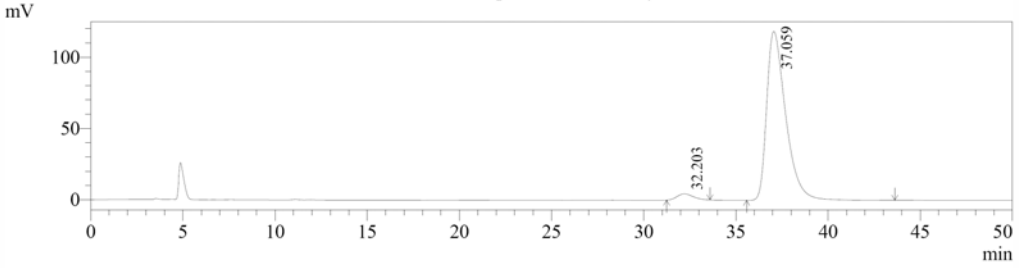
==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Gao Yaojun\G663.lcd

Acquired by : Admin
Sample Name : GE213
Sample ID : GYJ
Data File Name : G663.lcd
Method File Name : 10%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column 10%IPA



Chromatogram
GE213 C:\Users\User\Desktop\LC data\Gao Yaojun\G663.lcd



PeakTable

SPD-20A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	32.203	265472	4359	3.025	3.544
2	37.059	8510954	118616	96.975	96.456
Total		8776427	122975	100.000	100.000