



Supporting Information

for

The synthesis of chiral β -naphthyl- β -sulfanyl ketones via enantioselective sulfa-Michael reaction in the presence of a bifunctional cinchona/sulfonamide organocatalyst

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Copies of ^1H and ^{13}C NMR spectra, HPLC chromatograms and characterization data of the products

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I. General information

All chemicals were purchased from Sigma-Aldrich or Acros Organics. Column chromatography was performed using silica gel 60 (200-300 mesh) as supporting material. All the eluents were distilled prior to use. ^1H NMR and ^{13}C NMR spectra were recorded on a 400 MHz spectrometer, using CDCl_3 as the solvent. Chemical shift values are reported in ppm with TMS a standard, J values are given in hertz. Optical rotations were determined by the use of a polarimeter and reported as $[\alpha]_D^{25}$ (c in g/100 mL, solvent). Enantiomeric excess values were determined by chiral HPLC chromatography using Thermo-Finnigan instrument. All new products were further analyzed by LC/MS–HRMS–TOF or MALDI–ESI–TOFMS.

II. Characterization of products

***N*-((*S*)-(6-methoxyquinolin-4-yl)((1*S*,2*S*,4*S*,5*R*)-5-vinylquinuclidin-2-yl)methyl)-2,4,6-trimethyl-3-nitrobenzenesulfonamide (5)**

Off-white solid, 135.3 mg, mp 101 °C, 35% yield. $[\alpha]_D^{30} = -134.95$ (c 0.780, MeOH). ^1H NMR (400 MHz, CDCl_3) (mixture of rotamers) δ 8.58 (d, $J = 4.2$ Hz, 1H), 8.47 (d, $J = 4.5$ Hz, 1H), 7.97 (d, $J = 9.1$ Hz, 1H), 7.87 (d, $J = 9.2$ Hz, 1H), 7.74 – 7.53 (m, 1H), 7.50 – 7.45 (m, 1H), 7.44 – 7.31 (m, 1H), 7.20 (d, $J = 4.2$ Hz, 1H), 7.15 (d, $J = 4.5$ Hz, 1H), 6.54 (s, 1H), 6.44 (s, 1H), 5.78 – 5.56 (m, 1H), 5.31 (s, 1H), 5.10 (d, $J = 10.6$ Hz, 1H), 5.04 – 4.85 (m, 1H), 4.46 (d, $J = 10.9$ Hz, 1H), 3.99 (s, 1H), 3.94 (s, 1H), 3.46 (dd, $J = 17.9, 9.4$ Hz, 1H), 3.38 – 3.25 (m, $J = 12.0$ Hz, 1H), 3.22 – 3.09 (m, $J = 13.5, 6.8$ Hz, 1H), 3.09 – 2.92 (m, 1H), 2.90 – 2.71 (m, 1H), 2.41 (s, 1H), 2.39 (s, 1H), 2.34 (s, 1H), 2.13 (s, 1H), 2.12 (s, 1H), 1.96 (s, 1H), 1.75 (s, 1H), 1.71 – 1.59 (m, 2H), 1.48 – 1.19 (m, $J = 30.9, 19.8$ Hz, 1H), 1.06 – 0.79 (m, $J = 28.0, 13.4, 7.0$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3) (mixture of rotamers): δ 157.81, 156.81, 151.83, 151.22, 147.04, 146.51, 144.45, 144.18, 141.61, 140.97, 140.91, 140.75, 140.47, 138.89, 135.77, 134.82, 132.60, 132.40, 132.30, 132.13, 131.99, 131.89, 131.82, 131.79, 131.74, 131.33, 130.04, 129.81, 128.42, 128.30, 128.03, 126.34, 123.68, 121.35, 120.17, 119.72, 118.42, 114.72, 103.64, 100.68, 62.88, 61.06, 60.23, 55.76, 55.45, 55.28, 52.78, 40.27, 39.77, 39.42, 39.22, 27.74, 27.51, 27.21, 27.09, 26.06, 24.76, 23.22, 22.50, 16.83, 16.75, 15.88, 15.50, 14.06. IR (neat): 3077, 2934, 2871, 1619, 1589, 1530, 1506, 1475, 1429, 1359, 1262, 1238, 1168, 1138, 1103, 1032, 987, 912, 865, 840, 775, 717, 666, 563, 493 cm^{-1} . HRMS (ESI-TOF) m/z : $[\text{M} + \text{H}]^+$ Calcd. for $\text{C}_{29}\text{H}_{35}\text{N}_4\text{O}_5\text{S}$ 551.2328; Found 551.2339.

3-(Naphthalen-1-ylthio)-1,3-diphenylpropan-1-one (12a)

White solid, 68.61 mg, mp 99 °C, 93% yield in 23 h, in THF. HPLC (AD-H, 99:1 *n*-Hexane/Isopropanol, 0.8 mL/min, 220 nm): $t_{\text{minor}} = 33.445$ min, $t_{\text{major}} = 35.736$ min, 83% ee, $[\alpha]_D^{23} = -70.25$ (c 1.785, CHCl_3). ^1H NMR (400 MHz, CDCl_3): δ 8.42 (d, $J = 8.6$ Hz, 1H), 7.77 – 7.71 (m, 3H), 7.68 (d, $J = 8.2$ Hz, 1H), 7.48 – 7.38 (m, 4H), 7.31 (t, $J = 7.7$ Hz, 2H), 7.21 – 7.15 (m, 3H), 7.15 – 7.04 (m, 3H), 4.88 (dd, $J = 7.9, 6.3$ Hz, 1H), 3.61 (dd, $J = 17.2, 8.0$ Hz, 1H), 3.53 (dd, $J =$

17.2, 6.2 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃): δ 197.04, 141.18, 136.71, 134.45, 134.07, 133.26, 133.20, 131.34, 129.13, 128.63, 128.58, 128.47, 128.10, 127.82, 127.42, 126.82, 126.28, 125.81, 125.47, 48.89, 44.72. δ IR (neat): 3053, 3027, 2891, 2878, 1678, 1595, 1501, 1449, 1418, 1368, 1340, 1251, 1225, 1078, 1019, 1002, 981, 921, 801, 769, 750, 711, 689, 667, 642, 624, 599, 565, 549, 530, 419 cm⁻¹. MS (MALDI-TOF) *m/z*: [M + Na]⁺ Calcd. for C₂₅H₂₀NaOS 391.113; Found 391.133.

3-(Naphthalen-1-ylthio)-1-phenyl-3-(*m*-tolyl)propan-1-one (12b)

White solid, 66.79 mg, mp 56 °C, 87% yield in 46 h, in THF. HPLC (OD-H, 99:1 *n*-Hexane/Isopropanol, 0.8 mL/min, 220 nm): *t*_{minor} = 16.063 min, *t*_{major} = 14.139 min, 78% ee, [α]_D²⁴ = -111.4 (c 1.660, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.42 (d, *J* = 8.2 Hz, 1H), 7.75 (d, *J* = 7.4 Hz, 3H), 7.69 (d, *J* = 8.2 Hz, 1H), 7.54 – 7.38 (m, 4H), 7.31 (t, *J* = 7.6 Hz, 2H), 7.23 (t, *J* = 7.7 Hz, 1H), 7.02 (dd, *J* = 15.1, 7.7 Hz, 3H), 6.90 (d, *J* = 6.6 Hz, 1H), 4.95 – 4.76 (m, 1H), 3.62 (dd, *J* = 17.2, 8.1 Hz, 1H), 3.51 (dd, *J* = 17.2, 6.0 Hz, 1H), 2.17 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 197.12, 140.90, 138.03, 136.71, 134.41, 134.04, 133.19, 133.05, 131.47, 129.02, 128.58, 128.52, 128.31, 128.20, 128.07, 126.73, 126.22, 125.78, 125.43, 124.73, 48.29, 44.68, 21.38. IR (neat): 3054, 3022, 2920, 2852, 1681, 1594, 1502, 1448, 1415, 1363, 1334, 1249, 1216, 1055, 1019, 1000, 979, 877, 801, 784, 768, 754, 727, 713, 684, 638, 624, 602, 573, 534, 510, 443, 421 cm⁻¹. MS (MALDI-TOF) *m/z*: [M + Na]⁺ Calcd. for C₂₆H₂₂NaOS 405.129; Found 405.147.

3-(Naphthalen-1-ylthio)-1-phenyl-3-(*p*-tolyl)propan-1-one (12c)

White solid, 71.84 mg, mp 102 °C, 94% yield in 6 h, in DCM. HPLC (AD-H, 98:2 *n*-Hexane/Isopropanol, 0.8 mL/min, 254 nm): *t*_{minor} = 15.832 min, *t*_{major} = 14.441 min, 94% ee, [α]_D²³ = -91.42 (c 0.480, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.43 (d, *J* = 8.3 Hz, 1H), 7.77 – 7.70 (m, 3H), 7.68 (d, *J* = 8.2 Hz, 1H), 7.51 – 7.39 (m, 4H), 7.30 (t, *J* = 7.7 Hz, 2H), 7.26 – 7.19 (m, 1H), 7.14 – 7.06 (m, 2H), 6.95 (d, *J* = 7.9 Hz, 2H), 4.87 (dd, *J* = 8.3, 5.9 Hz, 1H), 3.60 (dd, *J* = 17.1, 8.3 Hz, 1H), 3.49 (dd, *J* = 17.1, 5.9 Hz, 1H), 2.19 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 197.19, 138.06, 137.10, 136.73, 134.37, 134.09, 133.22, 132.89, 131.63, 129.21, 128.99, 128.61, 128.10, 127.68, 126.80, 126.27, 125.80, 125.51, 48.10, 44.86, 21.17. IR (neat): 3053, 3030, 2944, 2922, 2892, 2861, 1681, 1595, 1515, 1502, 1449, 1417, 1361, 1334, 1307, 1251, 1226, 1155, 1113, 1062, 1019, 1001, 978, 954, 918, 801, 770, 759, 733, 701, 684, 649, 623, 583, 564, 534, 521, 435, 417 cm⁻¹. MS (MALDI-TOF) *m/z*: [M + Na]⁺ Calcd. for C₂₆H₂₂NaOS 405.129; Found 405.190.

3-(Naphthalen-1-ylthio)-3-phenyl-1-(*p*-tolyl)propan-1-one (12d)

White solid, 76.31 mg, mp 110-112 °C, >99% yield in 42 h, in THF. HPLC (AD-H, 98:2 *n*-Hexane/Isopropanol, 0.8 mL/min, 254 nm): *t*_{minor} = 22.531 min, *t*_{major} = 20.044 min, 91% ee, [α]_D²⁴ = -74.25 (c 1.910, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.41 (d, *J* = 8.3 Hz, 1H), 7.79 – 7.57 (m, 4H), 7.42 (dq, *J* = 15.4, 6.8 Hz, 3H), 7.27 – 6.98 (m, 8H), 4.88 (dd, *J* = 7.7, 6.4 Hz, 1H), 3.53 (qd, *J* = 17.1, 7.1 Hz, 2H), 2.26 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 196.64, 144.06, 141.25, 134.44, 134.31, 134.06, 133.11, 131.43, 129.29, 129.04, 128.53, 128.41, 128.22, 127.80, 127.35, 126.76, 126.22, 125.81, 125.43, 48.48, 44.57, 21.66. IR (neat): 3053, 3029, 2962, 2894, 1666, 1604, 1498, 1456, 1421, 1362, 1328, 1307, 1230, 118, 1019, 972, 942, 815, 800, 767, 698, 666, 594,

559, 524, 491, 456, 416 cm^{-1} . MS (MALDI-TOF) m/z : $[\text{M} + \text{Na}]^+$ Calcd. for $\text{C}_{26}\text{H}_{22}\text{NaOS}$ 405.129; Found 405.147.

3-(3-Methoxyphenyl)-3-(naphthalen-1-ylthio)-1-phenylpropan-1-one (12e)

White solid, 76.46 mg, mp 46-47 $^{\circ}\text{C}$, 73% yield in 24 h, in DCM. HPLC (OD-H, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 230 nm): $t_{\text{minor}} = 10.575$ min, $t_{\text{major}} = 9.406$ min, 63% ee, $[\alpha]_D^{24} = -92.87$ (c 2.100, CHCl_3). ^1H NMR (400 MHz, CDCl_3): δ 8.42 (d, $J = 8.2$ Hz, 1H), 7.75 (t, $J = 7.3$ Hz, 3H), 7.69 (d, $J = 8.2$ Hz, 1H), 7.52 – 7.38 (m, 4H), 7.32 (t, $J = 7.6$ Hz, 2H), 7.26 – 7.19 (m, 1H), 7.05 (t, $J = 7.9$ Hz, 1H), 6.79 (d, $J = 7.6$ Hz, 1H), 6.67 (d, $J = 17.9$ Hz, 1H), 6.62 (dd, $J = 8.1, 2.0$ Hz, 1H), 4.93 – 4.79 (m, 1H), 3.68 – 3.48 (m, 5H). ^{13}C NMR (100 MHz, CDCl_3): δ 195.52, 158.04, 141.25, 135.25, 132.97, 132.57, 131.76, 131.73, 129.85, 127.96, 127.62, 127.14, 127.03, 126.62, 125.30, 124.76, 124.31, 123.98, 118.59, 111.92, 111.54, 53.69, 46.89, 43.17. IR (neat): 3055, 3001, 2959, 2918, 2836, 1710, 1685, 1597, 1489, 1448, 1359, 1260, 1221, 1157, 1090, 1042, 981, 873, 774, 692, 530 cm^{-1} . MS (MALDI-TOF) m/z : $[\text{M} + \text{Na}]^+$ Calcd. for $\text{C}_{26}\text{H}_{22}\text{NaO}_2\text{S}$ 421.124; Found 421.137.

3-(4-Methoxyphenyl)-3-(naphthalen-1-ylthio)-1-phenylpropan-1-one (12f)

White solid, 74.21 mg, mp 102 $^{\circ}\text{C}$, 93% yield in 23 h, in DCM. HPLC (AD-H, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 220 nm): $t_{\text{minor}} = 15.595$ min, $t_{\text{major}} = 13.816$ min, 84% ee, $[\alpha]_D^{23} = -120.0$ (c 1.845, CHCl_3). ^1H NMR (400 MHz, CDCl_3): δ 8.42 (d, $J = 8.3$ Hz, 1H), 7.79 – 7.69 (m, 3H), 7.67 (d, $J = 8.2$ Hz, 1H), 7.51 – 7.37 (m, 4H), 7.29 (t, $J = 7.7$ Hz, 2H), 7.21 (dd, $J = 8.0, 7.4$ Hz, 1H), 7.13 – 7.07 (m, 2H), 6.73 – 6.60 (m, 2H), 4.86 (dd, $J = 8.3, 5.9$ Hz, 1H), 3.63 (s, $J = 6.0$ Hz, 3H), 3.58 (dd, $J = 17.1, 8.4$ Hz, 1H), 3.47 (dd, $J = 17.1, 5.9$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 197.17, 158.82, 136.76, 134.42, 133.17, 133.11, 133.04, 131.56, 128.98, 128.86, 128.58, 128.53, 128.06, 126.74, 126.22, 125.79, 125.46, 113.84, 55.23, 47.90, 44.90. IR (neat): 3051, 3006, 2953, 2931, 2891, 2834, 1681, 1609, 1594, 1512, 1448, 1415, 1363, 1334, 1293, 1247, 1223, 1176, 1107, 1060, 1029, 1000, 977, 954, 918, 850, 813, 800, 767, 736, 723, 699, 684, 667, 647, 621, 588, 564, 529, 427, 414 cm^{-1} . MS (MALDI-TOF) m/z : $[\text{M} + \text{Na}]^+$ Calcd. for $\text{C}_{26}\text{H}_{22}\text{NaO}_2\text{S}$ 421.124; Found 421.154.

3-(Naphthalen-1-ylthio)-1-phenyl-3-(3,4,5-trimethoxyphenyl)propan-1-one (12g)

White solid, 91.53 mg, mp 115-116 $^{\circ}\text{C}$, >99% yield in 24 h, in DCM. HPLC (AD-H, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 230 nm): $t_{\text{minor}} = 22.490$ min, $t_{\text{major}} = 16.387$ min, 96% ee, $[\alpha]_D^{23} = -123.30$ (c 2.410, CHCl_3). ^1H NMR (400 MHz, CDCl_3): δ 8.36 (d, $J = 8.1$ Hz, 1H), 7.84 – 7.76 (m, 2H), 7.76 – 7.66 (m, 2H), 7.52 – 7.37 (m, 4H), 7.34 (t, $J = 7.6$ Hz, 2H), 7.23 (t, $J = 7.7$ Hz, 1H), 6.27 (s, 2H), 4.80 (t, $J = 7.1$ Hz, 1H), 3.66 (s, 3H), 3.63 – 3.48 (m, 8H). ^{13}C NMR (100 MHz, CDCl_3): δ 195.70, 151.59, 135.82, 135.43, 135.31, 133.32, 132.67, 132.39, 131.99, 129.83, 127.91, 127.33, 127.12, 126.76, 125.39, 124.92, 124.48, 124.14, 103.46, 59.47, 54.67, 47.61, 43.06. IR (neat): 3057, 3001, 2970, 2934, 2899, 2838, 2827, 1682, 1590, 1513, 1454, 1430, 1366, 1335, 1320, 1254, 1223, 1182, 1125, 1008, 899, 805, 768, 754, 722, 688, 647, 557, 522, 416 cm^{-1} . MS (MALDI-TOF) m/z : $[\text{M} + \text{Na}]^+$ Calcd. for $\text{C}_{28}\text{H}_{26}\text{NaO}_4\text{S}$ 481.145; Found 481.137.

3-(2-Chlorophenyl)-3-(naphthalen-1-ylthio)-1-phenylpropan-1-one (12h)

White solid, 67.65 mg, mp 54-55 °C, 84% yield in 23 h, in THF. HPLC (OD-H, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 254 nm): $t_{\text{minor}} = 7.968$ min, $t_{\text{major}} = 9.813$ min, 66% ee, $[\alpha]_D^{24} = -4.622$ (c 1.350, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.73 – 8.41 (m, 1H), 7.97 – 7.79 (m, 4H), 7.68 – 7.52 (m, 4H), 7.50 – 7.32 (m, 5H), 7.18 (dd, *J* = 8.8, 5.1 Hz, 2H), 5.54 (t, *J* = 7.1 Hz, 1H), 3.72 (qd, *J* = 17.3, 7.2 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 196.58, 138.47, 136.51, 134.66, 134.00, 133.91, 133.51, 133.26, 130.73, 129.80, 129.32, 128.61, 128.42, 128.41, 128.08, 126.90, 126.73, 126.24, 125.82, 125.40, 44.68, 44.15. IR (neat): 3052, 2916, 2894, 1687, 1581, 1502, 1472, 1447, 1357, 1312, 1264, 1243, 1202, 1160, 1061, 1032, 981, 911, 797, 770, 749, 732, 679, 650, 588, 557, 538, 503, 459, 418 cm⁻¹. MS (MALDI-TOF) *m/z*: [M + Na]⁺ Calcd. for C₂₅H₁₉ClNaOS 425.074; Found 425.131.

3-(3-Chlorophenyl)-3-(naphthalen-1-ylthio)-1-phenylpropan-1-one (12i)

White solid, 63.78 mg, mp 85 °C, 79% yield in 22 h, in THF. HPLC (OD-H, 95:5 *n*-Hexane/Isopropanol, 1 mL/min, 220 nm): $t_{\text{minor}} = 9.514$ min, $t_{\text{major}} = 8.199$ min, 85% ee, $[\alpha]_D^{23} = -132.7$ (c 1.590, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.39 (d, *J* = 8.3 Hz, 1H), 7.88 – 7.64 (m, 4H), 7.54 – 7.38 (m, 4H), 7.33 (t, *J* = 7.7 Hz, 2H), 7.26 – 7.19 (m, 1H), 7.17 (s, 1H), 7.10 – 6.92 (m, 3H), 4.82 (t, *J* = 7.1 Hz, 1H), 3.67 – 3.45 (m, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 196.56, 143.36, 136.54, 134.49, 134.18, 134.08, 133.68, 133.38, 130.65, 129.55, 129.48, 128.67, 128.57, 128.07, 127.85, 127.49, 126.90, 126.31, 126.08, 125.68, 125.40, 47.89, 44.39. IR (neat): 3054, 3029, 2951, 2920, 2851, 1681, 1593, 1570, 1500, 1431, 1412, 1364, 1333, 1254, 1226, 1185, 1163, 1076, 1001, 984, 904, 834, 798, 769, 752, 729, 683, 64, 625, 604, 533, 508, 436, 419 cm⁻¹. MS (MALDI-TOF) *m/z*: [M + Na]⁺ Calcd. for C₂₅H₁₉ClNaOS 425.074; Found 425.087.

3-(4-Chlorophenyl)-3-(naphthalen-1-ylthio)-1-phenylpropan-1-one (12j)

White solid, 80.50 mg, mp 121-122 °C, >99% yield in 21 h, in THF. HPLC (AD-H, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 220 nm): $t_{\text{minor}} = 11.144$ min, $t_{\text{major}} = 9.939$ min, 71% ee, $[\alpha]_D^{24} = -125.2$ (c 2.090, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.40 (d, *J* = 8.2 Hz, 1H), 7.88 – 7.72 (m, 3H), 7.70 (d, *J* = 8.2 Hz, 1H), 7.55 – 7.38 (m, 4H), 7.33 (t, *J* = 7.7 Hz, 2H), 7.21 (dd, *J* = 14.7, 6.8 Hz, 1H), 7.13 – 7.03 (m, 4H), 4.83 (dd, *J* = 7.7, 6.5 Hz, 1H), 3.70 – 3.42 (m, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 196.69, 139.85, 136.58, 134.45, 134.09, 133.53, 133.38, 133.00, 130.81, 129.40, 129.14, 128.68, 128.62, 128.54, 128.07, 126.93, 126.33, 125.70, 125.46, 77.42, 77.10, 76.78, 47.75, 44.52. IR (neat): 3050, 3028, 2926, 2897, 1679, 1595, 1493, 1450, 1418, 1359, 1332, 1226, 1154, 1091, 1015, 976, 954, 917, 853, 815, 799, 769, 751, 732, 683, 656, 619, 571, 531, 505, 430 cm⁻¹. MS (MALDI-TOF) *m/z*: [M + Na]⁺ Calcd. for C₂₅H₁₉ClNaOS 425.074; Found 425.086.

3-(3-Bromophenyl)-3-(naphthalen-1-ylthio)-1-phenylpropan-1-one (12k)

White solid, 59.28 mg, mp 84 °C, 66% yield in 40 h, in THF. HPLC (OD-H, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 254 nm): $t_{\text{minor}} = 8.699$ min, $t_{\text{major}} = 7.584$ min, 51% ee, $[\alpha]_D^{24} = -145.1$ (c 1.480, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.39 (d, *J* = 8.2 Hz, 1H), 7.82 – 7.63 (m, 4H), 7.43 (dd, *J* = 15.1, 7.6 Hz, 4H), 7.37 – 7.27 (m, 3H), 7.29 – 7.11 (m, 2H), 7.03 (d, *J* = 7.6 Hz,

1H), 6.94 (t, $J = 7.8$ Hz, 1H), 4.80 (t, $J = 7.0$ Hz, 1H), 3.55 (d, $J = 7.0$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3): δ 195.46, 142.56, 135.43, 133.42, 133.00, 132.66, 132.32, 129.68, 129.53, 129.33, 128.77, 128.44, 127.60, 127.51, 127.00, 125.84, 125.47, 125.25, 124.61, 124.34, 121.33, 46.78, 43.28. IR (neat): 3056, 3041, 2927, 2892, 1680, 1594, 1565, 1501, 1475, 1448, 1429, 1415, 1357, 1329, 1219, 1151, 1061, 983, 953, 918, 878, 811, 795, 768, 753, 716, 685, 667, 638, 604, 570, 533, 508, 445, 433, 419 cm^{-1} . MS (MALDI-TOF) m/z : $[\text{M} + \text{Na}]^+$ Calcd. for $\text{C}_{25}\text{H}_{19}\text{BrNaOS}$ 469.024; Found 469.024.

1-(4-Bromophenyl)-3-(naphthalen-1-ylthio)-3-phenylpropan-1-one (12l)

White solid, 78.24 mg, mp 162-163 $^{\circ}\text{C}$, >99% yield in 23 h, in THF. HPLC (AD-H, 98:2 *n*-Hexane/Isopropanol, 1 mL/min, 254 nm): $t_{\text{minor}} = 16.944$ min, $t_{\text{major}} = 17.723$ min, 82% ee, $[\alpha]_D^{24} = -53.21$ (c 1.260, CHCl_3). ^1H NMR (400 MHz, CDCl_3): δ 8.40 (d, $J = 8.2$ Hz, 1H), 7.70 (dd, $J = 23.8$, 8.0 Hz, 2H), 7.56 (d, $J = 8.4$ Hz, 2H), 7.51 – 7.31 (m, 5H), 7.27 – 6.99 (m, 6H), 4.84 (t, $J = 7.0$ Hz, 1H), 3.65 – 3.31 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3): δ 194.26, 139.14, 133.59, 132.64, 132.26, 131.53, 130.11, 129.36, 127.79, 127.43, 126.79, 126.70, 126.65, 125.95, 125.71, 125.05, 124.50, 123.94, 123.65, 46.60, 42.89. IR (neat): 3055, 3030, 2899, 1682, 1583, 1500, 1452, 1396, 1365, 1331, 1220, 1177, 1070, 1007, 983, 823, 799, 774, 721, 699, 661, 626, 601, 557, 524, 470, 448, 419 cm^{-1} . MS (MALDI-TOF) m/z : $[\text{M} + \text{Na}]^+$ Calcd. for $\text{C}_{25}\text{H}_{19}\text{BrNaOS}$ 469.024; Found 469.058.

3-(Naphthalen-1-ylthio)-1-phenyl-3-(4-(trifluoromethyl)phenyl)propan-1-one (12m)

White solid, 79.57 mg, mp 118 $^{\circ}\text{C}$, 79% yield in 19 h, in THF. HPLC (AD-H, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 254 nm): $t_{\text{minor}} = 8.847$ min, $t_{\text{major}} = 7.195$ min, 67% ee, $[\alpha]_D^{23} = -74.02$ (c 1.730, CHCl_3). ^1H NMR (400 MHz, CDCl_3): δ 8.37 (d, $J = 7.8$ Hz, 1H), 7.88 – 7.68 (m, 4H), 7.54 – 7.30 (m, 8H), 7.28 – 7.16 (m, 3H), 4.89 (t, $J = 7.1$ Hz, 1H), 3.78 – 3.50 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3): δ 195.41, 144.34, 135.38, 133.42, 133.01, 132.74, 132.41, 129.34, 128.55, 128.33 (q, $J = 32.3$ Hz), 127.64, 127.54, 127.02, 126.99, 125.89, 125.29, 124.54, 124.34, 124.25 (dd, $J = 7.5$, 3.8 Hz), 46.87, 43.15. IR (neat): 3050, 2939, 2902, 1677, 1618, 1596, 1503, 1450, 1426, 1365, 1328, 1226, 1157, 1123, 1072, 1018, 986, 954, 918, 860, 821, 797, 769, 758, 708, 684, 647, 634, 620, 601, 563, 529, 425 cm^{-1} . MS (MALDI-TOF) m/z : $[\text{M} + \text{Na}]^+$ Calcd. for $\text{C}_{26}\text{H}_{19}\text{F}_3\text{NaOS}$ 459.101; Found 459.123.

3-(Naphthalen-1-ylthio)-1-(2-nitrophenyl)-3-phenylpropan-1-one (12n)

White solid, 73.61 mg, mp 112 $^{\circ}\text{C}$, 84% yield in 21 h, in THF. HPLC (AD-H, 99:1 *n*-Hexane/Isopropanol, 0.8 mL/min, 254 nm): $t_{\text{minor}} = 64.775$ min, $t_{\text{major}} = 68.571$ min, 82% ee, $[\alpha]_D^{24} = -1.545$ (c 1.165, CHCl_3). ^1H NMR (400 MHz, CDCl_3): δ 8.52 – 8.22 (m, 1H), 8.07 – 7.82 (m, 1H), 7.78 – 7.60 (m, 2H), 7.55 – 7.31 (m, 5H), 7.20 (t, $J = 7.7$ Hz, 1H), 7.16 – 7.00 (m, 5H), 6.94 – 6.81 (m, 1H), 4.75 (t, $J = 7.3$ Hz, 1H), 3.41 (t, $J = 8.7$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3): 198.21, 143.90, 138.96, 136.14, 132.76, 132.67, 132.51, 131.58, 129.39, 129.05, 127.05, 126.96, 126.27, 126.08, 126.05, 125.31, 124.74, 124.09, 123.93, 122.74, 47.22, 46.93. IR (neat): 3058, 3029, 2923, 2910, 2856, 1709, 1573, 1529, 1499, 1455, 1403, 1367, 1343, 1218, 1142, 1019, 987, 935, 856, 790, 767, 747, 732, 715, 697, 668, 634, 618, 572, 547, 508, 451, 420 cm^{-1} . (MALDI-TOF) m/z : $[\text{M} + \text{Na}]^+$ Calcd. for $\text{C}_{25}\text{H}_{19}\text{NNaO}_3\text{S}$ 436.098; Found 436.139.

3-(Naphthalen-1-ylthio)-3-(4-nitrophenyl)-1-phenylpropan-1-one (12o)

Yellow solid, 67.23 mg, mp 129-130 °C, 81% yield in 21 h, in THF. HPLC (AD-H, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 210 nm): $t_{\text{minor}} = 26.461$ min, $t_{\text{major}} = 24.532$ min, 68% ee, $[\alpha]_D^{23} = -153.6$ (c 1.665, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.37 (d, $J = 8.1$ Hz, 1H), 7.92 (d, $J = 8.7$ Hz, 2H), 7.83 – 7.68 (m, 4H), 7.54 – 7.40 (m, 3H), 7.37 (t, $J = 7.6$ Hz, 3H), 7.26 – 7.15 (m, 3H), 4.90 (t, $J = 7.1$ Hz, 1H), 3.74 – 3.55 (m, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 195.06, 148.01, 145.81, 135.24, 133.43, 133.12, 133.05, 132.59, 128.90, 128.76, 127.73, 127.66, 127.54, 127.01, 126.05, 125.40, 124.47, 124.36, 122.50, 46.75, 42.93. IR (neat): 3073, 3048, 2962, 2900, 2851, 1673, 1595, 1515, 1449, 1260, 1227, 1107, 1016, 975, 956, 918, 857, 798, 796, 751, 716, 682, 647, 618, 566, 536, 514, 427 cm⁻¹. MS (MALDI-TOF) m/z : $[M + Na]^+$ Calcd. for C₂₅H₁₉NNaO₃S 436.098; Found 436.151.

3-(Naphthalen-1-ylsulfonyl)-1,3-diphenylpropan-1-one (13a)

White solid, 17.22 mg, mp 135 °C, 43% yield. HPLC (IA, 95:5 *n*-Hexane/Isopropanol, 1 mL/min, 220 nm): $t_{\text{minor}} = 44.650$ min, $t_{\text{major}} = 47.501$ min, 86% ee, $[\alpha]_D^{22} = -156.9$ (c 1.140, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.74 (d, $J = 8.6$ Hz, 1H), 7.92 (dd, $J = 28.8, 7.8$ Hz, 4H), 7.75 (d, $J = 7.3$ Hz, 1H), 7.69 – 7.62 (m, 1H), 7.59 – 7.48 (m, 2H), 7.44 – 7.36 (m, $J = 7.7$ Hz, 2H), 7.25 (t, $J = 7.8$ Hz, 1H), 7.13 – 6.90 (m, $J = 28.3, 13.6, 7.1$ Hz, 5H), 5.22 (dd, $J = 9.2, 3.8$ Hz, 1H), 4.15 (dd, $J = 17.9, 3.8$ Hz, 1H), 3.94 (dd, $J = 18.0, 9.3$ Hz, 1H). ¹³C NMR (100 MHz, CDCl₃): δ 197.99, 136.16, 135.25, 133.87, 133.68, 132.56, 131.98, 129.41, 129.36, 139.13, 128.84, 128.75, 128.70, 128.33, 128.16, 126.97, 124.32, 123.93, 65.74, 36.79. IR (neat): 3034, 2957, 2915, 2852, 1685, 1596, 1505, 1449, 1420, 1363, 1341, 1303, 1235, 1196, 1150, 1025, 981, 921, 826, 801, 768, 750, 699, 686, 629, 594, 573, 555, 525, 506, 476 cm⁻¹. HRMS (ESI-TOF) m/z : $[M + Na]^+$ Calcd. for C₂₅H₂₀NaO₃S 423.1031; Found 423.1022.

3-(3-Methoxyphenyl)-3-(naphthalen-1-ylsulfonyl)-1-phenylpropan-1-one (13b)

White solid, 19.41 mg, mp 93 °C, 45% yield. HPLC (IA, 95:5 *n*-Hexane/Isopropanol, 1 mL/min, 254 nm): $t_{\text{minor}} = 18.229$ min, $t_{\text{major}} = 20.872$ min, 68% ee, $[\alpha]_D^{23} = -115.5$ (c 1.313, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.74 (d, $J = 8.7$ Hz, 1H), 7.96 (d, $J = 8.2$ Hz, 1H), 7.88 (t, $J = 7.5$ Hz, 3H), 7.80 (d, $J = 7.4$ Hz, 1H), 7.65 (t, $J = 7.8$ Hz, 1H), 7.58 – 7.48 (m, 2H), 7.40 (t, $J = 7.6$ Hz, 2H), 7.28 (t, $J = 7.8$ Hz, 1H), 6.91 (t, $J = 8.0$ Hz, 1H), 6.65 – 6.51 (m, 2H), 6.41 (s, $J = 9.9$ Hz, 1H), 5.18 (dd, $J = 9.3, 3.8$ Hz, 1H), 4.12 (dd, $J = 17.9, 3.9$ Hz, 1H), 3.93 (dd, $J = 18.0, 9.3$ Hz, 1H), 3.42 (s, $J = 10.6$ Hz, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 192.87, 157.18, 134.08, 133.07, 131.84, 131.73, 131.54, 129.96, 129.86, 127.34, 127.17, 126.94, 126.69, 126.63, 126.06, 124.84, 122.24, 121.88, 119.52, 112.64, 112.59, 63.71, 52.88, 34.58. IR (neat): 3053, 2960, 2918, 2849, 1726, 1685, 1594, 1493, 1447, 1362, 1305, 1258, 1231, 1149, 1121, 1035, 883, 792, 770, 688, 679, 633, 619, 593, 552, 528, 504, 486 cm⁻¹. HRMS (ESI-TOF) m/z : $[M]^+$ Calcd. for C₂₆H₂₂O₄S 430.1239; Found 439.1239.

3-(3-Methoxyphenyl)-3-(naphthalen-1-ylsulfonyl)-1-phenylpropan-1-one (13c)

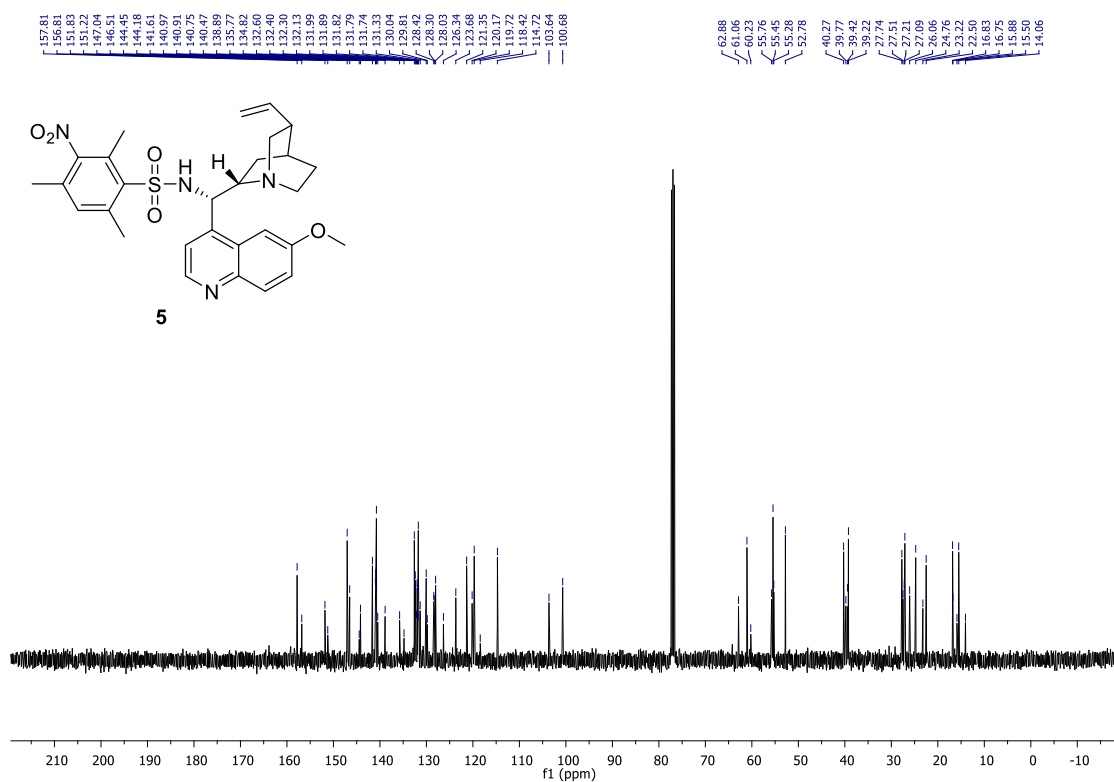
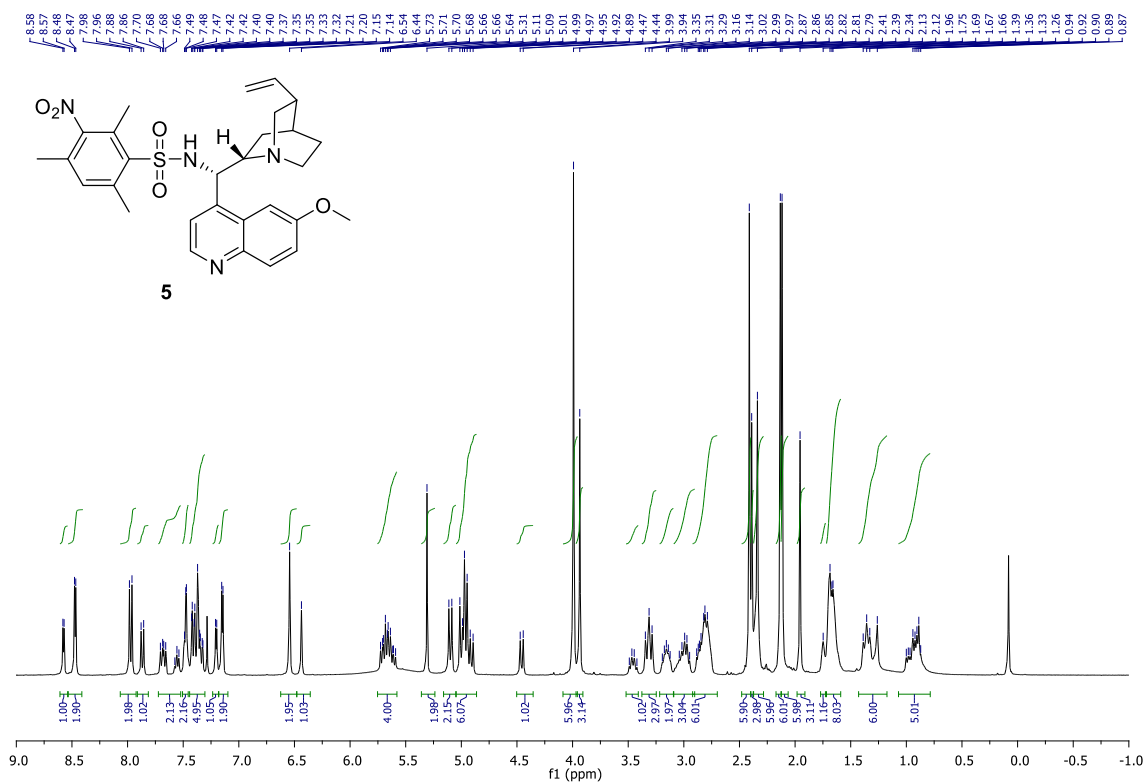
White solid, 26.61 mg, mp 146 °C, 62% yield. HPLC (IA, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 254 nm): $t_{\text{minor}} = 40.307$ min, $t_{\text{major}} = 45.189$ min, 86% ee, $[\alpha]_D^{23} = -173.1$ (c 1.773, CHCl₃). ¹H NMR

(400 MHz, CDCl₃): δ 8.73 (d, J = 8.6 Hz, 1H), 7.96 (d, J = 8.2 Hz, 1H), 7.87 (d, J = 7.7 Hz, 3H), 7.78 (d, J = 7.3 Hz, 1H), 7.66 (t, J = 7.8 Hz, 1H), 7.59 – 7.49 (m, 2H), 7.39 (t, J = 7.6 Hz, 2H), 7.29 (t, J = 7.8 Hz, 1H), 6.88 (d, J = 8.6 Hz, 2H), 6.53 (d, J = 8.7 Hz, 2H), 5.16 (dd, J = 9.4, 3.7 Hz, 1H), 4.09 (dd, J = 17.9, 3.8 Hz, 1H), 3.90 (dd, J = 17.9, 9.5 Hz, 1H), 3.61 (s, 3H), 1.51 (s, J = 19.6 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 194.08, 158.82, 135.20, 134.14, 132.87, 132.61, 131.13, 130.94, 129.55, 128.35, 128.08, 127.74, 127.71, 127.13, 125.90, 123.37, 123.31, 123.00, 112.79, 64.17, 54.14, 35.82. IR (neat): 3061, 3004, 2962, 2916, 2850, 1684, 1610, 1580, 1511, 1457, 1421, 1361, 1303, 1254, 1229, 1179, 1154, 1120, 1025, 979, 910, 852, 800, 768, 729, 711, 679, 639, 621, 600, 572, 552, 529, 505, 484, 440 cm⁻¹. HRMS (ESI-TOF) m/z : [M + Na]⁺ Calcd. for; C₂₆H₂₂NaO₄S 453.1136; Found 453.1164.

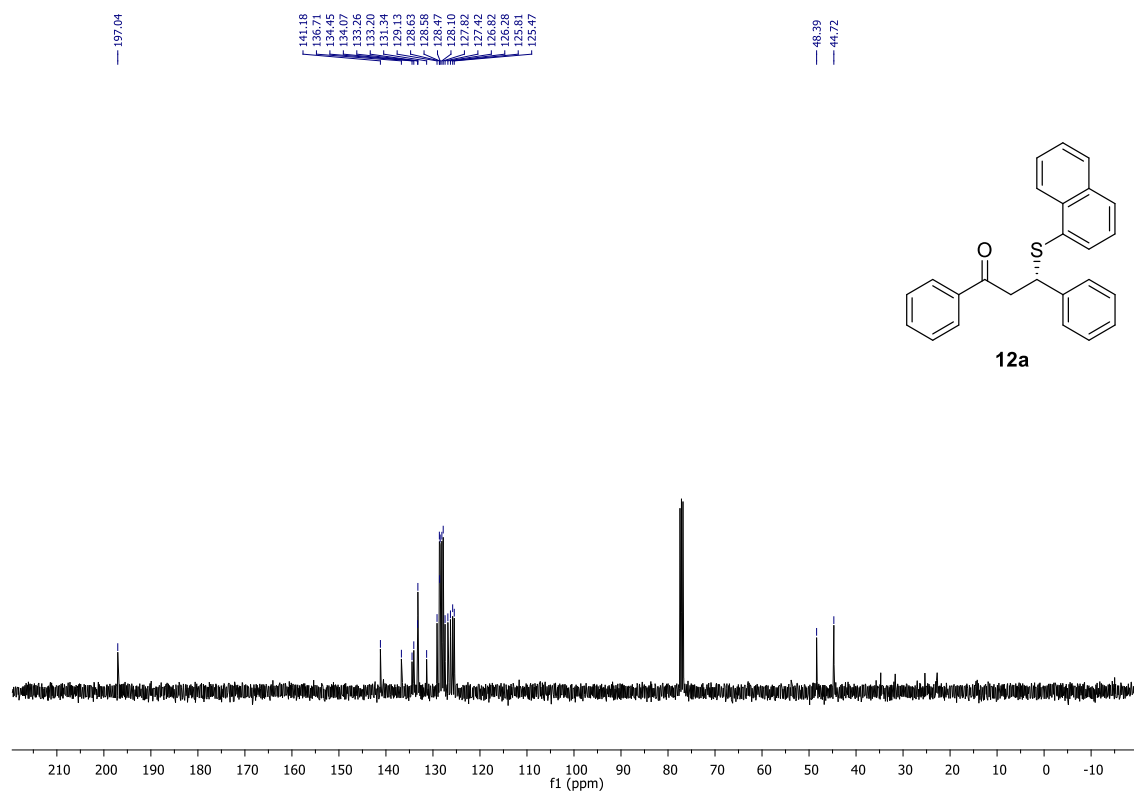
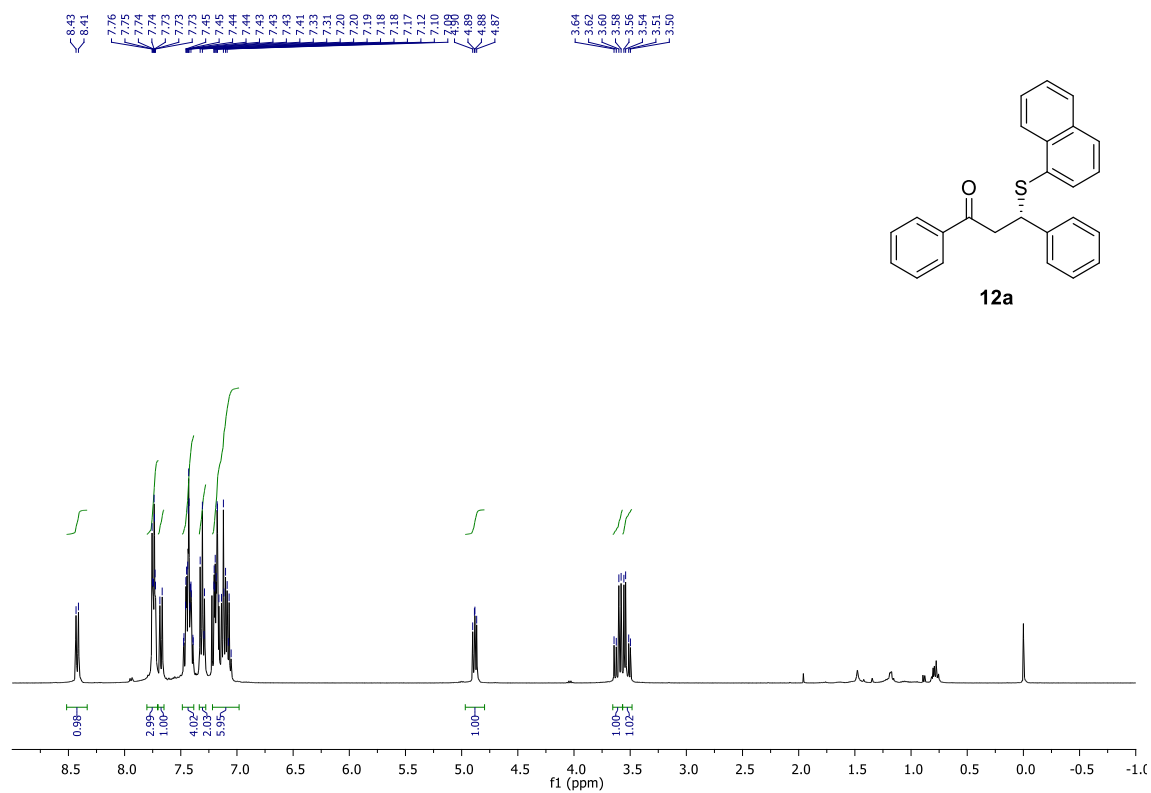
3-(4-Chlorophenyl)-3-(naphthalen-1-ylsulfonyl)-1-phenylpropan-1-one (13d)

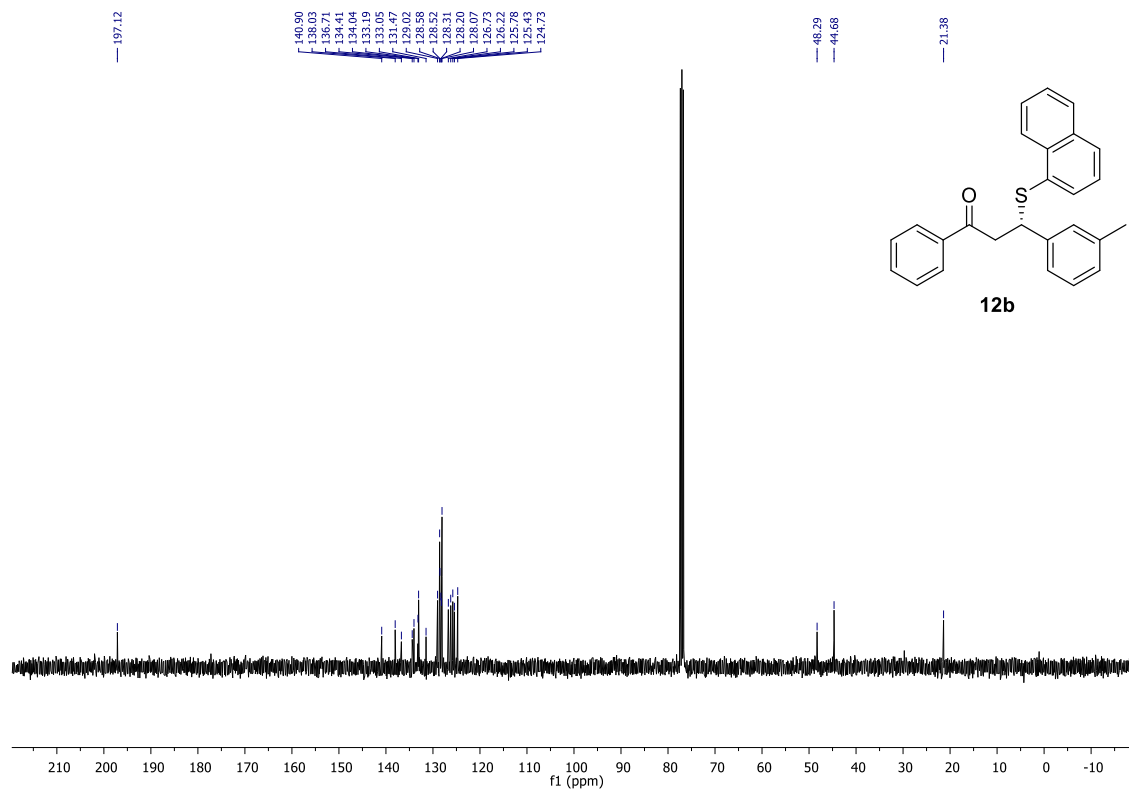
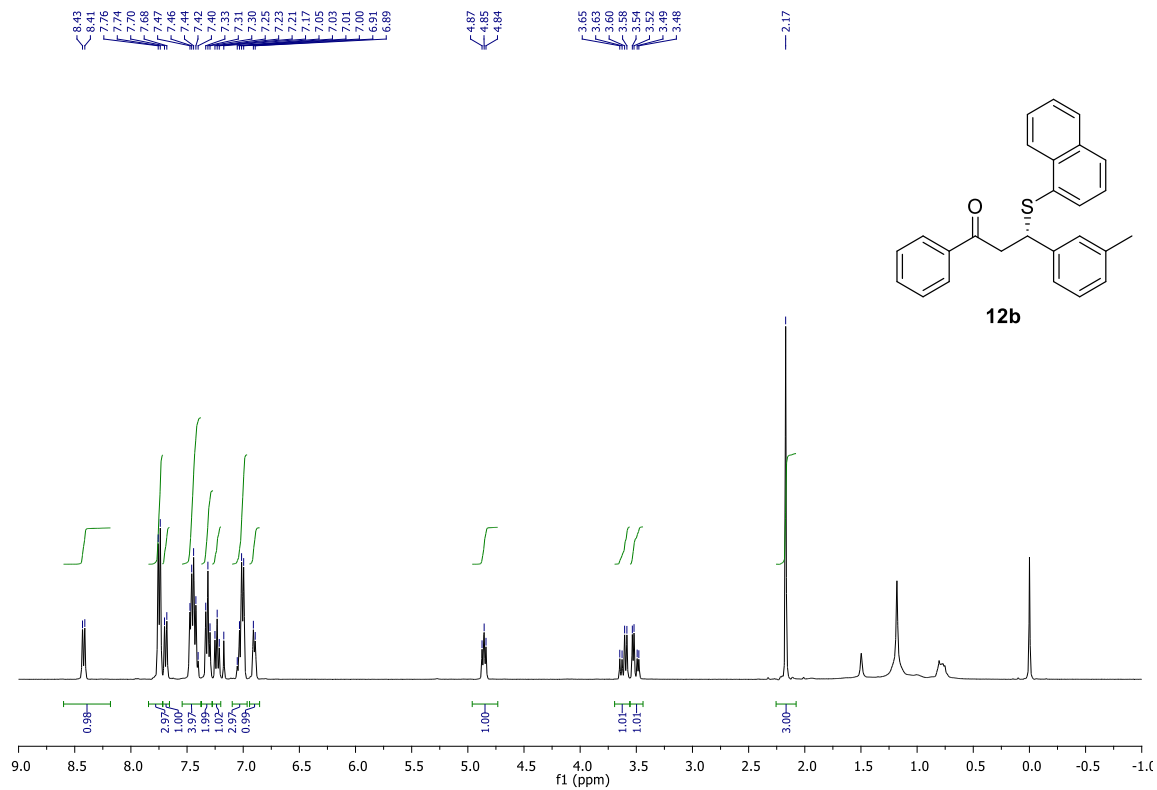
White solid, 12.28 mg, mp 134 °C, 28% yield. HPLC (IA, 90:10 *n*-Hexane/Isopropanol, 1 mL/min, 254 nm): t_{minor} = 25.206 min, t_{major} = 31.435 min, 66% ee, $[\alpha]_D^{23}$ = -135.7 (c 1.040, CHCl₃). ¹H NMR (400 MHz, CDCl₃): δ 8.71 (d, J = 8.7 Hz, 1H), 8.00 – 7.93 (m, J = 6.3 Hz, 1H), 7.90 – 7.82 (m, 3H), 7.77 (d, J = 7.4 Hz, 1H), 7.71 – 7.64 (m, 1H), 7.64 – 7.42 (m, 3H), 7.40 (t, J = 7.7 Hz, 2H), 7.35 – 7.27 (m, J = 15.3, 7.7 Hz, 1H), 6.93 (dd, J = 35.0, 8.5 Hz, 4H), 5.17 (dd, J = 9.6, 3.6 Hz, 1H), 4.01 (ddd, J = 27.6, 18.0, 6.6 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 193.63, 134.88, 134.30, 133.67, 132.75, 132.65, 130.89, 130.61, 130.05, 129.50, 128.43, 128.09, 127.80, 127.64, 127.42, 126.98, 125.92, 123.00, 122.87, 63.96, 49.26, 35.60. IR (neat): 3059, 2917, 2849, 1681, 1658, 1593, 1492, 1447, 1420, 1363, 1329, 1142, 1119, 1094, 1015, 979, 924, 858, 798, 772, 775, 707, 689, 631, 620, 598, 564, 533, 507, 481, 456 cm⁻¹. HRMS (ESI-TOF) m/z : [M + Na]⁺ Calcd. for C₂₅H₁₉ClNaO₃S 457.0641; Found 457.0666.

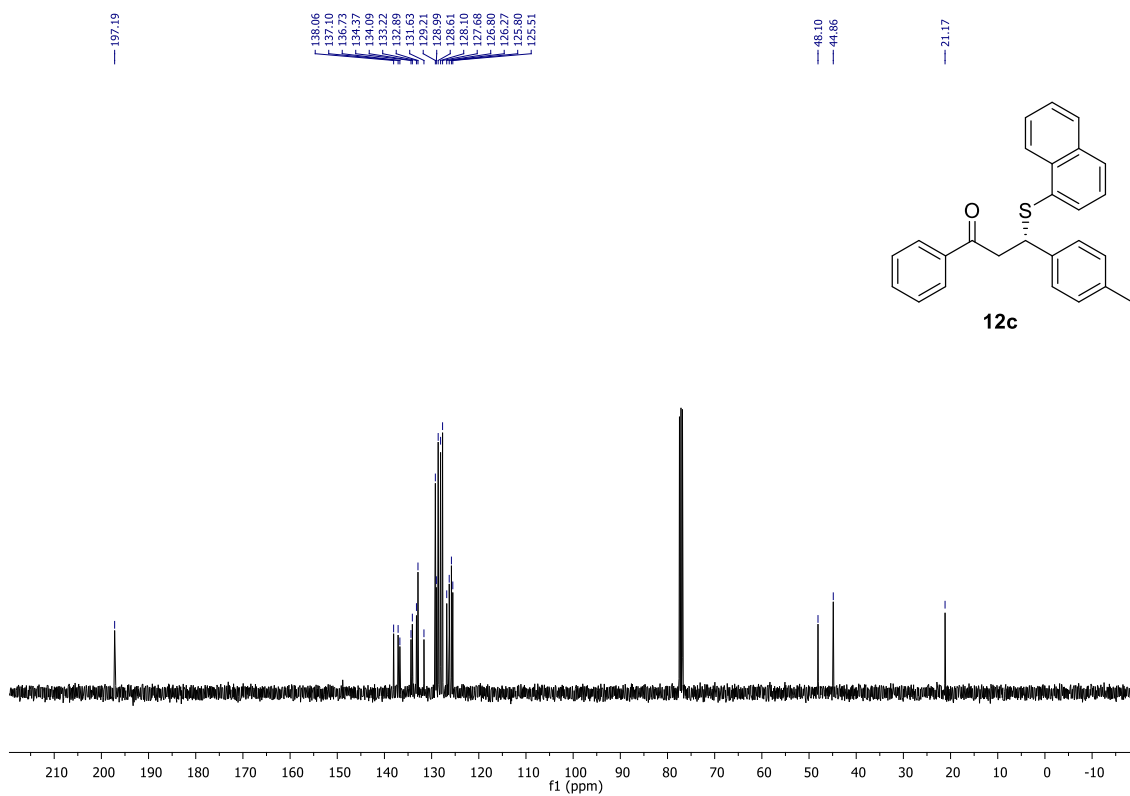
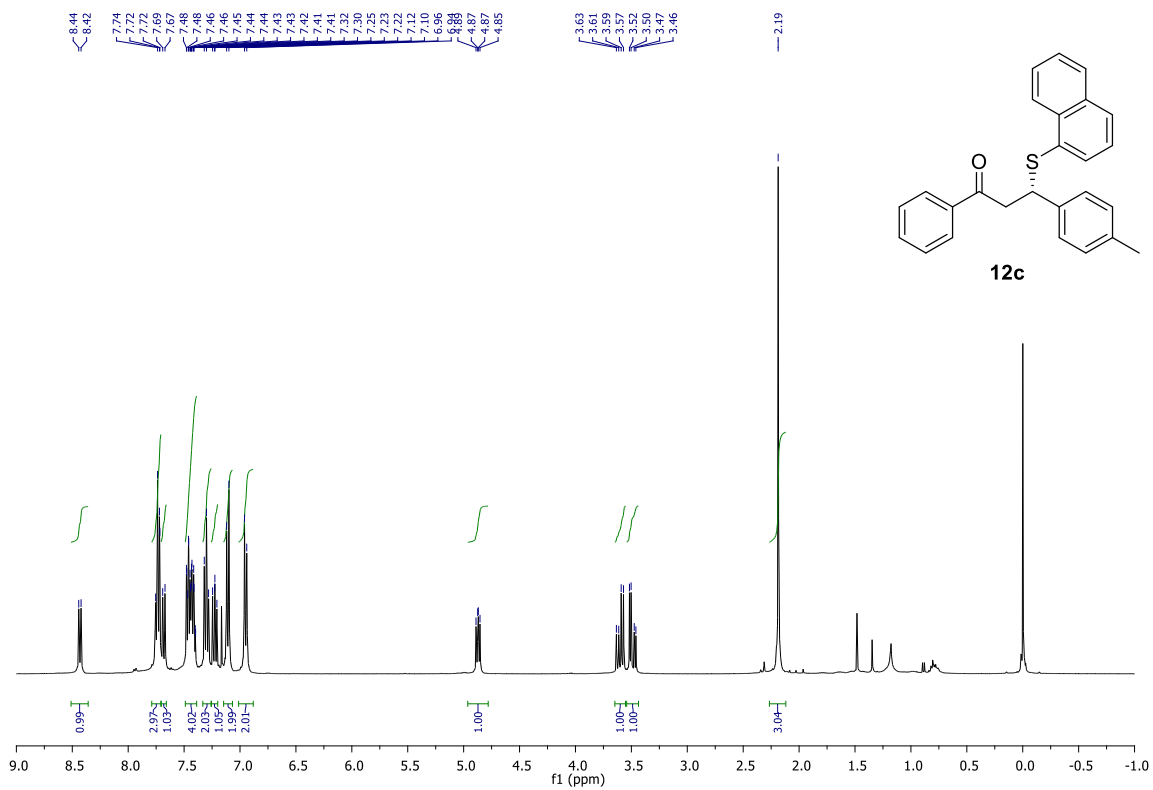
III. ^1H and ^{13}C NMR spectra of catalyst 5

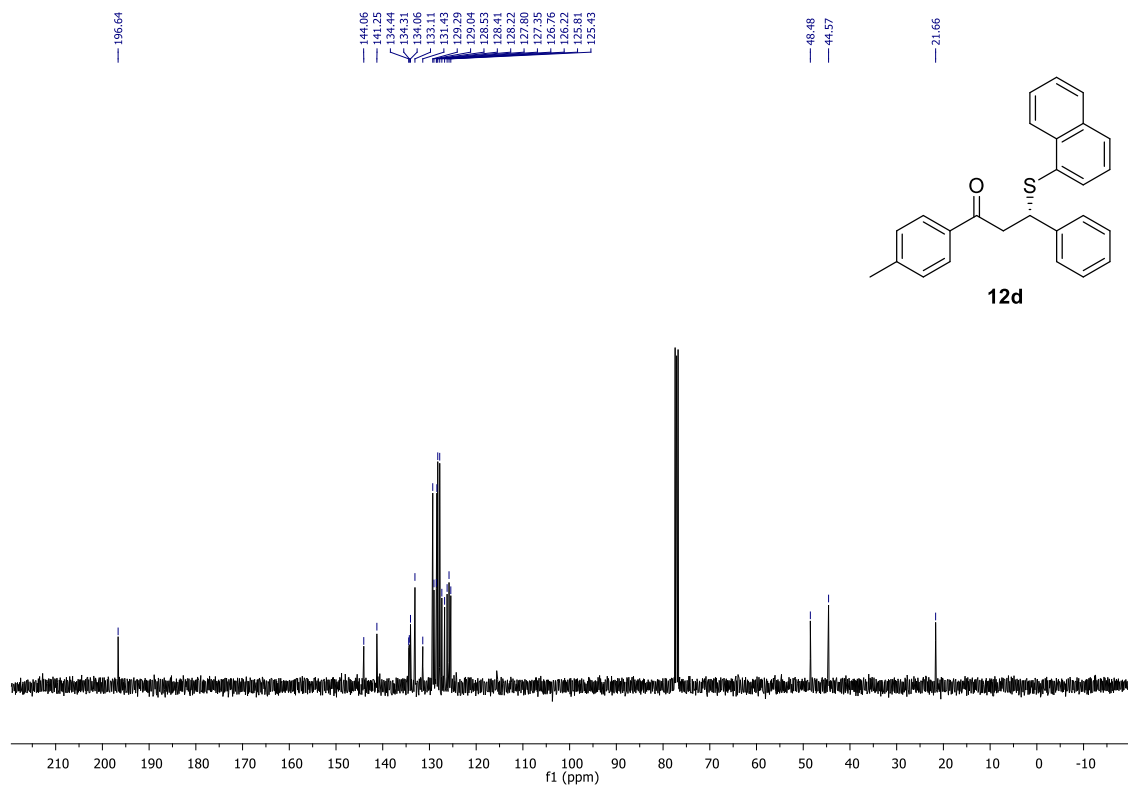
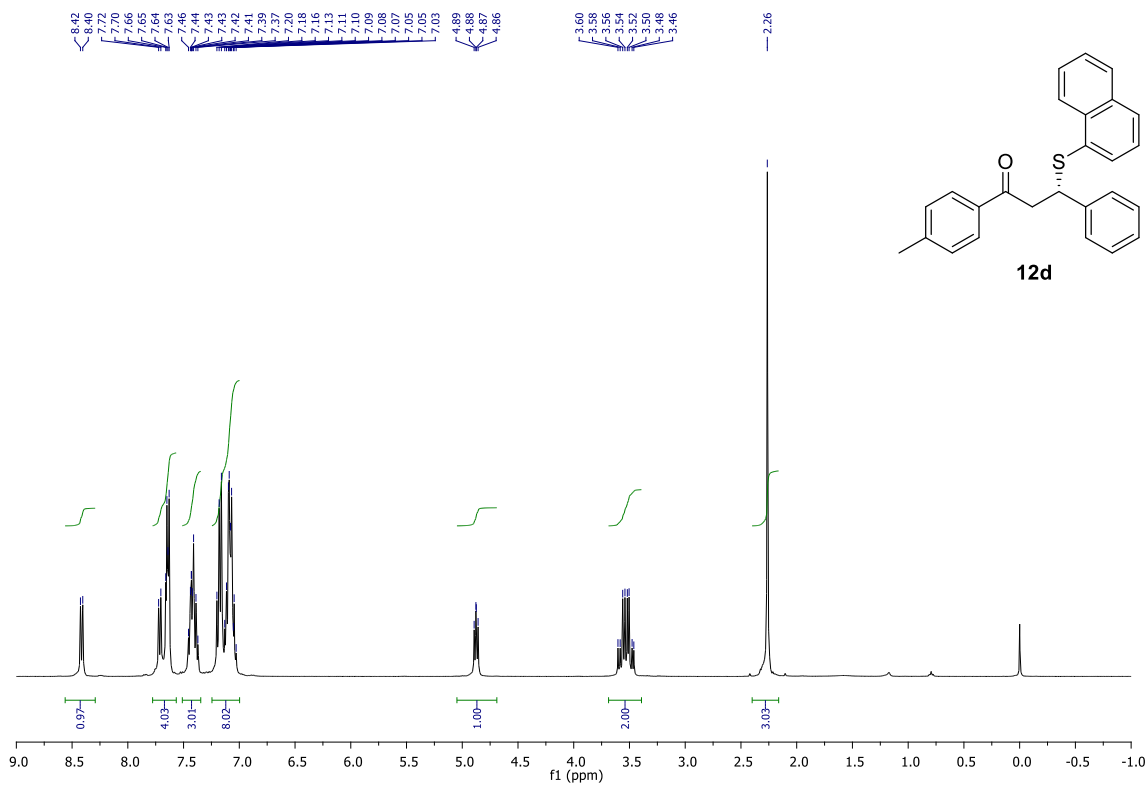


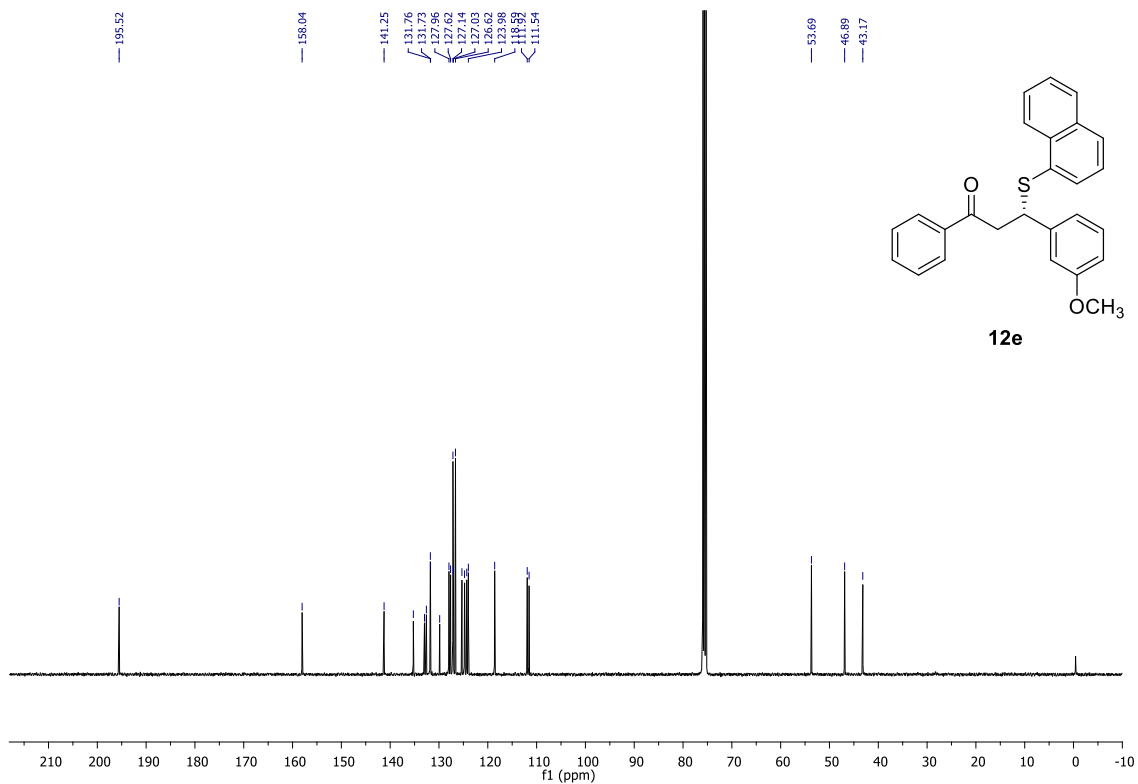
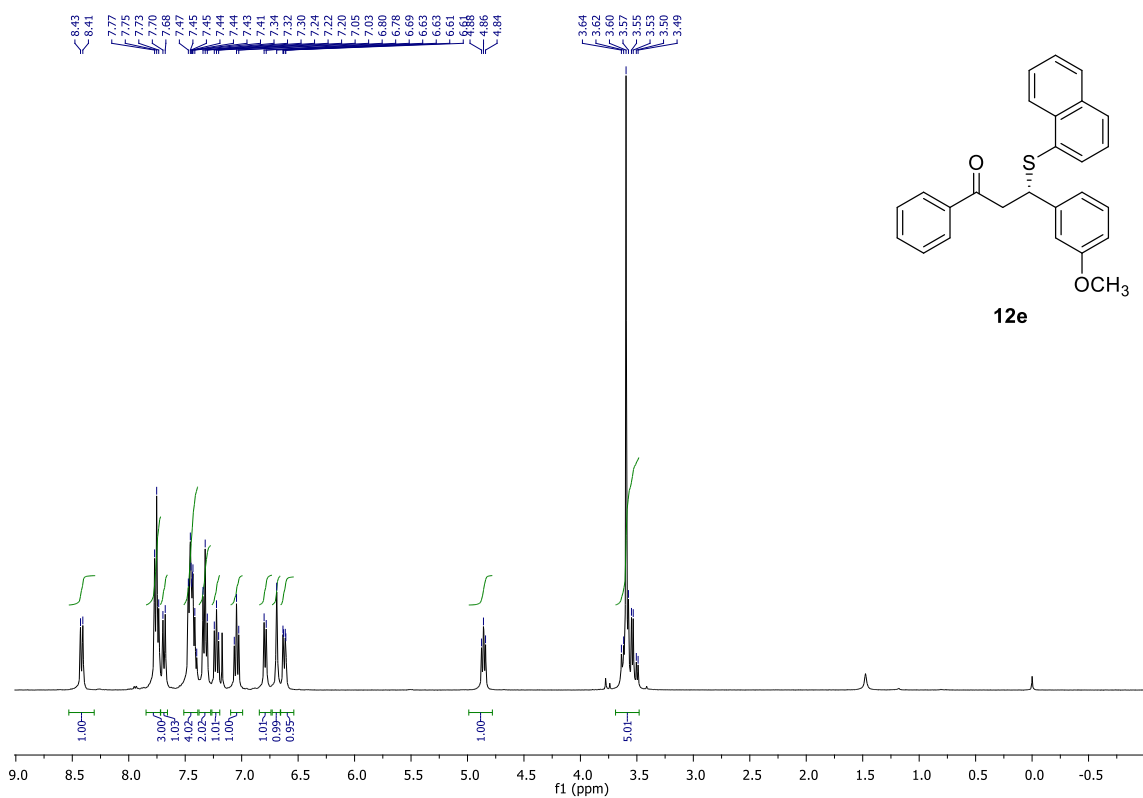
IV. ^1H and ^{13}C NMR spectra of products 12a–o

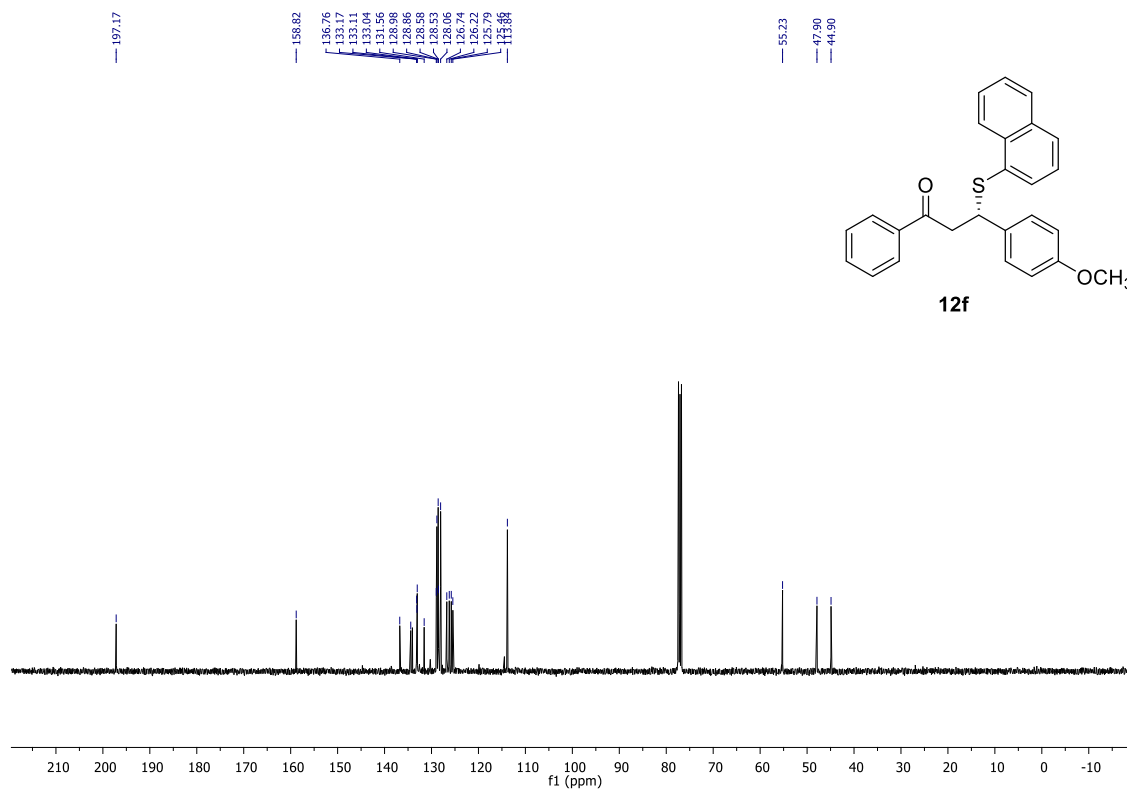
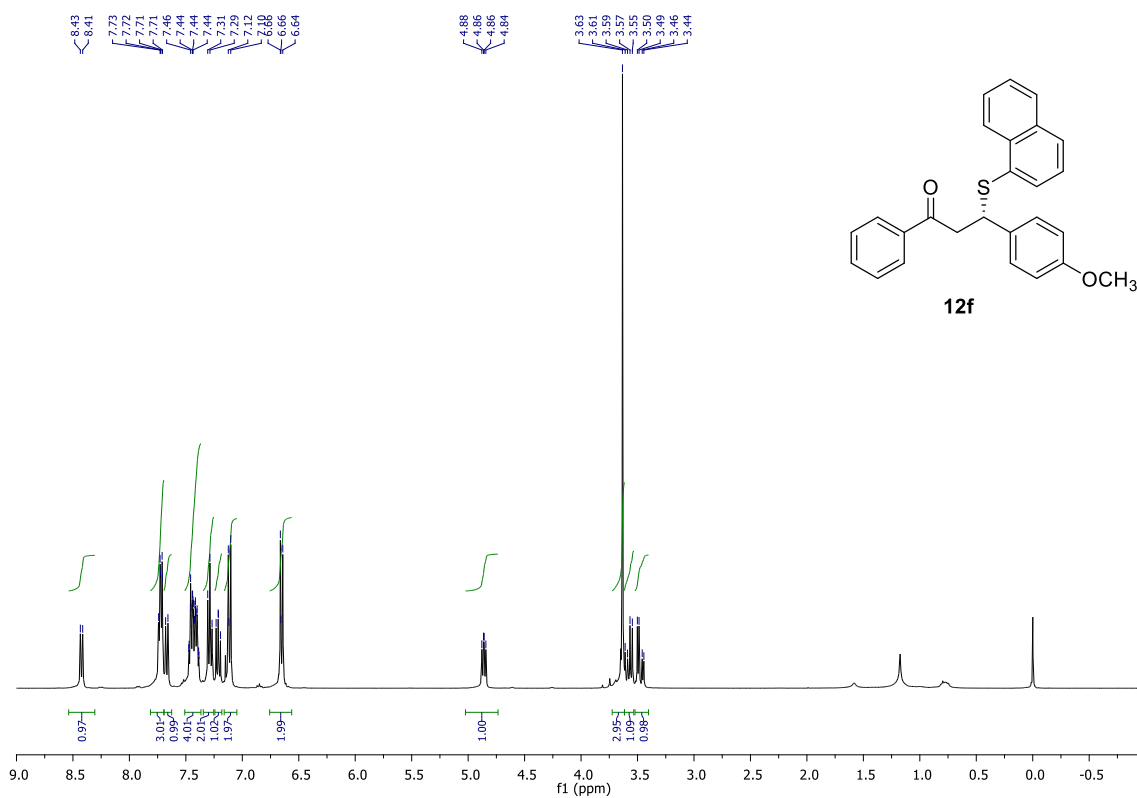


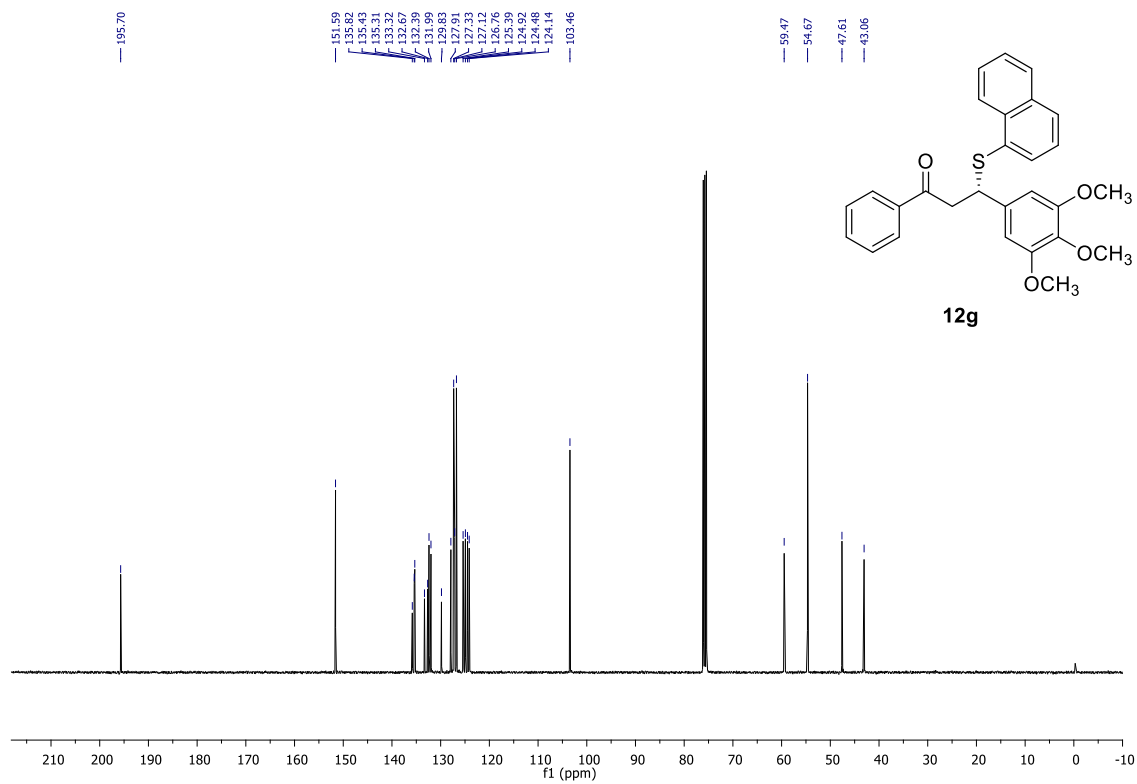
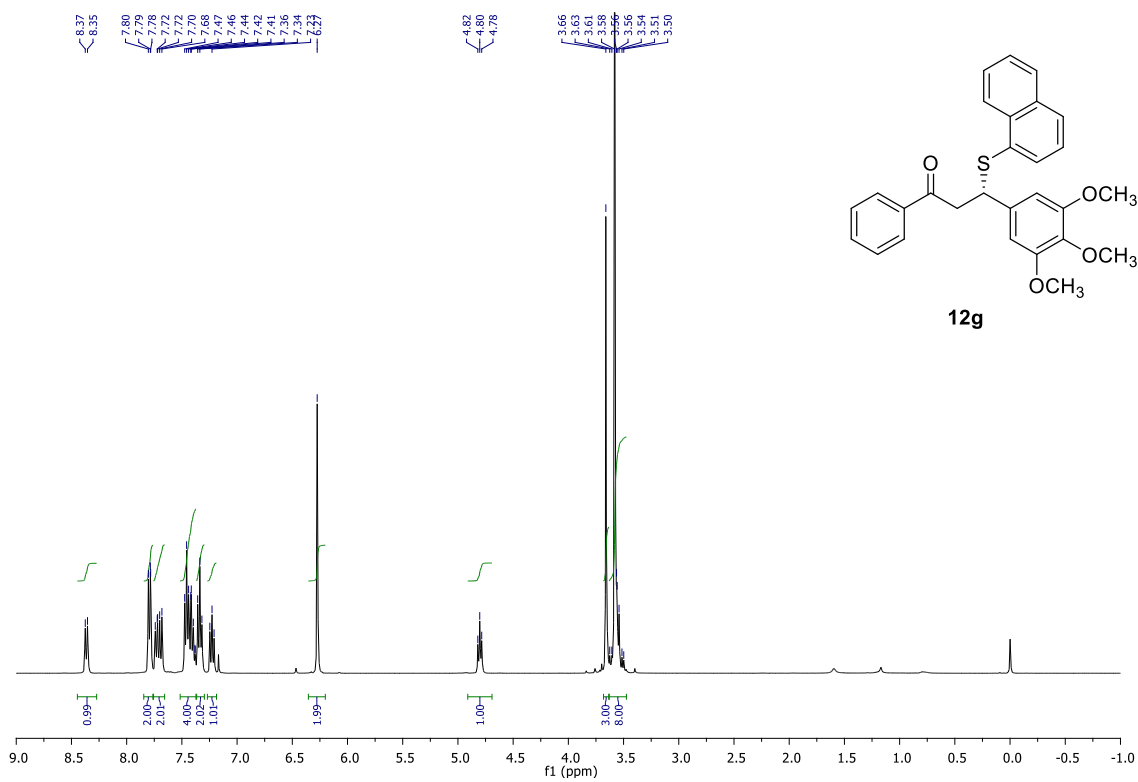


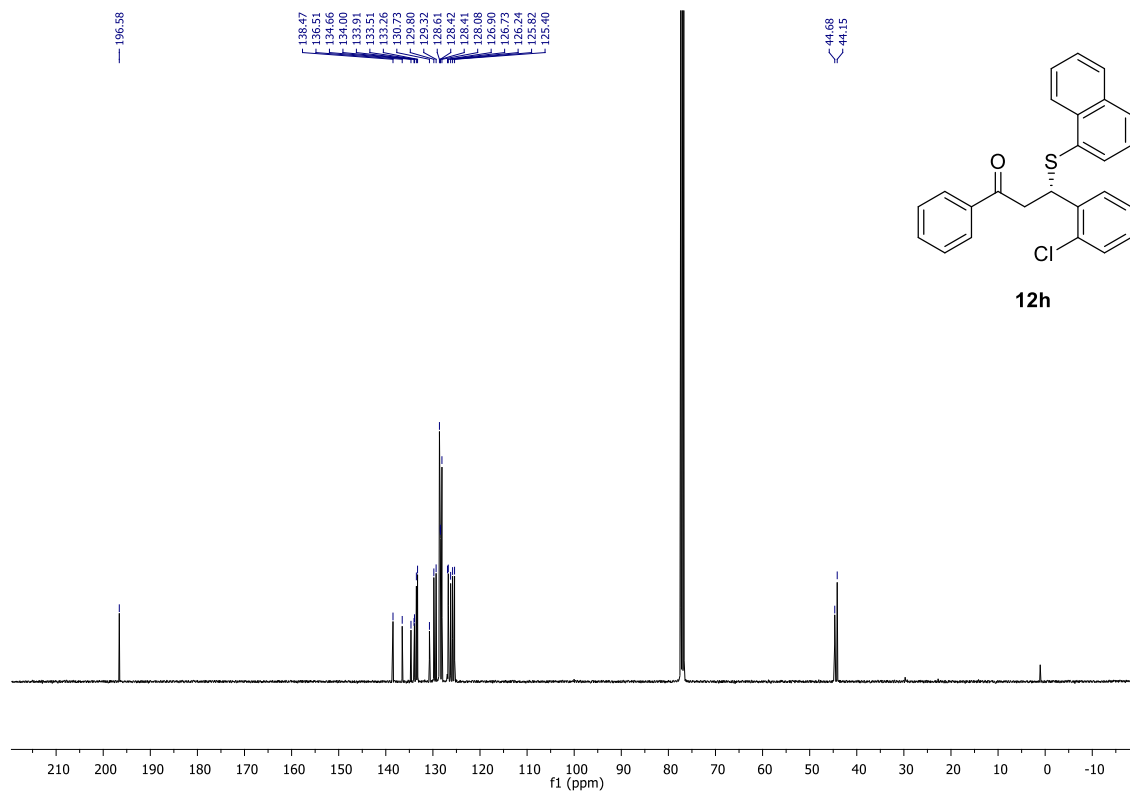
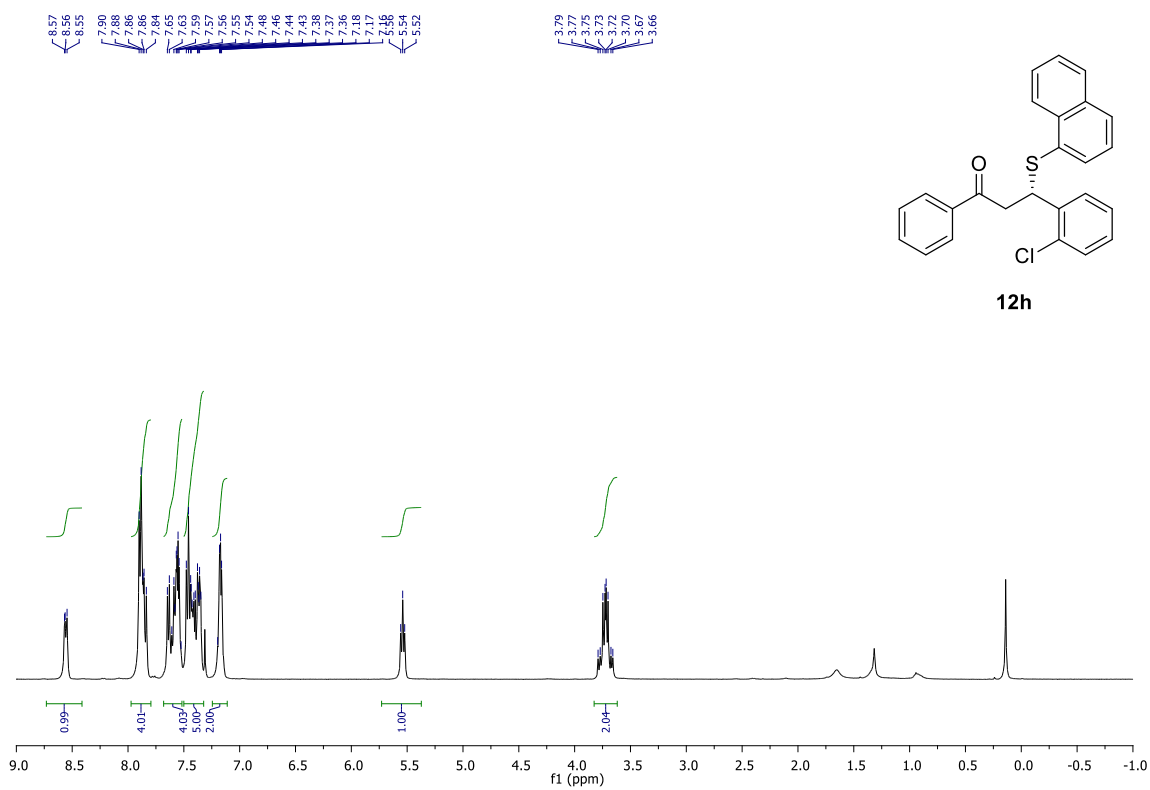


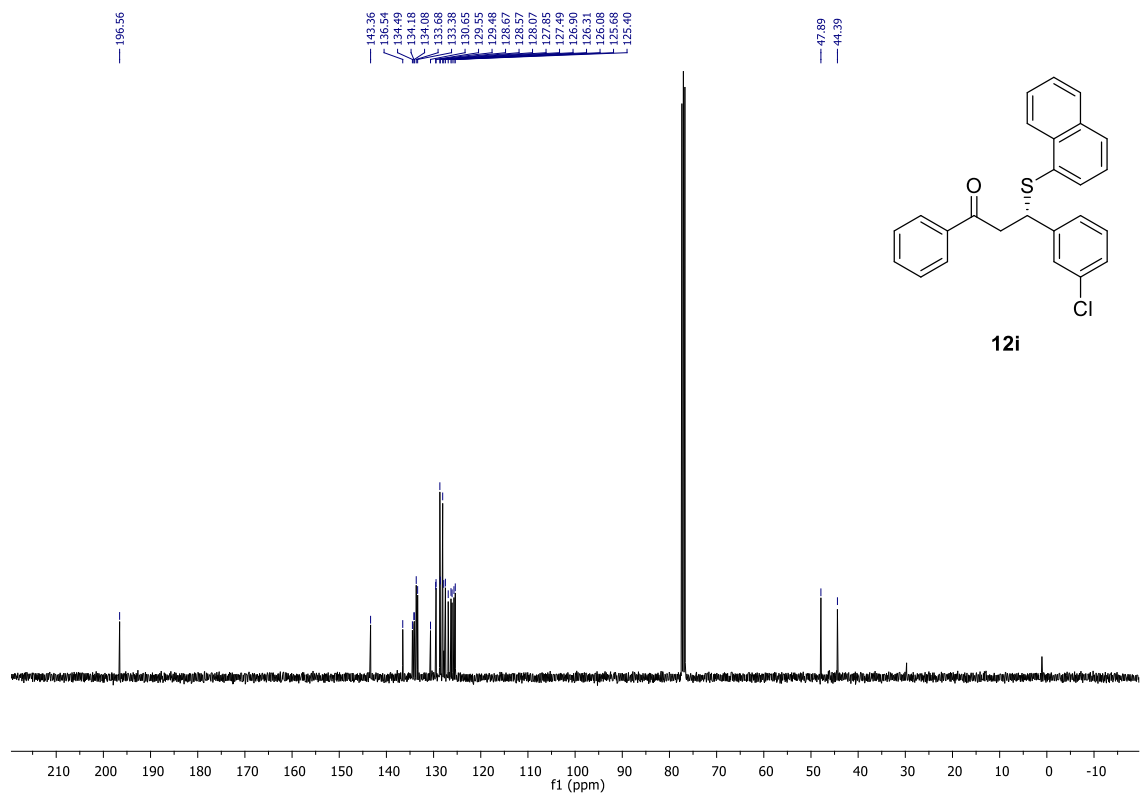
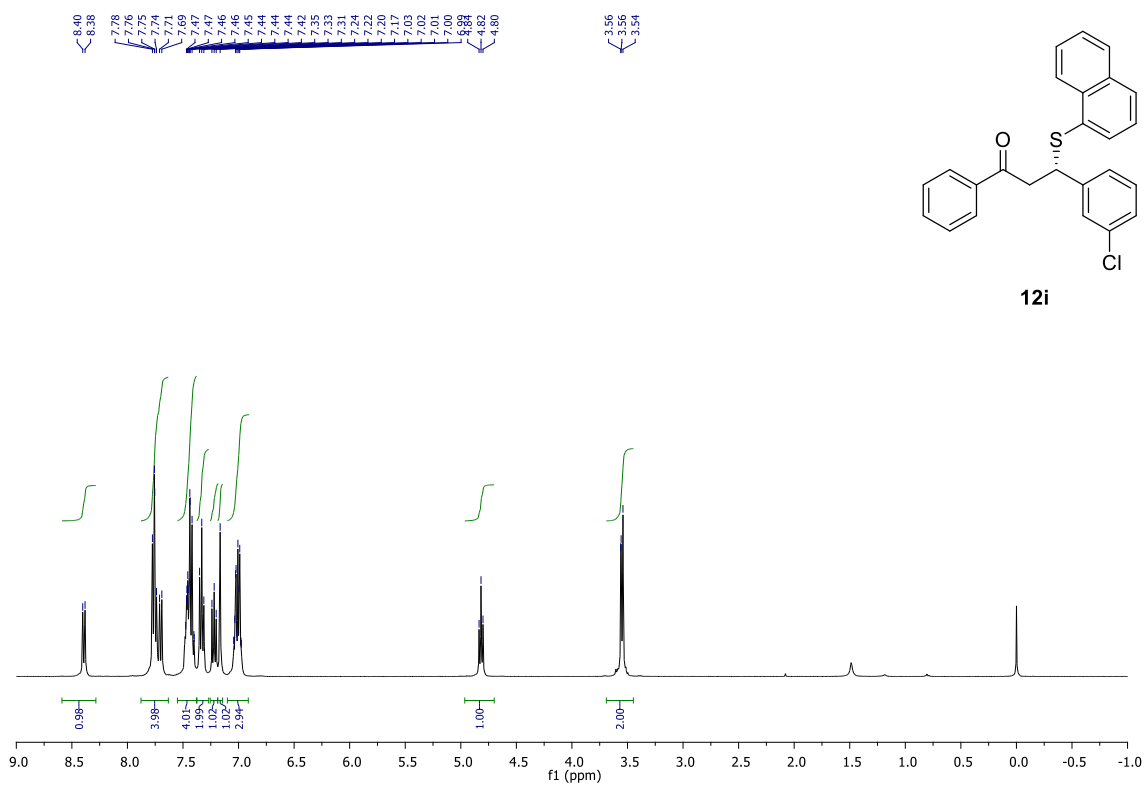


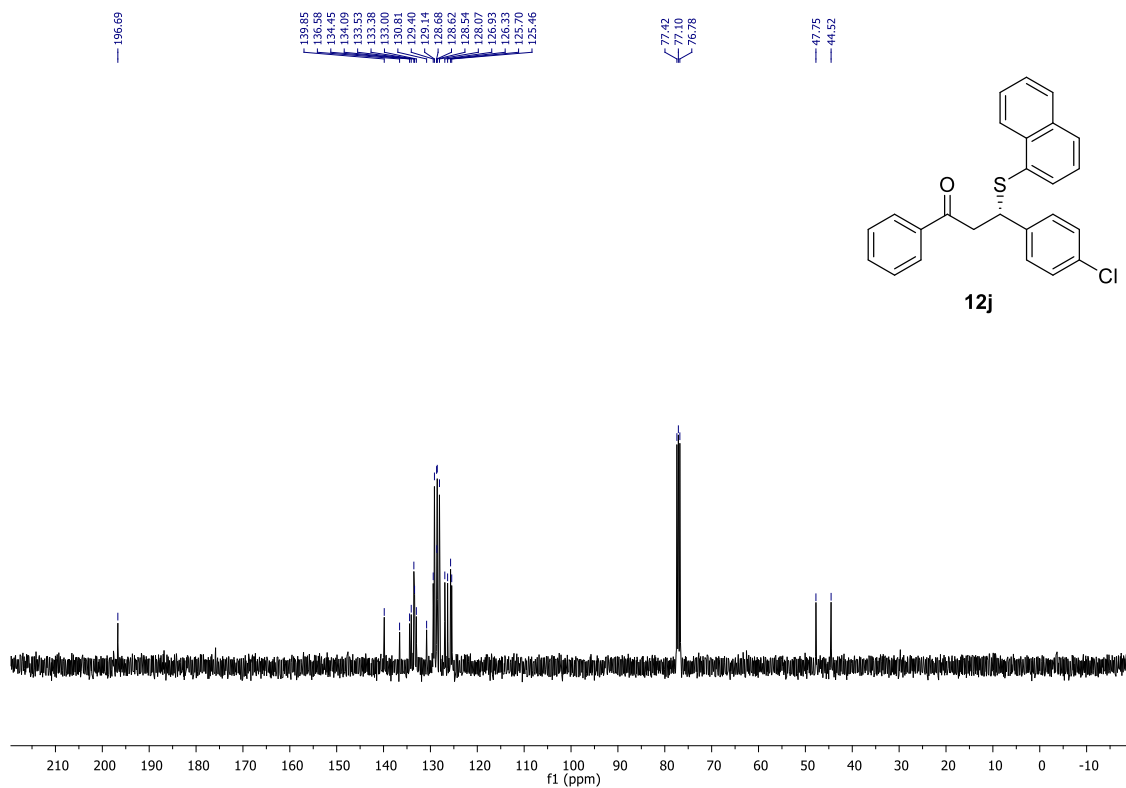
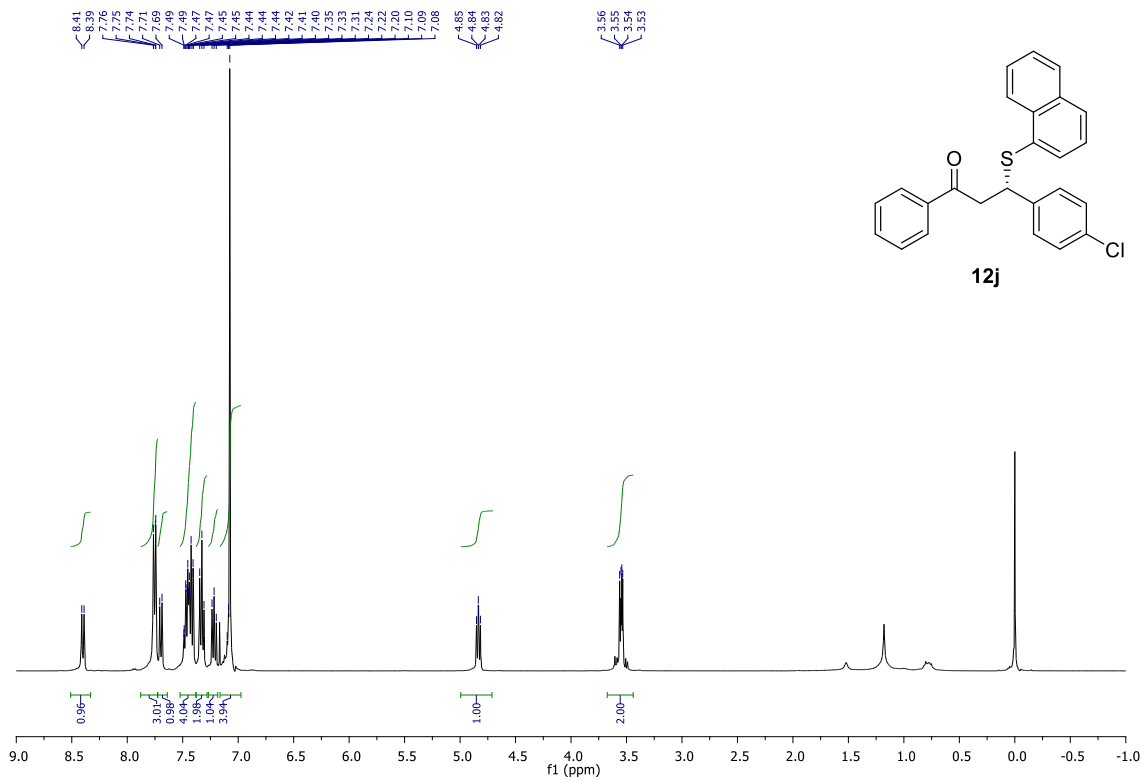


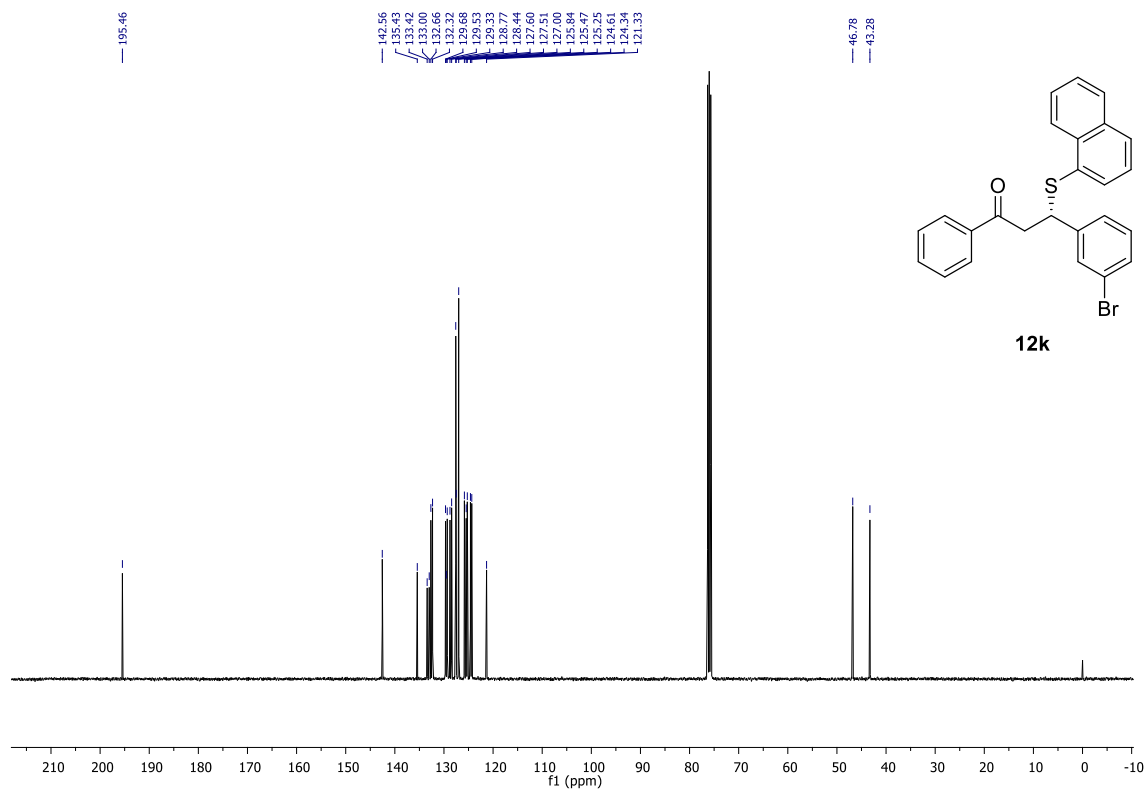
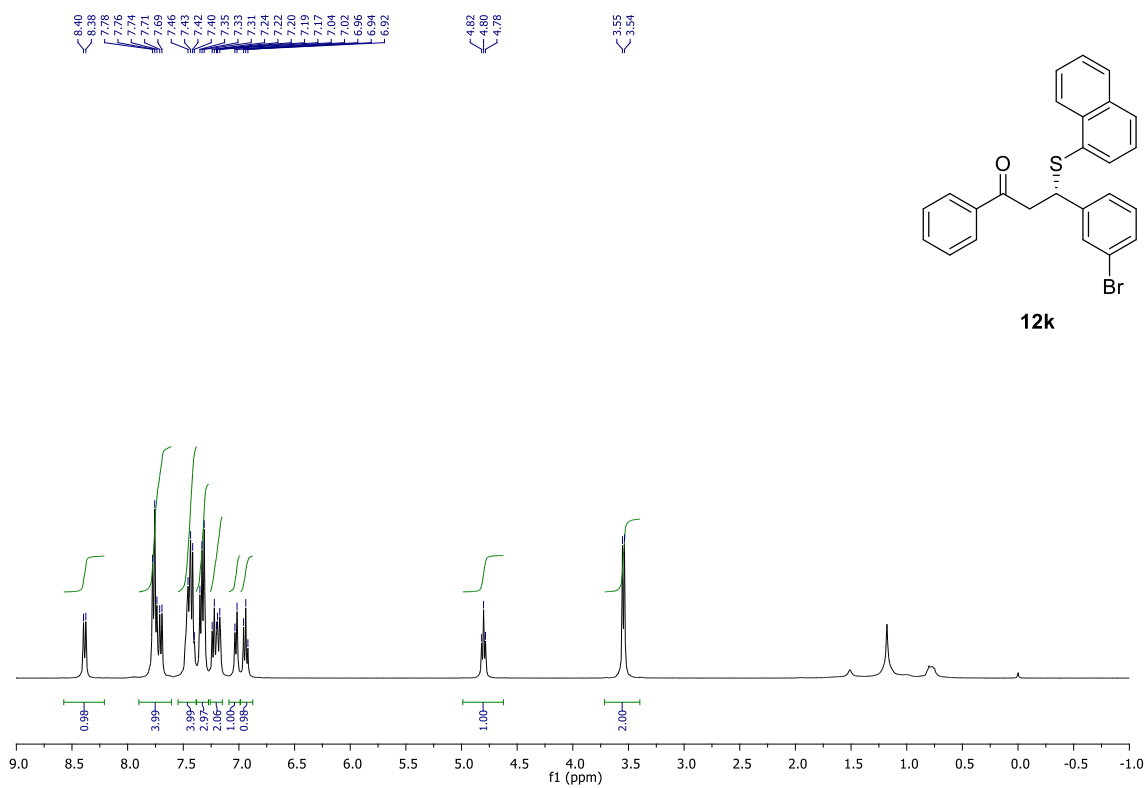


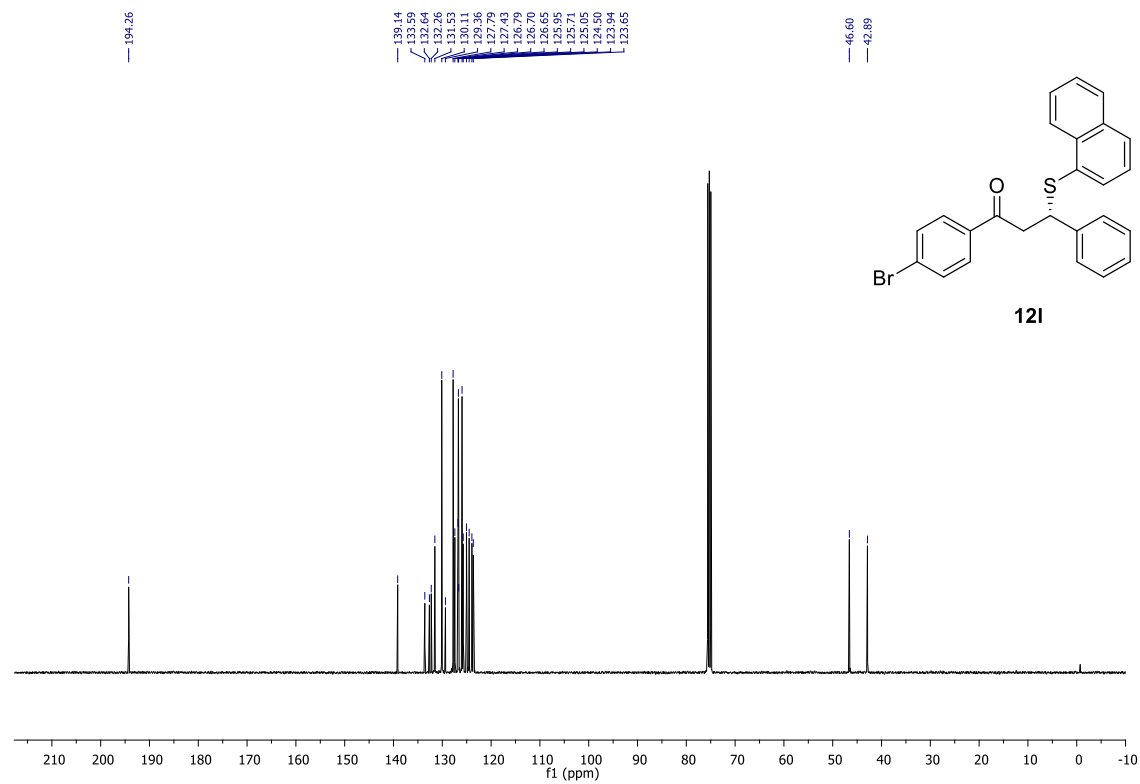
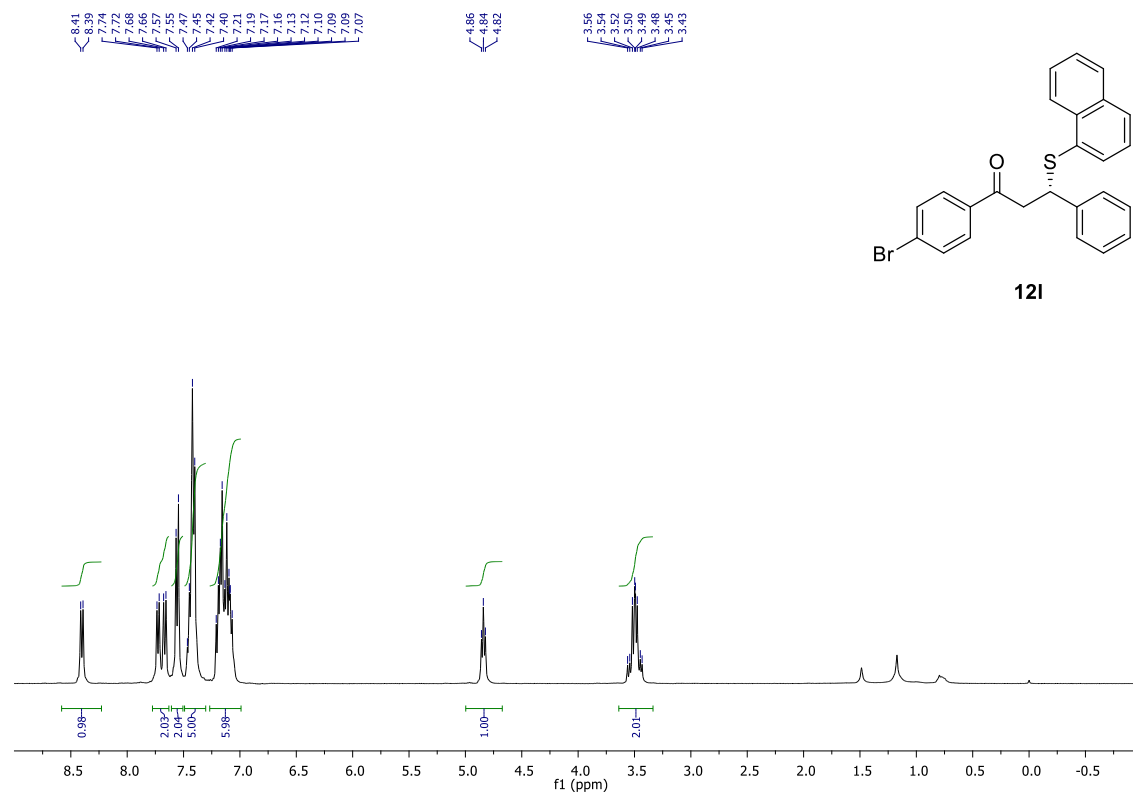


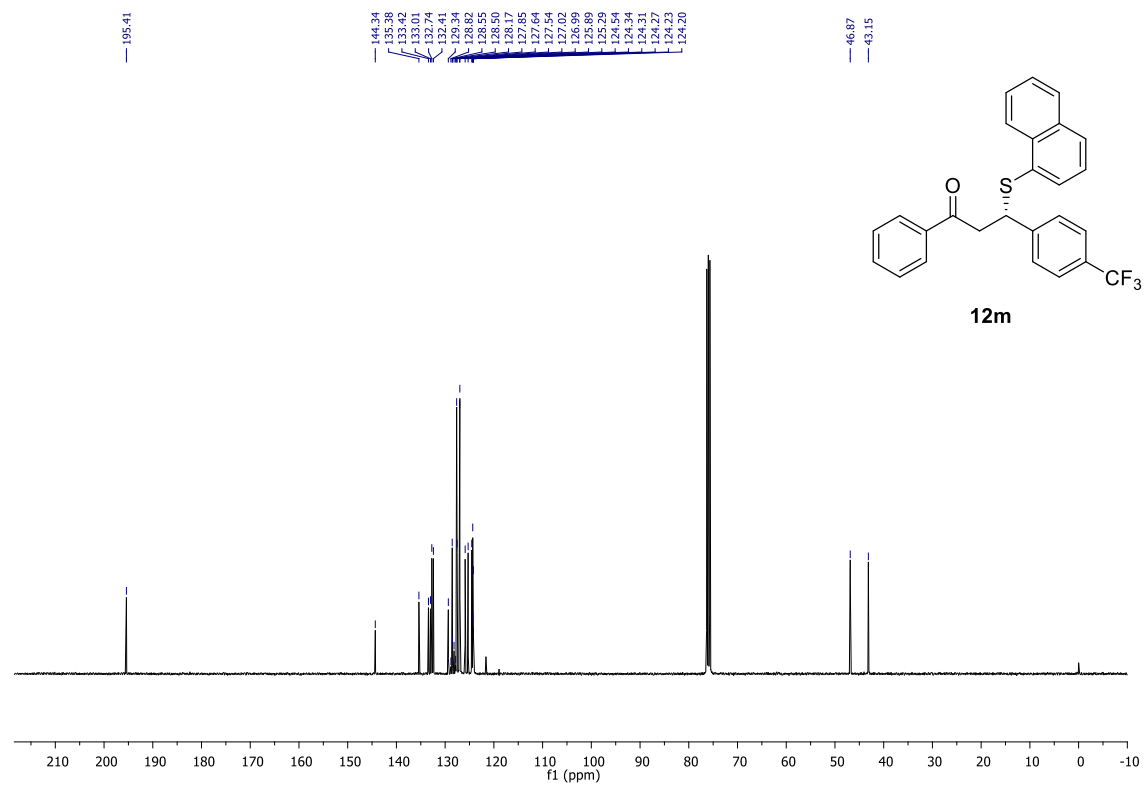
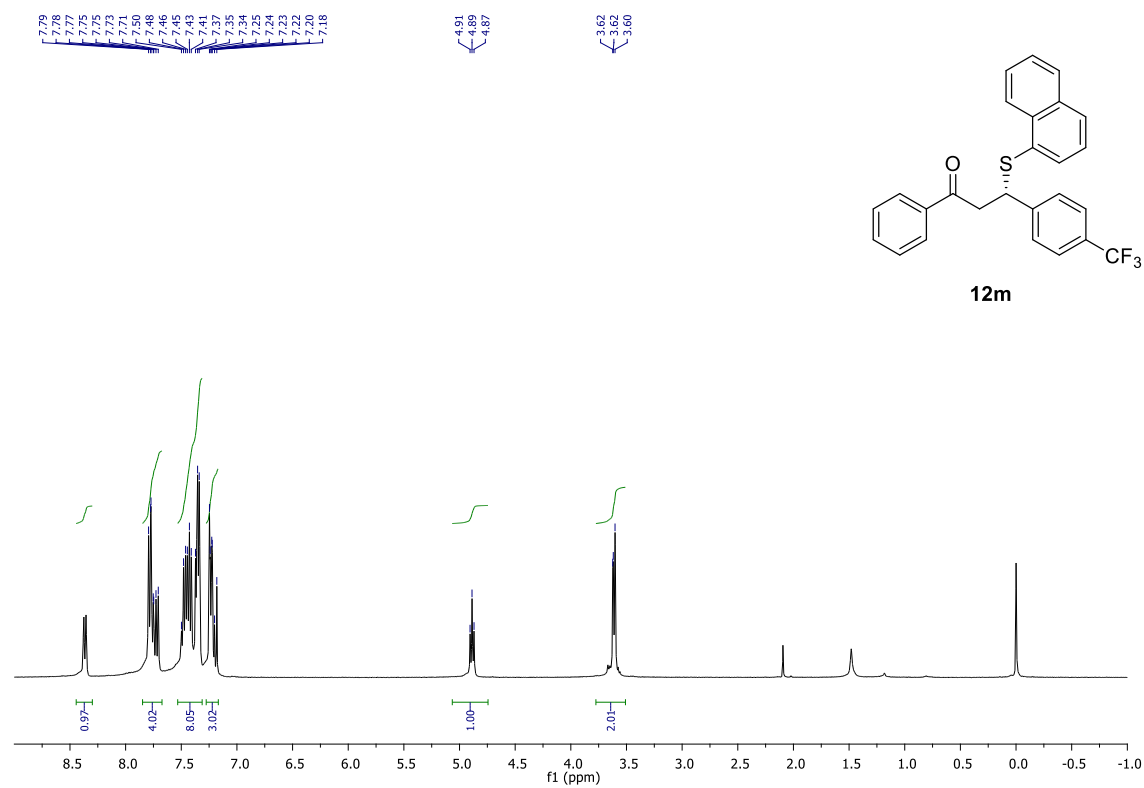


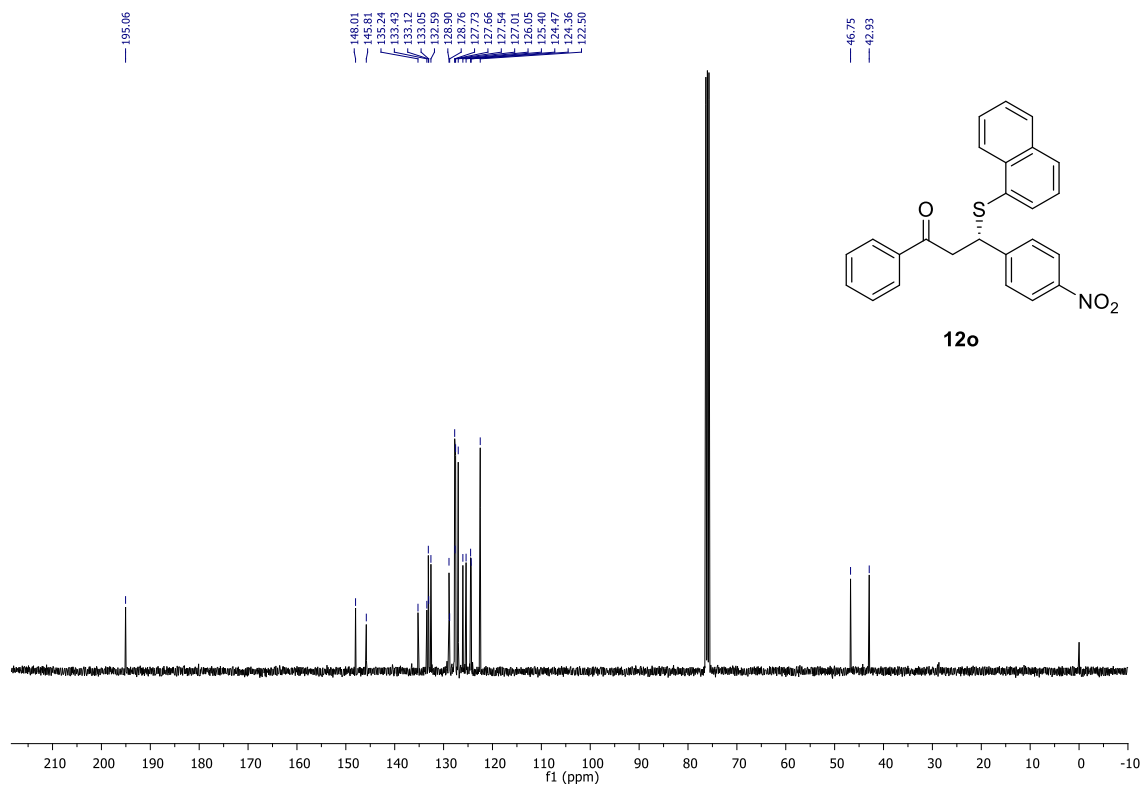
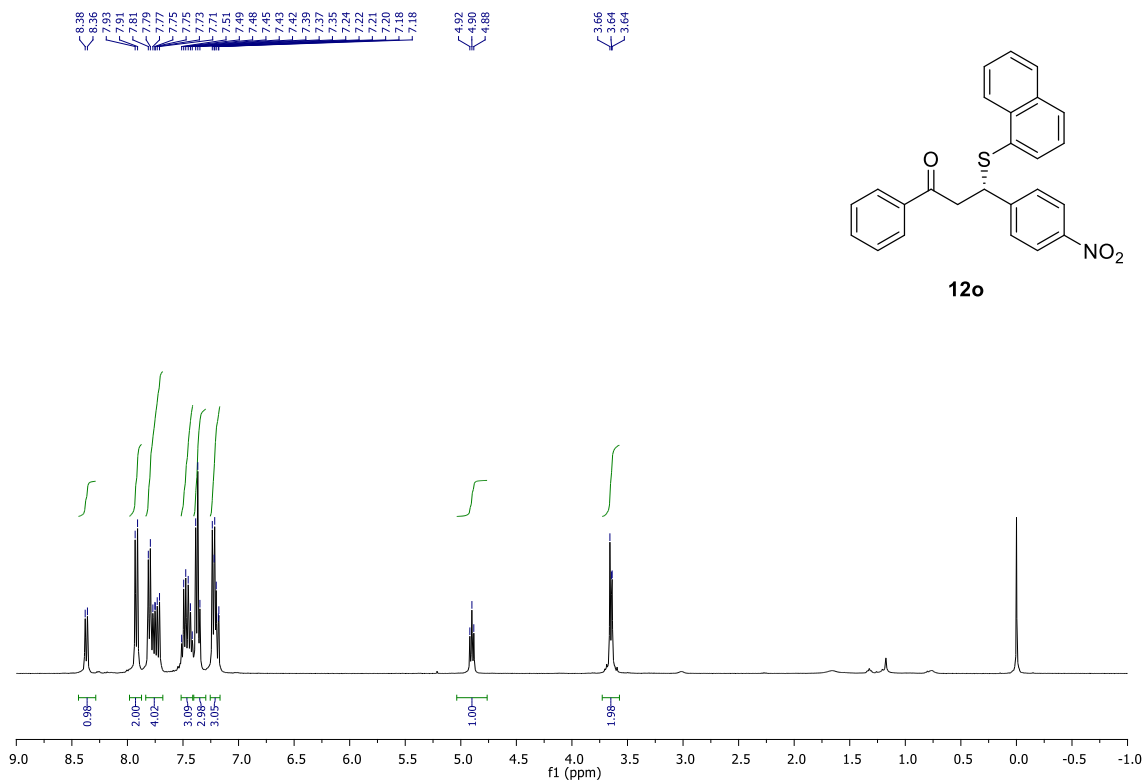




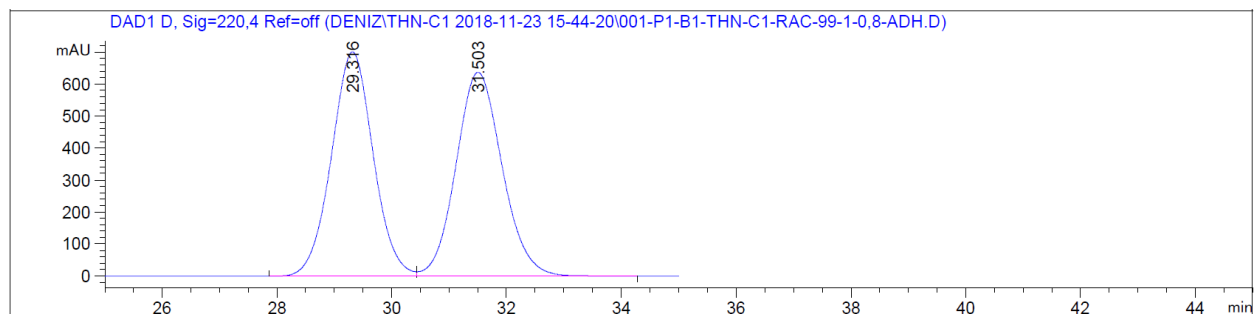








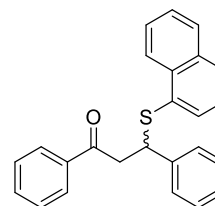
V. HPLC chromatograms of products 12a–o



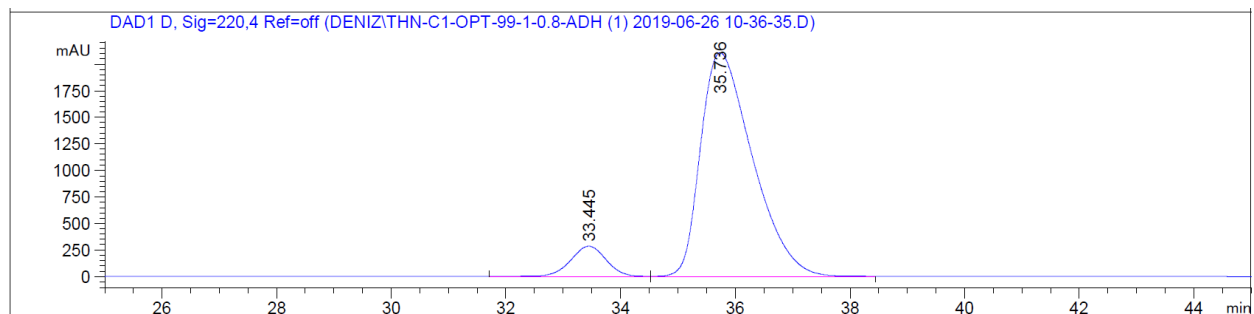
Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	29.316	BV	0.7698	3.55025e4	701.65533	49.8950
2	31.503	VB	0.8501	3.56520e4	637.84937	50.1050

Totals : 7.11545e4 1339.50470



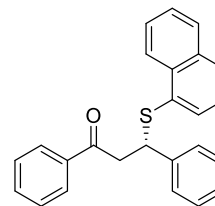
(rac)-12a



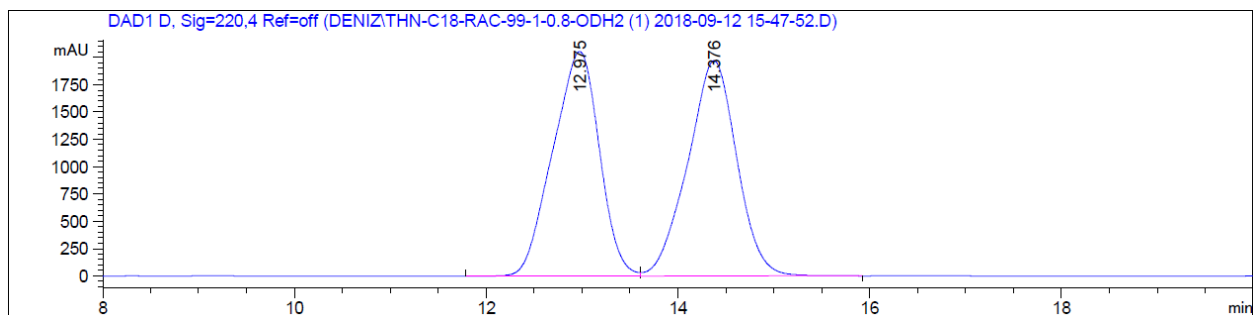
Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	33.445	BB	0.6536	1.21139e4	283.73450	8.3928
2	35.736	BB	0.8428	1.32223e5	2105.19702	91.6072

Totals : 1.44337e5 2388.93152



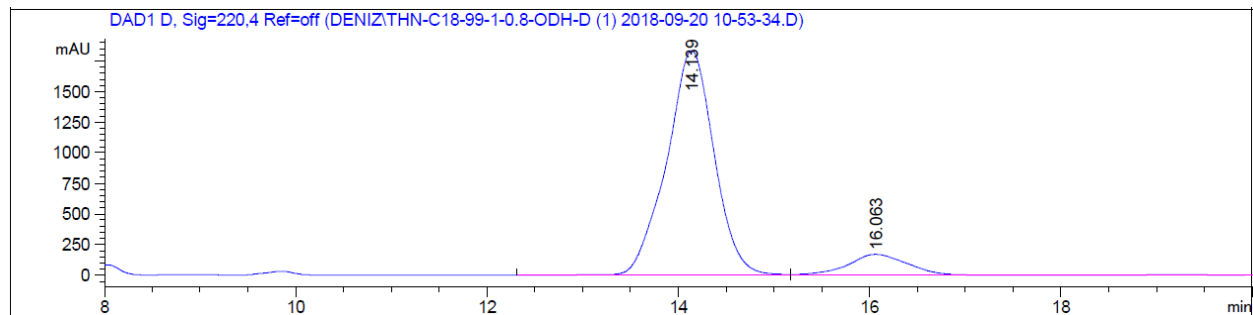
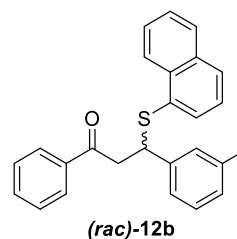
(S)-12a



Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.975	BV	0.4956	6.92892e4	2056.39526	49.7526
2	14.376	VB	0.5261	6.99784e4	1971.32837	50.2474

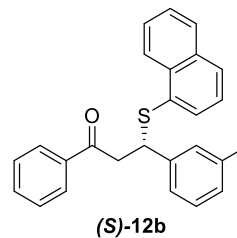
Totals : 1.39268e5 4027.72363

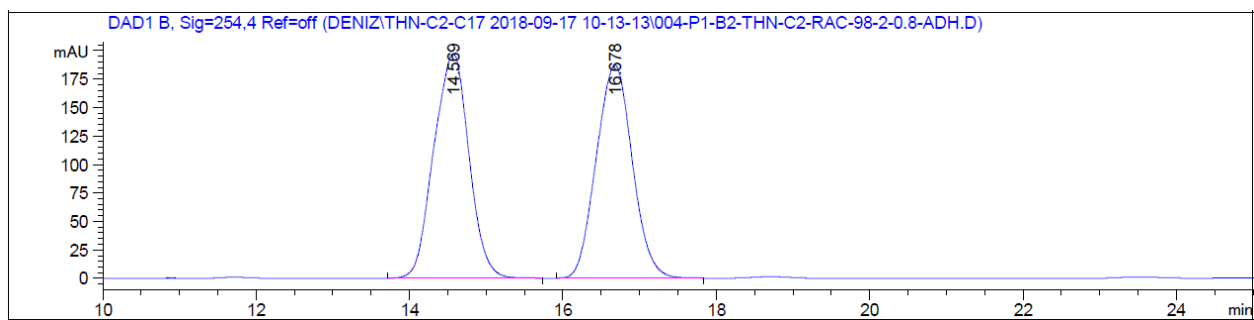


Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.139	BV	0.5148	6.34026e4	1836.55701	89.1188
2	16.063	VV R	0.6765	7741.29199	170.84424	10.8812

Totals : 7.11439e4 2007.40125

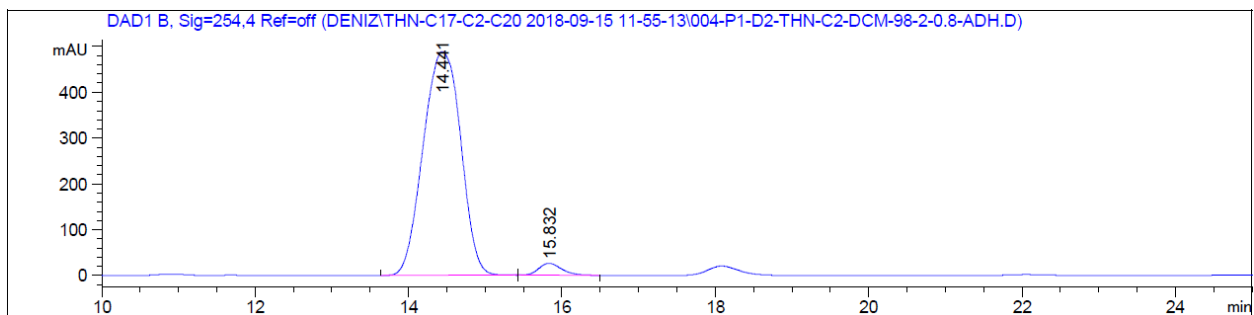
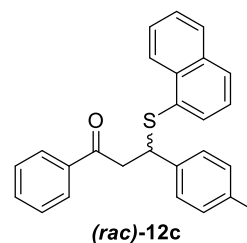




Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.569	BB	0.5150	6273.52637	197.29555	50.6657
2	16.678	BB	0.5030	6108.66602	187.07419	49.3343

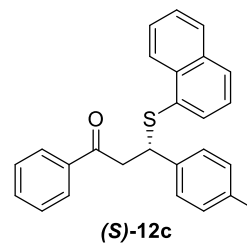
Totals : 1.23822e4 384.36974

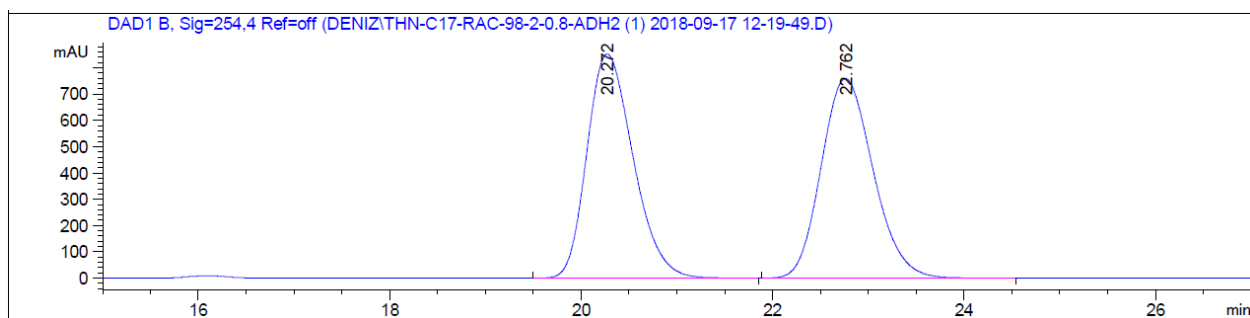


Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.441	BB	0.5500	1.66455e4	488.53439	96.8666
2	15.832	BB	0.3112	538.44464	26.15174	3.1334

Totals : 1.71839e4 514.68613

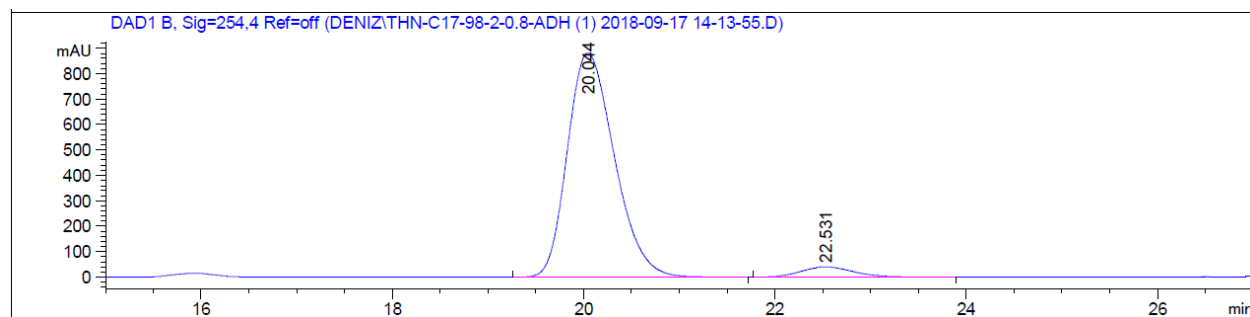
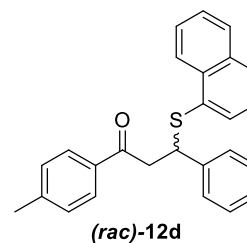




Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.272	BB	0.5211	2.85410e4	852.49890	49.9960
2	22.762	BB	0.5825	2.85456e4	758.69543	50.0040

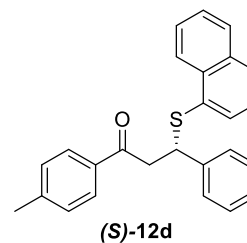
Totals : 5.70866e4 1611.19434

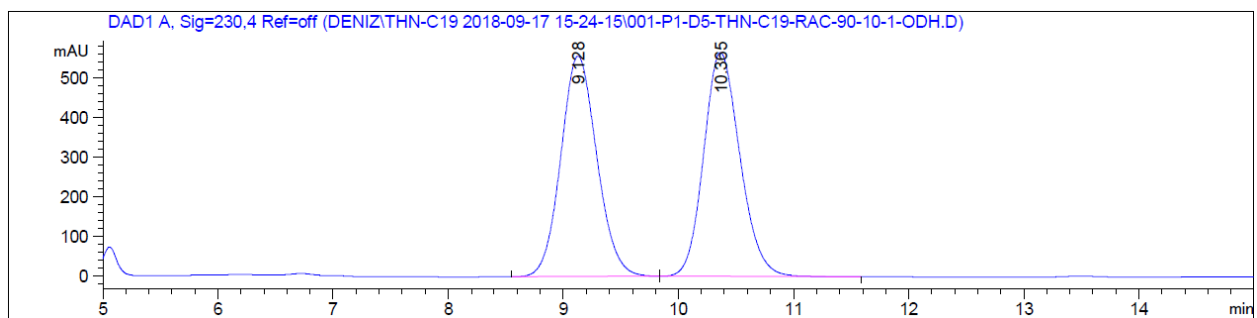


Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.044	BB	0.5308	3.00184e4	881.47162	95.3108
2	22.531	BB	0.5002	1476.88599	39.27663	4.6892

Totals : 3.14953e4 920.74825

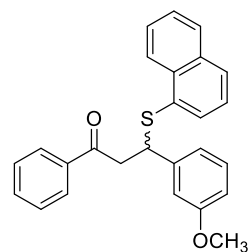




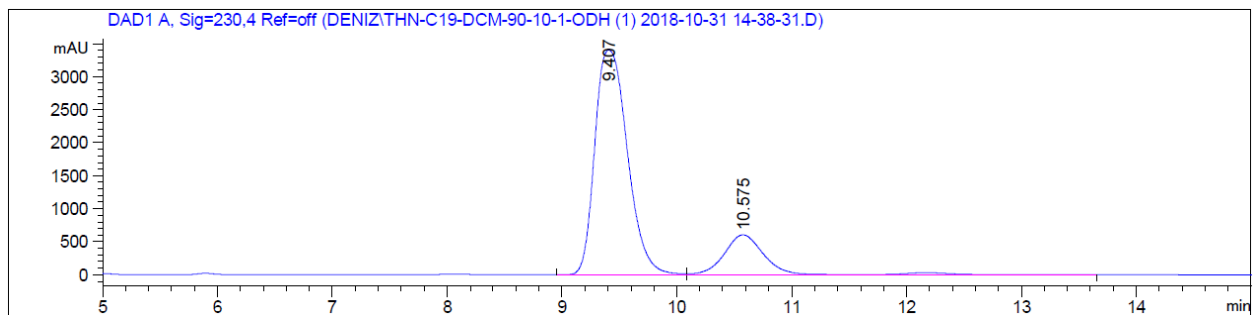
Signal 1: DAD1 A, Sig=230,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.128	BB	0.3359	1.21252e4	557.19781	49.4275
2	10.365	BB	0.3386	1.24061e4	566.28217	50.5725

Totals : 2.45312e4 1123.47998



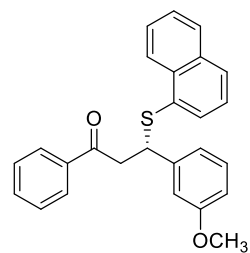
(rac)-12e



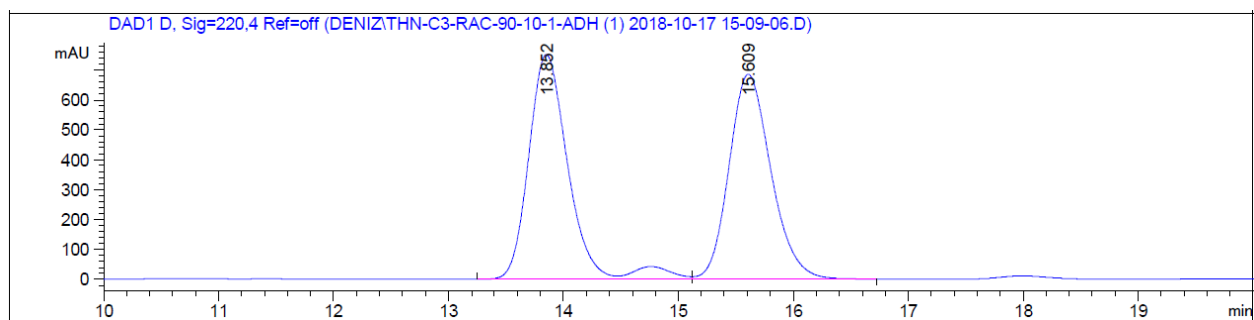
Signal 1: DAD1 A, Sig=230,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.407	BV	0.3099	6.70355e4	3402.12036	81.5014
2	10.575	VV R	0.3561	1.52152e4	604.47833	18.4986

Totals : 8.22507e4 4006.59869



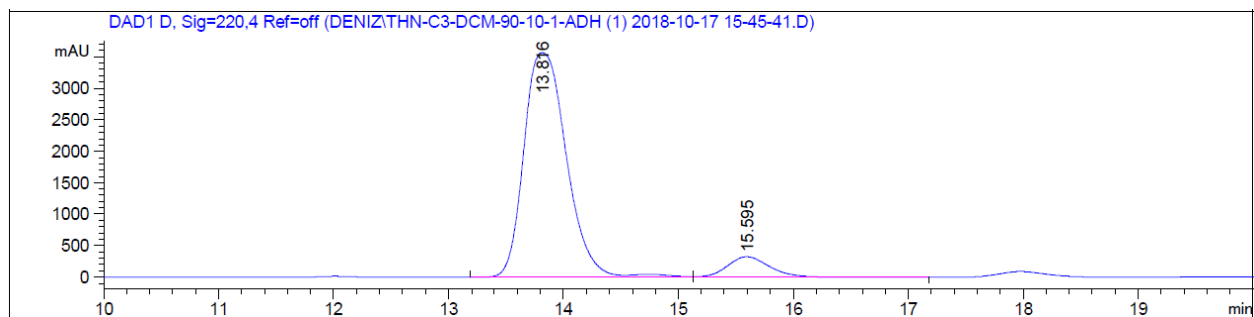
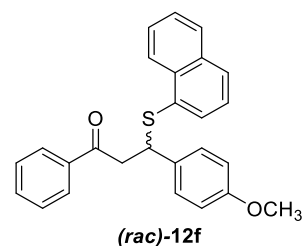
(S)-12e



Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.852	BV R	0.3547	1.82112e4	752.14575	51.2721
2	15.609	VB	0.3882	1.73076e4	685.24670	48.7279

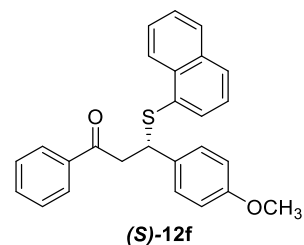
Totals : 3.55188e4 1437.39246

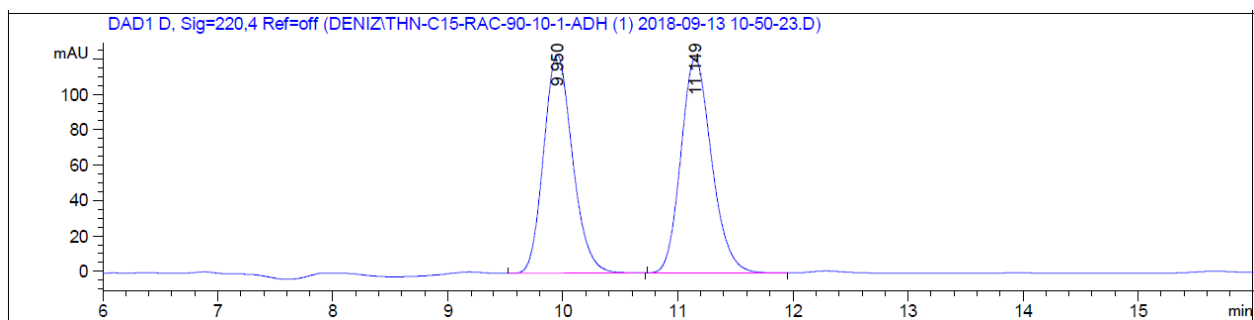


Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.816	BV R	0.2993	9.17834e4	3569.05933	91.7712
2	15.595	VB	0.3873	8229.84668	324.03961	8.2288

Totals : 1.00013e5 3893.09894

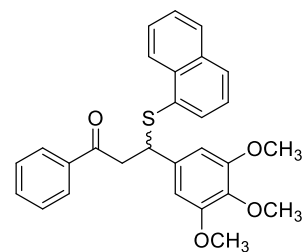




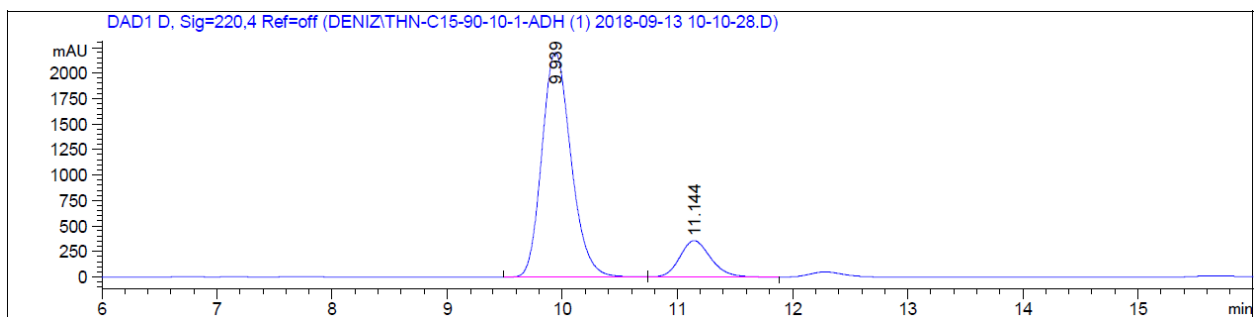
Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.950	BB	0.2683	2156.46191	123.72632	48.8890
2	11.149	BB	0.2862	2254.47583	121.39420	51.1110

Totals : 4410.93774 245.12052



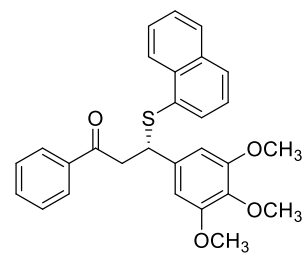
(rac)-12g



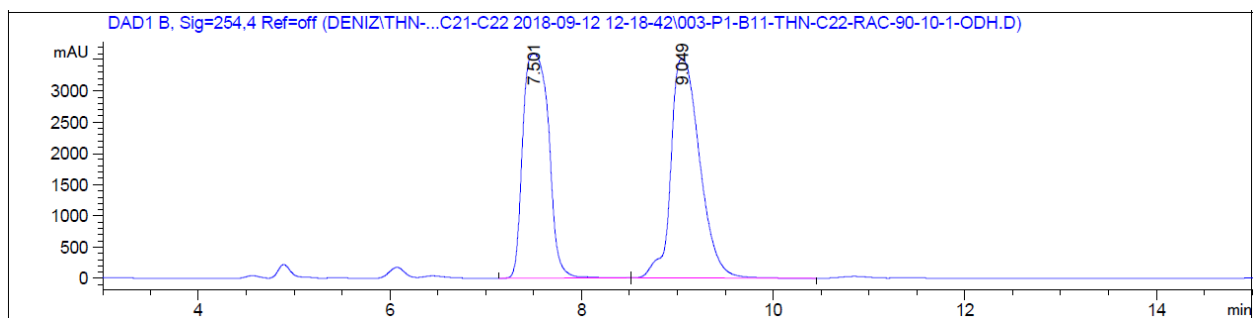
Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.939	BV	0.2725	3.87236e4	2203.32349	85.4165
2	11.144	VB	0.2856	6611.40771	356.05481	14.5835

Totals : 4.53350e4 2559.37830



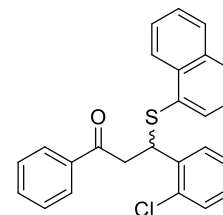
(S)-12g



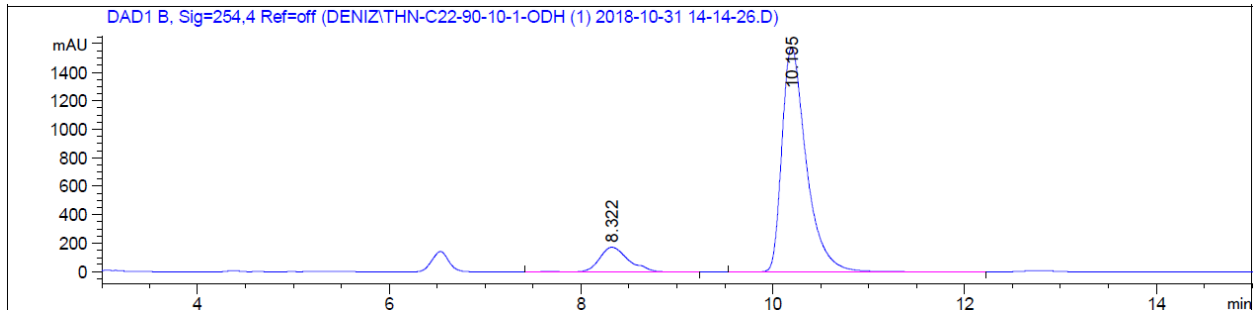
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.501	BB	0.3103	6.72355e4	3593.60767	47.7895
2	9.049	BB	0.3240	7.34555e4	3512.53784	52.2105

Totals : 1.40691e5 7106.14551



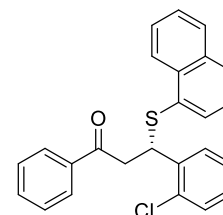
(rac)-12h



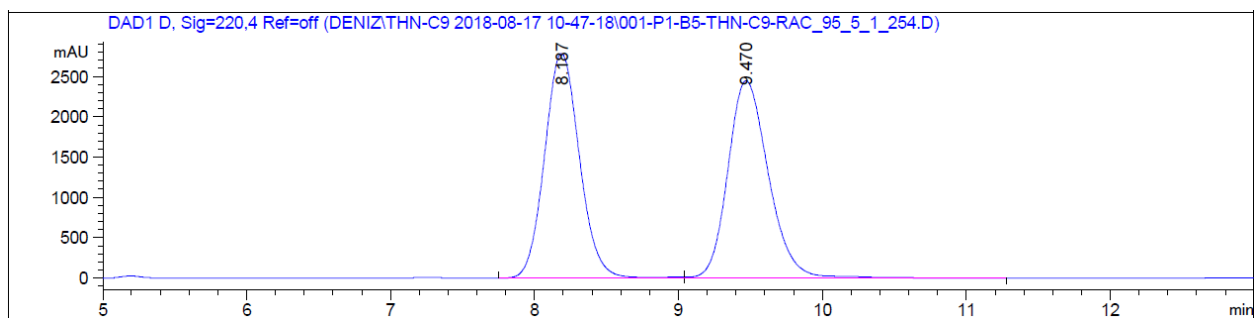
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.322	VB R	0.3137	3624.86670	172.64355	11.5050
2	10.195	BB	0.2682	2.78821e4	1577.27319	88.4950

Totals : 3.15069e4 1749.91675



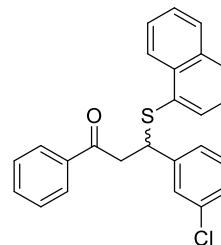
(S)-12h



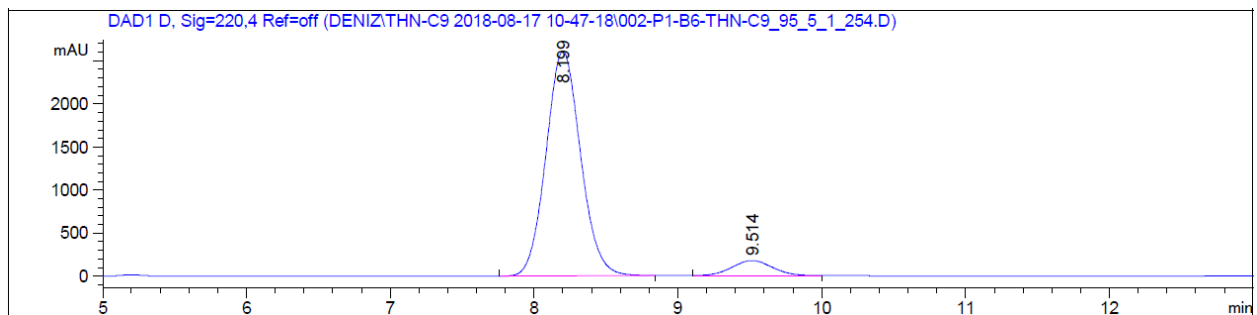
Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.187	BV R	0.2594	4.69352e4	2785.85107	49.4771
2	9.470	VB	0.3026	4.79274e4	2446.08301	50.5229

Totals : 9.48626e4 5231.93408



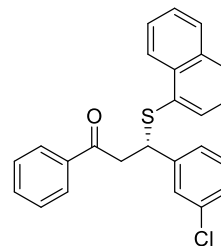
(rac)-12i



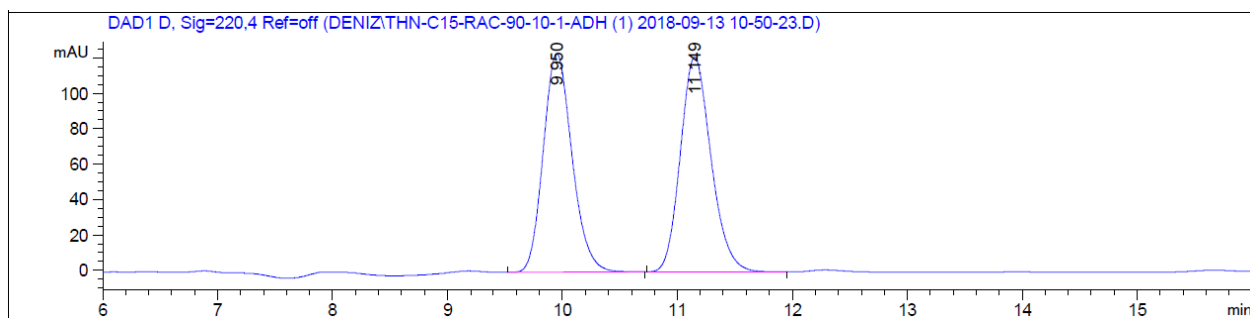
Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.199	BB	0.2573	4.35814e4	2609.86353	92.7353
2	9.514	BB	0.3016	3414.07690	175.42325	7.2647

Totals : 4.69955e4 2785.28677



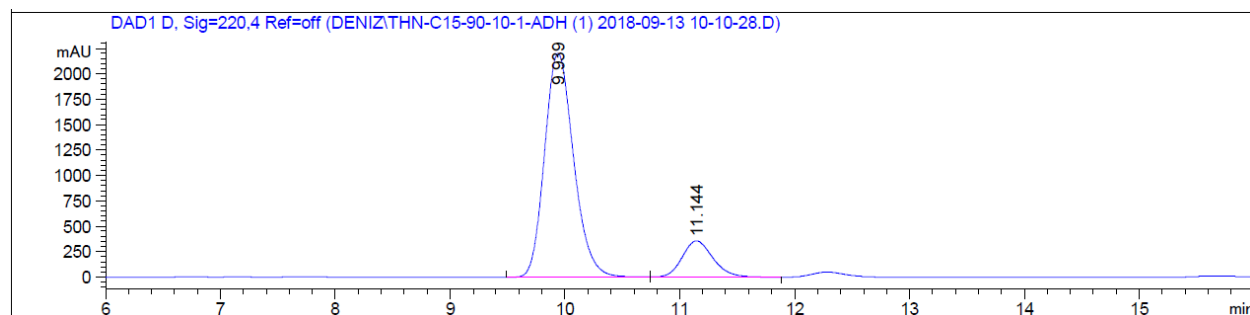
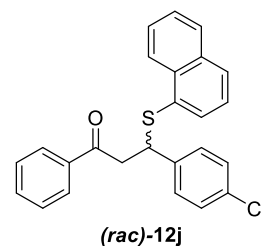
(S)-12i



Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.950	BB	0.2683	2156.46191	123.72632	48.8890
2	11.149	BB	0.2862	2254.47583	121.39420	51.1110

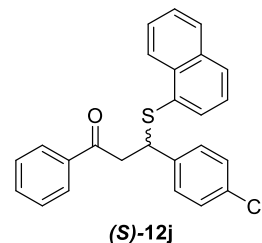
Totals : 4410.93774 245.12052

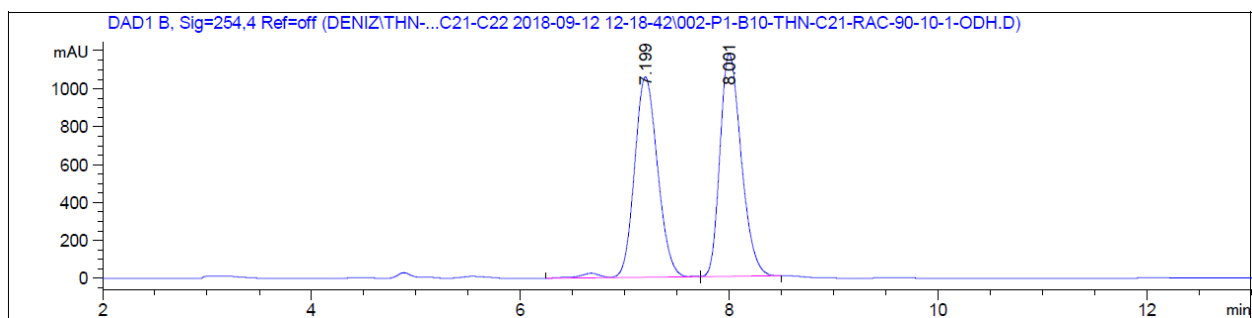


Signal 4: DAD1 D, Sig=220,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.939	BV	0.2725	3.87236e4	2203.32349	85.4165
2	11.144	VB	0.2856	6611.40771	356.05481	14.5835

Totals : 4.53350e4 2559.37830

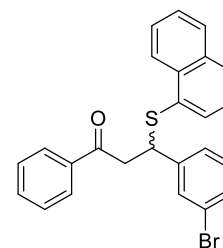




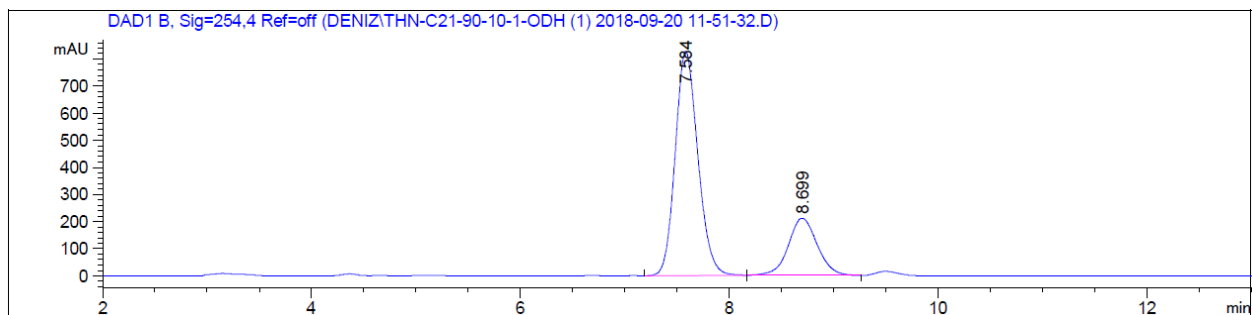
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.199	VV R	0.2365	1.63263e4	1055.59644	49.5946
2	8.001	BB	0.2194	1.65933e4	1173.67212	50.4054

Totals : 3.29196e4 2229.26855



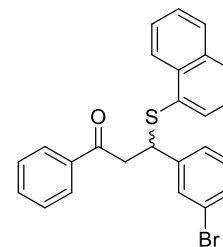
(rac)-12k



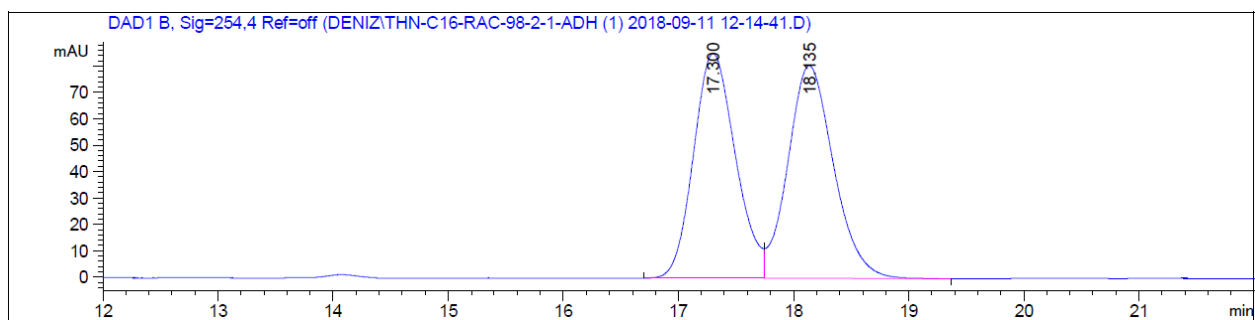
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.584	BB	0.2336	1.24848e4	827.05249	75.4838
2	8.699	BV	0.2968	4054.90894	210.45692	24.5162

Totals : 1.65397e4 1037.50941



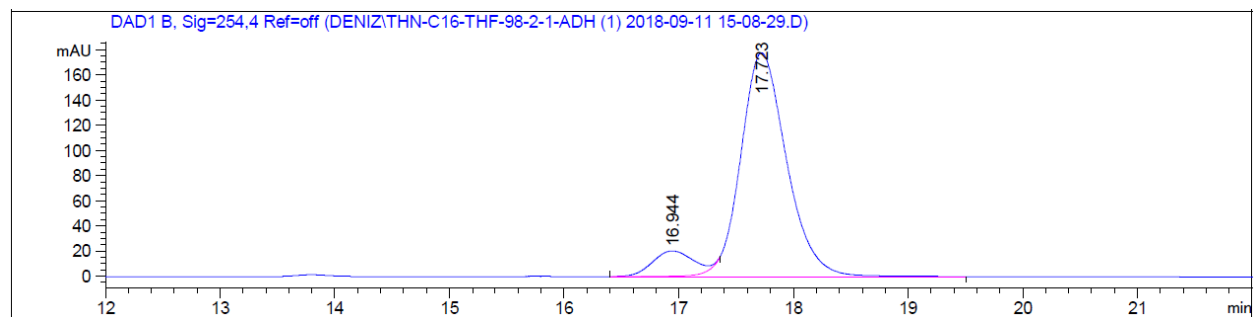
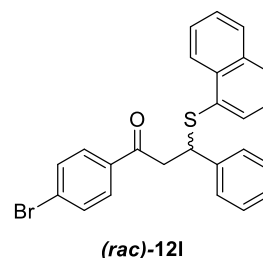
(S)-12k



Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.300	BV	0.3896	2160.08887	85.40229	49.1325
2	18.135	VB	0.4128	2236.36548	80.82732	50.8675

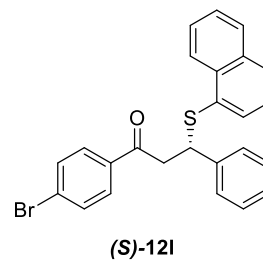
Totals : 4396.45435 166.22961

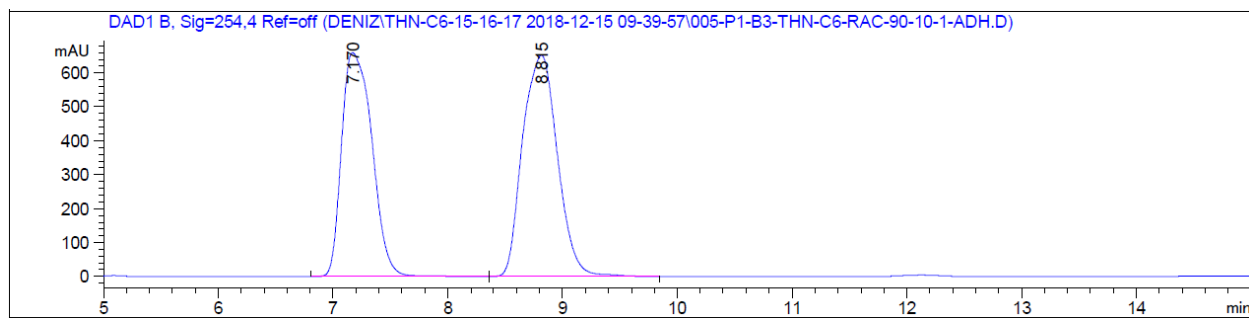


Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.944	BV E	0.3540	498.38351	20.36371	9.1561
2	17.723	VB R	0.4235	4944.82568	178.06689	90.8439

Totals : 5443.20920 198.43061

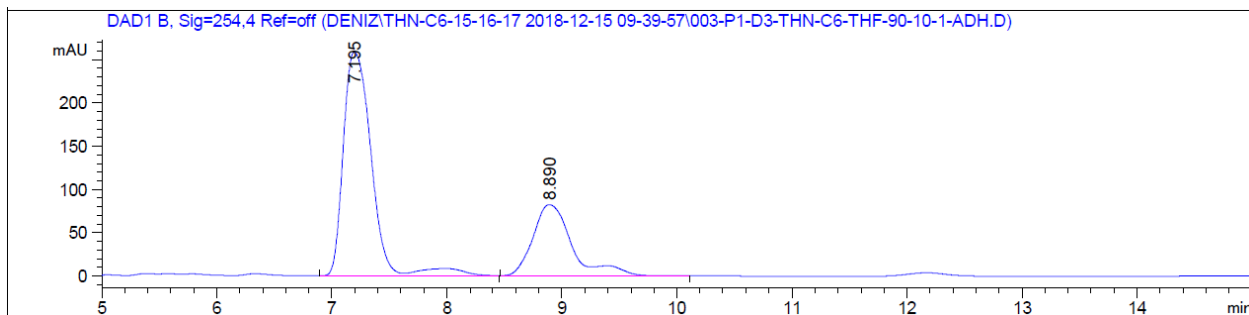
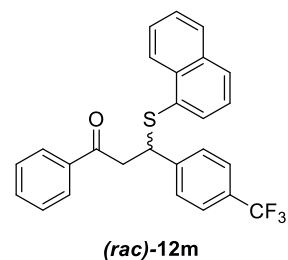




Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.170	BB	0.2999	1.21288e4	659.98712	46.8644
2	8.815	BB	0.3409	1.37519e4	652.39496	53.1356

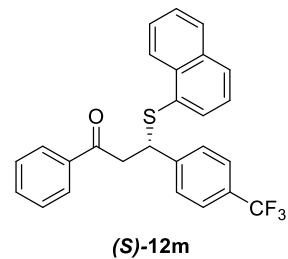
Totals : 2.58807e4 1312.38208

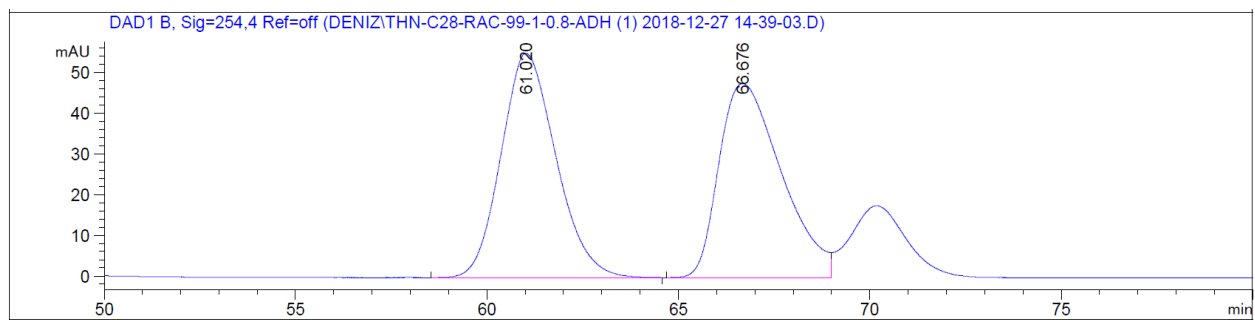


Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.195	BV R	0.2627	4425.58887	258.93863	69.4832
2	8.890	BV R	0.3337	1943.70544	82.17338	30.5168

Totals : 6369.29431 341.11201

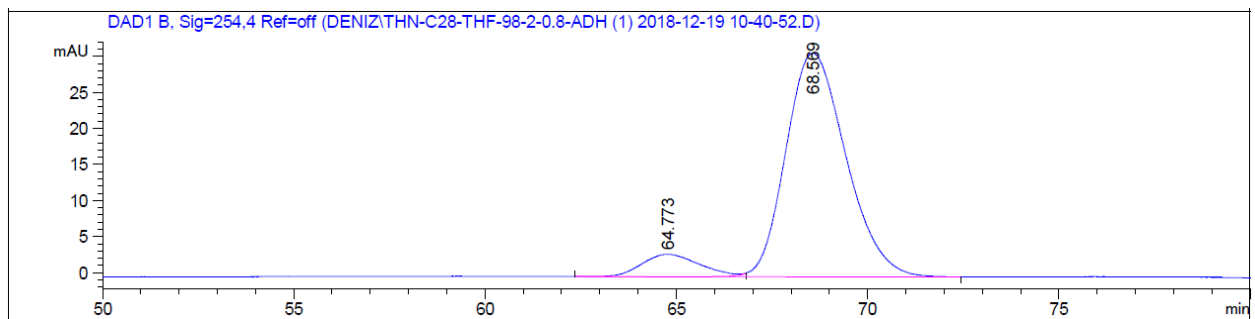
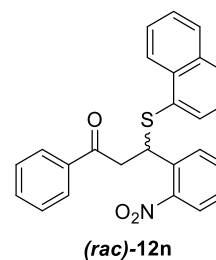




Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	61.020	BB	1.5805	5495.46240	55.05659	50.4427
2	66.676	BV	1.7547	5399.01172	47.62256	49.5573

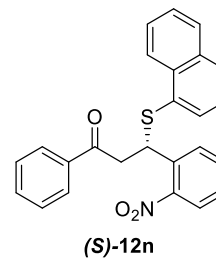
Totals : 1.08945e4 102.67915

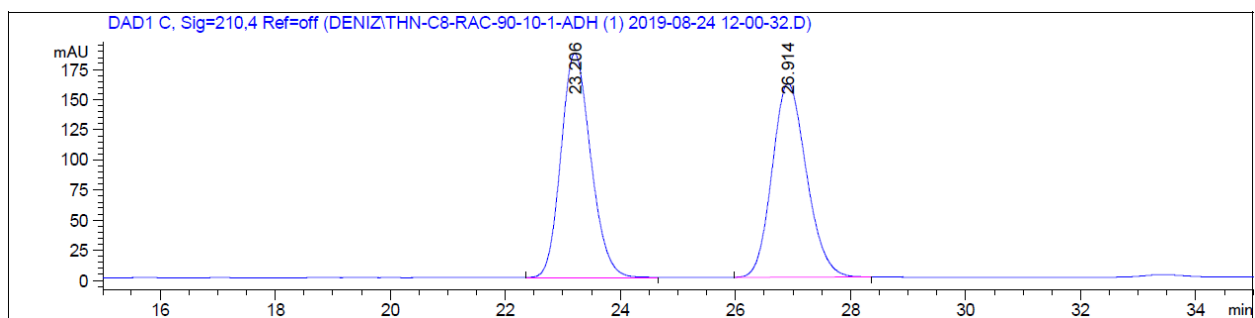


Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	64.773	BV E	1.6263	327.36319	3.11457	8.8062
2	68.569	VB R	1.7067	3390.04492	31.02762	91.1938

Totals : 3717.40811 34.14219

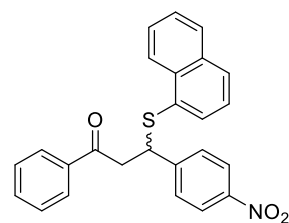




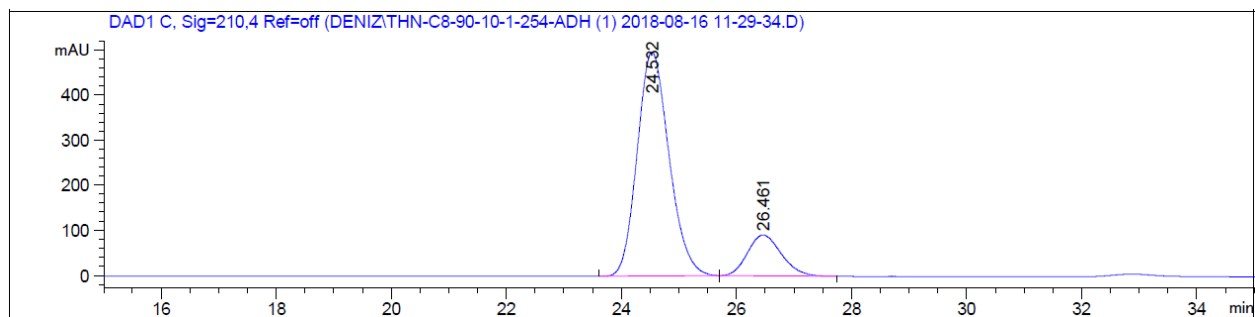
Signal 3: DAD1 C, Sig=210,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.206	BB	0.5442	6688.13721	185.93582	50.1028
2	26.914	BB	0.6263	6660.69531	160.79277	49.8972

Totals : 1.33488e4 346.72859



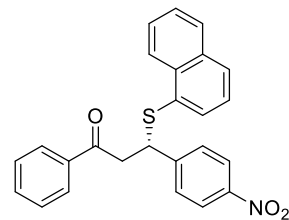
(rac)-12o



Signal 3: DAD1 C, Sig=210,4 Ref=off

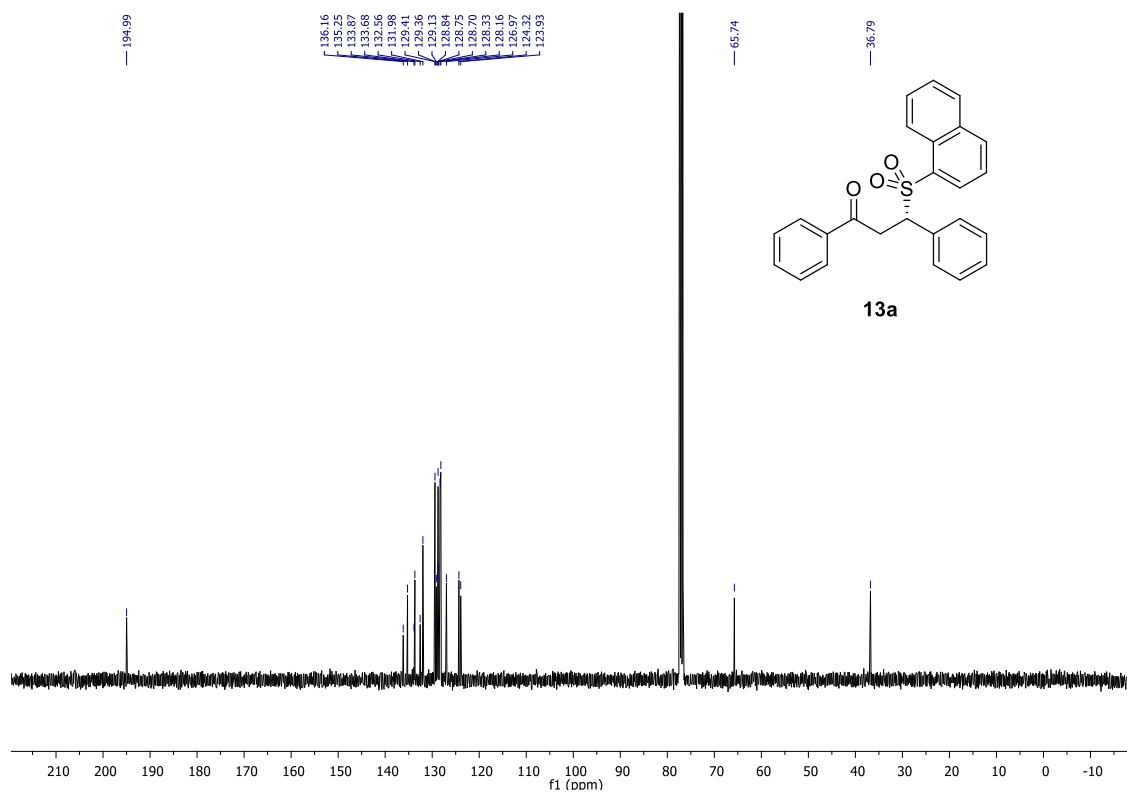
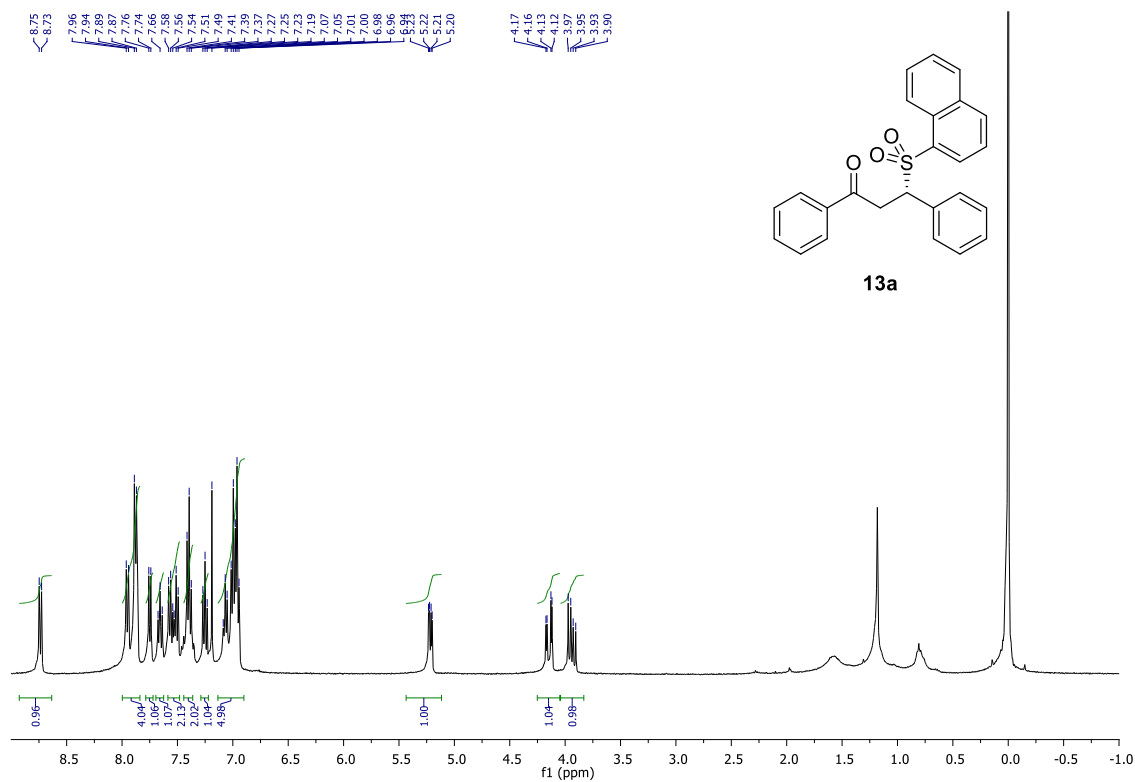
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.532	BB	0.5899	1.91059e4	496.51318	83.7845
2	26.461	BB	0.5904	3697.71533	90.46827	16.2155

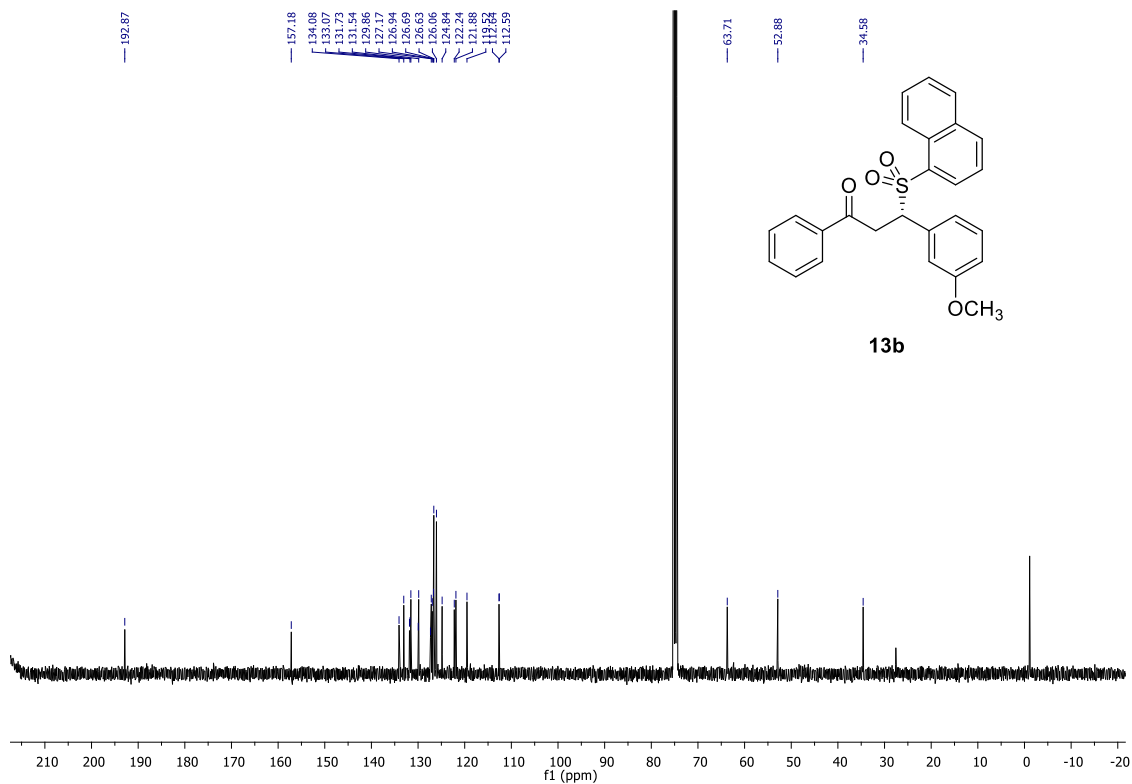
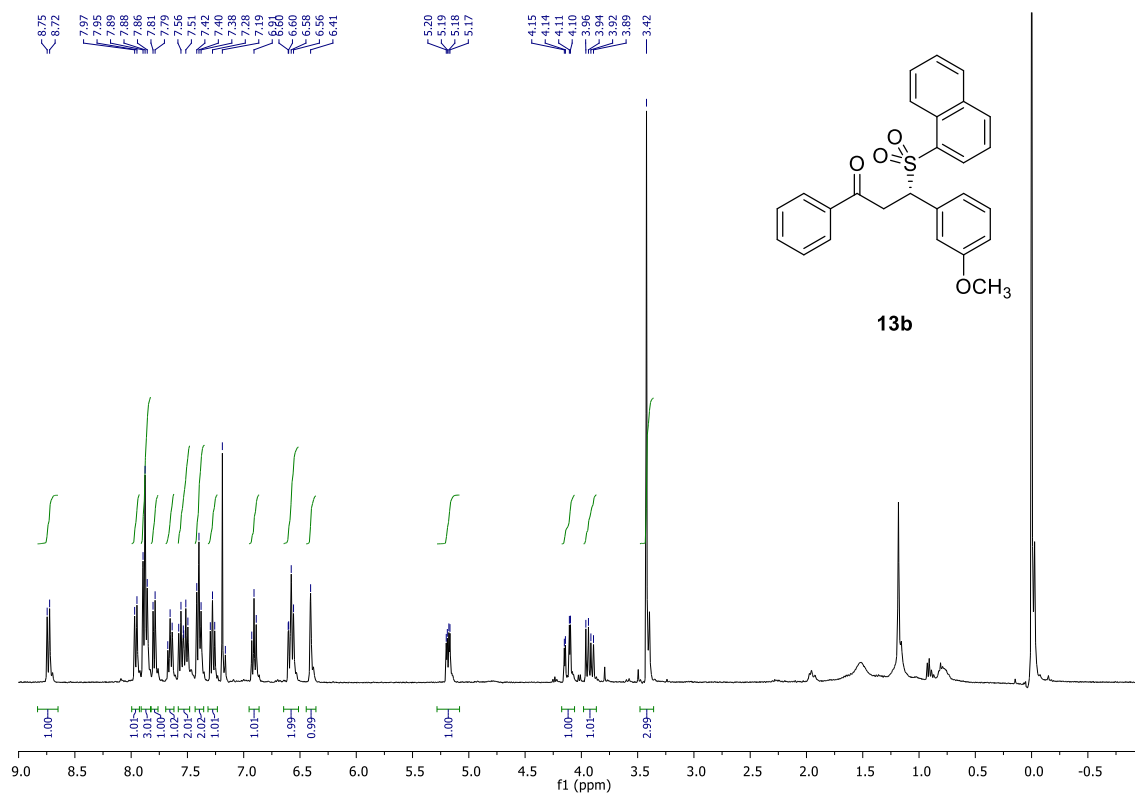
Totals : 2.28036e4 586.98145

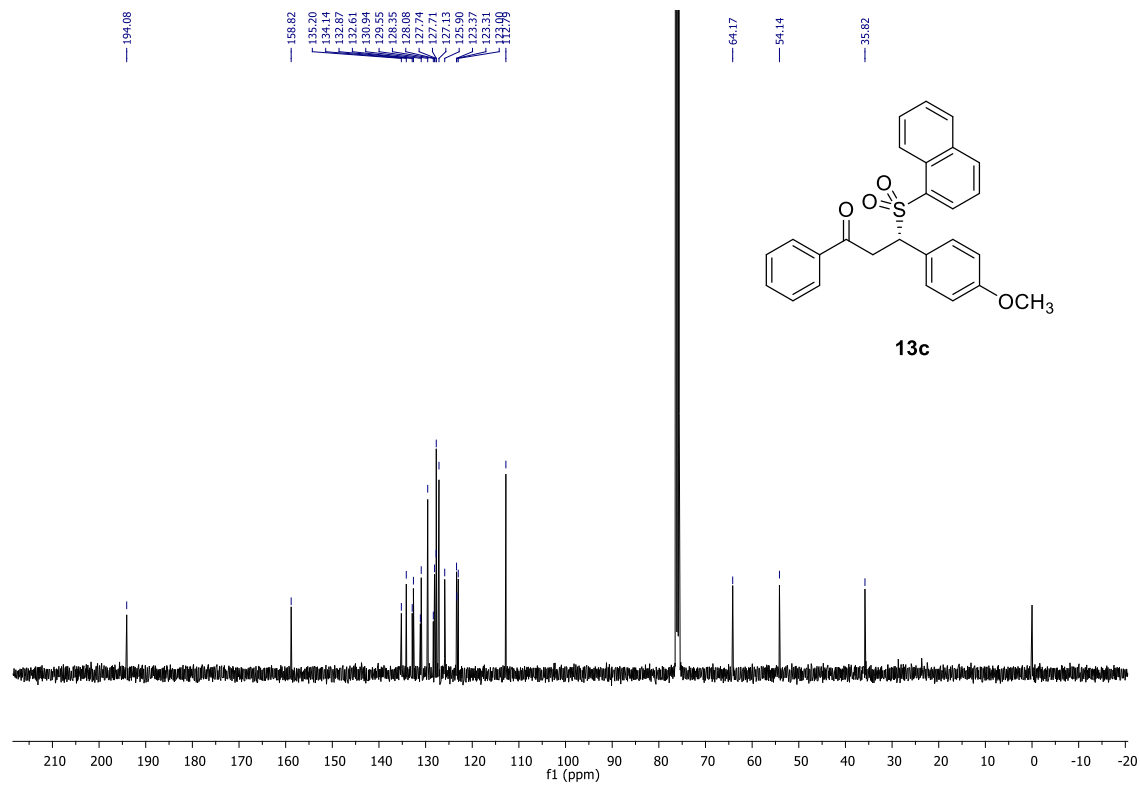
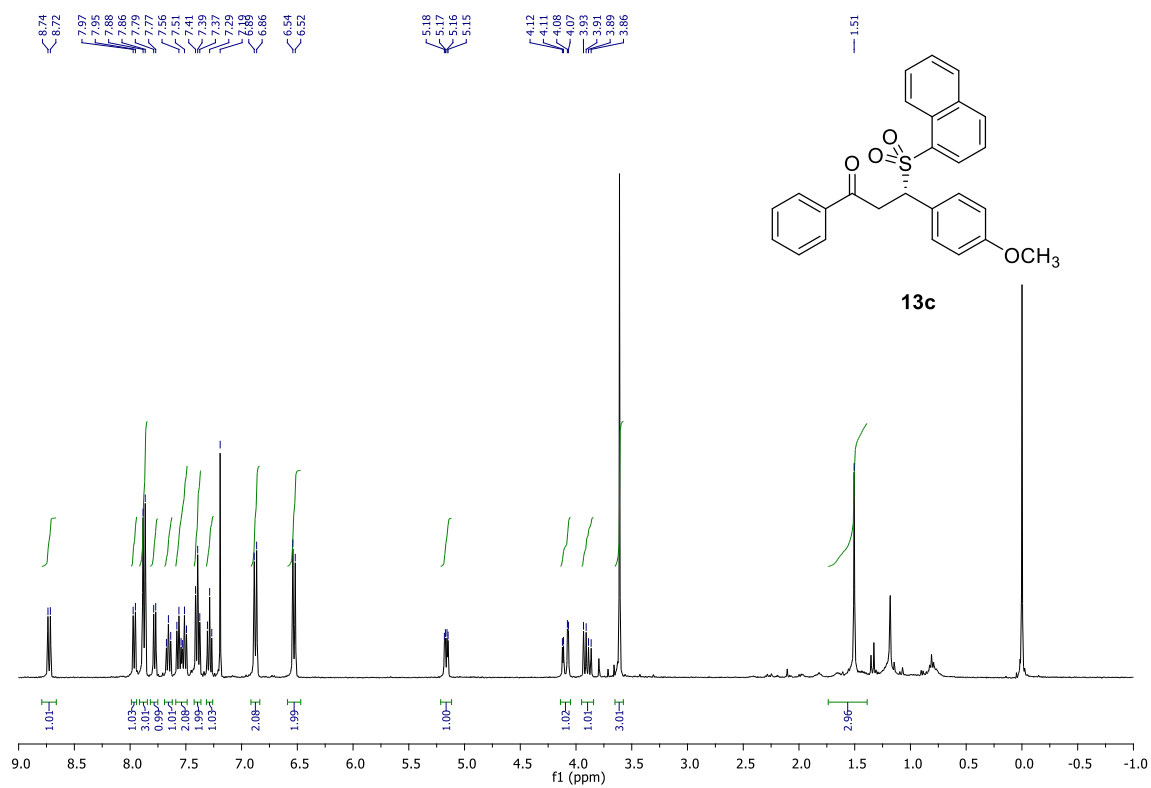


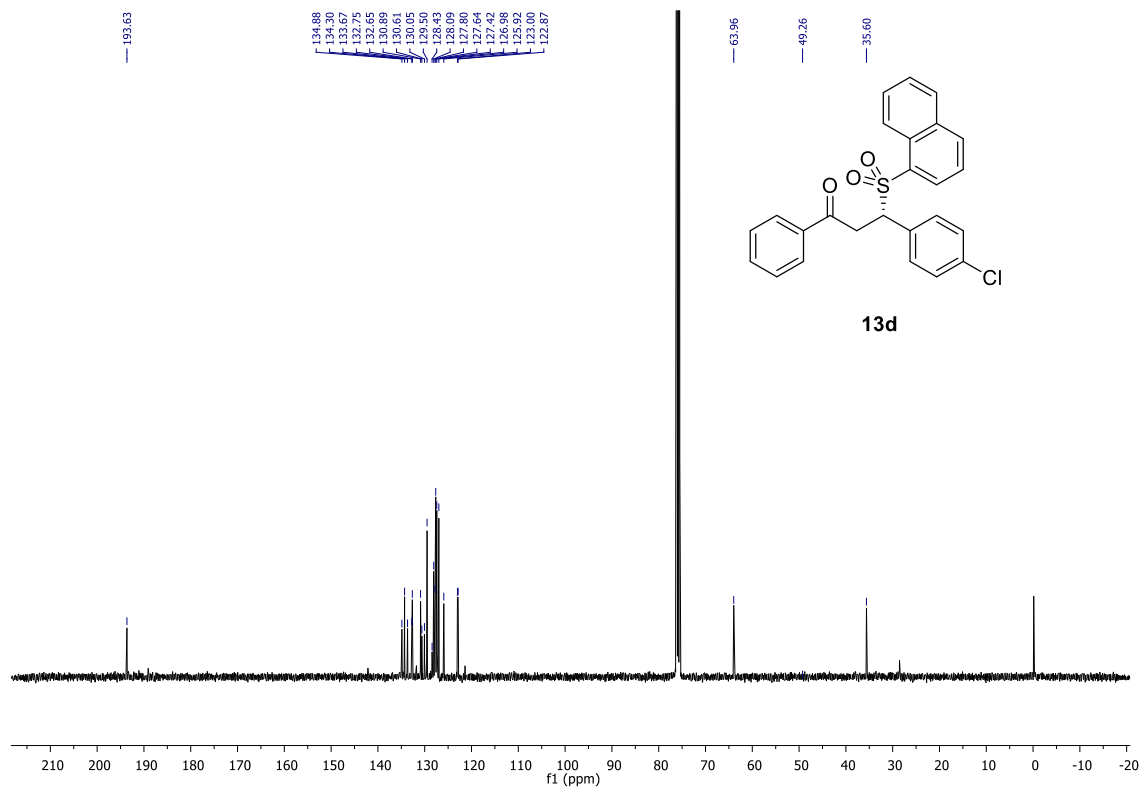
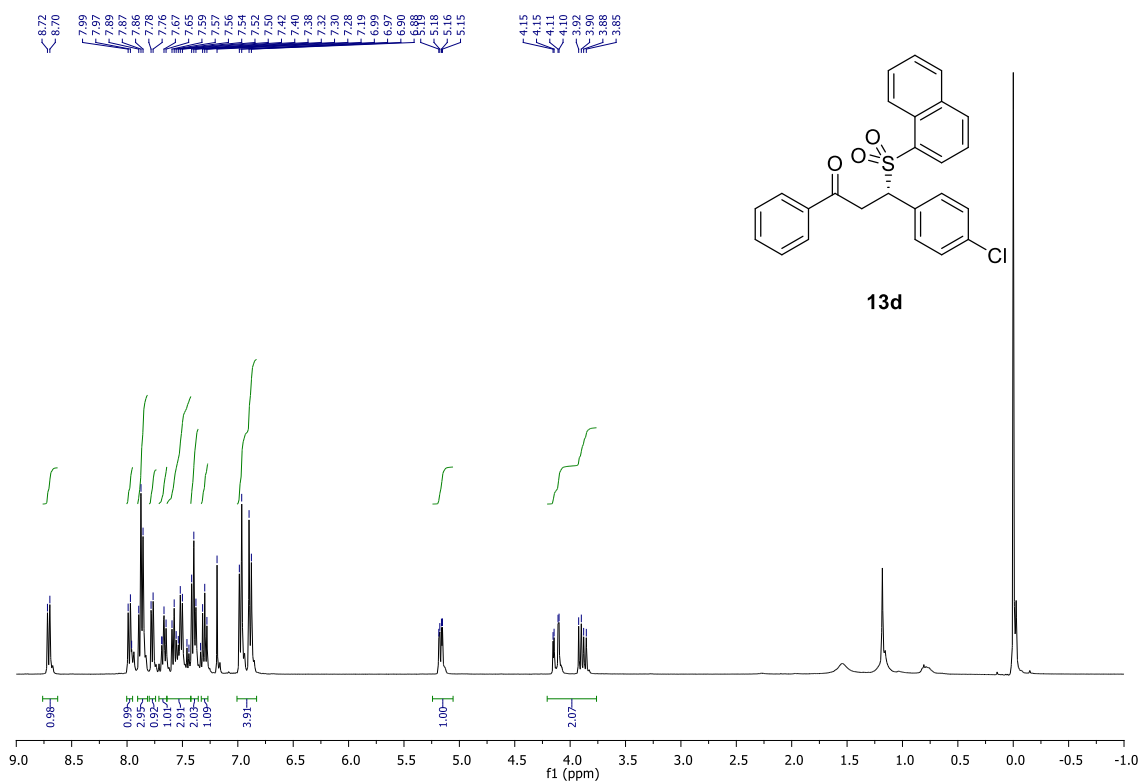
(S)-12o

VI. ^1H and ^{13}C NMR spectra of sulfones

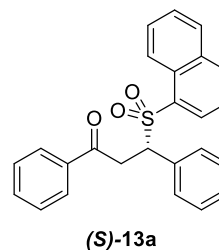
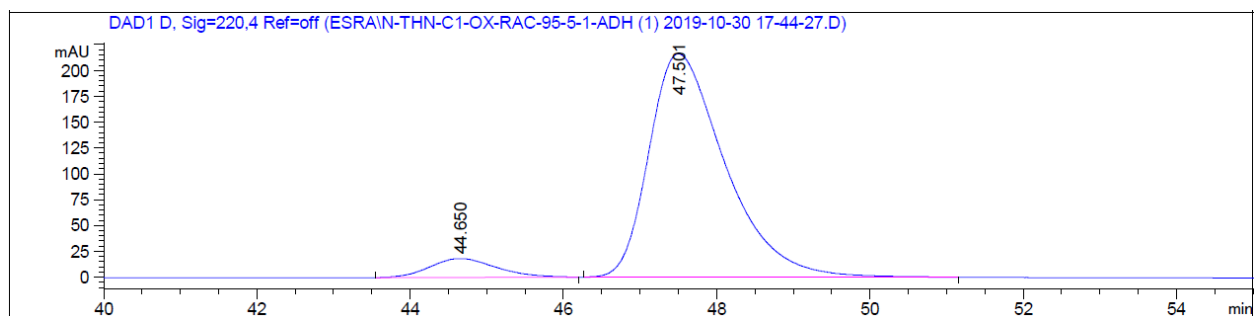
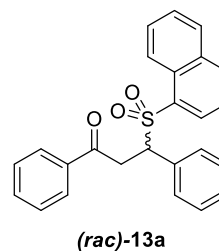
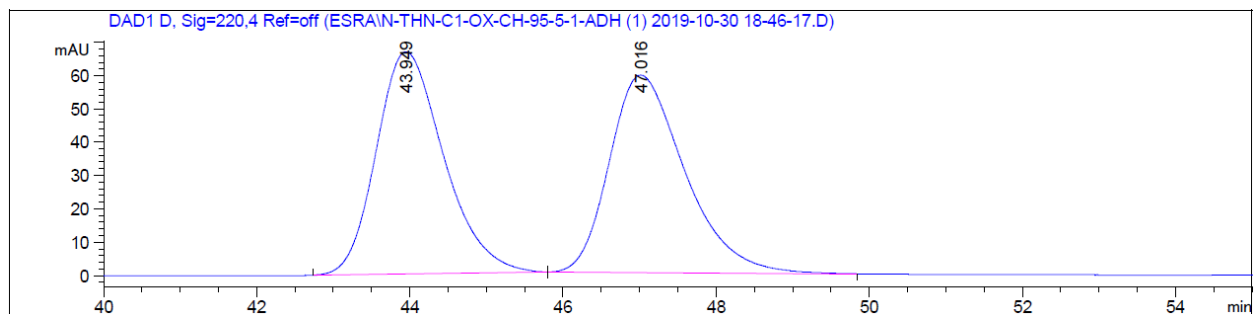


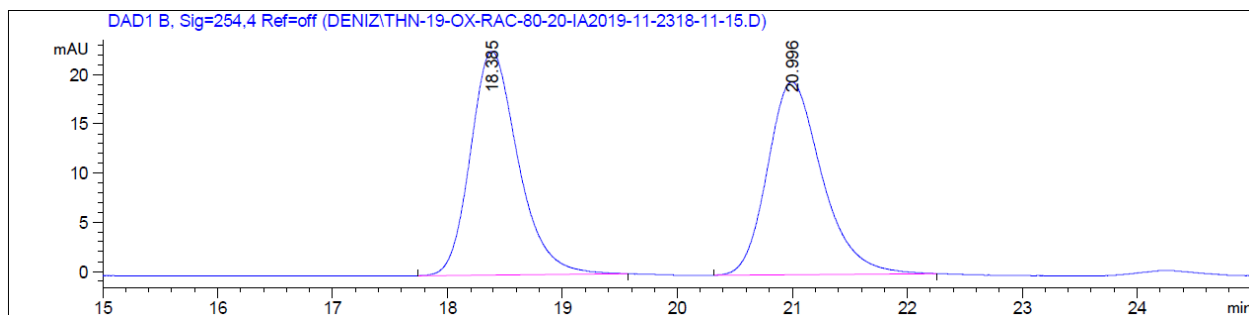






VII. HPLC chromatograms of sulfones

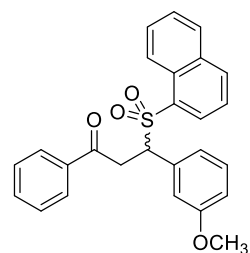




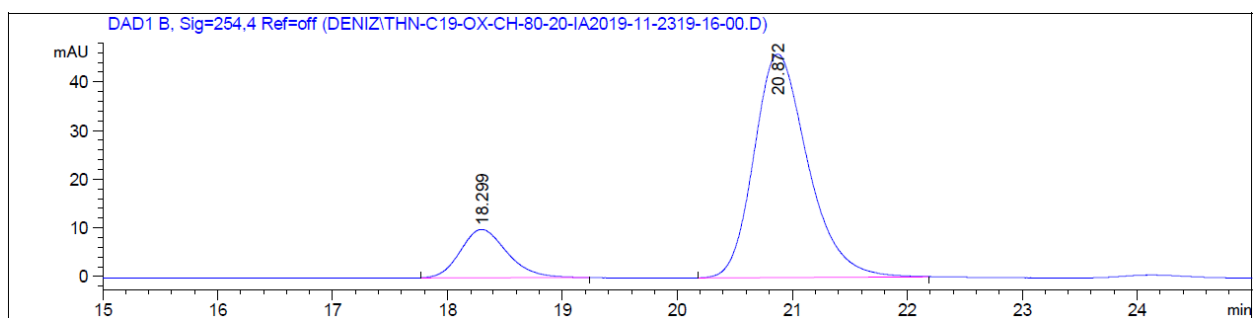
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.385	BB	0.3980	654.52106	22.75792	50.3000
2	20.996	BB	0.4316	646.71472	19.61943	49.7000

Totals : 1301.23578 42.37735



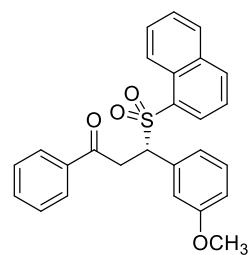
(rac)-13b



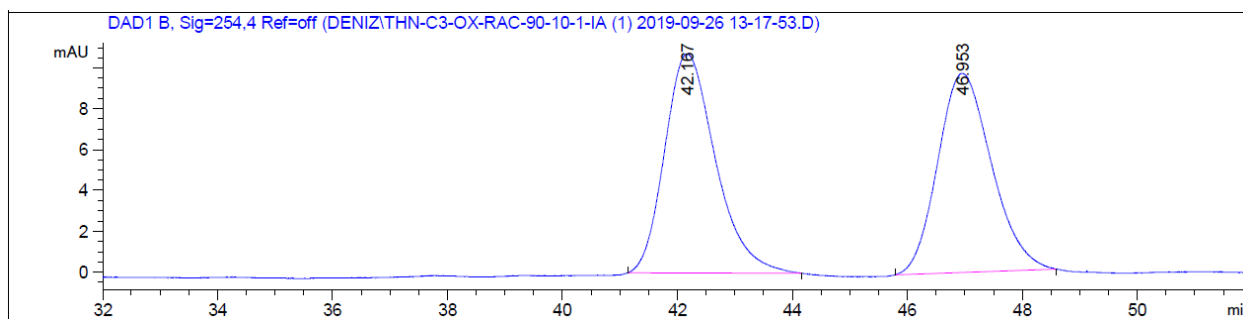
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.299	BB	0.3332	278.74411	9.89344	15.7637
2	20.872	BB	0.4698	1489.52661	45.87250	84.2363

Totals : 1768.27072 55.76594



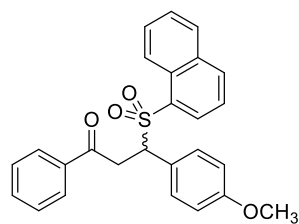
(S)-13b



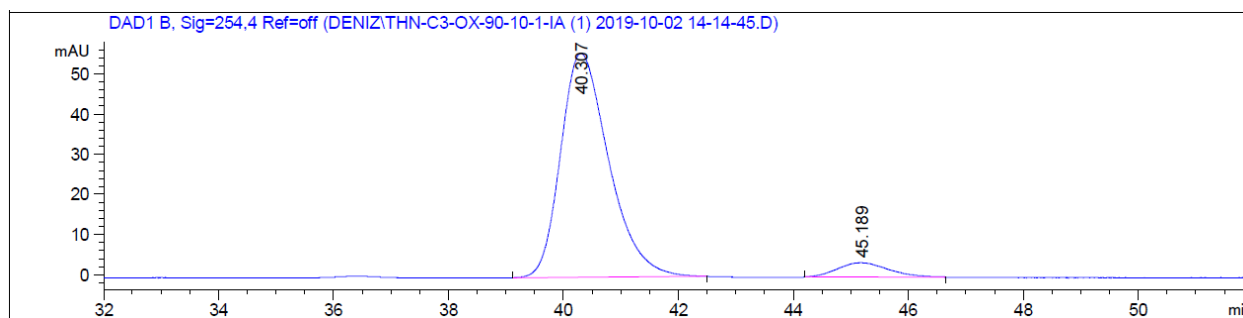
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	42.167	BB	0.7203	659.29974	10.73143	50.9837
2	46.953	BB	0.7614	633.85889	9.75670	49.0163

Totals : 1293.15863 20.48813



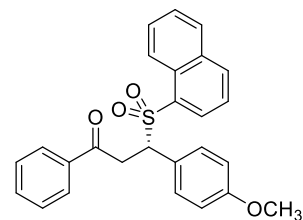
(rac)-13c



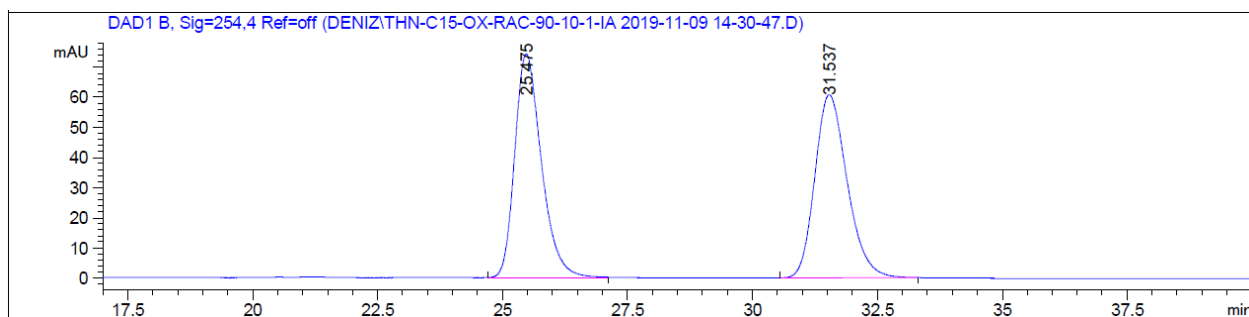
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	40.307	BB	0.6901	3244.40845	55.78027	93.6986
2	45.189	BB	0.7186	218.19139	3.55215	6.3014

Totals : 3462.59984 59.33243



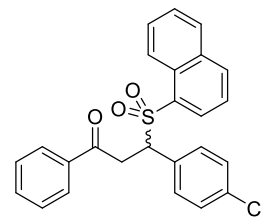
(S)-13c



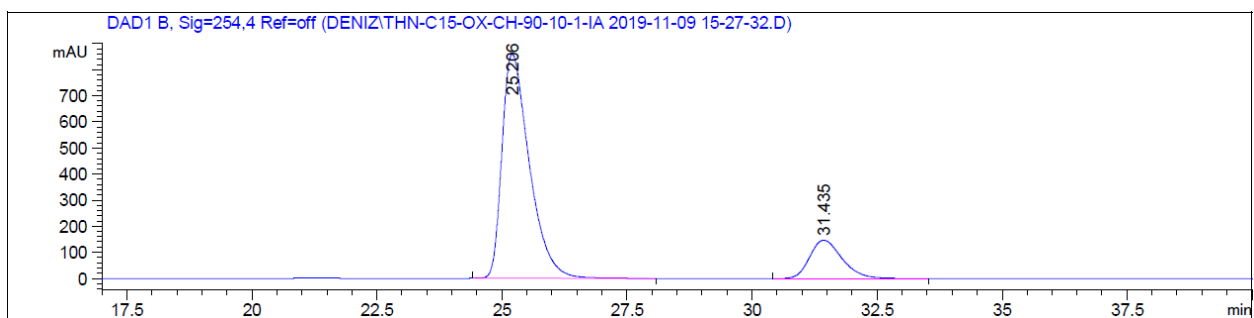
Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.475	BB	0.5347	2746.05493	74.20673	50.1017
2	31.537	BB	0.6004	2734.90576	60.78342	49.8983

Totals : 5480.96069 134.99014



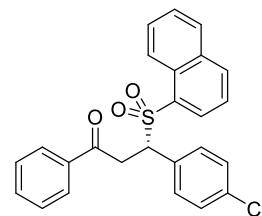
(rac)-13d



Signal 2: DAD1 B, Sig=254,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.206	BB	0.5778	3.27075e4	859.87500	83.1645
2	31.435	BB	0.6696	6621.16260	147.25027	16.8355

Totals : 3.93286e4 1007.12527



(S)-13d