

Enantio- and Diastereoselective Diarylmethylation of 1,3-Dicarbonyl Compounds

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Supporting Information

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I. General Information

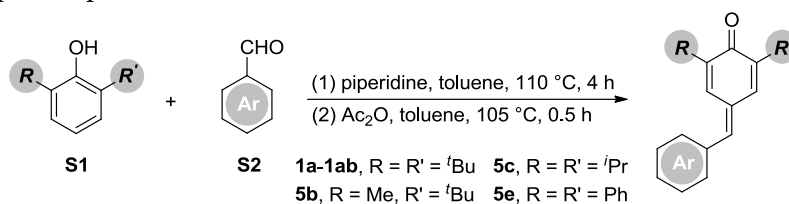
All air or moisture sensitive reactions were conducted in oven-dried glassware under nitrogen atmosphere using dry solvents. Anhydrous tetrahydrofuran was freshly distilled from sodium-benzophenone. Anhydrous benzene and toluene were freshly distilled from sodium. Unless otherwise stated, chemicals and reagents were used as

received. Flash column chromatography was performed over silica gel (200-300 mesh) purchased from Qindao Bangkai Co., China. ^1H and ^{13}C NMR spectra were recorded on a Bruker AV 500 MHz NMR spectrometer using residue solvent peaks as an internal standard (^1H NMR: CDCl_3 at 7.26 ppm, ^{13}C NMR: CDCl_3 at 77.0 ppm). HRMS were recorded on an Agilent 6545 Q-TOF LC/MS instrument with electrospray ionization (ESI) technique. X-ray diffraction was performed on a Gemini E X-ray single crystal diffractometer. Analytical chiral HPLC was performed on an Agilent 1600 Infinity instrument with Daicel Chiralcel OD-H column, or Daicel Chiralpak AD-H, IA-3, IC-3 columns. Optical rotations were measured on an Aton Paar MCP 150 polarimeter.

II. Preparation of Materials

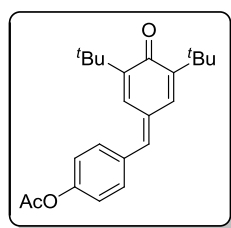
2.1 Synthesis of *p*-Quinone Methide Substrates

p-Quinone methide substrates **1a-1ab**, **5b**, **5c**, and **5e** were synthesized according to the literature reported procedure.¹



The characterization data of unreported compounds are shown as follows; the other quinone methides are known compounds.

4-((3,5-di-*tert*-butyl-4-oxocyclohexa-2,5-dien-1-ylidene)methyl)phenyl acetate (**1h**)



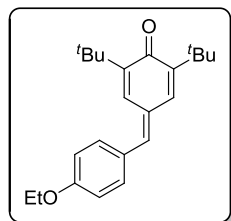
(yellow solid)

^1H NMR (500 MHz, CDCl_3) δ 7.51 (d, J = 2.4 Hz, 1H), 7.50 (d, J = 8.6 Hz, 2H), 7.22 (d, J = 8.6 Hz, 2H), 7.16 (s, 1H), 7.02 (d, J = 2.4 Hz, 1H), 2.36 (s, 3H), 1.35 (s, 9H), 1.32 (s, 9H).

^{13}C NMR (125 MHz, CDCl_3) δ 186.5, 169.1, 151.2, 149.7, 147.9, 141.1, 135.0, 133.6, 132.1, 131.4, 127.4, 122.0, 35.5, 35.0, 29.6, 29.5, 21.1.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{23}\text{H}_{28}\text{O}_3\text{Na}$: 375.1931, found: 353.2111.

2,6-di-*tert*-butyl-4-(4-ethoxybenzylidene)cyclohexa-2,5-dienone (**1i**) (yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.58 (d, J = 2.4 Hz, 1H), 7.46 (d, J = 8.7 Hz, 2H), 7.15 (s, 1H), 7.03 (d, J = 2.4 Hz, 1H), 6.99 (d, J = 8.7 Hz, 2H), 4.13 (q, J = 7.0 Hz, 2H), 1.48 (t, J = 7.0 Hz, 3H), 1.36 (s, 9H), 1.34 (s, 9H).

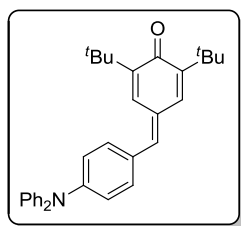
^{13}C NMR (125 MHz, CDCl_3) δ 186.5, 160.0, 149.0, 147.2, 142.7, 135.4, 132.2, 130.5, 128.5, 127.8, 114.9, 63.7, 35.4, 35.0, 29.6, 29.5, 14.8.

HRMS: (ESI⁺) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{23}\text{H}_{31}\text{O}_2$: 339.2319, found: 339.2325.

2,6-di-*tert*-butyl-4-(4-(diphenylamino)benzylidene)cyclohexa-2,5-dienone (**1j**)

(yellow solid)

¹ D. Richter, N. Hampel, T. Singer, A. R. Ofial, H. Mayr, *Eur. J. Org. Chem.* **2009**, 19, 3203

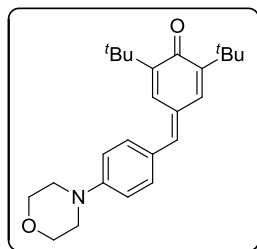


¹H NMR (500 MHz, CDCl₃) δ 7.64 (d, *J* = 2.4 Hz, 1H), 7.38 (d, *J* = 8.7 Hz, 2H), 7.37 – 7.31 (m, 4H), 7.23 – 7.18 (m, 4H), 7.15 (tt, *J* = 7.5, 1.2 Hz, 2H), 7.09 (d, *J* = 2.7 Hz, 2H), 7.07 (s, 1H), 7.02 (d, *J* = 2.4 Hz, 1H), 1.36 (s, 9H), 1.34 (s, 9H).

¹³C NMR (125 MHz, CDCl₃) δ 186.4, 149.1, 148.8, 147.0, 146.8, 142.6, 135.5, 131.9, 130.2, 129.6, 128.9, 127.7, 125.7, 124.3, 121.2, 35.5, 35.0, 29.62, 29.55.

HRMS: (ESI⁺) [*M*+Na]⁺ calcd for C₃₃H₃₅NONa: 484.2611, found: 484.2615.

2,6-di-tert-butyl-4-(4-morpholinobenzylidene)cyclohexa-2,5-dienone (1k) (yellow solid)

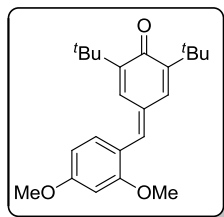


¹H NMR (500 MHz, CDCl₃) δ 7.63 (d, *J* = 2.4 Hz, 1H), 7.47 (d, *J* = 8.8 Hz, 2H), 7.12 (s, 1H), 7.02 (d, *J* = 2.4 Hz, 1H), 6.97 (d, *J* = 8.8 Hz, 2H), 3.98 – 3.84 (m, 4H), 3.40 – 3.26 (m, 4H), 1.36 (s, 9H), 1.35 (s, 9H).

¹³C NMR (125 MHz, CDCl₃) δ 186.4, 151.6, 148.7, 146.9, 143.0, 135.5, 132.3, 129.8, 127.9, 127.0, 114.6, 66.7, 48.0, 35.4, 34.9, 29.62, 29.55.

HRMS: (ESI⁺) [*M*+H]⁺ calcd for C₂₅H₃₄NO₂: 380.2584, found: 380.2590.

2,6-di-tert-butyl-4-(2,4-dimethoxybenzylidene)cyclohexa-2,5-dienone (1t) (yellow solid)

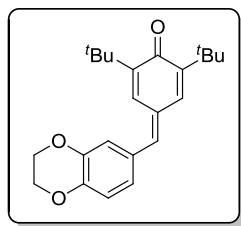


¹H NMR (500 MHz, CDCl₃) δ 7.50 (d, *J* = 2.4 Hz, 1H), 7.39 (s, 1H), 7.38 (d, *J* = 9.6 Hz, 1H), 7.08 (d, *J* = 2.4 Hz, 1H), 6.61 (dd, *J* = 8.5, 2.4 Hz, 1H), 6.53 (d, *J* = 2.4 Hz, 1H), 3.90 (s, 6H), 1.36 (s, 9H), 1.32 (s, 9H).

¹³C NMR (125 MHz, CDCl₃) δ 186.6, 162.5, 159.8, 148.6, 146.9, 138.6, 135.5, 132.8, 130.3, 128.3, 118.2, 105.0, 98.6, 55.6, 55.5, 35.4, 35.0, 29.6, 29.5.

HRMS: (ESI⁺) [*M*+H]⁺ calcd for C₂₃H₃₁O₃: 355.2268, found: 355.2266.

2,6-di-tert-butyl-4-((2,3-dihydrobenzo[*b*][1,4]dioxin-6-yl)methylene)cyclohexa-2,5-dienone (1u) (yellow solid)

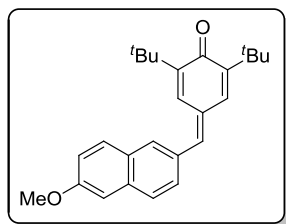


¹H NMR (500 MHz, CDCl₃) δ 7.58 (d, *J* = 2.4 Hz, 1H), 7.08 (s, 1H), 7.05 (d, *J* = 2.0 Hz, 1H), 7.04 – 6.98 (m, 2H), 6.96 (d, *J* = 8.3 Hz, 1H), 4.37 – 4.33 (m, 2H), 4.33 – 4.30 (m, 2H), 1.35 (s, 9H), 1.34 (s, 9H).

¹³C NMR (125 MHz, CDCl₃) δ 186.5, 149.1, 147.3, 144.9, 143.8, 142.3, 135.3, 130.9, 129.6, 127.7, 124.4, 119.3, 117.7, 64.6, 64.3, 35.5, 35.0, 29.6, 29.5.

HRMS: (ESI⁺) [*M*+Na]⁺ calcd for C₂₃H₂₈O₃Na: 375.1931, found: 375.1937.

2,6-di-tert-butyl-4-((6-methoxynaphthalen-2-yl)methylene)cyclohexa-2,5-dienone (1x) (yellow solid)

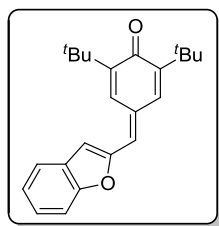


¹H NMR (500 MHz, CDCl₃) δ 7.90 (d, *J* = 1.6 Hz, 1H), 7.81 (dd, *J* = 8.7, 6.0 Hz, 2H), 7.68 (d, *J* = 2.4 Hz, 1H), 7.58 (dd, *J* = 8.7, 1.6 Hz, 1H), 7.34 (s, 1H), 7.23 (dd, *J* = 8.9, 2.5 Hz, 1H), 7.18 (d, *J* = 2.5 Hz, 1H), 7.09 (d, *J* = 2.4 Hz, 1H), 3.98 (s, 3H), 1.38 (s, 9H), 1.35 (s, 9H).

¹³C NMR (125 MHz, CDCl₃) δ 186.5, 159.0, 149.3, 147.6, 142.9, 135.2, 134.8, 131.6, 131.4, 130.7, 130.1, 128.8, 128.0, 128.0, 127.3, 119.7, 105.9, 55.4, 35.5, 35.0, 29.60, 29.56.

HRMS: (ESI⁺) [*M*+H]⁺ calcd for C₂₆H₃₁O₂: 375.2319, found: 375.2317.

4-(benzofuran-2-ylmethylene)-2,6-di-*tert*-butylcyclohexa-2,5-dienone (1y)(yellow solid)



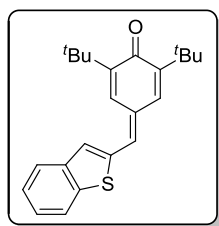
^1H NMR (500 MHz, CDCl_3) δ 8.39 (d, $J = 2.4$ Hz, 1H), 7.64 (dt, $J = 7.8$, 1.0 Hz, 1H), 7.57 – 7.51 (m, 1H), 7.41 (ddd, $J = 8.4$, 7.2, 1.3 Hz, 1H), 7.36 – 7.24 (m, 1H), 7.05 (s, 1H), 6.99 (d, $J = 2.4$ Hz, 1H), 6.81 (s, 1H), 1.43 (s, 9H), 1.36 (s, 9H).

^{13}C NMR (125 MHz, CDCl_3) δ 186.1, 156.4, 154.4, 149.5, 148.4, 134.6, 131.3, 128.5, 128.1, 126.8, 125.9, 123.7, 121.8, 113.9, 111.4, 35.7, 35.1,

29.63, 29.59.

HRMS: (ESI^+) [$\text{M}+\text{H}$] $^+$ calcd for $\text{C}_{23}\text{H}_{27}\text{O}_2$: 335.2006, found: 335.2002.

4-(benzo[*b*]thiophen-2-ylmethylene)-2,6-di-*tert*-butylcyclohexa-2,5-dienone (1z)



(yellow solid)

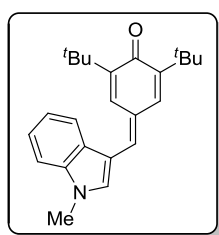
^1H NMR (500 MHz, CDCl_3) δ 7.96 (d, $J = 2.5$ Hz, 1H), 7.90 – 7.86 (m, 1H), 7.86 – 7.81 (m, 1H), 7.57 (s, 1H), 7.46 – 7.36 (m, 2H), 7.28 (s, 1H), 7.02 (d, $J = 2.5$ Hz, 1H), 1.43 (s, 9H), 1.36 (s, 9H).

^{13}C NMR (125 MHz, CDCl_3) δ 186.1, 149.7, 148.0, 142.3, 139.1, 138.7, 135.0, 134.3, 131.1, 130.9, 127.0, 126.4, 125.2, 124.5, 122.3, 35.8, 35.1,

29.7, 29.6.

HRMS: (ESI^+) [$\text{M}+\text{H}$] $^+$ calcd for $\text{C}_{23}\text{H}_{27}\text{OS}$: 351.1777, found: 351.1772.

2,6-di-*tert*-butyl-4-((1-methyl-1*H*-indol-3-yl)methylene)cyclohexa-2,5-dienone (1aa)



(yellow solid)

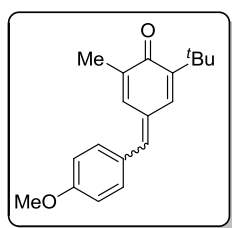
^1H NMR (500 MHz, CDCl_3) δ 7.83 (d, $J = 7.9$ Hz, 1H), 7.74 (d, $J = 2.4$ Hz, 1H), 7.50 (d, $J = 0.8$ Hz, 1H), 7.41 (d, $J = 1.1$ Hz, 1H), 7.40 – 7.36 (m, 1H), 7.31 (ddd, $J = 8.0$, 6.8, 1.3 Hz, 1H), 7.14 (d, $J = 2.4$ Hz, 1H), 3.94 (s, 3H), 1.40 (s, 9H), 1.39 (s, 9H).

^{13}C NMR (125 MHz, CDCl_3) δ 186.4, 148.1, 146.0, 137.1, 135.4, 134.7,

131.4, 128.1, 128.1, 128.0, 123.4, 121.4, 119.2, 113.0, 109.9, 35.4, 34.9, 33.6, 29.7, 29.6.

HRMS: (ESI^+) [$\text{M}+\text{H}$] $^+$ calcd for $\text{C}_{24}\text{H}_{30}\text{NO}$: 348.2322, found: 348.2322.

2-(*tert*-butyl)-4-(4-methoxybenzylidene)-6-methylcyclohexa-2,5-dienone (5b) (1.27:1 dr)



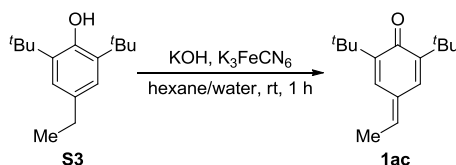
(yellow solid)

^1H NMR (500 MHz, CDCl_3) δ 7.65 (d, $J = 2.6$ Hz, 1H), 7.48 (d, $J = 8.7$ Hz, 2H), 7.17 (s, 1H), 7.07 (d, $J = 2.6$ Hz, 1H), 7.00 (d, $J = 8.7$ Hz, 2H), 3.89 (s, 3H), 2.08 (s, 3H), 1.36 (s, 9H) (major isomer).

^{13}C NMR (125 MHz, CDCl_3) δ 186.6, 160.7, 145.7, 143.1, 137.6, 137.1, 132.3, 130.1, 129.1, 128.5, 114.4, 55.4, 34.7, 29.3, 17.2 (major isomer).

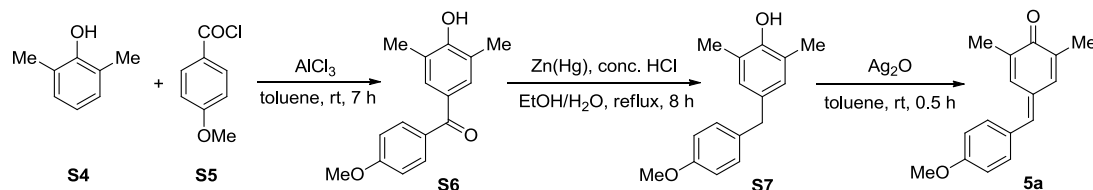
HRMS: (ESI^+) [$\text{M}+\text{Na}$] $^+$ calcd for $\text{C}_{19}\text{H}_{22}\text{O}_2\text{Na}$: 305.1512, found: 305.1521.

p-Quinone methide **1ac** was synthesized according to the literature reported procedure, and it is a known compound.²

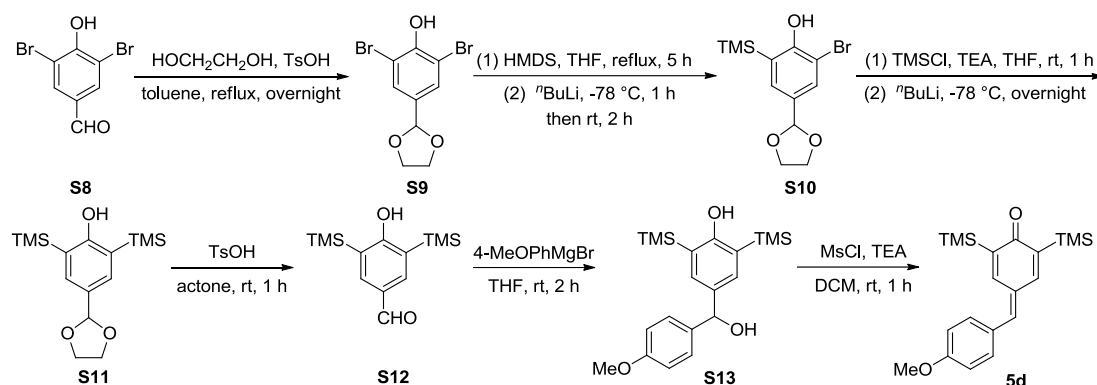


² Z.-Q. Liu, P.-S. You, L.-D. Zhang, D.-Q. Liu, S.-S. Liu, X.-Y. Guan, *Molecules* **2020**, *25*, 539

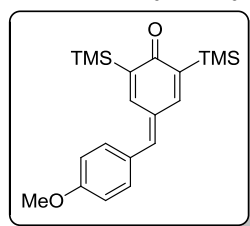
p-Quinone methide **5a** was synthesized according to the literature reported procedure, and it is a known compound.³



p-Quinone methide **5d** was synthesized according to the literature reported procedure.⁴



4-(4-methoxybenzylidene)-2,6-bis(trimethylsilyl)cyclohexa-2,5-dienone (**5d**)



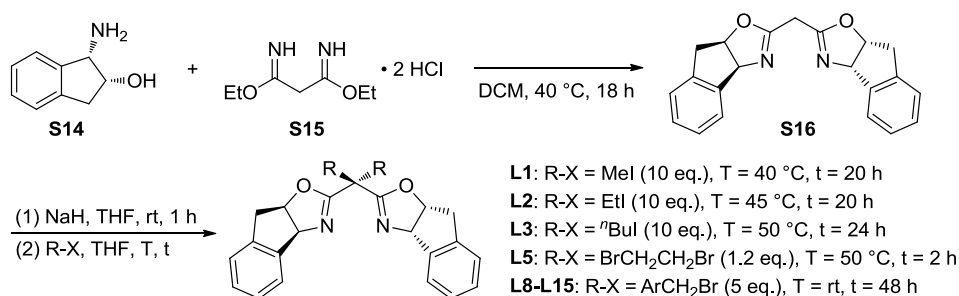
(yellow solid)

$^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.92 (d, $J = 2.0$ Hz, 1H), 7.50 (d, $J = 8.7$ Hz, 2H), 7.36 (d, $J = 2.0$ Hz, 1H), 7.23 (s, 1H), 7.02 (d, $J = 8.7$ Hz, 1H), 3.91 (s, 3H), 0.27 (s, 9H), 0.25 (s, 9H).

$^{13}\text{C NMR}$ (125 MHz, CDCl_3) δ 193.1, 161.1, 149.7, 144.2, 142.9, 141.8, 140.7, 132.6, 129.8, 128.1, 114.5, 55.4, -1.4.

HRMS: (ESI^+) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{20}\text{H}_{29}\text{O}_2\text{Si}_2$: 357.1701, found: 357.1705.

2.2 Synthesis of **L1-L3**, **L5**, **L8-L15**



Compound **S16** was synthesized according to the literature reported procedure.⁵

To a solution of **S16** in anhydrous THF was added NaH (7.0 equiv) in portions at rt . The resulting mixture was stirred at rt for 1 hour, and then the corresponding halide was

³ T. Uno, H. Ohta, A. Yamane, M. Kubo, T. Itoh, *Journal of Polymer Science, Part A: Polymer Chemistry*, **2015**, 53, 437

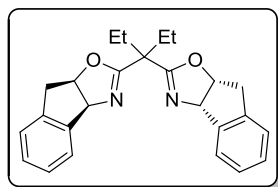
⁴ L. Roisera, M. Wasera, *Org. Lett.* **2017**, 19, 2338

⁵ J. L. Hofstra, A. H. Cherney, C. M. Ordner, S. E. Reisman, *J. Am. Chem. Soc.* **2018**, 140, 139

added. The mixture was continued to stir at the temperature indicated. After completion, the reaction was quenched with saturated NH_4Cl and extracted with CH_2Cl_2 . The combined organic layers were dried with Na_2SO_4 , filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/acetone) to afford the corresponding pure product.

Ligands **L1**, **L5**, **L8**, **L9**, **L11**, and **L12** are known compounds.

(3aS,3a'S,8aR,8a'R)-2,2'-(pentane-3,3-diyl)bis(8,8a-dihydro-3aH-indeno[1,2-d]oxazole) (L2) (white solid)



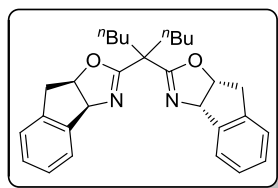
^1H NMR (500 MHz, CDCl_3) δ 7.51 (dd, J = 6.9, 1.8 Hz, 2H), 7.29 – 7.23 (m, 6H), 5.55 (d, J = 7.7 Hz, 2H), 5.24 (ddd, J = 8.1, 6.9, 1.5 Hz, 2H), 3.31 (dd, J = 17.8, 6.9 Hz, 2H), 2.97 (dd, J = 17.8, 1.5 Hz, 2H), 1.92 (qd, J = 7.5, 3.2 Hz, 4H), 0.56 (t, J = 7.5 Hz, 6H).

^{13}C NMR (125 MHz, CDCl_3) δ 168.5, 141.9, 139.7, 128.2, 127.3, 125.6, 125.0, 83.3, 76.4, 49.0, 39.6, 35.0, 24.7.

HRMS: (ESI^+) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{25}\text{H}_{27}\text{N}_2\text{O}_2$: 387.2067, found: 387.2073.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -246.1^\circ$ (c = 1.0, CH_2Cl_2).

(3aS,3a'S,8aR,8a'R)-2,2'-(nonane-5,5-diyl)bis(8,8a-dihydro-3aH-indeno[1,2-d]oxazole) (L3) (white solid)



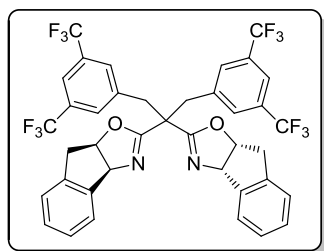
^1H NMR (500 MHz, CDCl_3) δ 7.55 – 7.50 (m, 2H), 7.31 – 7.22 (m, 6H), 5.56 (d, J = 7.5 Hz, 2H), 5.24 (ddd, J = 7.9, 6.8, 1.5 Hz, 2H), 3.30 (dd, J = 17.8, 6.7 Hz, 2H), 2.97 (dd, J = 17.7, 1.4 Hz, 2H), 1.87 (qdd, J = 13.8, 11.6, 5.0 Hz, 4H), 1.24 – 1.04 (m, 4H), 1.02 – 0.89 (m, 2H), 0.76 – 0.66 (m, 2H), 0.68 (t, J = 7.3 Hz, 6H).

^{13}C NMR (125 MHz, CDCl_3) δ 168.5, 141.9, 139.7, 128.2, 127.3, 125.6, 125.0, 83.3, 76.4, 49.0, 39.6, 35.0, 24.7.

HRMS: (ESI^+) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{29}\text{H}_{35}\text{N}_2\text{O}_2$: 443.2693, found: 443.2690.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -205.2^\circ$ (c = 1.0, CH_2Cl_2).

(3aS,3a'S,8aR,8a'R)-2,2'-(1,3-bis(3,5-bis(trifluoromethyl)phenyl)propane-2,2-diyl)bis(8,8a-dihydro-3aH-indeno[1,2-d]oxazole) (L10) (pale yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.73 (s, 2H), 7.65 (d, J = 1.6 Hz, 4H), 7.45 (dd, J = 6.8, 1.8 Hz, 2H), 7.35 – 7.22 (m, 6H), 5.48 (d, J = 7.9 Hz, 2H), 5.16 – 5.08 (m, 2H), 3.57 (d, J = 14.0 Hz, 2H), 3.29 (dd, J = 18.0, 7.1 Hz, 2H), 3.14 (d, J = 14.0 Hz, 2H), 2.84 (dd, J = 18.0, 1.6 Hz, 2H).

^{13}C NMR (125 MHz, CDCl_3) δ 165.2, 141.0, 139.2, 138.7, 131.3 (q, J = 32.5 Hz), 130.3 (q, J = 3.8 Hz), 128.6, 127.6, 125.5, 125.0,

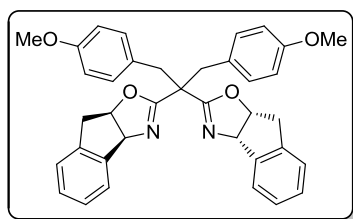
123.2 (q, J = 271.3 Hz), 121.0 (hept, J = 3.8 Hz), 83.3, 76.3, 47.9, 40.3, 39.4.

HRMS: (ESI^+) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{39}\text{H}_{27}\text{F}_{12}\text{N}_2\text{O}_2$: 783.1875, found: 783.1873.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -175.4^\circ$ (c = 2.0, CH_2Cl_2).

(3aS,3a'S,8aR,8a'R)-2,2'-(1,3-bis(4-methoxyphenyl)propane-2,2-diyl)bis(8,8a-dihydro-3aH-indeno[1,2-d]oxazole) (L13) (white solid)

^1H NMR (500 MHz, CDCl_3) δ 7.48 (d, J = 7.3 Hz, 2H), 7.40 – 7.30 (m, 6H), 6.67 (d, J = 8.6 Hz, 4H), 6.34 (d, J = 8.7 Hz, 4H), 5.63 (d, J = 7.9 Hz, 2H), 5.39 – 5.28 (m, 2H), 3.70 (s, 6H), 3.38 (dd, J = 18.0, 6.7 Hz, 2H), 3.19 (d, J = 14.3 Hz, 2H), 3.12 (d, J = 18.0 Hz, 2H), 2.99 (d, J =



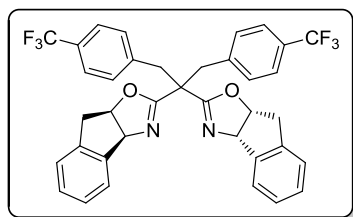
14.3 Hz, 2H).

^{13}C NMR (125 MHz, CDCl_3) δ 167.5, 157.9, 141.6, 139.8, 131.2, 128.3, 128.1, 127.4, 125.8, 125.1, 113.0, 83.4, 76.5, 55.0, 47.8, 39.3, 37.9.

HRMS: (ESI⁺) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{37}\text{H}_{35}\text{N}_2\text{O}_4$: 571.2591, found: 571.2597.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -55.8^\circ$ ($c = 0.5$, CH_2Cl_2).

(3aS,3a'S,8aR,8a'R)-2,2'-(1,3-bis(4-(trifluoromethyl)phenyl)propane-2,2-diyl)bis(8,8a-dihydro-3aH-indeno[1,2-d]oxazole) (L14) (pale yellow solid)



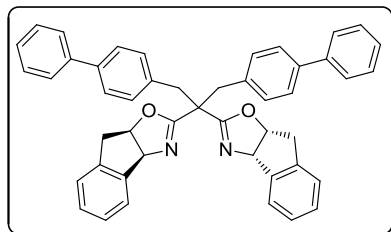
^1H NMR (500 MHz, CDCl_3) δ 7.47 – 7.42 (m, 2H), 7.42 – 7.38 (m, 2H), 7.37 – 7.30 (m, 4H), 7.00 (d, $J = 8.0$ Hz, 4H), 6.84 (d, $J = 8.0$ Hz, 4H), 5.64 (d, $J = 7.8$ Hz, 2H), 5.35 (ddd, $J = 7.8, 6.6, 1.1$ Hz, 2H), 3.38 (dd, $J = 20.0, 10.0$ Hz, 2H), 3.35 (d, $J = 10.0$ Hz, 2H), 3.05 (d, $J = 10.0$ Hz, 2H), 3.04 (d, $J = 20.0$ Hz, 2H).

^{13}C NMR (125 MHz, CDCl_3) δ 166.7, 141.4, 139.9, 139.6, 130.4, 128.7, 128.6 (q, $J = 32.5$ Hz), 127.7, 125.7, 125.2, 124.5 (q, $J = 3.8$ Hz), 124.2 (q, $J = 271.3$ Hz), 83.9, 76.4, 47.2, 39.7, 39.2.

HRMS: (ESI⁺) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{37}\text{H}_{29}\text{F}_6\text{N}_2\text{O}_2$: 647.2128, found: 647.2130.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -114.9^\circ$ ($c = 1.0$, CH_2Cl_2).

(3aS,3a'S,8aR,8a'R)-2,2'-(1,3-di([1,1'-biphenyl]-4-yl)propane-2,2-diyl)bis(8,8a-dihydro-3aH-indeno[1,2-d]oxazole) (L15) (white solid)



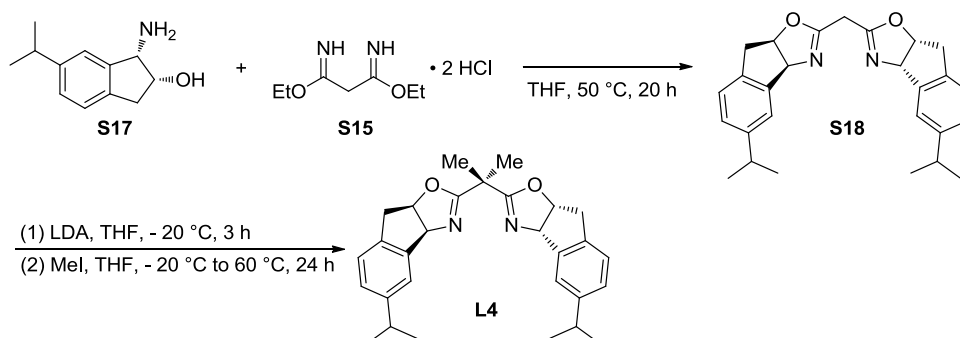
^1H NMR (500 MHz, CDCl_3) δ 7.54 – 7.48 (m, 6H), 7.44 (dd, $J = 8.5, 6.9$ Hz, 4H), 7.38 – 7.29 (m, 8H), 7.07 (d, $J = 8.2$ Hz, 4H), 6.87 (d, $J = 8.2$ Hz, 4H), 5.67 (d, $J = 7.8$ Hz, 2H), 5.37 (ddd, $J = 8.0, 6.8, 1.3$ Hz, 2H), 3.39 (dd, $J = 20.0, 10.0$ Hz, 2H), 3.35 (d, $J = 15.0$ Hz, 2H), 3.15 (d, $J = 15.0$ Hz, 2H), 3.13 (d, $J = 15.0$ Hz, 2H).

^{13}C NMR (125 MHz, CDCl_3) δ 167.3, 141.6, 141.0, 139.8, 139.0, 135.2, 130.6, 128.6, 128.4, 127.5, 127.0, 126.9, 126.3, 125.8, 125.1, 83.5, 76.5, 47.6, 39.4, 38.5.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{47}\text{H}_{38}\text{N}_2\text{O}_2\text{Na}$: 685.2825, found: 685.2818.

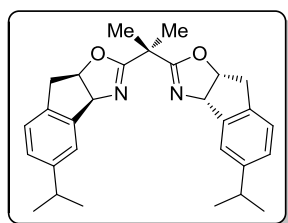
Specific rotation: $[\alpha]_{\text{D}}^{25} = -113.4^\circ$ ($c = 0.5$, CH_2Cl_2).

2.3 Synthesis of L4



Compounds **S17**, **S18** were synthesized according to the literature reported procedure.⁶ To a solution of **S18** (414 mg, 1.0 mmol) in anhydrous THF was added LDA (2.0 M in THF, 1.0 mL, 2.0 equiv) dropwise at -20 °C. The solution was stirred at -20 °C for additional 3 hours, and then CH₃I (710 mg, 5.0 equiv) was added. The solution was warmed to rt and heated at 60 °C for 24 hours. After completion, the reaction was quenched with saturated NH₄Cl and extracted with CH₂Cl₂. The combined organic layers were dried with Na₂SO₄, filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/acetone) to afford the pure product.

(3aS,3a'S,8aR,8a'R)-2,2'-(cyclopentane-1,1-diyl)bis(8,8a-dihydro-3aH-indeno[1,2-d]oxazole) (L4) (pale yellow solid)

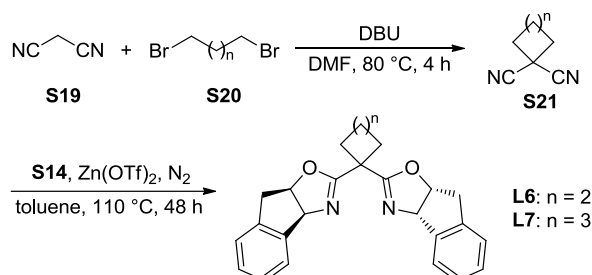


¹H NMR (500 MHz, CDCl₃) δ 7.41 (s, 2H), 7.16 (d, *J* = 1.4 Hz, 4H), 5.52 (d, *J* = 8.0 Hz, 2H), 5.31 (td, *J* = 7.6, 2.1 Hz, 2H), 3.32 (dd, *J* = 17.7, 7.2 Hz, 2H), 3.01 (dd, *J* = 17.7, 2.1 Hz, 2H), 2.94 (hept, *J* = 7.0 Hz, 2H), 1.45 (s, 6H), 1.27 (d, *J* = 7.0 Hz, 12H).

¹³C NMR (125 MHz, CDCl₃) δ 169.1, 148.3, 141.9, 137.1, 126.8, 124.8, 123.5, 83.5, 76.5, 39.4, 38.6, 34.0, 24.2, 24.1, 24.0.

HRMS: (ESI⁺) [M+H]⁺ calcd for C₂₉H₃₅N₂O₂: 443.2693, found: 443.2697.

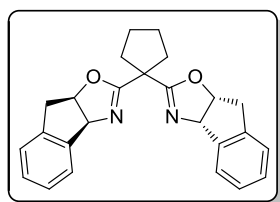
2.4 Synthesis of L6, L7



Compound **S21** was synthesized according to the literature reported procedure.⁷

A solution of **S21** and Zn(OTf)₂ (1.0 equiv) in anhydrous toluene was stirred at rt for 10 minutes, and then **S14** (2.2 equiv) was added. The mixture was heated at 110 °C for 48 hours under nitrogen atmosphere. After completion, ethyl acetate was added, and the organic layer was washed by saturated NaHCO₃ and brine. The collected organic layer was dried with Na₂SO₄, filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/acetone) to afford the corresponding pure products.

(3aS,3a'S,8aR,8a'R)-2,2'-(cyclopentane-1,1-diyl)bis(8,8a-dihydro-3aH-indeno[1,2-d]oxazole) (L6) (white solid)



¹H NMR (500 MHz, CDCl₃) δ 7.54 – 7.48 (m, 2H), 7.31 – 7.22 (m, 6H), 5.53 (d, *J* = 7.8 Hz, 2H), 5.27 (td, *J* = 7.4, 1.7 Hz, 2H), 3.31 (dd, *J* = 17.8, 7.0 Hz, 2H), 2.97 (dd, *J* = 17.8, 1.7 Hz, 2H), 2.28 – 2.16 (m, 2H), 2.16 – 2.07 (m, 2H), 1.68 – 1.48 (m, 4H).

⁶ C. Liu, J.-C. Yi, Z.-B. Zheng, Y. Tang, L.-X. Dai, S.-L. You, *Angew. Chem. Int. Ed.* **2016**, 55, 751

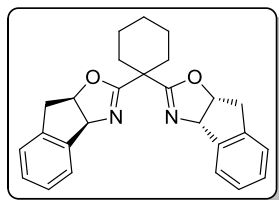
⁷ T.-Y. Tsai, K.-S. Shia, H.-J. Liu, *Synlett* **2003**, 97

^{13}C NMR (125 MHz, CDCl_3) δ 168.5, 141.9, 139.7, 128.2, 127.3, 125.6, 125.0, 83.3, 76.4, 49.0, 39.6, 35.0, 24.7.

HRMS: (ESI^+) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{25}\text{H}_{25}\text{N}_2\text{O}_2$: 385.1911, found: 385.1920.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -335.9^\circ$ ($c = 1.0$, CH_2Cl_2).

(3a*S*,3a'*S*,8a*R*,8a'*R*)-2,2'-(cyclohexane-1,1-diyl)bis(8,8a-dihydro-3a*H*-indeno[1,2-*d*]oxazole) (L7) (white solid)



^1H NMR (500 MHz, CDCl_3) δ 7.55 – 7.48 (m, 2H), 7.32 – 7.25 (m, 4H), 7.23 (dd, $J = 6.2, 2.4$ Hz, 2H), 5.55 (d, $J = 7.8$ Hz, 2H), 5.27 – 5.22 (m, 2H), 3.31 (dd, $J = 17.8, 6.9$ Hz, 2H), 2.95 (dd, $J = 17.8, 1.6$ Hz, 2H), 1.99 (td, $J = 8.1, 3.6$ Hz, 2H), 1.91 (ddd, $J = 13.6, 8.4, 2.9$ Hz, 2H), 1.55 – 1.40 (m, 2H), 1.35 – 1.23 (m, 4H).

^{13}C NMR (125 MHz, CDCl_3) δ 168.5, 141.9, 139.7, 128.2, 127.3, 125.6, 125.0, 83.3, 76.4, 49.0, 39.6, 35.0, 24.7.

HRMS: (ESI^+) $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{26}\text{H}_{27}\text{N}_2\text{O}_2$: 399.2067, found: 399.2063.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -272.8^\circ$ ($c = 0.5$, CH_2Cl_2).

III. Screening of Reaction Conditions

Table S1. Preliminary Screening of Ligands

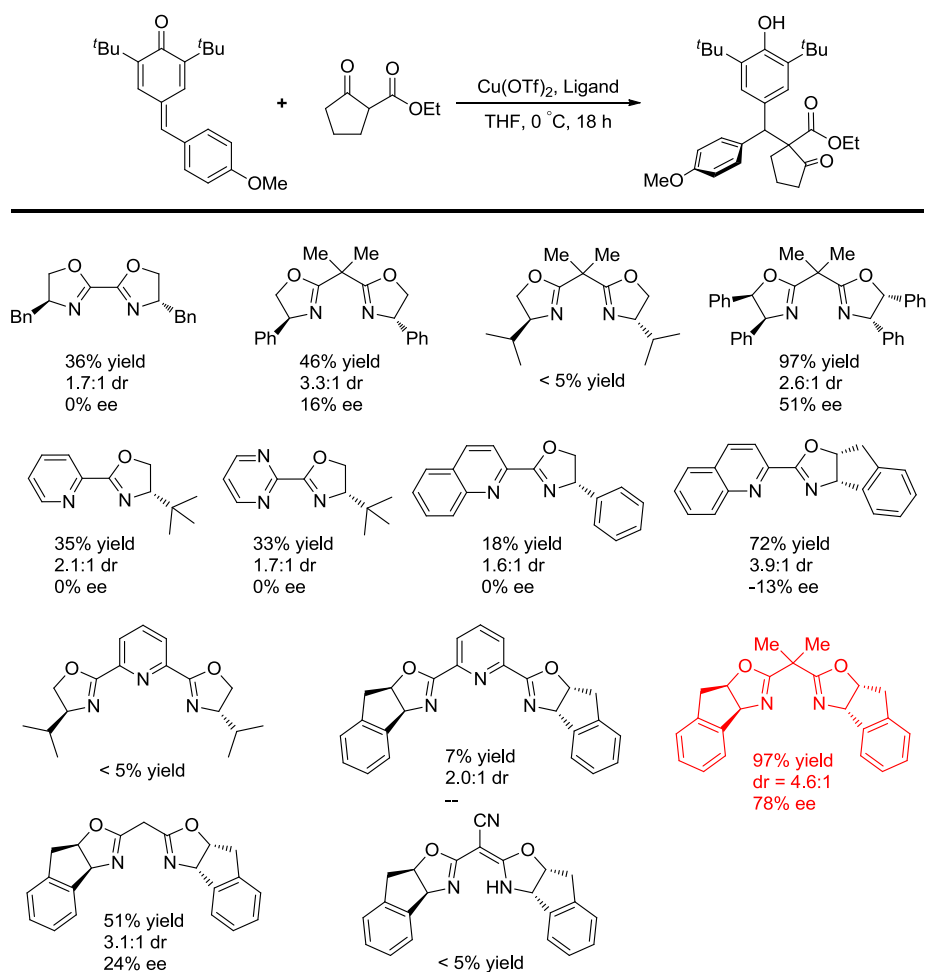
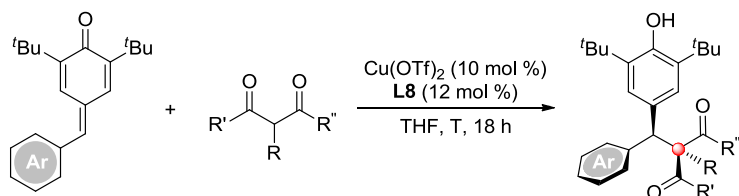


Table S2. Optimization of Reaction Conditions

entry	T (°C)	(x equiv)	t (h)	yield (%)	dr	ee (%)
1	-10	1.5	18	98	11.5:1	94
2	-15	1.5	18	98	14.6:1	98
3	-20	1.5	18	67	14.5:1	96
4	-20	1.5	24	73	14.5:1	97
5	-30	1.5	18	33	15.6:1	97
6	-30	1.5	24	46	15.4:1	96
7	-30	1.5	36	51	15.6:1	96
8	-15	1.2	18	73	13.9:1	94
9	-15	1.2	24	82	13.8:1	95
10	-15	1.5	12	89	14.3:1	97
11	-15	1.8	12	93	14.2:1	97
12	-15	1.8	18	98	14.7:1	98
13 ^a	-15	1.5	24	0	—	—

a: Without Cu(OTf)₂

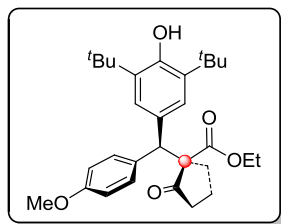
IV. Diarylmethylation of 1,3-Dicarbonyl Compounds



An oven-dried Schlenk tube was charged with Cu(OTf)₂ (1.8 mg, 0.005 mmol, 10 mol%), L8 (4.4 mg, 0.006 mmol, 12 mol%), *p*-quinone methide substrates (0.05 mmol) and a stir bar. The tube was degassed and refilled with nitrogen for 3 times, and then anhydrous THF (0.5 mL) was injected to the tube via a syringe. The reaction mixture was cooled to the temperature indicated. After stirring for 3 minutes, a solution of 1,3-dicarbonyl compounds (0.075 mol, 1.5 equiv) in anhydrous THF (0.5 mL) was injected to the reaction mixture via a syringe. After stirring at the same temperature for additional 18 hours, the reaction was quenched with saturated NH₄Cl and extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried with Na₂SO₄, filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate) to afford the pure product.

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (3a) (colorless oil)

¹H NMR (500 MHz, CDCl₃) δ 7.22 (d, *J* = 8.6 Hz, 2H), 6.90 (s, 2H), 6.82 (d, *J* = 8.7 Hz, 2H),



5.12 (s, 1H), 5.09 (s, 1H), 3.98 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.89 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.80 (s, 3H), 2.99 (dddd, $J = 12.7, 7.2, 4.0, 1.4$ Hz, 1H), 2.32 – 2.23 (m, 1H), 2.20 (ddd, $J = 13.1, 9.3, 7.4$ Hz, 1H), 1.82 (dddd, $J = 15.3, 12.1, 9.4, 7.6$ Hz, 1H), 1.69 (dt, $J = 18.5, 9.1$ Hz, 1H), 1.46 – 1.39 (m, 1H), 1.36 (s, 18H), 0.91 (t, $J = 7.1$ Hz, 3H).

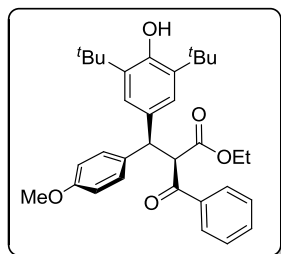
^{13}C NMR (125 MHz, CDCl_3) δ 214.3, 169.0, 158.0, 152.4, 135.4, 133.6, 131.0, 130.0, 126.5, 113.5, 66.6, 61.5, 55.2, 54.5, 38.7, 34.3, 30.3, 29.4, 19.5, 13.6.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{30}\text{H}_{40}\text{O}_5\text{Na}$: 503.2768, found: 503.2770.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -96.2^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 99.0:1.0, 0.7 mL/min, $\lambda = 210$ nm, retention time: 7.58 min (minor), 10.29 min (major).

(2R,3S)-ethyl 2-benzoyl-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (3b) (dark yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.88 (dd, $J = 8.1, 1.3$ Hz, 2H), 7.55 – 7.49 (m, 1H), 7.40 (t, $J = 7.7$ Hz, 2H), 7.32 (d, $J = 8.7$ Hz, 2H), 6.92 (s, 2H), 6.86 (d, $J = 8.7$ Hz, 2H), 5.34 (d, $J = 11.9$ Hz, 1H), 4.90 (d, $J = 11.9$ Hz, 1H), 4.91 (s, 1H), 4.00 (qd, $J = 7.1, 1.8$ Hz, 2H), 3.79 (s, 3H), 1.24 (s, 18H), 1.04 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 194.5, 167.9, 158.2, 152.1, 137.5, 135.5, 134.6, 133.1, 131.8, 129.0, 128.43, 128.35, 124.4, 113.8, 61.4,

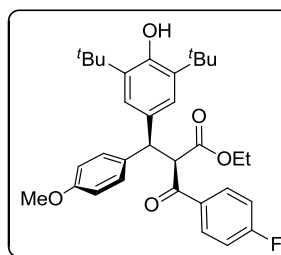
59.7, 55.2, 50.9, 34.1, 30.0, 13.8.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{40}\text{O}_5\text{Na}$: 539.2768, found: 539.2768.

Specific rotation: $[\alpha]_{\text{D}}^{25} = +3.6^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, $\lambda = 210$ nm, retention time: 14.80 min (minor), 16.91 min (major).

(2R,3S)-ethyl 3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-2-(4-fluorobenzoyl)-3-(4-methoxyphenyl)propanoate (3c) (dark yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.92 (dd, $J = 8.7, 5.5$ Hz, 2H), 7.35 – 7.27 (m, 2H), 7.08 (t, $J = 8.6$ Hz, 2H), 6.91 (s, 2H), 6.89 – 6.82 (m, 2H), 5.27 (d, $J = 11.8$ Hz, 1H), 4.93 (s, 1H), 4.89 (d, $J = 11.8$ Hz, 1H), 4.00 (qd, $J = 7.1, 1.9$ Hz, 2H), 3.79 (s, 3H), 1.26 (s, 18H), 1.04 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 192.9, 167.8, 165.7 (d, $J = 253.8$ Hz), 158.3, 152.2, 135.7, 134.5, 134.0 (d, $J = 2.5$ Hz), 131.9, 131.1

(d, $J = 10.0$ Hz), 129.0, 124.4, 115.6 (d, $J = 22.5$ Hz), 113.9, 61.5, 59.9, 55.2, 50.9, 34.2, 30.1, 13.8.

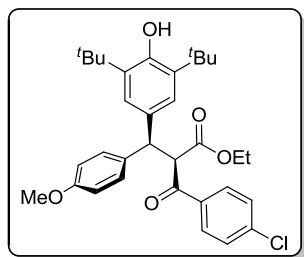
^{19}F NMR (471 MHz, CDCl_3) δ -104.82.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}\text{FO}_5\text{Na}$: 557.2674, found: 557.2678.

Specific rotation: $[\alpha]_{\text{D}}^{25} = +2.2^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, $\lambda = 254$ nm, retention time: 19.23 min (major).

(2R,3S)-ethyl 2-(4-chlorobenzoyl)-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (3d) (yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.81 (d, J = 8.6 Hz, 2H), 7.37 (d, J = 8.6 Hz, 2H), 7.31 (d, J = 8.7 Hz, 2H), 6.91 (s, 2H), 6.86 (d, J = 8.7 Hz, 2H), 5.26 (d, J = 11.8 Hz, 1H), 4.94 (s, 1H), 4.87 (d, J = 11.8 Hz, 1H), 4.01 (qd, J = 7.1, 1.7 Hz, 2H), 3.79 (s, 3H), 1.26 (s, 18H), 1.04 (t, J = 7.1 Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 193.4, 167.7, 158.2, 152.2, 139.6, 135.8, 135.6, 134.4, 131.7, 129.7, 128.9, 128.7, 124.4, 113.9, 61.5,

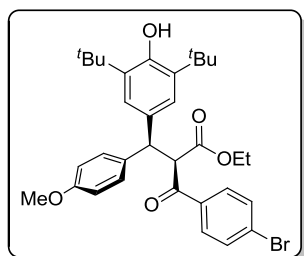
59.9, 55.2, 50.9, 34.1, 30.1, 13.8.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}^{35}\text{ClO}_5\text{Na}$: 573.2378, found: 573.2381; $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}^{37}\text{ClO}_5\text{Na}$: 575.2349, found: 575.2368.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -8.0^\circ$ (c = 1.0, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 90.0:10.0, 0.5 mL/min, λ = 210 nm, retention time: 12.68 min (minor), 13.83 min (major).

(2R,3S)-ethyl 2-(4-bromobenzoyl)-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (3e) (yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.72 (d, J = 8.6 Hz, 2H), 7.54 (d, J = 8.6 Hz, 2H), 7.30 (d, J = 8.7 Hz, 2H), 6.90 (s, 2H), 6.86 (d, J = 8.7 Hz, 2H), 5.24 (d, J = 11.8 Hz, 1H), 4.94 (s, 1H), 4.87 (d, J = 11.8 Hz, 1H), 4.00 (qd, J = 7.1, 1.6 Hz, 2H), 3.79 (s, 3H), 1.26 (s, 18H), 1.04 (t, J = 7.1 Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 193.7, 167.7, 158.3, 152.2, 136.2, 135.6, 134.4, 131.7, 131.7, 129.8, 128.9, 128.4, 124.4, 113.9, 61.5,

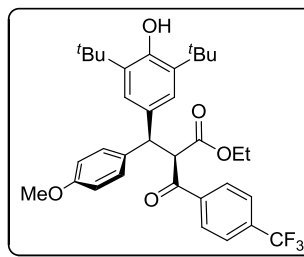
59.9, 55.2, 50.9, 34.1, 30.1, 13.9.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}^{79}\text{BrO}_5\text{Na}$: 617.1873, found: 617.1874; $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}^{81}\text{BrO}_5\text{Na}$: 619.1853, found: 619.1861.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -4.0^\circ$ (c = 1.0, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak IC-H column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, λ = 210 nm, retention time: 26.03 min (major).

(2R,3S)-ethyl 3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)-2-(4-(trifluoromethyl)benzoyl)propanoate (3f) (red solid)



^1H NMR (500 MHz, CDCl_3) δ 7.93 (d, J = 8.2 Hz, 2H), 7.65 (d, J = 8.2 Hz, 2H), 7.32 (d, J = 8.6 Hz, 2H), 6.89 (s, 2H), 6.87 (d, J = 8.6 Hz, 2H), 5.30 (d, J = 11.8 Hz, 1H), 4.94 (s, 1H), 4.87 (d, J = 11.8 Hz, 1H), 4.02 (qd, J = 7.1, 1.1 Hz, 2H), 3.80 (s, 3H), 1.24 (s, 18H), 1.06 (t, J = 7.1 Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 194.1, 167.5, 158.4, 152.3, 140.4, 135.8, 134.28 (q, J = 32.5 Hz), 134.26, 131.5, 128.8, 128.5, 125.4

(q, J = 3.8 Hz), 124.5, 123.5 (q, J = 271.3 Hz), 114.0, 61.6, 60.3, 55.2, 51.2, 34.1, 30.1, 13.9.

^{19}F NMR (471 MHz, CDCl_3) δ -63.23.

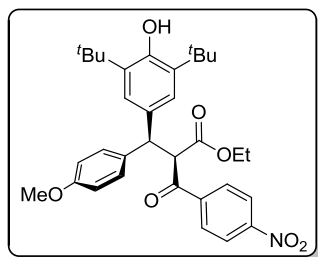
HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{34}\text{H}_{39}\text{F}_3\text{O}_5\text{Na}$: 607.2642, found: 607.2644.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -15.9^\circ$ (c = 1.0, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 92.0:8.0, 0.5 mL/min, λ = 210 nm, retention time: 9.90 min (minor), 10.57 min (major).

(2R,3S)-ethyl 3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)-2-(4-nitro-

benzoyl)propanoate (3g) (yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 8.23 (d, J = 8.8 Hz, 2H), 7.96 (d, J = 8.8 Hz, 2H), 7.31 (d, J = 8.7 Hz, 2H), 6.90 (s, 2H), 6.87 (d, J = 8.7 Hz, 2H), 5.28 (d, J = 11.8 Hz, 1H), 4.96 (s, 1H), 4.87 (d, J = 11.8 Hz, 1H), 4.03 (q, J = 7.1 Hz, 2H), 3.80 (s, 3H), 1.25 (s, 18H), 1.06 (t, J = 7.1 Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 193.8, 167.3, 158.4, 152.4, 150.0, 142.0, 135.8, 133.9, 131.4, 129.2, 128.8, 124.4, 123.6, 114.0, 61.8,

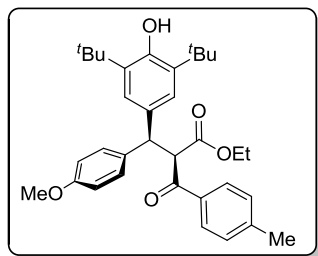
60.6, 55.2, 51.1, 34.1, 30.1, 13.9.

HRMS: (ESI $^+$) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}\text{NO}_7\text{Na}$: 584.2619, found: 584.2619.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -5.7^\circ$ (c = 1.0, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 90.0:10.0, 0.5 mL/min, λ = 254 nm, retention time: 16.50 min (major), 17.59 min (minor).

(2R,3S)-ethyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)-2-(4-methylbenzoyl)propanoate (3h) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.80 (d, J = 8.1 Hz, 2H), 7.32 (d, J = 8.6 Hz, 2H), 7.20 (d, J = 8.1 Hz, 2H), 6.92 (s, 2H), 6.85 (d, J = 8.6 Hz, 2H), 5.31 (d, J = 11.8 Hz, 1H), 4.91 (s, 1H), 4.89 (d, J = 11.8 Hz, 1H), 3.98 (qd, J = 7.1, 2.8 Hz, 2H), 3.79 (s, 3H), 2.39 (s, 3H), 1.25 (s, 18H), 1.03 (t, J = 7.1 Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 193.9, 168.1, 158.1, 152.1, 144.0, 135.4, 135.0, 134.7, 132.0, 129.1, 129.0, 128.6, 124.4, 113.8, 61.3,

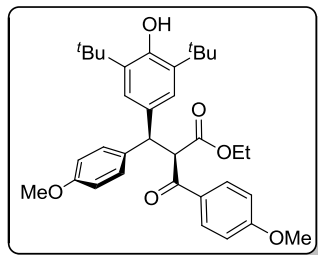
59.6, 55.2, 50.8, 34.1, 30.1, 21.6, 13.8.

HRMS: (ESI $^+$) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{34}\text{H}_{42}\text{O}_5\text{Na}$: 553.2924, found: 553.2925.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -3.7^\circ$ (c = 1.0, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 90.0:10.0, 0.6 mL/min, λ = 254 nm, retention time: 10.04 min (minor), 12.25 min (major).

(2R,3S)-ethyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl)-2-(4-methoxybenzoyl)-3-(4-methoxyphenyl)propanoate (3i) (yellow oil)



^1H NMR (500 MHz, CDCl_3) δ 7.91 (d, J = 9.0 Hz, 2H), 7.31 (d, J = 8.6 Hz, 2H), 6.93 (s, 2H), 6.88 (d, J = 9.0 Hz, 2H), 6.85 (d, J = 8.6 Hz, 2H), 5.28 (d, J = 11.9 Hz, 1H), 4.91 (s, 1H), 4.90 (d, J = 11.1 Hz, 1H), 3.98 (qd, J = 7.1, 3.1 Hz, 2H), 3.86 (s, 3H), 3.79 (s, 3H), 1.26 (s, 18H), 1.02 (t, J = 7.1 Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 192.5, 168.2, 163.6, 158.1, 152.0, 135.4, 134.8, 132.1, 130.9, 130.8, 130.4, 129.0, 124.4, 113.8, 61.3,

59.4, 55.5, 55.2, 50.6, 34.1, 30.1, 13.9.

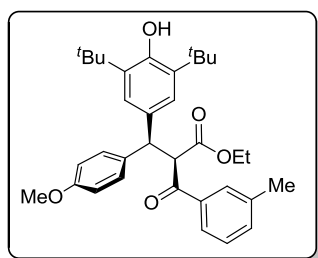
HRMS: (ESI $^+$) $[\text{M}+\text{K}]^+$ calcd for $\text{C}_{34}\text{H}_{42}\text{O}_6\text{K}$: 585.2613, found: 585.2638.

Specific rotation: $[\alpha]_{\text{D}}^{25} = +2.6^\circ$ (c = 1.0, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 90.0:10.0, 0.5 mL/min, λ = 210 nm, retention time: 20.60 min (minor), 28.98 min (major).

(2R,3S)-ethyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)-2-(3-methylbenzoyl)propanoate (3j) (colorless oil)

^1H NMR (500 MHz, CDCl_3) δ 7.71 (d, J = 7.6 Hz, 1H), 7.63 (s, 1H), 7.36 – 7.27 (m, 4H), 6.92



(s, 2H), 6.86 (d, $J = 8.7$ Hz, 2H), 5.33 (d, $J = 11.8$ Hz, 1H), 4.91 (s, 1H), 4.89 (d, $J = 11.8$ Hz, 1H), 4.00 (qt, $J = 7.1, 3.7$ Hz, 2H), 3.79 (s, 3H), 2.37 (s, 3H), 1.25 (s, 18H), 1.04 (t, $J = 7.1$ Hz, 3H).
 ^{13}C NMR (125 MHz, CDCl_3) δ 194.8, 168.0, 158.2, 152.1, 138.2, 137.7, 135.5, 134.7, 133.9, 131.9, 129.0, 128.8, 128.3, 125.6, 124.4, 113.8, 61.4, 59.7, 55.2, 51.0, 34.1, 30.1, 21.3, 13.9.

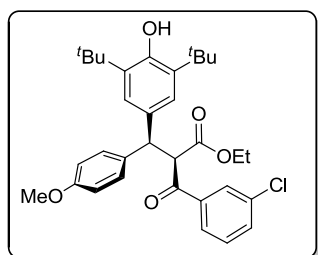
HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{34}\text{H}_{42}\text{O}_5\text{Na}$: 553.2924,

found: 553.2923.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -0.7^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 92.0:8.0, 0.5 mL/min, $\lambda = 254$ nm, retention time: 12.97 min (minor), 13.67 min (major).

(2R,3S)-ethyl 2-(3-chlorobenzoyl)-3-(3,5-di-tert-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (3k) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.78 – 7.72 (m, 2H), 7.49 (ddd, $J = 8.0, 2.1, 1.0$ Hz, 1H), 7.37 – 7.29 (m, 3H), 6.90 (s, 2H), 6.86 (d, $J = 8.7$ Hz, 2H), 5.25 (d, $J = 11.8$ Hz, 1H), 4.94 (s, 1H), 4.86 (d, $J = 11.8$ Hz, 1H), 4.02 (qd, $J = 7.1, 2.8$ Hz, 2H), 3.80 (s, 3H), 1.26 (s, 18H), 1.06 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 193.7, 167.6, 158.3, 152.3, 139.2, 135.7, 134.8, 134.3, 132.9, 131.5, 129.7, 128.9, 128.3, 126.3,

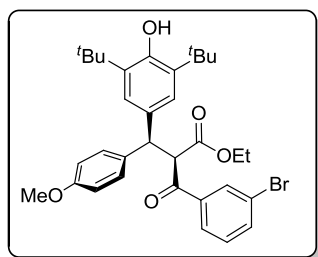
124.5, 113.9, 61.6, 59.9, 55.2, 51.1, 34.1, 30.1, 13.9.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}^{35}\text{ClO}_5\text{Na}$: 573.2378, found: 573.2375; $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}^{37}\text{ClO}_5\text{Na}$: 575.2349, found: 575.2366.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -21.5^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, $\lambda = 210$ nm, retention time: 15.79 min (major), 26.68 min (minor).

(2R,3S)-ethyl 2-(3-bromobenzoyl)-3-(3,5-di-tert-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (3l) (yellow oil)



^1H NMR (500 MHz, CDCl_3) δ 7.91 (t, $J = 1.8$ Hz, 1H), 7.79 (dt, $J = 7.7, 1.3$ Hz, 1H), 7.66 – 7.63 (m, 1H), 7.37 – 7.28 (m, 3H), 6.90 (s, 2H), 6.86 (d, $J = 8.7$ Hz, 2H), 5.25 (d, $J = 11.8$ Hz, 1H), 4.95 (s, 1H), 4.86 (d, $J = 11.8$ Hz, 1H), 4.02 (tq, $J = 7.1, 3.3$ Hz, 2H), 3.80 (s, 3H), 1.27 (s, 18H), 1.06 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 193.6, 167.6, 158.3, 152.3, 139.4, 135.8, 135.8,

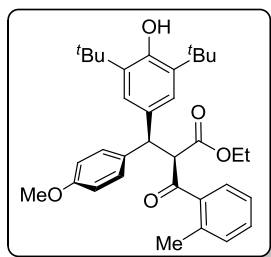
134.4, 131.6, 131.2, 130.0, 128.9, 126.8, 124.5, 122.8, 113.9, 61.5, 60.0, 55.2, 51.1, 34.2, 30.1, 13.9.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}^{79}\text{BrO}_5\text{Na}$: 617.1873, found: 617.1875; $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{39}^{81}\text{BrO}_5\text{Na}$: 619.1853, found: 617.1862.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -18.5^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, $\lambda = 254$ nm, retention time: 17.99 min (major), 27.53 min (minor).

(2R,3S)-ethyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)-2-(2-methylbenzoyl)propanoate (3m) (dark yellow oil)



¹H NMR (500 MHz, CDCl₃) δ 7.89 (dd, *J* = 7.3, 1.6 Hz, 1H), 7.38 – 7.29 (m, 4H), 7.08 (d, *J* = 7.3 Hz, 1H), 6.95 (s, 2H), 6.83 (d, *J* = 8.6 Hz, 2H), 5.26 (d, *J* = 12.1 Hz, 1H), 4.98 (s, 1H), 4.80 (d, *J* = 12.1 Hz, 1H), 4.08 (tq, *J* = 7.1, 3.4 Hz, 2H), 3.77 (s, 3H), 1.80 (s, 3H), 1.24 (s, 18H), 1.12 (t, *J* = 7.1 Hz, 3H).

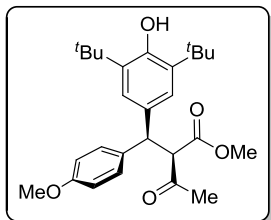
¹³C NMR (125 MHz, CDCl₃) δ 197.8, 168.0, 158.2, 152.4, 139.3, 138.8, 135.6, 134.8, 131.5, 131.28, 131.25, 128.6, 128.1, 125.5, 124.5, 113.9, 62.1, 61.4, 55.2, 52.1, 34.1, 29.9, 19.6, 14.0.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₄H₄₂O₅Na: 553.2924, found: 553.2929.

Specific rotation: [α]_D²⁵ = –25.3° (*c* = 1.0, CH₂Cl₂).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.0:2.0, 0.5 mL/min, λ = 210 nm, retention time: 15.68 min (minor), 17.99 min (major).

(R)-methyl 2-((S)-(3,5-di-tert-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-3-oxobutanoate (3n) (yellow oil)



¹H NMR (500 MHz, CDCl₃) δ 7.23 (d, *J* = 8.7 Hz, 2H), 7.03 (s, 2H), 6.83 (d, *J* = 8.7 Hz, 2H), 5.08 (s, 1H), 4.64 (d, *J* = 12.1 Hz, 1H), 4.46 (d, *J* = 12.1 Hz, 1H), 3.78 (s, 3H), 3.55 (s, 3H), 2.04 (s, 3H), 1.41 (s, 18H).

¹³C NMR (125 MHz, CDCl₃) δ 202.3, 168.4, 158.2, 152.5, 136.0, 134.3, 131.7, 128.5, 124.3, 113.9, 65.8, 55.1, 52.4, 50.5, 34.3, 30.3,

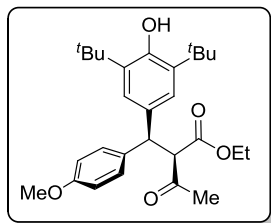
30.1.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₂₇H₃₆O₅Na: 463.2455, found: 463.2459.

Specific rotation: [α]_D²⁵ = +2.5° (*c* = 1.0, CH₂Cl₂).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, λ = 280 nm, retention time: 10.91 min (major), 13.38 min (minor).

(R)-ethyl 2-((S)-(3,5-di-tert-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-3-oxobutanoate (3o) (yellow oil)



¹H NMR (500 MHz, CDCl₃) δ 7.24 (d, *J* = 8.7 Hz, 2H), 7.04 (s, 2H), 6.82 (d, *J* = 8.7 Hz, 2H), 5.08 (s, 1H), 4.63 (d, *J* = 12.1 Hz, 1H), 4.44 (d, *J* = 12.1 Hz, 1H), 4.00 (qd, *J* = 7.1, 1.6 Hz, 2H), 3.77 (s, 3H), 2.05 (s, 3H), 1.41 (s, 18H), 1.05 (t, *J* = 7.1 Hz, 3H).

¹³C NMR (125 MHz, CDCl₃) δ 202.4, 167.9, 158.2, 152.5, 136.0, 134.4, 131.8, 128.6, 124.2, 113.9, 66.0, 61.3, 55.2, 50.5, 34.3, 31.6,

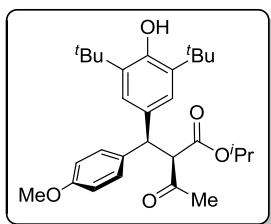
30.3, 13.8.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₂₈H₃₈O₅Na: 477.2611, found: 477.2613.

Specific rotation: [α]_D²⁵ = +5.5° (*c* = 1.0, CH₂Cl₂).

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 96.0:4.0, 0.6 mL/min, λ = 280 nm, retention time: 9.82 min (major), 12.30 min (minor).

(R)-isopropyl 2-((S)-(3,5-di-tert-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-3-oxobutanoate (3p) (yellow oil)



¹H NMR (500 MHz, CDCl₃) δ 7.24 (d, *J* = 8.7 Hz, 2H), 7.04 (s, 2H), 6.82 (d, *J* = 8.7 Hz, 2H), 5.07 (s, 1H), 4.84 (hept, *J* = 6.3 Hz, 1H), 4.62 (d, *J* = 12.2 Hz, 1H), 4.41 (d, *J* = 12.2 Hz, 1H), 3.77 (s, 3H), 1.41 (s, 18H), 1.05 (d, *J* = 6.3 Hz, 3H), 1.00 (d, *J* = 6.3 Hz, 3H).

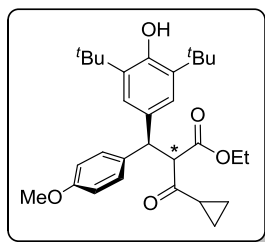
^{13}C NMR (125 MHz, CDCl_3) δ 202.4, 167.5, 158.2, 152.5, 135.9, 134.5, 132.0, 128.7, 124.2, 113.8, 68.9, 66.2, 55.2, 50.5, 34.3, 31.6, 30.3, 21.4, 21.3.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{29}\text{H}_{40}\text{O}_5\text{Na}$: 491.2768, found: 491.2768.

Specific rotation: $[\alpha]_{\text{D}}^{25} = +6.0^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 97.0:3.0, 0.45 mL/min, $\lambda = 210$ nm, retention time: 13.53 min (major), 17.21 min (minor).

(2*R*/5*S*,3*S*)-ethyl 2-(cyclopropanecarbonyl)-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (3q) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.22 (d, $J = 8.7$ Hz, 2H), 7.09 (s, 2H), 6.82 – 6.79 (m, 2H), 5.05 (s, 1H), 4.72 (d, $J = 10.0$ Hz, 1H), 4.52 (d, $J = 10.0$ Hz, 1H), 4.01 – 3.96 (m, 2H), 3.77 (s, 3H), 2.17 (tt, $J = 7.7, 5.4$ Hz, 1H), 1.42 (s, 18H), 0.98 (t, $J = 7.1$ Hz, 3H), 0.93 – 0.84 (m, 2H), 0.75 – 0.67 (m, 2H) (diastereoisomer **A**).

δ 7.27 (d, $J = 8.7$ Hz, 2H), 7.04 (s, 2H), 6.83 (d, $J = 8.7$ Hz, 2H), 5.05 (s, 1H), 4.70 (d, $J = 12.1$ Hz, 1H), 4.54 (d, $J = 12.1$ Hz, 1H), 4.02 (qd, $J = 7.1, 2.8$ Hz, 2H), 3.78 (s, 3H), 2.05 (tt, $J = 7.6, 4.8$ Hz, 1H), 1.40 (s, 18H), 1.07 (t, $J = 7.1$ Hz, 3H), 0.85 – 0.72 (m, 4H) (diastereoisomer **B**).

^{13}C NMR (125 MHz, CDCl_3) δ 204.1, 168.21, 158.15, 152.36, 135.7, 134.3, 132.5, 128.9, 124.2, 113.9, 66.5, 61.1, 55.16, 50.5, 34.3, 20.5, 13.8, 11.9, 11.40. (diastereoisomer **A**).

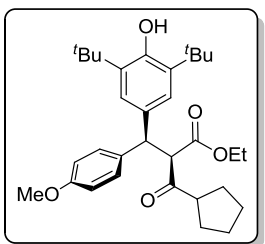
δ 204.0, 168.17, 158.20, 152.34, 135.8, 134.6, 132.1, 128.7, 124.5, 113.9, 66.3, 61.2, 55.18, 50.6, 30.3, 21.0, 13.9, 11.8, 11.36. (diastereoisomer **B**).

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{30}\text{H}_{40}\text{O}_5\text{Na}$: 503.2768, found: 503.2776.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -3.8^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 95.0:5.0, 0.5 mL/min, $\lambda = 280$ nm, retention time: 12.71 min (major), 16.56 min (minor) (diastereoisomer **A**)/15.47 min (minor), 17.16 min (major) (diastereoisomer **B**).

(2*R*,3*S*)-ethyl 2-(cyclopentanecarbonyl)-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (3r) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.28 (d, $J = 8.7$ Hz, 2H), 7.02 (s, 2H), 6.84 (d, $J = 8.7$ Hz, 2H), 4.68 (d, $J = 12.0$ Hz, 1H), 4.52 (d, $J = 12.0$ Hz, 1H), 4.07 – 3.94 (m, 2H), 3.78 (s, 3H), 2.71 (m, 1H), 1.78 – 1.17 (m, 8H), 1.39 (s, 3H), 1.03 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 206.2, 167.9, 158.2, 152.4, 135.9, 134.6, 132.2, 128.7, 124.8, 113.9, 65.0, 61.2, 55.2, 52.4, 50.5, 34.3, 30.3, 28.51, 28.49, 25.8, 25.7, 13.9.

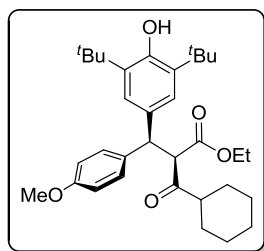
HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{32}\text{H}_{44}\text{O}_5\text{Na}$: 531.3081, found: 531.3086.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -40.6^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 97.0:3.0, 0.45 mL/min, $\lambda = 210$ nm, retention time: 16.53 min (major), 30.26 min (minor).

(2*R*,3*S*)-ethyl 2-(cyclohexanecarbonyl)-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (3s) (colorless oil)

^1H NMR (500 MHz, CDCl_3) δ 7.28 (d, $J = 8.7$ Hz, 2H), 7.02 (s, 2H), 6.84 (d, $J = 8.7$ Hz, 2H), 5.06 (s, 1H), 4.63 (d, $J = 12.1$ Hz, 1H), 4.56 (d, $J = 12.1$ Hz, 1H), 4.05 – 3.95 (m, 2H), 3.78 (s, 3H), 2.04 (m, 1H), 1.76 – 1.67 (m, 2H), 1.62 – 1.54 (m, 2H), 1.40 (s, 18H), 1.34 – 1.22 (m, 2H),



1.20 – 1.08 (m, 2H), 1.04 (t, $J = 7.1$ Hz, 3H), 1.01 – 0.83 (m, 2H).

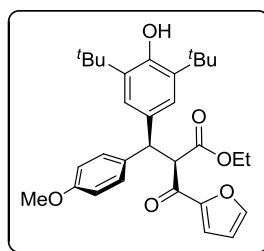
^{13}C NMR (125 MHz, CDCl_3) δ 207.1, 167.9, 158.1, 152.5, 135.9, 134.5, 132.1, 128.5, 124.7, 113.9, 63.5, 61.1, 55.2, 52.3, 50.9, 34.3, 30.2, 28.0, 27.4, 25.72, 25.67, 25.2, 13.9.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{46}\text{O}_5\text{Na}$: 545.3237, found: 545.3238.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -59.3^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.0:2.0, 0.5 mL/min, $\lambda = 210$ nm, retention time: 11.13 min (major), 15.24 min (minor).

(2R,3S)-ethyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl)-2-(furan-2-carbonyl)-3-(4-methoxyphenyl)propanoate (3t) (yellow oil)



^1H NMR (500 MHz, CDCl_3) δ 7.58 (d, $J = 1.6$ Hz, 1H), 7.32 (d, $J = 8.7$ Hz, 2H), 7.21 (d, $J = 3.3$ Hz, 1H), 7.00 (s, 2H), 6.85 (d, $J = 8.7$ Hz, 2H), 6.51 (dd, $J = 3.6, 1.7$ Hz, 1H), 5.15 (d, $J = 12.0$ Hz, 1H), 4.95 (s, 1H), 4.87 (d, $J = 12.0$ Hz, 1H), 3.99 (q, $J = 7.1$ Hz, 2H), 3.79 (s, 3H), 1.31 (s, 18H), 1.03 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 182.3, 167.7, 158.2, 152.4, 152.2, 147.0, 135.5, 134.5, 131.8, 128.9, 124.3, 118.5, 113.8, 112.5, 61.4,

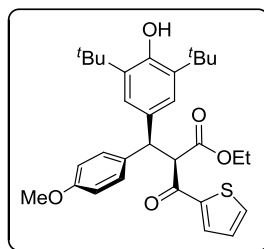
59.7, 55.2, 50.3, 34.2, 30.2, 13.8.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{31}\text{H}_{38}\text{O}_6\text{Na}$: 529.2561, found: 529.2569.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -3.7^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 95.0:5.0, 0.8 mL/min, $\lambda = 280$ nm, retention time: 25.24 min (major), 31.33 min (minor).

(2R,3S)-ethyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)-2-(thiophene-2-carbonyl)propanoate (3u) (yellow oil)



^1H NMR (500 MHz, CDCl_3) δ 7.77 (dd, $J = 3.8, 1.1$ Hz, 1H), 7.62 (dd, $J = 4.9, 1.1$ Hz, 1H), 7.31 (d, $J = 8.6$ Hz, 2H), 7.08 (dd, $J = 4.9, 3.8$ Hz, 1H), 6.97 (s, 2H), 6.86 (d, $J = 8.6$ Hz, 2H), 5.09 (d, $J = 11.9$ Hz, 1H), 4.94 (s, 1H), 4.89 (d, $J = 11.9$ Hz, 1H), 3.99 (q, $J = 7.1$ Hz, 2H), 3.80 (s, 3H), 1.28 (s, 18H), 1.03 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 186.4, 167.7, 158.3, 152.2, 144.4, 135.6, 134.5, 134.5, 132.8, 131.9, 129.0, 128.0, 124.4, 113.9, 61.4,

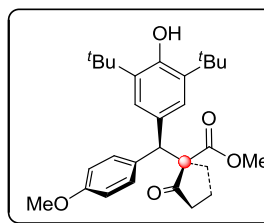
55.2, 50.6, 46.5, 34.2, 30.1, 13.8.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{31}\text{H}_{38}\text{O}_5\text{SNa}$: 545.2332, found: 545.2339.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -30.4$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 90.0:10.0, 0.8 mL/min, $\lambda = 210$ nm, retention time: 13.12 min (major), 15.58 min (minor).

(R)-methyl 1-((S)-3-(3,5-di-tert-butyl-4-hydroxyphenyl)-4-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (3v) (pale yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.21 (d, $J = 8.7$ Hz, 2H), 6.91 (s, 2H), 6.83 (d, $J = 8.7$ Hz, 2H), 5.12 (s, 1H), 5.10 (s, 1H), 3.80 (s, 3H), 3.47 (s, 3H), 3.00 (dddd, $J = 12.8, 7.3, 4.0, 1.4$ Hz, 1H), 2.33 – 2.17 (m, 2H), 1.89 – 1.74 (m, 1H), 1.74 – 1.66 (m, 1H), 1.48 – 1.38 (m, 1H), 1.37 (s, 18H).

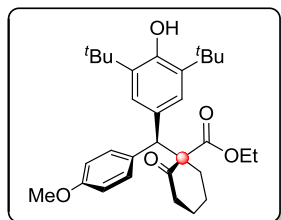
^{13}C NMR (125 MHz, CDCl_3) δ 214.4, 169.5, 157.9, 152.4, 135.4, 133.4, 130.7, 129.9, 126.5, 113.5, 66.8, 55.1, 54.6, 52.7, 38.8, 34.3, 30.3, 29.2, 19.6.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{29}\text{H}_{38}\text{O}_5\text{Na}$: 489.2611, found: 489.2612.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -84.6^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, $\lambda = 210$ nm, retention time: 9.40 min (major), 11.33 min (minor).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-2-oxocyclohexanecarboxylate (3w) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.37 (d, $J = 8.7$ Hz, 2H), 7.23 (s, 2H), 6.79 (d, $J = 8.7$ Hz, 2H), 5.05 (s, 1H), 4.87 (s, 1H), 3.98 – 3.88 (m, 1H), 3.85 – 3.73 (m, 1H), 3.77 (s, 3H), 2.61 (dd, $J = 13.8$, 3.0 Hz, 1H), 2.52 – 2.46 (m, 1H), 2.46 – 2.37 (m, 1H), 1.95 (ddd, $J = 12.6$, 6.0, 3.0 Hz, 1H), 1.80 – 1.71 (m, 2H), 1.60 – 1.51 (m, 2H), 1.42 (s, 18H), 0.95 (t, $J = 7.1$ Hz, 3H).

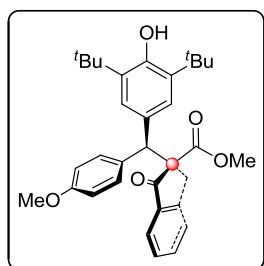
^{13}C NMR (125 MHz, CDCl_3) δ 206.7, 171.0, 158.1, 152.1, 134.9, 133.6, 131.7, 131.4, 127.3, 113.1, 66.5, 61.1, 55.2, 42.0, 34.4, 31.6, 30.4, 29.7, 26.8, 22.9, 13.6.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{31}\text{H}_{42}\text{O}_5\text{Na}$: 517.2924, found: 517.2927.

Specific rotation: $[\alpha]_{\text{D}}^{25} = +13.6^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.5 mL/min, $\lambda = 210$ nm, retention time: 11.99 min (major), 15.34 min (minor).

(S)-methyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-2-oxo-2,3-dihydro-1H-indene-1-carboxylate (3x) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.63 (d, $J = 7.5$ Hz, 1H), 7.46 (t, $J = 7.5$ Hz, 1H), 7.30 (d, $J = 7.5$ Hz, 1H), 7.25 (t, $J = 7.5$ Hz, 1H), 7.22 (d, $J = 8.7$ Hz, 2H), 6.87 (d, $J = 8.7$ Hz, 2H), 6.75 (s, 2H), 5.39 (s, 1H), 4.88 (s, 1H), 4.18 (d, $J = 17.1$ Hz, 1H), 3.83 (s, 3H), 3.57 (s, 3H), 3.52 (d, $J = 17.1$ Hz, 1H), 1.20 (s, 18H).

^{13}C NMR (125 MHz, CDCl_3) δ 201.7, 170.2, 158.0, 153.9, 152.2, 135.2, 135.0, 133.8, 130.2, 129.7, 127.2, 126.1, 125.8, 124.3, 113.7,

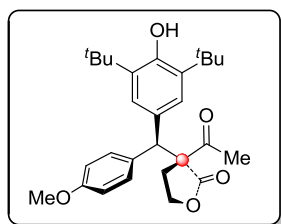
66.5, 55.2, 54.1, 52.9, 34.1, 33.6, 30.1.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{38}\text{O}_5\text{Na}$: 537.2611, found: 537.2616.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -207.9$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, $\lambda = 210$ nm, retention time: 23.46 min (major), 28.36 min (minor).

(S)-3-acetyl-3-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)di hydrofuran-2(3H)-one (3y) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.10 (d, $J = 8.7$ Hz, 2H), 6.94 (s, 2H), 6.86 (d, $J = 8.7$ Hz, 2H), 5.25 (s, 1H), 5.18 (s, 1H), 4.06 (td, $J = 8.3$, 7.3 Hz, 1H), 3.81 (s, 3H), 3.49 (td, $J = 8.7$, 4.6 Hz, 1H), 3.30 (ddd, $J = 12.7$, 8.3, 4.6 Hz, 1H), 2.31 (ddd, $J = 12.7$, 9.1, 7.3 Hz, 1H), 2.24 (s, 3H), 1.37 (s, 18H).

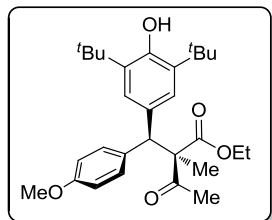
^{13}C NMR (125 MHz, CDCl_3) δ 201.6, 175.4, 158.5, 152.9, 135.9, 131.4, 130.1, 129.9, 126.0, 114.2, 67.5, 66.3, 55.2, 53.7, 34.4, 30.2, 25.9, 25.5.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{28}\text{H}_{36}\text{O}_5\text{Na}$: 475.2455, found: 475.2460.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -120.2^\circ$ ($c = 0.5$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 97.5:2.5, 0.5 mL/min, $\lambda = 210$ nm, retention time: 15.70 min (major), 18.05 min (minor).

(R)-ethyl 2-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-2-methyl-3-oxobutanoate (3z) (colorless oil)



$^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.27 (d, $J = 8.7$ Hz, 2H), 7.09 (s, 2H), 6.80 (d, $J = 8.7$ Hz, 2H), 5.09 (s, 1H), 5.08 (s, 1H), 4.09 – 4.00 (m, 2H), 3.79 (s, 3H), 2.03 (s, 3H), 1.48 (s, 3H), 1.40 (s, 18H), 1.11 (t, $J = 7.1$ Hz, 3H).

$^{13}\text{C NMR}$ (125 MHz, CDCl_3) δ 205.1, 172.1, 158.1, 152.3, 135.4, 133.8, 131.0, 130.9, 126.5, 113.3, 65.5, 61.4, 55.2, 53.7, 34.4, 30.4,

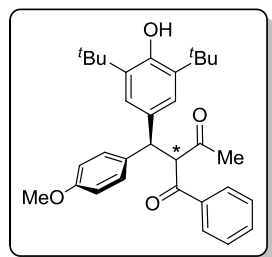
27.2, 18.4, 13.8.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{29}\text{H}_{40}\text{O}_5\text{Na}$: 491.2768, found: 491.2775.

Specific rotation: $[\alpha]_{\text{D}}^{25} = +9.1$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 97.0:3.0, 0.8 mL/min, $\lambda = 210$ nm, retention time: 7.20 min (minor), 10.36 min (major).

(R/S)-2-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-1-phenyl butane-1,3-dione (3aa) (colorless oil)



$^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.99 – 7.93 (m, 2H), 7.58 – 7.48 (m, 1H), 7.43 (t, $J = 7.7$ Hz, 2H), 7.17 (d, $J = 8.7$ Hz, 2H), 7.13 (s, 2H), 6.70 (d, $J = 8.7$ Hz, 2H), 5.51 (d, $J = 4.3$ Hz, 1H), 5.49 (d, $J = 4.3$ Hz, 1H), 5.11 (s, 1H), 3.69 (s, 3H), 2.01 (s, 3H), 1.44 (s, 18H) (diastereoisomer A).

δ 7.87 – 7.80 (m, 2H), 7.58 – 7.48 (m, 1H), 7.39 (t, $J = 7.7$ Hz, 2H), 7.34 – 7.29 (m, 2H), 6.92 (s, 2H), 6.87 (d, $J = 8.7$ Hz, 2H), 4.98 (d, $J = 11.9$ Hz, 1H), 4.92 (d, $J = 11.9$ Hz, 1H), 4.91 (s, 1H), 3.80 (s, 3H), 2.13 (s, 3H), 1.24 (s, 18H) (diastereoisomer B).

$^{13}\text{C NMR}$ (125 MHz, CDCl_3) δ 203.1, 194.7, 158.0, 152.6, 137.2, 136.1, 134.7, 133.4, 132.0, 130.0, 128.59, 128.5, 124.7, 113.9, 70.0, 55.1, 51.0, 34.4, 30.6, 27.7 (diastereoisomer A).

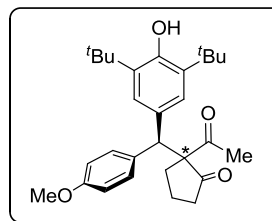
δ 203.6, 195.7, 158.4, 152.2, 137.7, 135.7, 134.0, 133.2, 132.1, 128.7, 128.63, 128.4, 124.3, 114.2, 69.3, 55.2, 51.6, 34.2, 30.1, 28.1 (diastereoisomer B).

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{32}\text{H}_{38}\text{O}_4\text{Na}$: 509.2662, found: 509.2669.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -14.9^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, $\lambda = 254$ nm, retention time: 9.69 min (major), 11.93 min (minor) (diastereoisomer A)/13.06 min (minor), 19.23 min (major) (diastereoisomer B).

(R/S)-2-acetyl-2-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)cyclopentanone (3ab) (colorless oil)



$^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.14 (d, $J = 8.7$ Hz, 2H), 6.95 (s, 2H), 6.83 (d, $J = 8.7$ Hz, 2H), 5.23 (s, 1H), 5.10 (s, 1H), 3.80 (s, 3H), 3.14 – 3.06 (m, 1H), 2.27 – 2.13 (m, 1H), 2.11 (s, 3H), 2.09 – 1.97 (m, 1H), 1.78 – 1.65 (m, 2H), 1.50 – 1.38 (m, 1H), 1.36 (s, 18H) (diastereoisomer A).

δ 6.99 – 6.94 (m, 2H), 6.81 (s, 2H), 6.78 (d, $J = 8.7$ Hz, 2H), 5.19 (s,

1H), 5.11 (s, 1H), 3.78 (s, 3H), 3.24 – 3.14 (m, 1H), 2.27 – 2.13 (m, 1H), 2.08 – 1.98 (m, 1H), 2.06 (s, 3H), 1.77 – 1.65 (m, 2H), 1.50 – 1.38 (m, 1H), 1.41 (s, 18H) (diastereoisomer B).

¹³C NMR (125 MHz, CDCl₃) δ 215.68, 203.0, 158.2, 135.5, 132.7, 131.3, 130.0, 126.2, 124.3, 114.0, 74.8, 55.2, 54.8, 34.3, 31.6, 30.3, 27.3, 26.1, 19.4 (diastereoisomer A).

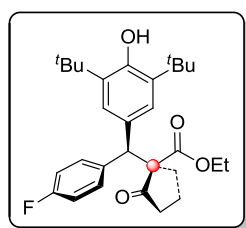
δ¹³C NMR (126 MHz, Chloroform-*d*) δ 215.72, 202.6, 152.5, 136.0, 133.4, 131.0, 130.8, 125.6, 124.9, 113.5, 75.1, 55.1, 54.6, 39.2, 31.9, 30.4, 27.5, 25.9, 19.7 (diastereoisomer B).

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₂₉H₃₈O₄Na: 473.2662, found: 473.2667.

Specific rotation: [α]_D²⁵ = -18.3° (c = 0.9, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, λ = 210 nm, retention time: 7.04 min (major), 7.46 min (minor) (diastereoisomer A)/8.80 min (minor), 9.74 min (major) (diastereoisomer B).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-fluorophenyl)methyl)-2-oxocyclopentanecarboxylate (4a) (pale yellow oil)



¹H NMR (500 MHz, CDCl₃) δ 7.33 – 7.22 (m, 2H), 6.98 (t, *J* = 8.7 Hz, 2H), 6.86 (s, 2H), 5.18 (s, 1H), 5.12 (s, 1H), 3.99 (dq, *J* = 10.8, 7.0 Hz, 1H), 3.90 (dq, *J* = 10.8, 7.1 Hz, 1H), 2.99 (ddd, *J* = 12.3, 7.2, 4.2 Hz, 1H), 2.28 (ddd, *J* = 18.2, 8.4, 4.6 Hz, 1H), 2.19 (ddd, *J* = 13.0, 9.2, 7.5 Hz, 1H), 1.93 – 1.78 (m, 1H), 1.70 (dt, *J* = 18.4, 9.2 Hz, 1H), 1.50 – 1.36 (m, 1H), 1.36 (s, 18H), 0.90 (t, *J* = 7.1 Hz, 3H).

¹³C NMR (125 MHz, CDCl₃) δ 214.09, 168.77, 161.3 (d, *J* = 243.8 Hz), 152.51, 137.3 (d, *J* = 3.8 Hz), 135.52, 130.4, 130.3 (d, *J* = 7.5 Hz), 126.42, 115.0 (d, *J* = 21.3 Hz), 66.4, 61.6, 54.4, 38.6, 34.3, 30.2, 29.2, 19.5, 13.5.

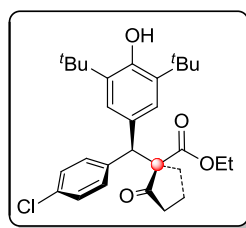
¹⁹F NMR (471 MHz, CDCl₃) δ -116.73.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₂₉H₃₇FO₄Na: 491.2568, found: 491.2570.

Specific rotation: [α]_D²⁵ = -74.8° (c = 1.0, CH₂Cl₂).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 99.5:0.5, 0.5 mL/min, λ = 254 nm, retention time: 18.06 min (major), 22.09 min (minor).

(R)-ethyl 1-((S)-(4-chlorophenyl)(3,5-di-*tert*-butyl-4-hydroxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4b) (yellow solid)



¹H NMR (500 MHz, CDCl₃) δ 7.27 (d, *J* = 8.6 Hz, 1H), 7.23 (d, *J* = 8.6 Hz, 2H), 6.85 (s, 2H), 5.16 (s, 1H), 5.12 (s, 1H), 3.99 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.91 (dq, *J* = 10.8, 7.1 Hz, 1H), 2.99 (ddd, *J* = 12.3, 7.2, 4.0 Hz, 1H), 2.28 (ddd, *J* = 18.5, 8.4, 4.5 Hz, 1H), 2.23 – 2.15 (m, 1H), 1.86 (ddt, *J* = 16.8, 12.6, 7.2 Hz, 1H), 1.69 (dt, *J* = 18.4, 9.2 Hz, 1H), 1.44 – 1.38 (m, 1H), 1.36 (s, 18H), 0.92 (t, *J* = 7.1 Hz, 3H).

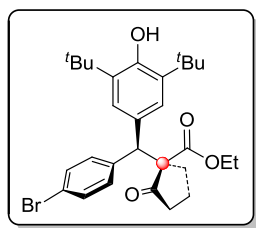
¹³C NMR (125 MHz, CDCl₃) δ 214.0, 168.8, 152.6, 140.2, 132.1, 131.3, 130.2, 128.3, 126.5, 125.5, 66.2, 61.7, 54.6, 38.6, 34.3, 30.3, 29.3, 19.5, 13.6.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₂₉H₃₇³⁵ClO₄Na: 507.2273, found: 507.2279; [M+Na]⁺ calcd for C₂₉H₃₇³⁷ClO₄Na: 509.2243, found: 509.2259.

Specific rotation: [α]_D²⁵ = -48.0° (c = 0.5, CH₂Cl₂).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 99.5:0.5, 0.5 mL/min, λ = 210 nm, retention time: 16.60 min (minor), 17.48 min (major).

(R)-ethyl 1-((S)-(4-bromophenyl)(3,5-di-*tert*-butyl-4-hydroxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4c) (yellow solid)



¹H NMR (500 MHz, CDCl₃) δ 7.41 (d, *J* = 8.5 Hz, 1H), 7.17 (d, *J* = 8.5 Hz, 2H), 6.85 (s, 2H), 5.14 (s, 1H), 5.12 (s, 1H), 3.99 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.91 (dq, *J* = 10.8, 7.1 Hz, 1H), 2.98 (dddd, *J* = 12.9, 7.4, 4.1, 1.4 Hz, 1H), 2.32 – 2.23 (m, 1H), 2.19 (ddd, *J* = 13.1, 9.1, 7.5 Hz, 1H), 1.90 – 1.80 (m, 1H), 1.70 (dd, *J* = 18.3, 9.1 Hz, 1H), 1.45 – 1.34 (m, 1H), 1.37 (s, 18H), 0.92 (t, *J* = 7.1 Hz, 3H).

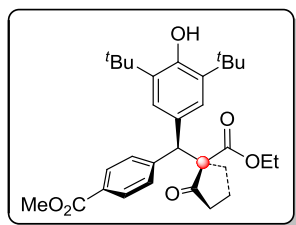
¹³C NMR (125 MHz, CDCl₃) δ 214.0, 168.8, 152.6, 140.7, 135.6, 131.3, 130.6, 130.0, 126.5, 120.1, 66.2, 61.7, 54.6, 38.6, 34.3, 30.2, 29.3, 19.5, 13.6.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₂₉H₃₇⁷⁹BrO₄Na: 551.1767, found: 551.1770; [M+Na]⁺ calcd for C₂₉H₃₇⁸¹BrO₄Na: 553.1747, found: 553.1755.

Specific rotation: [α]_D²⁵ = –62.8° (*c* = 1.0, CH₂Cl₂).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 99.5:0.5, 0.5 mL/min, λ = 210 nm, retention time: 17.55 min (major), 23.51 min (minor).

methyl 4-((S)-(3,5-di-tert-butyl-4-hydroxyphenyl)((R)-1-(ethoxycarbonyl)-2-oxocyclopentyl)methyl)benzoate (4d) (colorless oil)



¹H NMR (500 MHz, CDCl₃) δ 7.97 (d, *J* = 8.4 Hz, 2H), 7.37 (d, *J* = 8.4 Hz, 2H), 6.83 (s, 2H), 5.25 (s, 1H), 5.13 (s, 1H), 3.99 – 3.93 (m, 1H), 3.92 (s, 3H), 3.91 – 3.85 (m, 1H), 3.03 (dddd, *J* = 12.9, 7.4, 4.3, 1.3 Hz, 1H), 2.34 – 2.19 (m, 2H), 1.92 – 1.81 (m, 1H), 1.76 – 1.65 (m, 1H), 1.42 – 1.36 (m, 1H), 1.35 (s, 18H), 0.86 (t, *J* = 7.1 Hz, 3H).

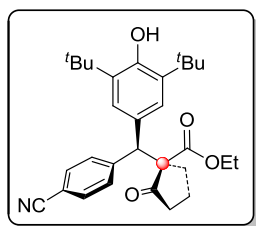
¹³C NMR (125 MHz, CDCl₃) δ 213.8, 168.8, 167.0, 152.6, 147.3, 135.7, 129.9, 129.5, 128.9, 128.1, 126.6, 66.1, 61.6, 55.1, 52.0, 38.6, 34.3, 30.3, 29.4, 19.5, 13.5.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₁H₄₀O₆Na: 531.2717, found: 531.2720.

Specific rotation: [α]_D²⁵ = –98.5° (*c* = 1.0, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 90.0:10.0, 0.8 mL/min, λ = 254 nm, retention time: 7.65 min (major), 7.94 min (minor).

(R)-ethyl 1-((S)-(4-cyanophenyl)(3,5-di-tert-butyl-4-hydroxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4e) (colorless oil)



¹H NMR (500 MHz, CDCl₃) δ 7.60 (d, *J* = 8.4 Hz, 2H), 7.41 (d, *J* = 8.4 Hz, 2H), 6.79 (s, 2H), 5.24 (s, 1H), 5.16 (s, 1H), 3.99 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.91 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.04 – 2.96 (m, 1H), 2.34 – 2.26 (m, 1H), 2.21 (ddd, *J* = 13.1, 9.0, 7.6 Hz, 1H), 1.93 – 1.82 (m, 1H), 1.70 (dt, *J* = 18.4, 9.2 Hz, 1H), 1.44 – 1.36 (m, 1H), 1.35 (s, 18H), 0.90 (t, *J* = 7.1 Hz, 3H).

¹³C NMR (125 MHz, CDCl₃) δ 213.4, 168.7, 152.8, 147.6, 135.9, 132.0, 129.6, 129.3, 126.5, 118.8, 110.2, 65.8, 61.8, 55.1, 38.4, 34.3, 30.2, 29.4, 19.5, 13.6.

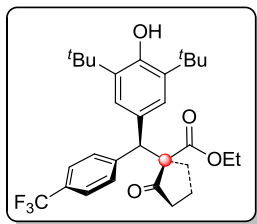
HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₀H₃₇NO₄Na: 498.2615, found: 498.2617.

Specific rotation: [α]_D²⁵ = –98.9° (*c* = 1.0, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 97.0:3.0, 0.8 mL/min, λ = 254 nm, retention time: 20.77 min (major), 22.26 min (minor).

(R)-ethyl 1-((S)-(3,5-di-tert-butyl-4-hydroxyphenyl)(4-(trifluoromethyl)phenyl)methyl)-2-oxocyclopentanecarboxylate (4f) (colorless oil)

¹H NMR (500 MHz, CDCl₃) δ 7.56 (d, *J* = 8.1 Hz, 2H), 7.42 (d, *J* = 8.1 Hz, 2H), 6.84 (s, 2H),



^1H NMR (500 MHz, CDCl_3) δ 5.24 (s, 1H), 5.14 (s, 1H), 3.98 (dq, J = 10.8, 7.1 Hz, 1H), 3.90 (dq, J = 10.8, 7.1 Hz, 1H), 3.02 (ddd, J = 12.3, 7.4, 4.2 Hz, 1H), 2.34 – 2.20 (m, 2H), 1.94 – 1.83 (m, 1H), 1.71 (dt, J = 18.3, 9.1 Hz, 1H), 1.46 – 1.36 (m, 1H), 1.36 (s, 18H), 0.88 (t, J = 7.1 Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 213.6, 168.8, 152.7, 146.0, 135.8, 130.3, 129.2, 128.6 (q, J = 39.0 Hz), 126.6, 125.1 (q, J = 4.5 Hz), 124.2 (q, J = 324.0 Hz), 66.0, 61.7, 55.0, 38.5, 34.3, 30.2, 29.5, 19.5, 13.5.

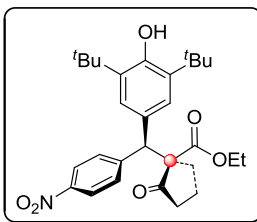
^{19}F NMR (471 MHz, CDCl_3) δ -62.44.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{30}\text{H}_{37}\text{F}_3\text{O}_4\text{Na}$: 541.2536, found: 541.2531.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -82.3^\circ$ (c = 1.0, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, λ = 210 nm, retention time: 6.21 min (major), 6.70 min (minor).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-nitrophenyl)methyl)-2-oxocyclopentanecarboxylate (4g) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 8.18 (d, J = 8.8 Hz, 2H), 7.46 (d, J = 8.8 Hz, 2H), 6.81 (s, 2H), 5.30 (s, 1H), 5.17 (s, 1H), 4.01 – 3.96 (m, 1H), 3.96 – 3.91 (m, 1H), 3.02 (ddd, J = 12.4, 7.4, 4.3 Hz, 2H), 2.37 – 2.20 (m, 2H), 1.96 – 1.85 (m, 1H), 1.71 (dt, J = 18.5, 9.2 Hz, 1H), 1.47 – 1.36 (m, 1H), 1.36 (s, 18H), 0.92 (t, J = 7.1 Hz, 3H).

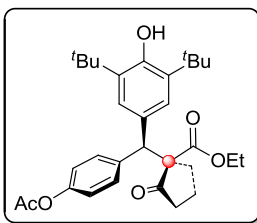
^{13}C NMR (125 MHz, CDCl_3) δ 213.3, 168.7, 152.9, 149.8, 146.4, 136.0, 130.9, 129.7, 126.6, 123.5, 65.8, 61.8, 54.9, 38.4, 34.4, 31.6, 30.2, 19.5, 13.6.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{29}\text{H}_{37}\text{NO}_6\text{Na}$: 518.2513, found: 518.2519.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -94.4^\circ$ (c = 0.5, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, λ = 254 nm, retention time: 20.63 min (major), 22.87 min (minor).

(R)-ethyl 1-((S)-(4-acetoxyphenyl)(3,5-di-*tert*-butyl-4-hydroxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4h) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.30 (d, J = 8.5 Hz, 2H), 7.02 (d, J = 8.5 Hz, 1H), 6.88 (s, 2H), 5.18 (s, 1H), 5.11 (s, 1H), 4.02 (dq, J = 10.6, 7.1 Hz, 1H), 3.89 (dq, J = 10.6, 7.1 Hz, 1H), 3.00 (dddd, J = 12.9, 7.4, 4.1, 1.3 Hz, 1H), 2.37 – 2.16 (m, 2H), 2.29 (s, 3H), 1.92 – 1.78 (m, 1H), 1.70 (dt, J = 18.4, 9.1 Hz, 1H), 1.47 – 1.33 (m, 1H), 1.36 (s, 18H), 0.89 (t, J = 7.1 Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 214.0, 169.1, 168.9, 152.5, 149.2, 139.2, 135.6, 130.5, 129.8, 126.6, 121.2, 66.4, 61.7, 54.7, 38.6, 34.3, 30.3, 29.5, 21.1, 19.5, 13.5.

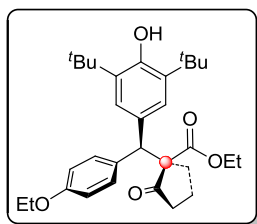
HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{31}\text{H}_{40}\text{O}_6\text{Na}$: 531.2717, found: 531.2722.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -79.9^\circ$ (c = 1.0, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 97.5:2.5, 0.6 mL/min, λ = 210 nm, retention time: 18.97 min (minor), 20.95 min (major).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-ethoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4i) (yellow oil)

^1H NMR (500 MHz, CDCl_3) δ 7.20 (d, J = 8.7 Hz, 2H), 6.90 (s, 2H), 6.81 (d, J = 8.7 Hz, 2H), 5.12 (s, 1H), 5.09 (s, 1H), 4.07 – 3.94 (m, 3H), 3.89 (dq, J = 10.7, 7.1 Hz, 1H), 3.05 – 2.93 (m, 1H), 2.32 – 2.22 (m, 1H), 2.22 – 2.15 (m, 1H), 1.89 – 1.75 (m, 1H), 1.70 (dd, J = 18.3, 9.1 Hz,



1H), 1.44 – 1.38 (m, 1H), 1.41 (t, $J = 7.1$ Hz, 3H), 1.36 (s, 18H), 0.90 (t, $J = 7.1$ Hz, 3H).

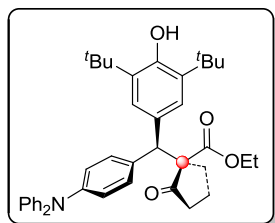
^{13}C NMR (125 MHz, CDCl_3) δ 214.3, 169.0, 157.3, 152.4, 135.4, 133.5, 131.1, 130.0, 126.5, 114.2, 66.6, 63.4, 61.5, 54.6, 38.7, 34.3, 30.3, 29.4, 19.5, 14.8, 13.6.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{31}\text{H}_{42}\text{O}_5\text{Na}$: 517.2924, found: 517.2928.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -102.5^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.5 mL/min, $\lambda = 210$ nm, retention time: 15.62 min (minor), 16.39 min (major).

(R)-ethyl 1-((S)-(3,5-di-tert-butyl-4-hydroxyphenyl)(4-(diphenylamino)phenyl)methyl)-2-oxocyclopentanecarboxylate (4j) (yellow oil)



^1H NMR (500 MHz, CDCl_3) δ 7.28 – 7.17 (m, 6H), 7.07 – 7.02 (m, 6H), 7.00 (t, $J = 8.4$ Hz, 2H), 6.92 (s, 2H), 5.16 (s, 1H), 5.13 (s, 1H), 4.13 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.93 (dq, $J = 10.7, 7.1$ Hz, 1H), 2.99 (tt, $J = 10.7, 3.3$ Hz, 1H), 2.34 – 2.25 (m, 1H), 2.18 (ddd, $J = 13.1, 9.2, 7.4$ Hz, 1H), 1.91 – 1.80 (m, 1H), 1.72 (dt, $J = 18.5, 9.2$ Hz, 1H), 1.50 – 1.36 (m, 1H), 1.39 (s, 18H), 0.96 (t, $J = 7.1$ Hz, 3H).

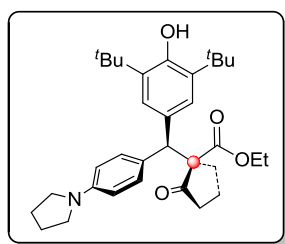
^{13}C NMR (125 MHz, CDCl_3) δ 214.4, 168.8, 152.4, 147.8, 145.9, 136.2, 135.4, 130.8, 129.8, 129.1, 126.5, 124.4, 123.7, 122.4, 66.6, 61.6, 54.7, 38.7, 34.4, 30.3, 29.3, 19.6, 13.6.

HRMS: (ESI⁺) $[\text{M}+\text{K}]^+$ calcd for $\text{C}_{41}\text{H}_{47}\text{NO}_4\text{K}$: 656.3137, found: 656.3136.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -60.2^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 98.0:2.0, 0.35 mL/min, $\lambda = 280$ nm, retention time: 14.52 min (major), 17.69 min (minor).

(R)-ethyl 1-((S)-(3,5-di-tert-butyl-4-hydroxyphenyl)(4-(pyrrolidin-1-yl)phenyl)methyl)-2-oxocyclopentanecarboxylate (4k) (red oil)



^1H NMR (500 MHz, CDCl_3) δ 7.14 (d, $J = 8.7$ Hz, 2H), 6.98 (s, 2H), 6.48 (d, $J = 8.7$ Hz, 2H), 5.05 (s, 1H), 5.02 (s, 1H), 3.99 – 3.94 (m, 1H), 3.94 – 3.87 (m, 1H), 3.26 (ddd, $J = 7.3, 4.9, 2.4$ Hz, 4H), 2.98 (dddd, $J = 12.8, 7.2, 3.9, 1.4$ Hz, 1H), 2.30 – 2.18 (m, 2H), 2.00 (td, $J = 7.7, 7.1, 3.9$ Hz, 4H), 1.84 – 1.74 (m, 1H), 1.73 – 1.65 (m, 1H), 1.46 – 1.32 (m, 1H), 1.37 (s, 18H), 0.95 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 214.5, 169.2, 152.2, 146.5, 135.2, 131.7, 129.8, 128.1, 126.5, 111.5, 66.9, 61.4, 54.8, 47.7, 38.9, 34.3, 30.4, 29.6, 25.4, 19.6, 13.7.

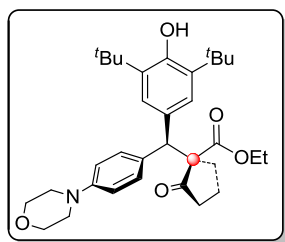
HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{33}\text{H}_{45}\text{NO}_4\text{Na}$: 542.3241, found: 542.3244.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -53.6^\circ$ ($c = 0.25$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, $\lambda = 254$ nm, retention time: 9.15 min (minor), 11.46 min (major).

(R)-ethyl 1-((S)-(3,5-di-tert-butyl-4-hydroxyphenyl)(4-morpholinophenyl)methyl)-2-oxocyclopentanecarboxylate (4l) (brown oil)

^1H NMR (500 MHz, CDCl_3) δ 7.21 (d, $J = 8.7$ Hz, 2H), 6.92 (s, 2H), 6.84 (d, $J = 8.7$ Hz, 2H), 5.08 (s, 2H), 3.98 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.94 – 3.83 (m, 5H), 3.12 (q, $J = 4.3$ Hz, 4H), 2.98 (dddd, $J = 12.8, 7.2, 3.9, 1.4$ Hz, 1H), 2.30 – 2.16 (m, 2H), 1.88 – 1.76 (m, 1H), 1.68 (dt, $J = 18.4, 9.2$ Hz, 1H), 1.44 – 1.34 (m, 1H), 1.36 (s, 18H), 0.90 (t, $J = 7.1$ Hz, 3H).



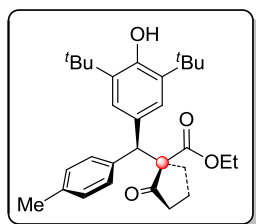
¹³C NMR (125 MHz, CDCl₃) δ 214.3, 169.0, 152.3, 135.4, 131.0, 130.7, 129.7, 126.5, 125.6, 115.5, 66.9, 66.6, 61.5, 54.6, 49.6, 38.7, 34.3, 30.3, 29.7, 19.5, 13.6.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₃H₄₅NO₄Na: 558.3190, found: 558.3183.

Specific rotation: [α]_D²⁵ = -42.4° (c = 1.1, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 90.0:10.0, 0.8 mL/min, λ = 254 nm, retention time: 7.39 min (minor), 8.02 min (major).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(*p*-tolyl)methyl)-2-oxocyclopentanecarboxylate (4m) (colorless oil)



¹H NMR (500 MHz, CDCl₃) δ 7.22 – 7.13 (m, 2H), 7.08 (d, *J* = 7.8 Hz, 2H), 6.91 (s, 2H), 5.13 (s, 1H), 5.09 (s, 1H), 3.97 (dq, *J* = 8.6, 7.1 Hz, 2H), 3.90 (dq, *J* = 8.6, 7.1 Hz, 2H), 3.00 (ddd, *J* = 12.1, 7.2, 4.0 Hz, 1H), 2.34 – 2.17 (m, 2H), 2.31 (s, 3H), 1.82 (ddd, *J* = 20.8, 12.9, 5.1 Hz, 1H), 1.69 (dt, *J* = 18.5, 9.2 Hz, 1H), 1.44 – 1.36 (m, 1H), 1.37 (s, 18H), 0.90 (t, *J* = 7.1 Hz, 3H).

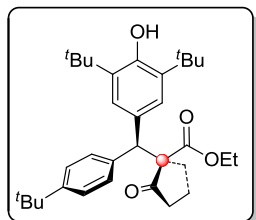
¹³C NMR (125 MHz, CDCl₃) δ 214.5, 169.0, 152.4, 138.3, 135.6, 135.3, 130.9, 128.8, 128.8, 126.5, 66.5, 61.5, 55.0, 38.8, 34.3, 30.3, 29.4, 21.0, 19.6, 13.5.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₀H₄₀O₄Na: 487.2819, found: 487.2818.

Specific rotation: [α]_D²⁵ = -76.2° (c = 0.9, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, λ = 210 nm, retention time: 7.58 min (minor), 8.17 min (major).

(R)-ethyl 1-((S)-(4-(*tert*-butyl)phenyl)(3,5-di-*tert*-butyl-4-hydroxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4n) (colorless oil)



¹H NMR (500 MHz, CDCl₃) δ 7.28 (d, *J* = 8.3 Hz, 2H), 7.22 (d, *J* = 8.3 Hz, 2H), 6.93 (s, 2H), 5.12 (s, 1H), 5.08 (s, 1H), 4.01 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.86 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.01 (ddt, *J* = 12.3, 7.7, 3.3 Hz, 1H), 2.25 (dddd, *J* = 17.2, 13.2, 8.6, 5.7 Hz, 2H), 1.89 – 1.77 (m, 1H), 1.70 (dt, *J* = 18.5, 9.2 Hz, 1H), 1.44 – 1.36 (m, 1H), 1.36 (s, 18H), 1.29 (s, 9H), 0.81 (t, *J* = 7.1 Hz, 3H).

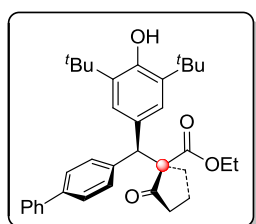
¹³C NMR (125 MHz, CDCl₃) δ 214.4, 169.0, 152.4, 149.1, 138.3, 135.4, 130.9, 128.6, 126.6, 125.0, 66.6, 61.5, 55.0, 38.7, 34.3, 31.3, 30.4, 30.3, 29.6, 19.6, 13.3.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₃H₄₆O₄Na: 529.3288, found: 529.3291.

Specific rotation: [α]_D²⁵ = -87.9° (c = 1.0, CH₂Cl₂).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 99.5:0.5, 0.7 mL/min, λ = 210 nm, retention time: 8.27 min (minor), 10.98 min (major).

(R)-ethyl 1-((S)-[1,1'-biphenyl]-4-yl(3,5-di-*tert*-butyl-4-hydroxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4o) (yellow solid)



¹H NMR (500 MHz, CDCl₃) δ 7.65 – 7.59 (m, 2H), 7.55 (d, *J* = 8.4 Hz, 2H), 7.45 (t, *J* = 7.8 Hz, 2H), 7.38 (d, *J* = 8.4 Hz, 2H), 7.37 – 7.32 (m, 1H), 6.94 (s, 2H), 5.23 (s, 1H), 5.12 (s, 1H), 4.01 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.91 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.06 (dddd, *J* = 12.9, 7.3, 4.1, 1.4 Hz, 1H), 2.41 – 2.22 (m, 2H), 1.87 (ddt, *J* = 20.1, 9.6, 3.2 Hz, 1H),

1.72 (dt, $J = 18.5, 9.2$ Hz, 1H), 1.47 – 1.33 (m, 1H), 1.37 (s, 18H), 0.89 (t, $J = 7.1$ Hz, 3H).

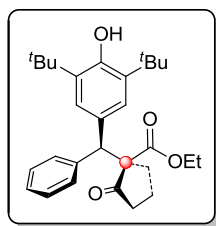
^{13}C NMR (125 MHz, CDCl_3) δ 214.3, 168.9, 152.5, 140.7, 140.7, 138.9, 135.5, 130.5, 129.3, 128.7, 127.1, 126.9, 126.8, 126.6, 66.4, 61.6, 55.0, 38.7, 34.3, 30.3, 29.5, 19.6, 13.5.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{35}\text{H}_{42}\text{O}_4\text{Na}$: 549.2975, found: 549.2974.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -94.2^\circ$ ($c = 0.9$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 97.0:3.0, 0.5 mL/min, $\lambda = 210$ nm, retention time: 11.19 min (minor), 12.60 min (major).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(phenyl)methyl)-2-oxocyclopentanecarboxylate (4p) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.33 – 7.08 (m, 5H), 6.89 (s, 2H), 5.19 (s, 1H), 5.10 (s, 1H), 3.97 (dq, $J = 10.8, 7.1$ Hz, 1H), 3.87 (dq, $J = 10.8, 7.1$ Hz, 1H), 3.11 – 2.97 (m, 1H), 2.26 (dddd, $J = 22.4, 13.2, 7.1, 4.4$ Hz, 2H), 1.92 – 1.80 (m, 1H), 1.70 (dt, $J = 18.3, 9.2$ Hz, 1H), 1.46 – 1.34 (m, 1H), 1.36 (s, 18H), 0.85 (t, $J = 7.1$ Hz, 3H).

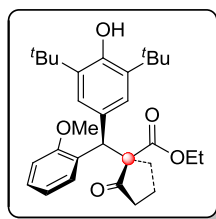
^{13}C NMR (125 MHz, CDCl_3) δ 214.3, 169.0, 152.4, 141.6, 135.5, 130.8, 128.9, 128.2, 126.6, 126.2, 66.4, 61.5, 55.3, 38.7, 34.3, 30.3, 29.5, 19.6, 13.5.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{29}\text{H}_{38}\text{O}_4\text{Na}$: 473.2662, found: 473.2662.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -72.7^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, $\lambda = 210$ nm, retention time: 6.67 min (minor), 7.69 min (major).

(R)-ethyl 1-((R)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(2-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4q) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.33 (dd, $J = 7.6, 1.6$ Hz, 1H), 7.18 (td, $J = 7.8, 1.6$ Hz, 1H), 6.94 (s, 2H), 6.91 (td, $J = 7.6, 1.1$ Hz, 1H), 6.82 (dd, $J = 8.2, 1.1$ Hz, 1H), 5.66 (s, 1H), 5.06 (s, 1H), 3.97 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.82 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.74 (s, 3H), 3.09 – 2.97 (m, 1H), 2.31 – 2.16 (m, 2H), 1.88 – 1.75 (m, 1H), 1.70 (dt, $J = 18.2, 9.0$ Hz, 1H), 1.46 – 1.29 (m, 1H), 1.36 (s, 18H), 0.80 (t, $J = 7.1$ Hz, 3H).

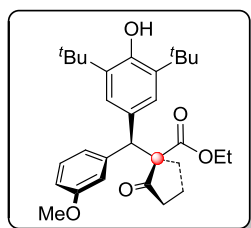
^{13}C NMR (125 MHz, CDCl_3) δ 214.5, 169.0, 157.3, 152.3, 135.2, 130.4, 130.3, 128.3, 127.4, 126.4, 119.9, 111.0, 66.5, 61.3, 55.7, 47.7, 38.8, 34.3, 30.4, 29.9, 19.6, 13.4.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{30}\text{H}_{40}\text{O}_5\text{Na}$: 503.2768, found: 503.2774.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -32.4^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, $\lambda = 280$ nm, retention time: 11.59 min (major), 16.17 min (minor).

(R)-ethyl 1-((R)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(3-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4r) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.20 (t, $J = 7.9$ Hz, 1H), 6.92 (s, 2H), 6.91 – 6.88 (m, 1H), 6.85 (t, $J = 2.1$ Hz, 1H), 6.75 (dd, $J = 8.2, 2.5$ Hz, 1H), 5.14 (s, 1H), 5.10 (s, 1H), 4.00 (dq, $J = 10.8, 7.1$ Hz, 1H), 3.89 (dq, $J = 10.8, 7.1$ Hz, 1H), 3.79 (s, 3H), 3.10 – 2.97 (m, 1H), 2.36 – 2.17 (m, 2H), 1.83 (dddd, $J = 18.0, 14.6, 9.1, 7.4$ Hz, 1H), 1.70 (dd, $J = 18.3, 9.1$ Hz, 1H), 1.42 – 1.32 (m, 1H), 1.37 (s, 18H), 0.89 (t, $J = 7.1$

Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 214.4, 168.8, 159.4, 152.5, 143.0, 135.4, 130.4, 129.1, 126.5,

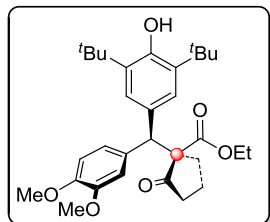
121.2, 114.8, 112.0, 66.5, 61.5, 55.4, 55.1, 38.7, 34.3, 30.3, 29.5, 19.6, 13.5.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₀H₄₀O₅Na: 503.2768, found: 503.2770.

Specific rotation: [α]_D²⁵ = -68.1° (c = 1.0, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, λ = 280 nm, retention time: 11.64 min (major), 12.96 min (minor).

(R)-ethyl 1-((R)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(3,4-dimethoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4s) (yellow oil)



¹H NMR (500 MHz, CDCl₃) δ 6.94 (s, 2H), 6.90 – 6.82 (m, 2H), 6.80 (d, *J* = 8.3 Hz, 1H), 5.10 (s, 1H), 5.09 (s, 1H), 3.98 (dq, *J* = 10.9, 7.1 Hz, 1H), 3.88 (dq, *J* = 10.9, 7.1 Hz, 1H), 3.87 (s, 3H), 3.85 (s, 3H), 3.03 – 2.95 (m, 1H), 2.27 (ddd, *J* = 18.3, 8.1, 4.0 Hz, 1H), 2.18 (ddd, *J* = 13.1, 9.5, 7.4 Hz, 1H), 1.88 – 1.78 (m, 1H), 1.69 (dt, *J* = 18.5, 9.2 Hz, 1H), 1.44 – 1.35 (m, 1H), 1.37 (s, 18H), 0.91 (t, *J* = 7.1

Hz, 3H).

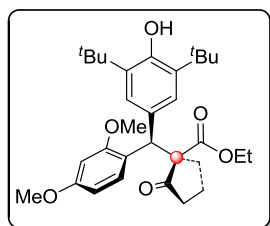
¹³C NMR (125 MHz, CDCl₃) δ 214.2, 168.9, 152.4, 148.6, 147.5, 135.5, 134.1, 130.8, 126.4, 120.8, 113.1, 110.8, 66.8, 61.5, 55.82, 55.79, 55.0, 38.7, 34.3, 30.3, 29.5, 19.6, 13.7.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₁H₄₂O₆Na: 533.2874, found: 533.2878.

Specific rotation: [α]_D²⁵ = -64.9° (c = 1.0, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 95.0:5.0, 0.8 mL/min, λ = 280 nm, retention time: 15.51 min (major), 18.37 min (minor).

(R)-ethyl 1-((R)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(2,4-dimethoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4t) (colorless oil)



¹H NMR (500 MHz, CDCl₃) δ 7.24 (d, *J* = 8.4 Hz, 1H), 6.95 (s, 2H), 6.45 (dd, *J* = 8.4, 2.5 Hz, 1H), 6.40 (d, *J* = 2.5 Hz, 1H), 5.56 (s, 1H), 5.05 (s, 1H), 4.01 – 3.92 (m, 1H), 3.91 – 3.82 (m, 1H), 3.81 (s, 3H), 3.72 (s, 3H), 2.99 (dddd, *J* = 12.9, 7.3, 4.1, 1.5 Hz, 1H), 2.25 (dddd, *J* = 18.0, 8.1, 4.1, 1.4 Hz, 1H), 2.17 (ddd, *J* = 13.1, 9.2, 7.4 Hz, 1H), 1.85 – 1.74 (m, 1H), 1.69 (ddd, *J* = 18.3, 9.8, 8.6 Hz, 1H), 1.41 –

1.32 (m, 1H), 1.37 (s, 18H), 0.86 (t, *J* = 7.1 Hz, 3H).

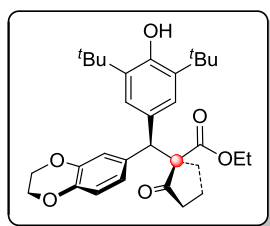
¹³C NMR (125 MHz, CDCl₃) δ 214.5, 169.1, 159.2, 158.3, 152.2, 135.2, 130.8, 128.9, 126.4, 122.8, 103.3, 98.9, 66.7, 61.3, 55.6, 55.2, 47.2, 38.8, 34.3, 30.4, 19.6, 13.5.

HRMS: (ESI⁺) [M+Na]⁺ calcd for C₃₁H₄₂O₆Na: 533.2874, found: 533.2876.

Specific rotation: [α]_D²⁵ = -30.1° (c = 1.0, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 97.0:3.0, 0.5 mL/min, λ = 210 nm, retention time: 17.01 min (minor), 20.67 min (major).

(R)-ethyl 1-((R)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(2,3-dihydrobenzo[*b*][1,4]dioxin-7-yl)methyl)-2-oxocyclopentanecarboxylate (4u) (colorless oil)



¹H NMR (500 MHz, CDCl₃) δ 6.92 (s, 2H), 6.81 (d, *J* = 1.2 Hz, 1H), 6.77 (d, *J* = 1.2 Hz, 2H), 5.09 (s, 1H), 5.04 (s, 1H), 4.24 (d, *J* = 1.9 Hz, 4H), 4.04 (dq, *J* = 10.7, 7.1 Hz, 1H), 3.93 (dq, *J* = 10.7, 7.1 Hz, 1H), 2.97 (dtd, *J* = 12.9, 5.5, 4.5, 2.7 Hz, 1H), 2.24 (tddd, *J* = 20.5, 13.2, 6.7, 4.5 Hz, 2H), 1.81 (tdd, *J* = 17.2, 15.7, 7.1, 4.6 Hz, 1H), 1.67 (dt, *J* = 18.5, 9.3 Hz, 1H), 1.46 – 1.36 (m, 1H), 1.37 (s, 18H), 0.96 (t, *J* =

7.1 Hz, 3H).

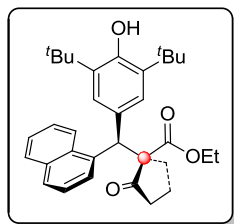
^{13}C NMR (125 MHz, CDCl_3) δ 214.2, 169.0, 152.4, 143.1, 141.9, 135.4, 134.9, 130.8, 126.5, 121.9, 118.0, 116.7, 66.5, 64.4, 64.3, 61.5, 54.6, 38.7, 34.3, 30.3, 29.4, 19.6, 13.6.

HRMS: (ESI^+) [$\text{M}+\text{Na}$] $^+$ calcd for $\text{C}_{31}\text{H}_{40}\text{O}_6\text{Na}$: 531.2717, found: 531.2722.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -97.2^\circ$ ($c = 0.5$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 95.0:5.0, 0.8 mL/min, $\lambda = 210$ nm, retention time: 10.11 min (minor), 10.60 min (major).

(R)-ethyl 1-((R)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(naphthalen-1-yl)methyl)-2-oxocyclopentanecarboxylate (4v) (yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 8.24 – 8.14 (m, 1H), 7.86 – 7.77 (m, 1H), 7.73 (d, $J = 8.2$ Hz, 1H), 7.50 (dd, $J = 7.3, 1.1$ Hz, 1H), 7.47 – 7.41 (m, 3H), 6.95 (s, 2H), 6.05 (s, 1H), 5.06 (s, 1H), 3.81 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.68 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.22 (ddd, $J = 12.6, 7.4, 4.7$ Hz, 1H), 2.41 – 2.27 (m, 2H), 1.89 (dp, $J = 12.2, 8.3$ Hz, 1H), 1.76 (dt, $J = 18.0, 8.9$ Hz, 1H), 1.37 – 1.25 (m, 1H), 1.33 (s, 18H), 0.43 (t, $J = 7.1$ Hz, 3H).

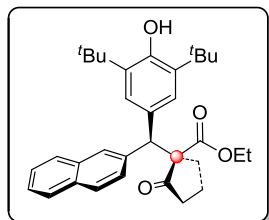
^{13}C NMR (125 MHz, CDCl_3) δ 214.6, 168.9, 152.6, 137.6, 135.6, 134.1, 132.1, 129.8, 128.5, 127.2, 126.2, 125.9, 125.3, 124.6, 124.4, 124.1, 66.9, 61.3, 50.9, 38.8, 34.3, 30.3, 29.7, 19.6, 13.1.

HRMS: (ESI^+) [$\text{M}+\text{Na}$] $^+$ calcd for $\text{C}_{33}\text{H}_{40}\text{O}_4\text{Na}$: 523.2819, found: 523.2819.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -101.9^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.5 mL/min, $\lambda = 210$ nm, retention time: 15.24 min (major), 18.52 min (minor).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(naphthalen-2-yl)methyl)-2-oxocyclopentanecarboxylate (4w) (pale yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.86 – 7.78 (m, 2H), 7.78 – 7.73 (m, 2H), 7.46 (ddd, $J = 6.9, 4.3, 1.8$ Hz, 2H), 7.40 (dd, $J = 8.5, 1.9$ Hz, 1H), 6.94 (s, 2H), 5.35 (s, 1H), 5.10 (s, 1H), 4.00 – 3.78 (m, 2H), 3.16 (ddd, $J = 12.6, 7.5, 4.4$ Hz, 1H), 2.42 – 2.22 (m, 2H), 1.88 (dp, $J = 12.6, 8.6$ Hz, 1H), 1.72 (dt, $J = 18.2, 9.1$ Hz, 1H), 1.47 – 1.38 (m, 1H), 1.35 (s, 18H), 0.78 (t, $J = 7.1$ Hz, 3H).

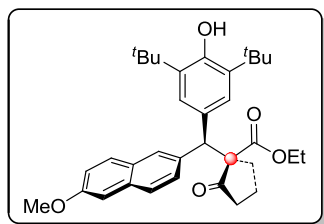
^{13}C NMR (125 MHz, CDCl_3) δ 214.2, 169.1, 152.5, 139.3, 135.6, 133.3, 132.1, 130.5, 128.1, 127.9, 127.8, 127.5, 126.8, 126.7, 125.8, 125.5, 66.4, 61.6, 55.4, 38.7, 34.3, 30.3, 29.6, 19.6, 13.5.

HRMS: (ESI^+) [$\text{M}+\text{Na}$] $^+$ calcd for $\text{C}_{33}\text{H}_{40}\text{O}_4\text{Na}$: 523.2819, found: 523.2823.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -108.2^\circ$ ($c = 0.8$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, $\lambda = 254$ nm, retention time: 8.89 min (major), 10.93 min (minor).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(6-methoxynaphthalen-2-yl)methyl)-2-oxocyclopentanecarboxylate (4x) (yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.70 (d, $J = 8.9$ Hz, 1H), 7.67 (d, $J = 1.7$ Hz, 1H), 7.66 (d, $J = 8.6$ Hz, 1H), 7.37 (dd, $J = 8.5, 1.9$ Hz, 1H), 7.14 (dd, $J = 8.9, 2.5$ Hz, 1H), 7.11 (d, $J = 2.4$ Hz, 1H), 6.95 (s, 2H), 5.32 (s, 1H), 5.10 (s, 1H), 3.93 (s, 3H), 3.97 – 3.87 (m, 1H), 3.90 – 3.80 (m, 1H), 3.18 – 3.10 (m, 1H), 2.35 – 2.25 (m, 2H), 1.93 – 1.81 (m, 1H), 1.72 (dt, $J = 18.3, 9.1$ Hz, 1H), 1.43 – 1.32 (m, 1H), 1.35 (s, 18H), 0.78 (t, $J = 7.1$ Hz, 3H).

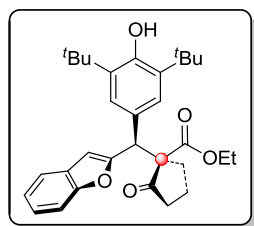
^{13}C NMR (125 MHz, CDCl_3) δ 214.3, 169.1, 157.4, 152.5, 150.0, 136.9, 135.5, 133.1, 130.8, 129.3, 128.8, 128.5, 126.70, 126.66, 118.6, 105.6, 66.5, 61.5, 55.24, 55.22, 38.7, 34.3, 30.3, 29.5, 19.6, 13.5.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{34}\text{H}_{42}\text{O}_5\text{Na}$: 553.2924, found: 553.2928.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -128.7^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 98.5:1.5, 0.7 mL/min, $\lambda = 210$ nm, retention time: 9.22 min (minor), 9.90 min (major).

(R)-ethyl 1-((S)-benzo[*b*]furan-2-yl(3,5-di-*tert*-butyl-4-hydroxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4y) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.52 (dd, $J = 7.3, 1.5$ Hz, 1H), 7.45 – 7.41 (m, 1H), 7.24 (td, $J = 7.3, 1.6$ Hz, 1H), 7.20 (td, $J = 7.3, 1.6$ Hz, 1H), 7.06 (s, 2H), 6.55 (s, 1H), 5.33 (s, 1H), 5.17 (s, 1H), 4.10 (dq, $J = 10.8, 7.1$ Hz, 1H), 4.03 (dq, $J = 10.8, 7.1$ Hz, 1H), 2.99 (dddd, $J = 13.2, 7.5, 4.2, 1.2$ Hz, 1H), 2.37 (ddd, $J = 13.5, 9.1, 7.6$ Hz, 1H), 2.30 – 2.21 (m, 1H), 1.97 – 1.83 (m, 1H), 1.71 – 1.59 (m, 2H), 1.47 – 1.36 (m, 1H),

1.39 (s, 18H), 1.03 (t, $J = 7.1$ Hz, 3H).

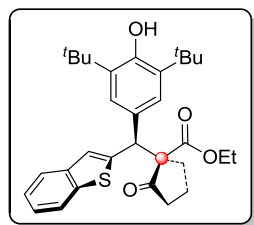
^{13}C NMR (125 MHz, CDCl_3) δ 213.0, 168.9, 158.0, 154.5, 153.1, 135.8, 128.4, 127.4, 126.6, 123.6, 122.5, 120.6, 110.9, 104.2, 65.3, 61.8, 49.0, 38.7, 34.3, 30.3, 28.8, 19.6, 13.8.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{31}\text{H}_{38}\text{O}_5\text{Na}$: 513.2611, found: 513.2619.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -86.5^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 95.0:5.0, 0.8 mL/min, $\lambda = 210$ nm, retention time: 5.53 min (minor), 5.80 min (major).

(R)-ethyl 1-((S)-benzo[*b*]thiophen-2-yl(3,5-di-*tert*-butyl-4-hydroxyphenyl)methyl)-2-oxocyclopentanecarboxylate (4z) (yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.76 (d, $J = 7.9$ Hz, 1H), 7.71 (dd, $J = 7.6, 1.3$ Hz, 1H), 7.33 (td, $J = 7.5, 1.3$ Hz, 1H), 7.30 – 7.25 (m, 1H), 7.17 (s, 1H), 7.08 (s, 2H), 5.46 (s, 1H), 5.16 (s, 1H), 4.07 (dq, $J = 10.8, 7.1$ Hz, 1H), 4.00 (dq, $J = 10.8, 7.1$ Hz, 1H), 3.04 (ddd, $J = 12.7, 7.7, 4.4$ Hz, 1H), 2.37 (ddd, $J = 13.3, 8.9, 7.7$ Hz, 1H), 2.26 (ddd, $J = 18.1, 8.6, 4.5$ Hz, 1H), 1.89 (dp, $J = 12.5, 8.8$ Hz, 1H), 1.66 (dt, $J = 18.4, 9.2$

Hz, 1H), 1.47 – 1.36 (m, 1H), 1.39 (s, 18H), 0.99 (t, $J = 7.1$ Hz, 3H).

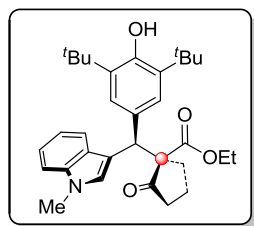
^{13}C NMR (125 MHz, CDCl_3) δ 213.1, 168.9, 152.9, 145.6, 139.6, 139.5, 135.6, 129.0, 126.6, 124.0, 123.8, 123.1, 122.2, 121.9, 66.7, 61.8, 51.0, 38.7, 34.4, 30.3, 28.9, 19.5, 13.7.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{31}\text{H}_{38}\text{O}_4\text{SNa}$: 529.2383, found: 529.2386.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -82.2^\circ$ ($c = 1.0$, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 99.0:1.0, 0.55 mL/min, $\lambda = 254$ nm, retention time: 14.19 min (major), 14.50 min (minor).

(R)-ethyl 1-((R)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(1-methyl-1H-indol-3-yl)methyl)-2-oxocyclopentanecarboxylate (4aa) (colorless oil)



^1H NMR (500 MHz, CDCl_3) δ 7.48 (dt, $J = 7.9, 0.9$ Hz, 1H), 7.25 (t, $J = 9.0$ Hz, 1H), 7.18 (ddd, $J = 8.1, 6.9, 1.1$ Hz, 1H), 7.08 (s, 2H), 7.06 – 7.02 (m, 1H), 7.01 (s, 1H), 5.42 (s, 1H), 5.05 (s, 1H), 3.91 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.86 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.79 (s, 3H), 2.96 (dddd, $J = 12.9, 7.3, 4.3, 1.4$ Hz, 1H), 2.36 – 2.29 (m, 1H), 2.27 – 2.19 (m,

1H), 1.85 – 1.75 (m, 1H), 1.71 – 1.62 (m, 1H), 1.38 – 1.28 (m, 1H), 1.37 (s, 18H), 0.75 (t, $J = 7.1$ Hz, 3H).

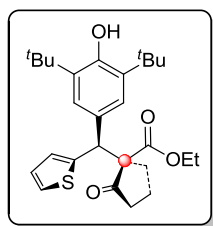
^{13}C NMR (125 MHz, CDCl_3) δ 214.1, 169.6, 152.4, 136.6, 135.2, 130.1, 128.2, 126.5, 125.5, 121.5, 119.8, 118.6, 114.6, 108.6, 67.0, 61.4, 46.5, 39.1, 34.3, 32.8, 30.4, 29.1, 19.4, 13.4.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{32}\text{H}_{41}\text{NO}_4\text{Na}$: 526.2928, found: 526.2930.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -50.9^\circ$ ($c = 0.8$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 90.0:10.0, 0.8 mL/min, $\lambda = 280$ nm, retention time: 5.71 min (major), 6.03 min (minor).

(R)-ethyl 1-((S)-(3,5-di-*tert*-butyl-4-hydroxyphenyl)(thiophen-2-yl)methyl)-2-oxocyclopentanecarboxylate (4ab) (yellow solid)



^1H NMR (500 MHz, CDCl_3) δ 7.20 – 7.14 (m, 1H), 7.04 (s, 2H), 7.00 – 6.89 (m, 2H), 5.42 (s, 1H), 5.12 (s, 1H), 4.08 (dq, $J = 10.8, 7.1$ Hz, 1H), 3.98 (dq, $J = 10.8, 7.1$ Hz, 1H), 2.94 (ddt, $J = 12.7, 7.9, 4.0$ Hz, 1H), 2.33 – 2.20 (m, 2H), 1.92 – 1.78 (m, 1H), 1.71 – 1.58 (m, 1H), 1.47 – 1.38 (m, 1H), 1.39 (s, 18H), 1.03 (t, $J = 7.1$ Hz, 3H).

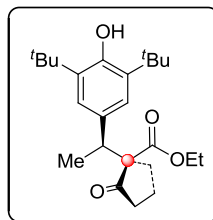
^{13}C NMR (125 MHz, CDCl_3) δ 213.3, 168.8, 152.7, 144.1, 135.5, 129.7, 126.5, 126.2, 125.8, 123.9, 67.1, 61.7, 50.3, 38.8, 34.4, 30.3, 28.8, 19.5, 13.6.

HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{27}\text{H}_{36}\text{O}_4\text{SNa}$: 479.2227, found: 479.2231.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -50.1^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 99.0:1.0, 0.5 mL/min, $\lambda = 280$ nm, retention time: 12.50 min (major), 15.51 min (minor).

(R)-ethyl 1-((S)-1-(3-(*tert*-butyl)-4-hydroxy-5-methylphenyl)ethyl)-2-oxocyclopentanecarboxylate (4ac) (yellow oil)



^1H NMR (500 MHz, CDCl_3) δ 7.02 (s, 2H), 5.13 (s, 1H), 4.34 – 4.15 (m, 2H), 3.83 (q, $J = 7.1$ Hz, 1H), 2.62 – 2.47 (m, 1H), 2.20 – 2.04 (m, 2H), 1.88 – 1.68 (m, 2H), 1.57 – 1.48 (m, 1H), 1.44 (s, 18H), 1.30 (d, $J = 7.1$ Hz, 3H), 1.26 (t, $J = 7.1$ Hz, 3H) (diastereoisomer **A**).

δ 6.99 (s, 2H), 5.09 (s, 1H), 4.09 – 3.95 (m, 2H), 3.65 (q, $J = 7.1$ Hz, 1H), 2.46 – 2.36 (m, 1H), 2.01 – 1.93 (m, 1H), 1.79 – 1.68 (m, 2H), 1.55 – 1.45 (m, 1H), 1.43 (s, 18H), 1.39 – 1.32 (m, 1H), 1.30 (d, $J = 7.1$ Hz, 3H), 1.12 (t, $J = 7.1$ Hz, 3H) (diastereoisomer **B**).

^{13}C NMR (125 MHz, CDCl_3) δ 214.4, 170.0, 152.53, 135.3, 131.3, 125.7, 66.42, 61.6, 42.8, 39.0, 34.34, 30.4, 27.3, 19.3, 16.3, 14.1 (diastereoisomer **A**).

δ 214.6, 169.7, 152.47, 135.4, 132.7, 124.7, 66.35, 61.3, 43.8, 39.2, 34.30, 30.3, 29.4, 19.5, 17.7, 13.9 (diastereoisomer **B**).

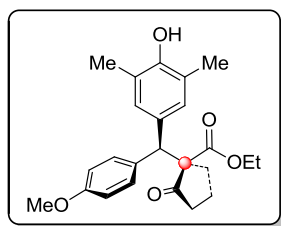
HRMS: (ESI^+) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{21}\text{H}_{30}\text{O}_4\text{Na}$: 369.2036, found: 369.2040.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -15.3^\circ$ ($c = 1.2$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 98.5:1.5, 0.8 mL/min, $\lambda = 280$ nm, retention time: 11.93 min (major), 12.44 min (minor).

(R)-ethyl 1-((S)-(4-hydroxy-3,5-dimethylphenyl)(4-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (6a) (pale yellow oil)

^1H NMR (500 MHz, CDCl_3) δ 7.18 (d, $J = 8.7$ Hz, 2H), 6.87 (s, 2H), 6.82 (d, $J = 8.7$ Hz, 2H), 5.08 (s, 1H), 4.61 (s, 1H), 4.06 – 3.87 (m, 2H), 3.79 (s, 3H), 3.12 – 2.96 (m, 1H), 2.35 – 2.23 (m,



2H), 2.21 (s, 6H), 1.95 – 1.80 (m, 1H), 1.74 (dq, $J = 19.1, 9.5$ Hz, 1H), 1.56 (dtt, $J = 20.8, 8.1, 4.3$ Hz, 1H), 0.92 (t, $J = 7.1$ Hz, 3H) (diastereoisomer **A**).

δ 7.04 (d, $J = 8.7$ Hz, 2H), 6.76 (d, $J = 8.7$ Hz, 2H), 6.69 (s, 2H), 5.07 (s, 1H), 4.60 (s, 1H), 4.06 – 3.85 (m, 2H), 3.76 (s, 3H), 3.10 – 2.92 (m, 1H), 2.34 – 2.23 (m, 2H), 2.16 (s, 6H), 1.97 – 1.80 (m, 1H),

1.74 (dq, $J = 19.1, 9.5$ Hz, 1H), 1.57 (dtd, $J = 18.1, 8.1, 3.9$ Hz, 1H), 0.91 (t, $J = 7.1$ Hz, 3H) (diastereoisomer **B**).

^{13}C NMR (125 MHz, CDCl_3) δ 214.2, 168.79, 158.2, 150.9, 133.8, 133.0, 131.1, 129.8, 122.6, 113.6, 66.4, 61.56, 55.2, 53.7, 38.6, 29.30, 19.80, 15.98, 13.6 (diastereoisomer **A**).

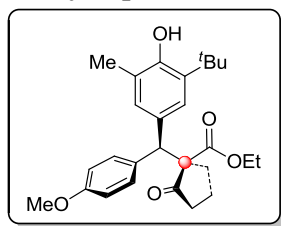
δ 214.3, 168.84, 157.9, 150.6, 133.0, 132.2, 130.2, 129.1, 122.7, 113.5, 66.5, 61.52, 55.1, 53.6, 38.6, 29.34, 19.78, 16.01, 13.6 (diastereoisomer **B**).

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{24}\text{H}_{28}\text{O}_5\text{Na}$: 419.1829, found: 419.1834.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -86.2^\circ$ ($c = 0.9, \text{CH}_2\text{Cl}_2$).

HPLC analysis of the product: Daicel Chiralpak IA-3 column, hexane/*i*-PrOH = 95.0:5.0, 0.5 mL/min, $\lambda = 210$ nm, retention time: 33.00 min (major), 44.60 min (minor).

(R)-ethyl 1-((S)-(3-(tert-butyl)-4-hydroxy-5-methylphenyl)(4-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (6b) (yellow oil)



^1H NMR (500 MHz, CDCl_3) δ 7.20 (d, $J = 8.7$ Hz, 2H), 6.93 (d, $J = 2.2$ Hz, 1H), 6.82 (d, $J = 8.7$ Hz, 2H), 6.65 (d, $J = 2.2$ Hz, 1H), 5.11 (s, 1H), 4.69 (s, 1H), 3.99 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.90 (dq, $J = 10.7, 7.1$ Hz, 1H), 3.80 (s, 3H), 3.04 – 2.96 (m, 1H), 2.30 – 2.21 (m, 2H), 2.15 (s, 3H), 1.90 – 1.81 (m, 1H), 1.78 – 1.67 (m, 1H), 1.50 (qd, $J = 8.5, 4.1$ Hz, 1H), 1.35 (s, 9H), 0.91 (t, $J = 7.1$ Hz, 3H).

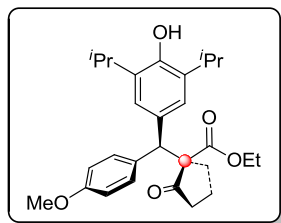
^{13}C NMR (125 MHz, CDCl_3) δ 214.3, 168.9, 157.9, 151.3, 135.2, 133.7, 131.7, 131.0, 129.9, 126.8, 122.7, 113.6, 66.5, 61.6, 55.2, 54.1, 38.7, 34.5, 29.7, 29.3, 19.7, 16.1, 13.6.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{27}\text{H}_{34}\text{O}_5\text{Na}$: 461.2298, found: 461.2303.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -93.0^\circ$ ($c = 0.8, \text{CH}_2\text{Cl}_2$).

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 97.5:2.5, 0.8 mL/min, $\lambda = 280$ nm, retention time: 14.88 min (major), 17.35 min (minor).

(R)-ethyl 1-((S)-(4-hydroxy-3,5-diisopropylphenyl)(4-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (6c) (pale yellow oil)



^1H NMR (500 MHz, CDCl_3) δ 7.20 (d, $J = 8.3$ Hz, 2H), 6.83 (d, $J = 8.3$ Hz, 2H), 6.77 (s, 2H), 5.15 (s, 1H), 4.73 (s, 1H), 3.99 (dq, $J = 10.6, 7.1$ Hz, 1H), 3.91 (dq, $J = 10.6, 7.1$ Hz, 1H), 3.80 (s, 3H), 3.07 (hept, $J = 6.8$ Hz, 2H), 3.01 (ddd, $J = 12.1, 7.2, 4.0$ Hz, 1H), 2.24 (ddt, $J = 26.3, 16.6, 6.3$ Hz, 2H), 1.83 (dq, $J = 21.0, 8.8$ Hz, 1H), 1.76 – 1.66 (m, 1H), 1.42 (ddt, $J = 12.4, 8.2, 4.1$ Hz, 1H), 1.22 (d, $J = 6.8$ Hz, 6H), 1.14 (d, $J = 6.8$ Hz, 6H), 0.92 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (125 MHz, CDCl_3) δ 214.4, 169.0, 157.9, 148.5, 133.6, 133.3, 132.4, 129.9, 125.1, 113.5, 66.5, 61.6, 55.2, 54.3, 38.7, 29.3, 27.1, 22.7, 22.7, 19.6, 13.6.

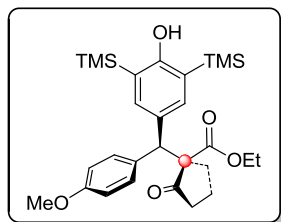
HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{28}\text{H}_{36}\text{O}_5\text{Na}$: 475.2455, found: 475.2458.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -79.1^\circ$ ($c = 0.9, \text{CH}_2\text{Cl}_2$).

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 95.0:5.0,

0.5 mL/min, λ = 280 nm, retention time: 21.11 min (major), 22.37 min (minor).

(R)-ethyl 1-((S)-(4-hydroxy-3,5-bis(trimethylsilyl)phenyl)(4-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (6d) (yellow oil)



$^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.21 (d, J = 8.7 Hz, 2H), 7.09 (s, 2H), 6.83 (d, J = 8.7 Hz, 2H), 5.13 (s, 1H), 4.94 (s, 1H), 3.99 (dq, J = 10.7, 7.1 Hz, 1H), 3.91 (dq, J = 10.7, 7.1 Hz, 1H), 3.80 (s, 3H), 3.10 – 2.87 (m, 1H), 2.35 – 2.24 (m, 1H), 2.23 – 2.11 (m, 1H), 1.86 (dt, J = 12.2, 9.9, 7.7 Hz, 1H), 1.72 (ddd, J = 18.8, 10.2, 8.9 Hz, 1H), 1.54 (qd, J = 8.6, 3.8 Hz, 1H), 0.91 (t, J = 7.1 Hz, 3H), 0.28 (s,

18H).

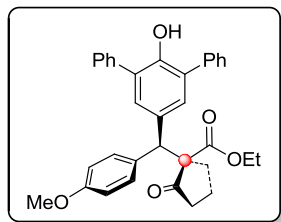
$^{13}\text{C NMR}$ (125 MHz, CDCl_3) δ 214.0, 168.8, 163.9, 158.0, 138.1, 133.4, 131.9, 130.0, 123.6, 113.5, 66.6, 61.6, 55.2, 53.9, 38.6, 29.3, 19.7, 13.6, -0.6.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{28}\text{H}_{40}\text{O}_5\text{Si}_2\text{Na}$: 535.2306, found: 535.2306.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -82.8^\circ$ (c = 1.2, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 99.2:0.8, 0.5 mL/min, λ = 210 nm, retention time: 17.27 min (major).

(R)-ethyl 1-((S)-(2'-hydroxy-[1,1':3',1''-terphenyl]-5'-yl)(4-methoxyphenyl)methyl)-2-oxocyclopentanecarboxylate (6e) (yellow oil)



$^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.58 – 7.33 (m, 10H), 7.23 (d, J = 8.7 Hz, 2H), 7.06 (s, 2H), 6.82 (d, J = 8.7 Hz, 2H), 5.39 (s, 1H), 5.23 (s, 1H), 4.05 – 3.96 (m, 1H), 3.96 – 3.90 (m, 1H), 3.79 (s, 3H), 3.08 (ddd, J = 12.1, 5.2, 2.5 Hz, 1H), 2.44 – 2.30 (m, 2H), 2.03 – 1.83 (m, 2H), 1.74 – 1.66 (m, 1H), 0.93 (t, J = 7.1 Hz, 3H) (diastereoisomer **A**).

$\delta^1\text{H NMR}$ (500 MHz, Chloroform-*d*) δ 7.57 – 7.36 (m, 10H), 7.10 (d, J = 8.7 Hz, 2H), 6.95 (s, 2H), 6.78 (d, J = 8.7 Hz, 2H), 5.32 (s, 1H), 5.24 (s, 1H), 4.18 – 4.11 (m, 1H), 4.07 – 3.97 (m, 1H), 3.82 (s, 3H), 3.10 – 3.01 (m, 1H), 2.45 – 2.22 (m, 2H), 2.00 – 1.83 (m, 2H), 1.69 (dq, J = 10.9, 3.8, 3.2 Hz, 1H), 0.95 (t, J = 7.1 Hz, 3H) (diastereoisomer **B**).

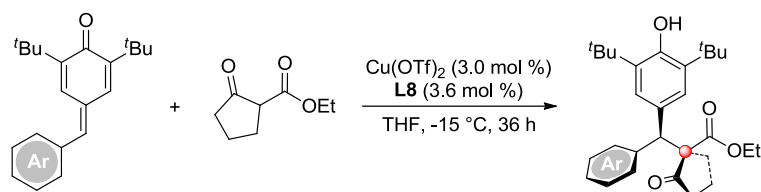
$^{13}\text{C NMR}$ (125 MHz, CDCl_3) δ 214.0, 213.9, 170.0, 168.83, 168.79, 168.7, 158.3, 158.1, 148.1, 147.8, 137.64, 137.56, 137.3, 135.8, 133.3, 132.8, 131.5, 131.1, 130.4, 129.9, 129.25, 129.24, 129.0, 128.9, 128.8, 128.7, 128.6, 128.5, 128.4, 128.3, 127.64, 127.57, 66.6, 66.5, 61.7, 60.4, 55.3, 55.2, 53.8, 53.7, 38.6, 38.5, 29.5, 29.3, 21.3, 19.8, 14.2, 13.6 (diastereoisomer **A** and **B**).

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{34}\text{H}_{32}\text{O}_5\text{Na}$: 543.2142, found: 543.2149.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -71.5^\circ$ (c = 1.5, CH_2Cl_2).

HPLC analysis of the product: Daicel Chiralcel OD-H column, hexane/*i*-PrOH = 96.0:4.0, 0.7 mL/min, λ = 254 nm, retention time: 28.76 min (minor), 33.55 min (major).

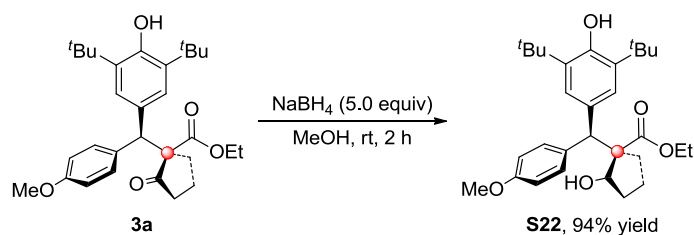
V. Gram-Scale Synthesis



An oven-dried Schlenk flask was charged with $\text{Cu}(\text{OTf})_2$ (32.5 mg, 0.09 mmol, 3 mol%), **L8** (79.5 mg, 0.108 mmol, 3.6 mol%), *p*-quinone methide substrates (3 mmol) and a stir bar. The flask was degassed and refilled with nitrogen for 3 times, and then anhydrous THF (25 mL) was injected to the tube via a syringe. The reaction mixture was cooled to $-15\text{ }^{\circ}\text{C}$. After stirring for 3 minutes, a solution of ethyl 2-oxocyclopentanecarboxylate (702 mg, 4.5 mmol, 1.5 equiv) in anhydrous THF (15 mL) was injected to the reaction mixture via a syringe. After stirring at the same temperature for additional 36 hours, the reaction was quenched with saturated NH_4Cl and extracted with ethyl acetate ($3 \times 100\text{ mL}$). The combined organic layers were dried with Na_2SO_4 , filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate) to afford the pure product.

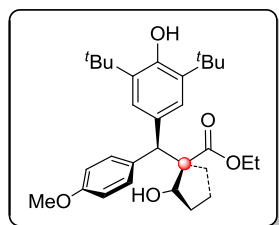
VI. Synthesis of Compounds 7 and 8

6.1 Synthesis of Compound 7



To a solution of compound **3a** (240 mg, 0.5 mmol) in methanol (50 mL) was added NaBH_4 (95 mg, 2.5 mmol) in portions. The reaction mixture was then stirred at rt for 2 hours. After completion, the reaction mixture was quenched with saturated NH_4Cl solution and extracted with ethyl acetate ($3 \times 50\text{ mL}$). The combined organic solvents were concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 6/1) to afford a colorless oil **S22**.

(1R,2S)-ethyl 1-((S)-((S)-3,5-di-*tert*-butyl-4-hydroxyphenyl)(4-methoxyphenyl)methyl)-2-hydroxycyclopentanecarboxylate (S22**)**

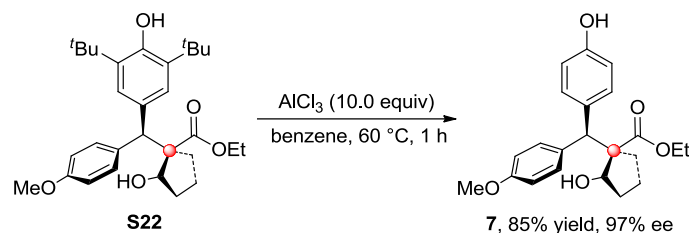


$^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.50 (d, $J = 8.7\text{ Hz}$, 2H), 7.11 (s, 2H), 6.86 (d, $J = 8.7\text{ Hz}$, 2H), 5.05 (s, 1H), 4.51 (s, 1H), 4.44 (s, 1H), 3.90 (dq, $J = 10.4, 7.2\text{ Hz}$, 1H), 3.80 (s, 3H), 3.80 – 3.69 (m, 1H), 2.46 (ddd, $J = 11.7, 8.6, 2.7\text{ Hz}$, 1H), 2.11 – 1.95 (m, 1H), 1.89 – 1.69 (m,

3H), 1.60 – 1.51 (m, 2H), 1.41 (s, 18H), 0.93 (t, $J = 7.1$ Hz, 3H).

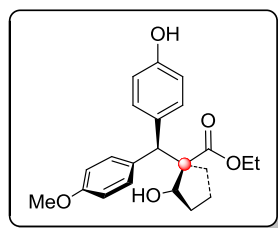
^{13}C NMR (125 MHz, CDCl_3) δ 175.2, 158.1, 152.1, 135.0, 134.6, 132.4, 130.5, 126.0, 113.7, 77.5, 64.1, 60.4, 55.2, 54.3, 34.3, 32.6, 32.0, 30.3, 20.8, 13.6.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{30}\text{H}_{42}\text{O}_5\text{Na}$: 505.2924, found: 505.2931.



An oven-dried Schlenk tube was charged with AlCl_3 (133.3 mg, 1.0 mmol, 10 eq.) and a stir bar. The tube was degassed and refilled with nitrogen for 3 times, and then a solution of **S12** (48.2 mg, 0.1 mmol) in anhydrous benzene (5.0 mL) was injected to the tube via a syringe. The mixture was heated at 60 °C for 1 hours. The reaction was quenched with water and extracted with ethyl acetate (3 $\times$ 50 mL). The combined organic layers were dried with Na_2SO_4 , filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 2/1) to afford the pure product **7** as a colorless solid.

(1R,2S)-ethyl 2-hydroxy-1-((R)-(4-hydroxyphenyl)(4-methoxyphenyl)methyl)cyclopentanecarboxylate (7)



^1H NMR (500 MHz, CDCl_3) δ 7.41 (d, $J = 8.7$ Hz, 2H), 7.21 (d, $J = 8.5$ Hz, 2H), 6.83 (d, $J = 8.7$ Hz, 2H), 6.71 (d, $J = 8.5$ Hz, 2H), 5.37 (s, 1H), 4.55 (s, 1H), 4.52 (s, 1H), 3.92 (dddd, $J = 17.8, 10.8, 7.2, 3.6$ Hz, 2H), 3.79 (s, 3H), 2.44 (ddd, $J = 11.7, 8.4, 2.9$ Hz, 1H), 2.01 (dt, $J = 13.0, 9.1$ Hz, 1H), 1.89 – 1.81 (m, 1H), 1.78 – 1.65 (m, 2H), 1.59 (ddd, $J = 13.7, 5.2, 3.1$ Hz, 1H), 1.55 – 1.49 (m, 1H), 1.00 (t, $J = 7.1$

Hz, 3H).

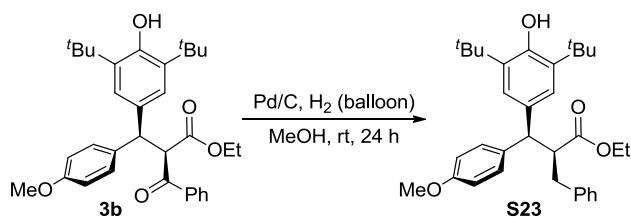
^{13}C NMR (125 MHz, CDCl_3) δ 175.4, 158.1, 154.2, 134.6, 134.3, 130.9, 130.2, 114.8, 113.7, 77.4, 63.4, 60.6, 55.2, 52.9, 32.4, 32.3, 20.6, 13.7.

HRMS: (ESI⁺) $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{22}\text{H}_{26}\text{O}_5\text{Na}$: 393.1672, found: 393.1676.

Specific rotation: $[\alpha]_{\text{D}}^{25} = -33.0^\circ$ ($c = 1.0$, CH_2Cl_2)

HPLC analysis of the product: Daicel Chiralpak IC-3 column, hexane/*i*-PrOH = 92.0:8.0, 0.8 mL/min, $\lambda = 210$ nm, retention time: 21.73 min (minor), 22.85 min (major).

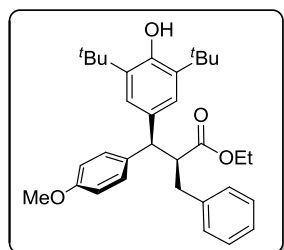
6.2 Synthesis of Compound 8



An oven-dried vial was charged with compound **3b** (256 mg, 0.5 mmol), 5% Pd/C (250 mg), methanol (50 mL) and a stir bar. The reaction mixture was degassed and refilled with

H₂ for 3 times, and then stirred at rt for 24 hours under H₂ atmosphere (balloon). After completion, the reaction mixture was filtered through a Celite pad and the filtrate was washed with ethyl acetate for 3 times (3 × 50 mL). The combined organic solvents were concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate) to afford the pure product **S23**.

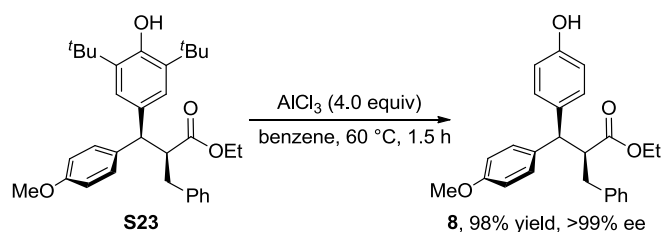
(2S,3S)-ethyl 2-benzyl-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (S23**)**



¹H NMR (500 MHz, CDCl₃) δ 7.31 – 7.22 (m, 4H), 7.21 – 7.15 (m, 3H), 7.12 – 7.06 (m, 2H), 6.80 (d, *J* = 8.7 Hz, 2H), 5.10 (s, 1H), 4.05 (d, *J* = 11.7 Hz, 1H), 3.79 – 3.70 (m, 2H), 3.76 (s, 3H), 3.44 (ddd, *J* = 11.7, 8.9, 5.7 Hz, 1H), 2.88 – 2.71 (m, 2H), 1.47 (s, 18H), 0.82 (t, *J* = 7.1 Hz, 3H).

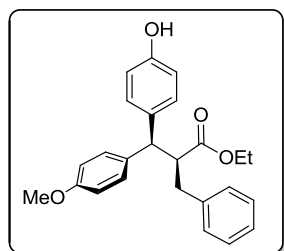
¹³C NMR (125 MHz, CDCl₃) δ 174.6, 158.1, 152.4, 139.7, 136.1, 135.6, 132.9, 128.8, 128.6, 128.3, 126.2, 124.3, 113.7, 59.9, 55.2, 54.3, 54.2, 38.1, 34.4, 30.4, 13.8.

HRMS: (ESI⁺) [*M*+Na]⁺ calcd for C₃₃H₄₂O₄Na: 525.2975, found: 525.2974.



An oven-dried Schlenk tube was charged with AlCl₃ (26.7 mg, 0.20 mmol, 4 eq.) and a stir bar. The tube was degassed and refilled with nitrogen for 3 times, and then a solution of **S23** (25.0 mg, 0.05 mmol) in anhydrous benzene (2.0 mL) was injected to the tube via a syringe. The mixture was heated at 60 °C for 1.5 hours. The reaction was quenched with water and extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried with Na₂SO₄, filtered, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate) to afford the product **8** as a colorless oil.

(2S,3R)-ethyl 2-benzyl-3-(4-hydroxyphenyl)-3-(4-methoxyphenyl)propanoate (8**)**



¹H NMR (500 MHz, CDCl₃) δ 7.30 – 7.22 (m, 6H), 7.21 – 7.16 (m, 1H), 7.14 – 7.07 (m, 2H), 6.82 (d, *J* = 8.5 Hz, 2H), 6.78 (d, *J* = 8.7 Hz, 2H), 5.00 (s, 1H), 4.11 (d, *J* = 11.6 Hz, 1H), 3.75 (s, 3H), 3.74 (q, *J* = 7.1 Hz, 2H), 3.44 (ddd, *J* = 11.6, 9.7, 5.3 Hz, 1H), 2.87 – 2.73 (m, 2H), 0.81 (t, *J* = 7.1 Hz, 3H).

¹³C NMR (125 MHz, CDCl₃) δ 174.4, 158.2, 154.3, 139.3, 135.1, 134.9, 129.1, 128.7, 128.7, 128.3, 126.3, 115.7, 113.8, 60.00, 55.2,

53.6, 53.3, 38.1, 13.8.

HRMS: (ESI⁺) [*M*+Na]⁺ calcd for C₂₅H₂₆O₄Na: 413.1723, found: 413.1730.

Specific rotation: [α]_D²⁵ = -8.8° (*c* = 0.5, CH₂Cl₂)

HPLC analysis of the product: Daicel Chiralpak AD-H column, hexane/*i*-PrOH = 80.0:20.0, 0.5 mL/min, λ = 210 nm, retention time: 34.23 min (major).

Density (calculated)	1.156 Mg/m ³
Absorption coefficient	0.081 mm ⁻¹
F(000)	1192
Crystal size	? x ? x ? mm ³
Theta range for data collection	3.413 to 29.351°.
Index ranges	-13<=h<=14, -19<=k<=19, -27<=l<=28
Reflections collected	17567
Independent reflections	7044 [R(int) = 0.0674]
Completeness to theta = 25.242°	99.7 %
Absorption correction	None
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	7044 / 0 / 384
Goodness-of-fit on F ²	1.032
Final R indices [I>2sigma(I)]	R1 = 0.0864, wR2 = 0.1593
R indices (all data)	R1 = 0.2473, wR2 = 0.2271
Absolute structure parameter	-1.4(10)
Extinction coefficient	n/a
Largest diff. peak and hole	0.258 and -0.205 e.Å ⁻³

7.2 Relative Configuration of 3v

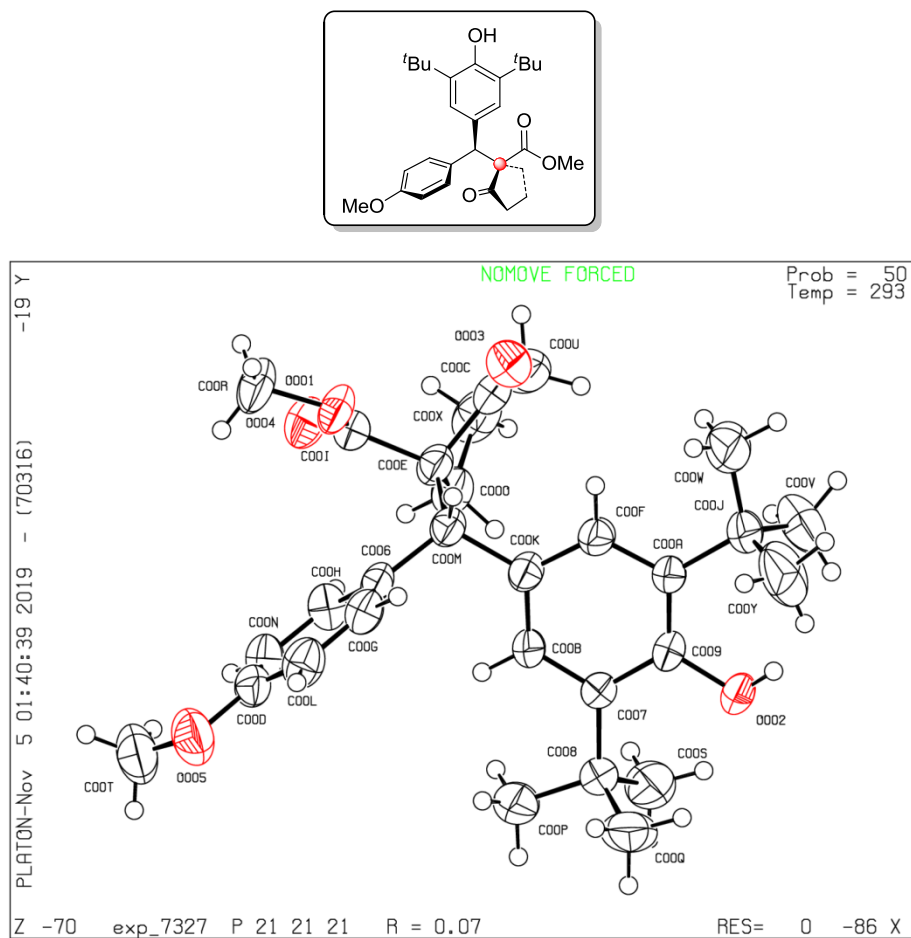


Figure S2. ORTEP Drawing of 3v (CCDC1958259)

Identification code	exp_7327	
Empirical formula	C ₂₉ H ₃₈ O ₅	
Formula weight	466.59	
Temperature	293(2) K	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	P2 ₁ 2 ₁ 2 ₁	
Unit cell dimensions	a = 10.0470(9) Å	a = 90°.
	b = 11.0487(7) Å	b = 90°.
	c = 24.2420(14) Å	g = 90°.
Volume	2691.0(3) Å ³	
Z	4	
Density (calculated)	1.152 Mg/m ³	
Absorption coefficient	0.077 mm ⁻¹	
F(000)	1008	

Crystal size	? x ? x ? mm ³
Theta range for data collection	3.362 to 29.433°.
Index ranges	-12<=h<=13, -13<=k<=14, -32<=l<=32
Reflections collected	21343
Independent reflections	6455 [R(int) = 0.0649]
Completeness to theta = 25.242°	99.6 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	1.00000 and 0.30697
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	6455 / 2 / 316
Goodness-of-fit on F ²	1.027
Final R indices [I>2sigma(I)]	R1 = 0.0652, wR2 = 0.1506
R indices (all data)	R1 = 0.1185, wR2 = 0.1814
Absolute structure parameter	-1.4(10)
Extinction coefficient	n/a
Largest diff. peak and hole	0.230 and -0.239 e.Å ⁻³

7.3 Absolute Configuration of 4z

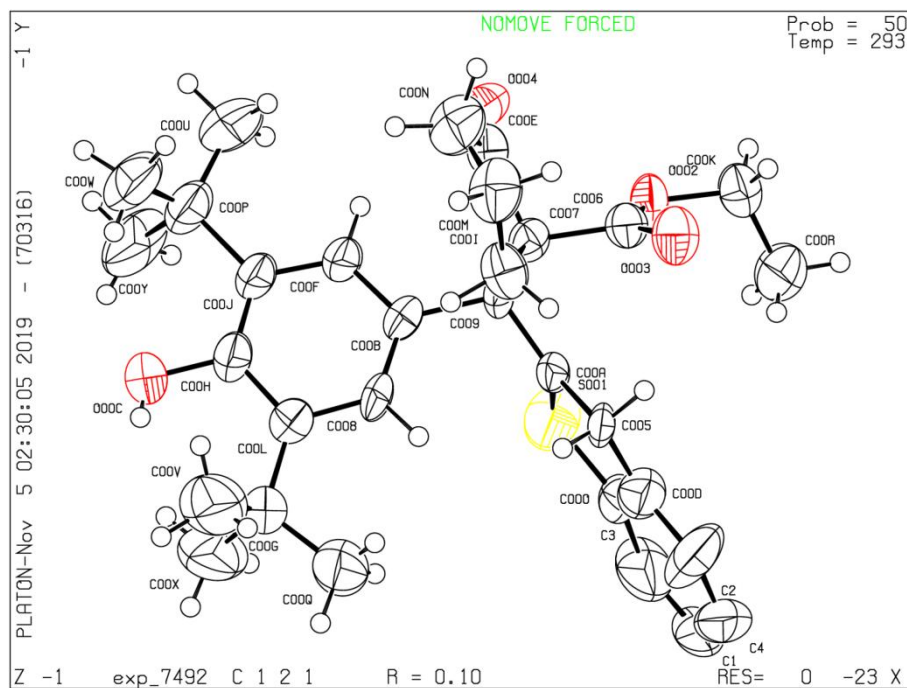
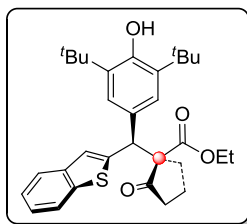


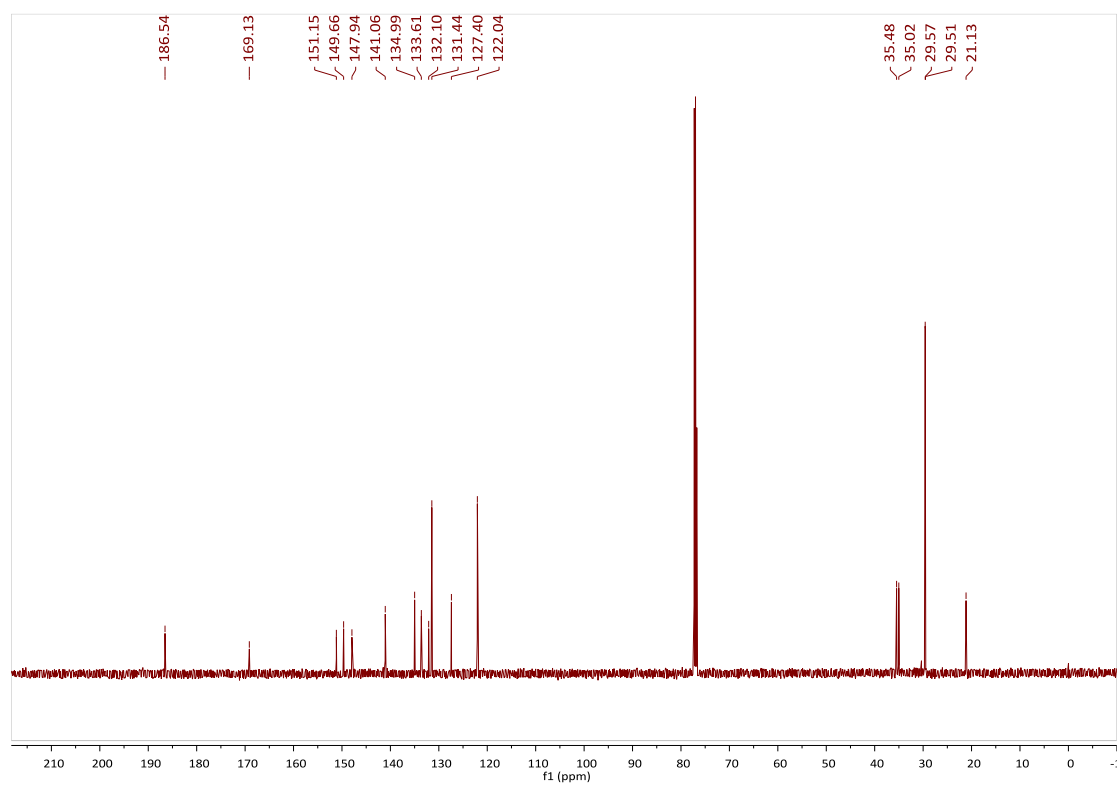
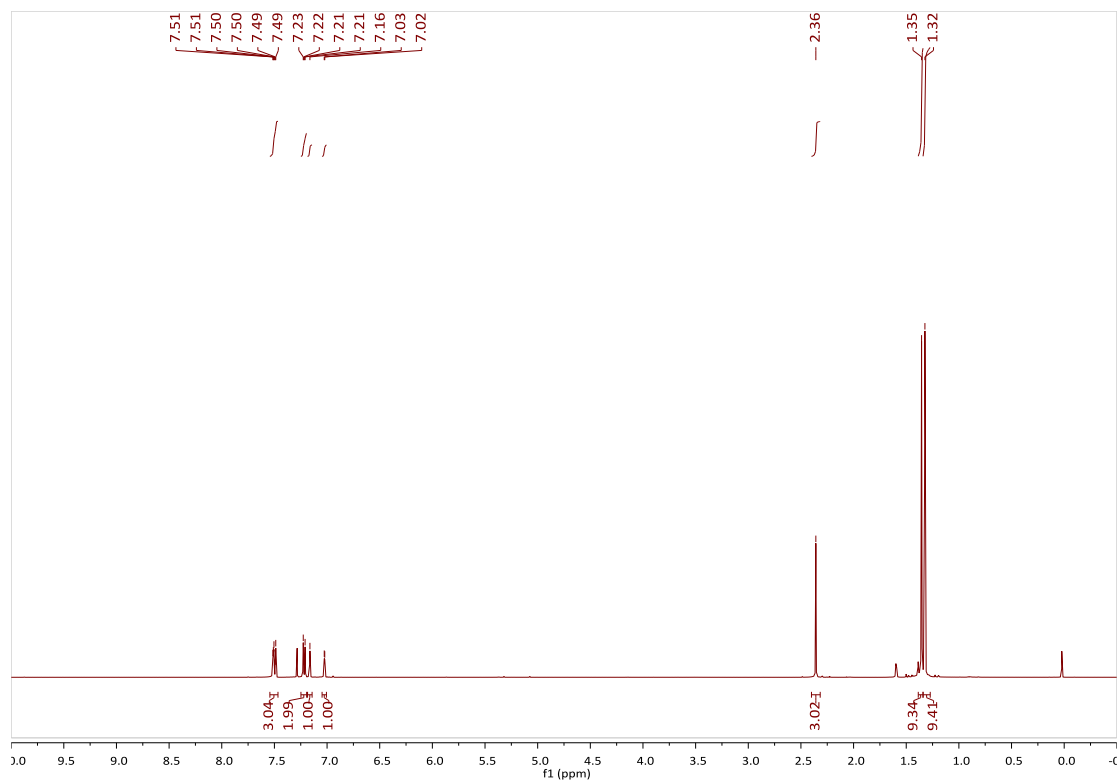
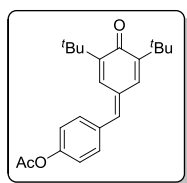
Figure S3. ORTEP Drawing of **4z** (CCDC1963687)

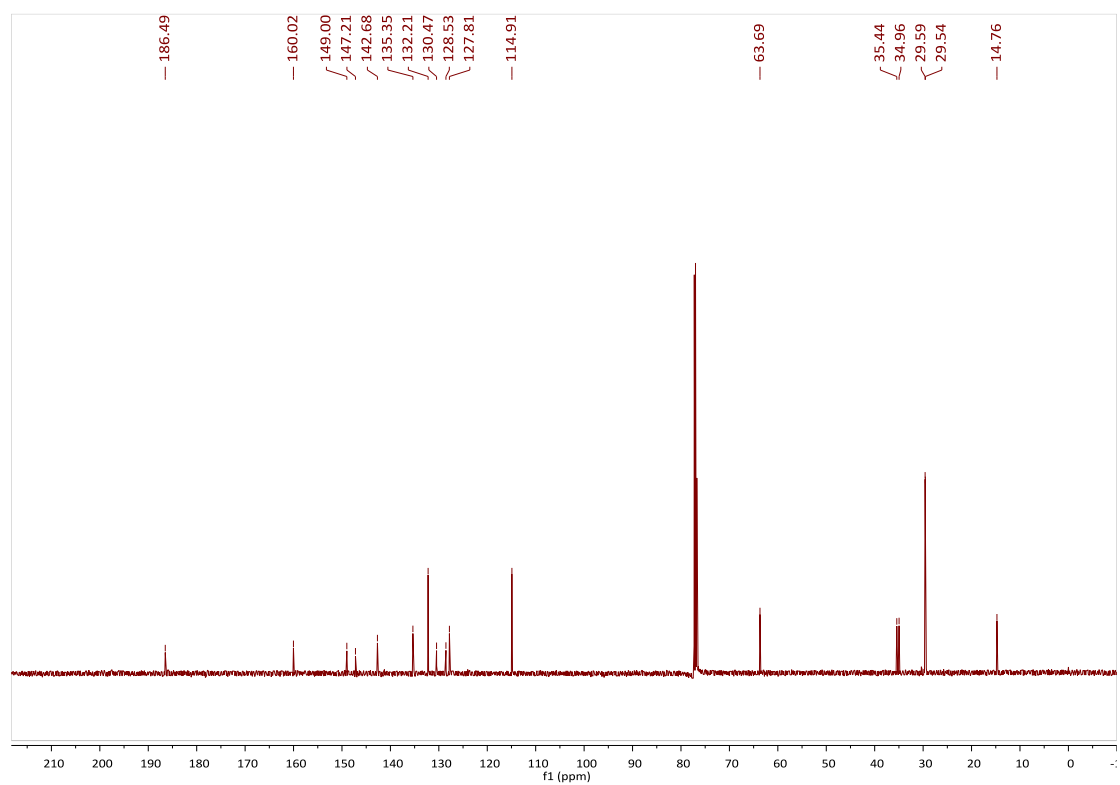
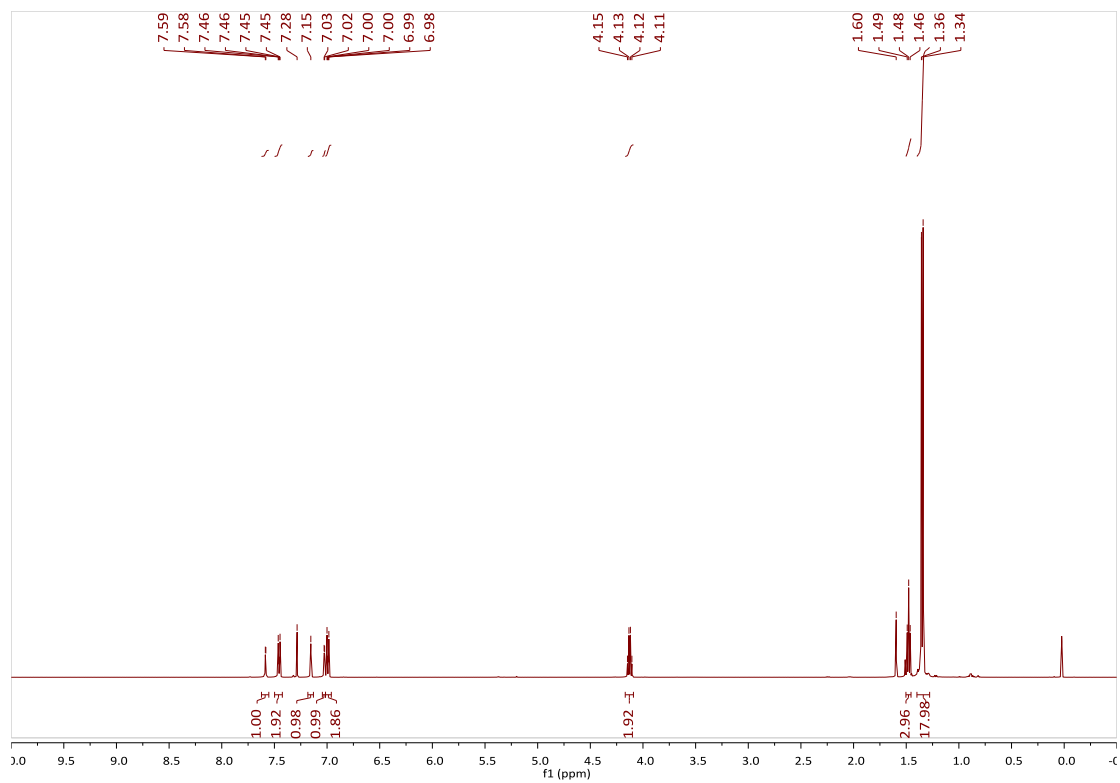
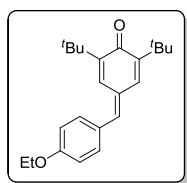
Identification code	exp_7492
Empirical formula	C ₃₁ H ₃₉ O ₄ S
Formula weight	507.68
Temperature	293(2) K
Wavelength	0.71073 Å
Crystal system	Monoclinic
Space group	C 1 2 1
Unit cell dimensions	$a = 23.808(4)$ Å $b = 10.360(3)$ Å $c = 11.8065(17)$ Å
	$\alpha = 90^\circ$ $\beta = 95.046(15)^\circ$ $\gamma = 90^\circ$
Volume	2900.7(9) Å ³
Z	4
Density (calculated)	1.163 Mg/m ³
Absorption coefficient	0.144 mm ⁻¹
F(000)	1092

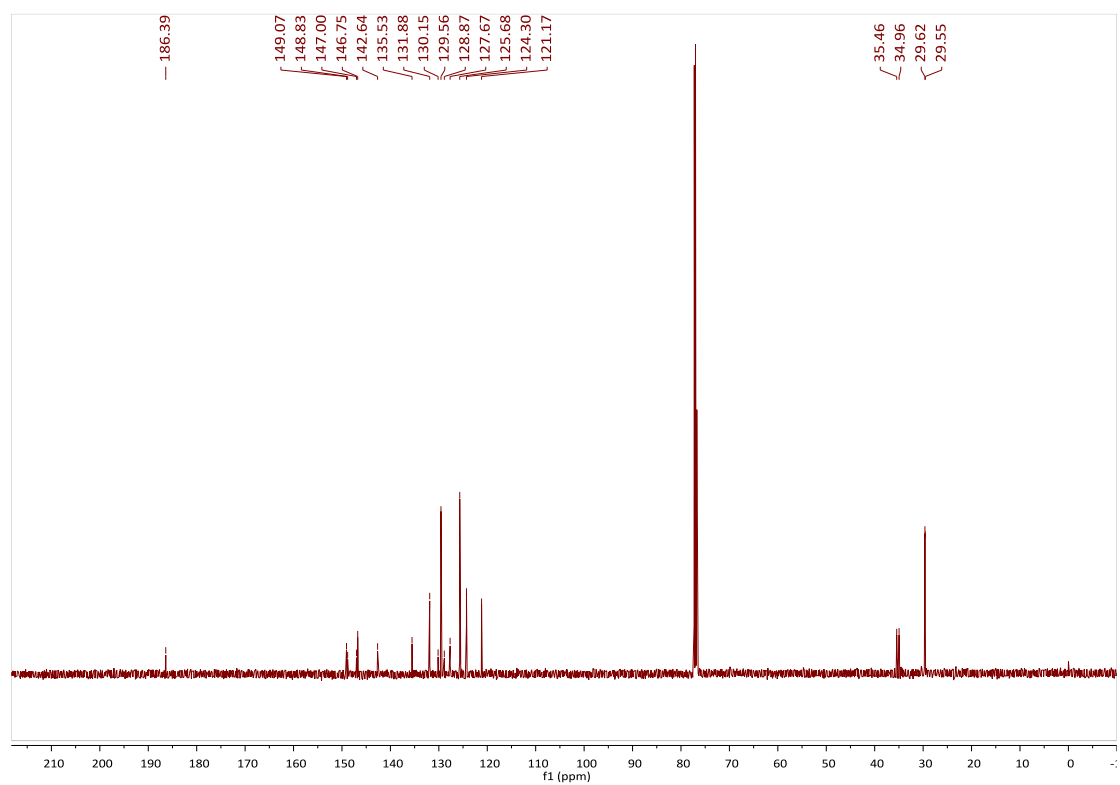
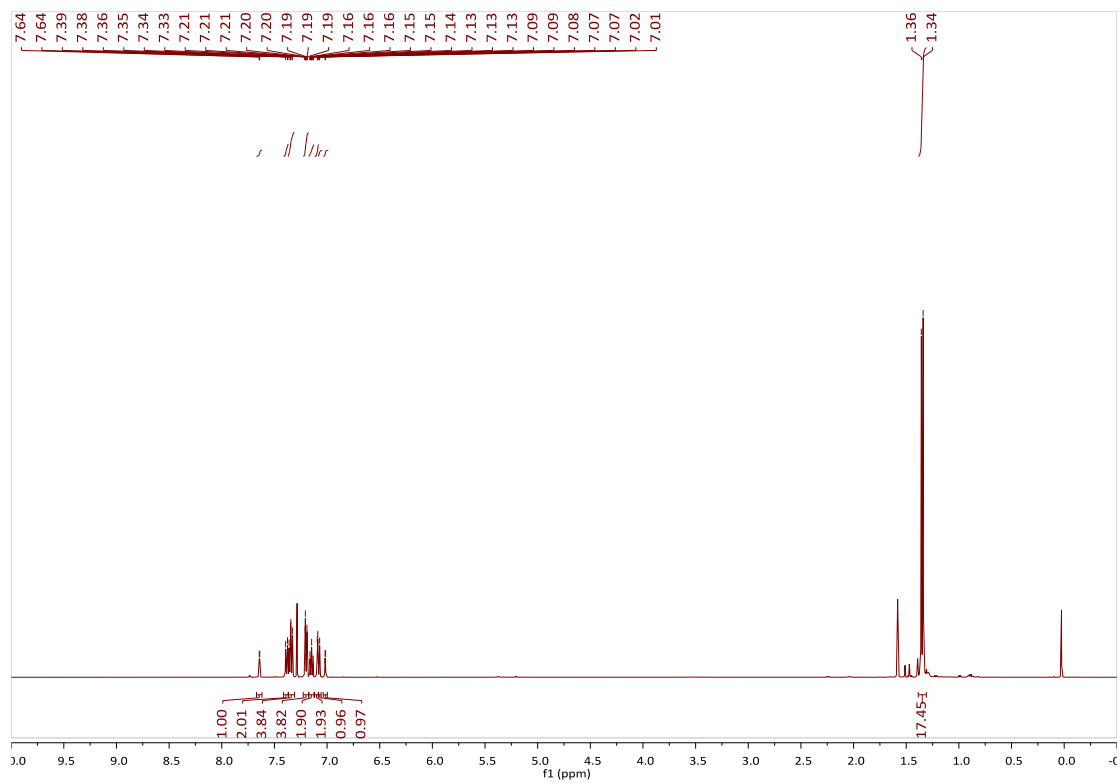
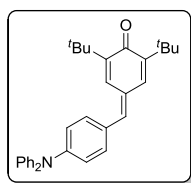
Crystal size	? x ? x ? mm ³
Theta range for data collection	3.436 to 29.479°.
Index ranges	-32<=h<=23, -13<=k<=13, -15<=l<=15
Reflections collected	11710
Independent reflections	6219 [R(int) = 0.0758]
Completeness to theta = 25.242°	99.7 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	1.00000 and 0.50177
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	6219 / 3 / 333
Goodness-of-fit on F ²	0.992
Final R indices [I>2sigma(I)]	R1 = 0.1019, wR2 = 0.2143
R indices (all data)	R1 = 0.1964, wR2 = 0.2670
Absolute structure parameter	-0.02(18)
Extinction coefficient	n/a
Largest diff. peak and hole	0.350 and -0.328 e.Å ⁻³

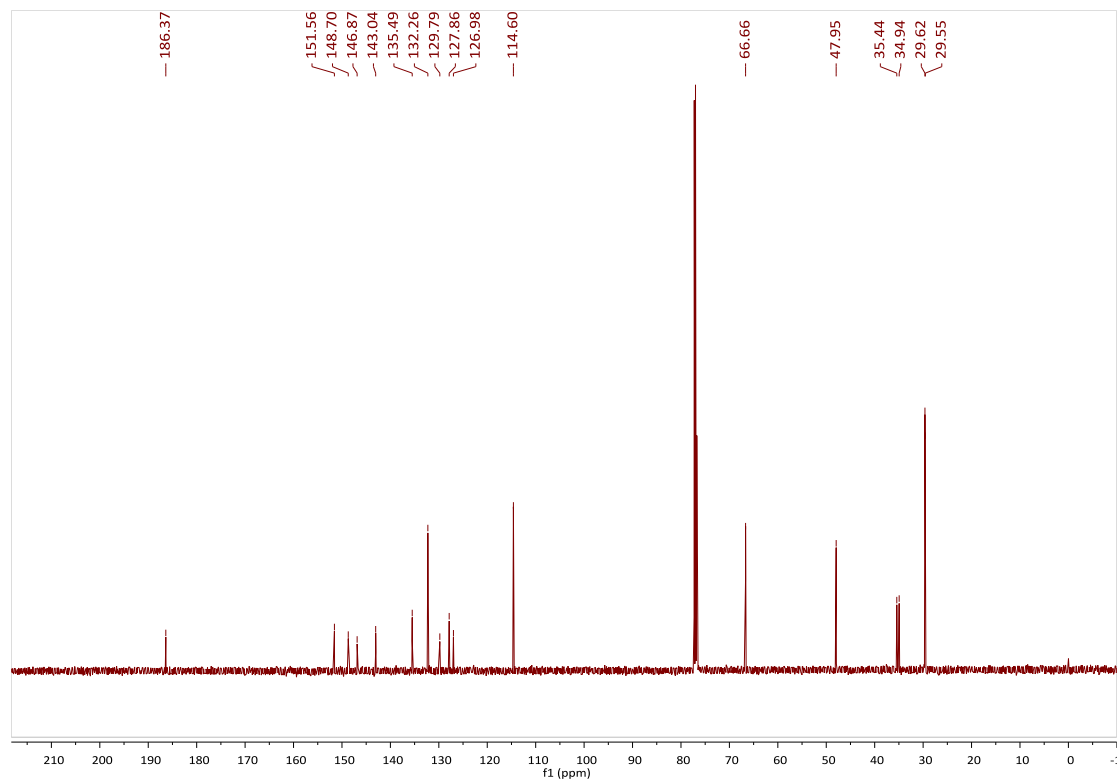
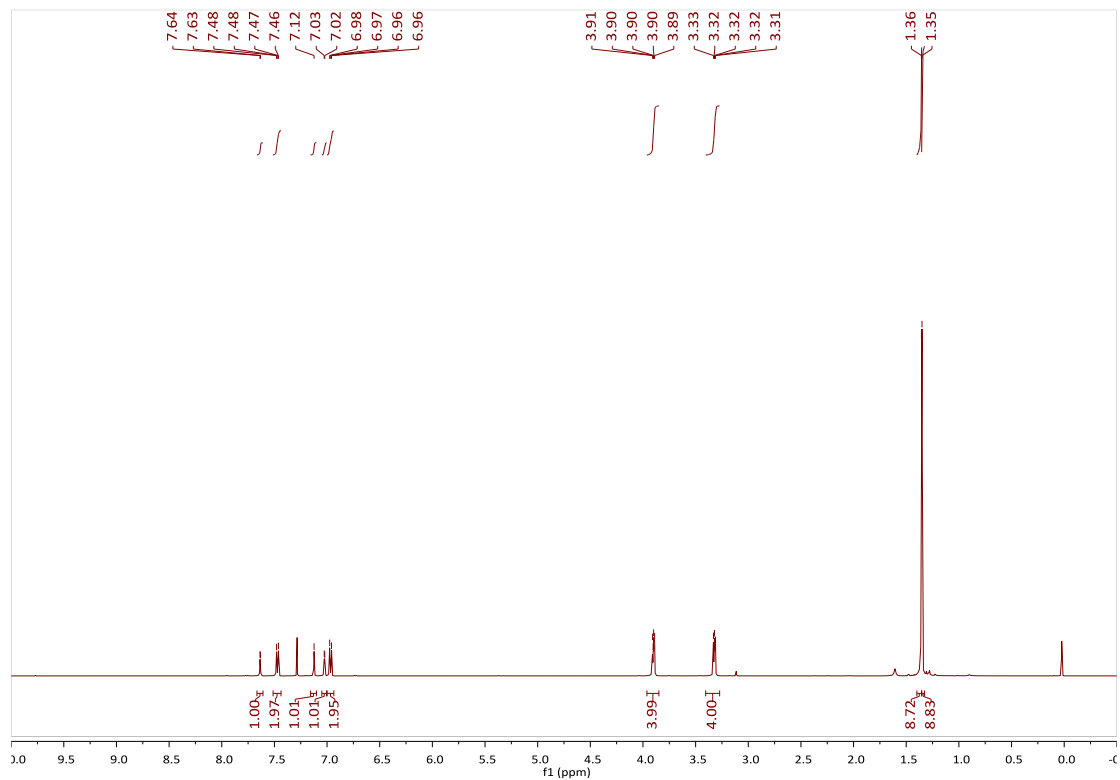
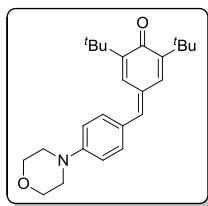
VIII. NMR Spectra and HPLC Spectra

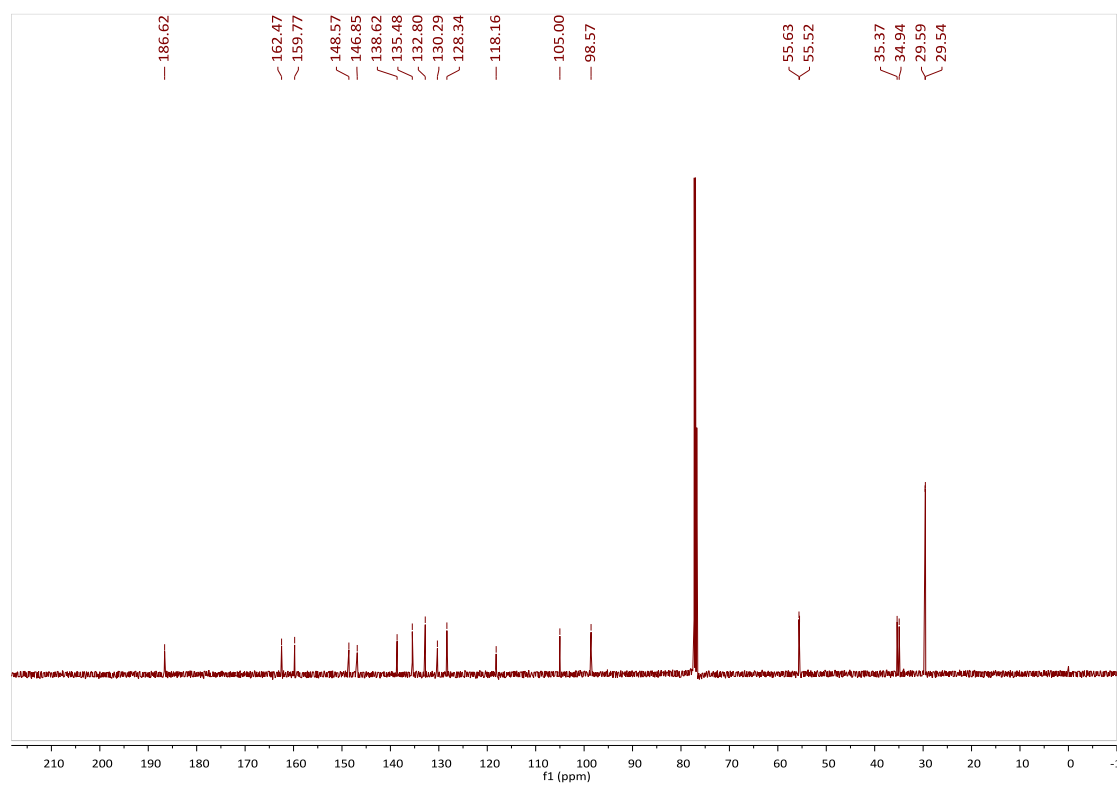
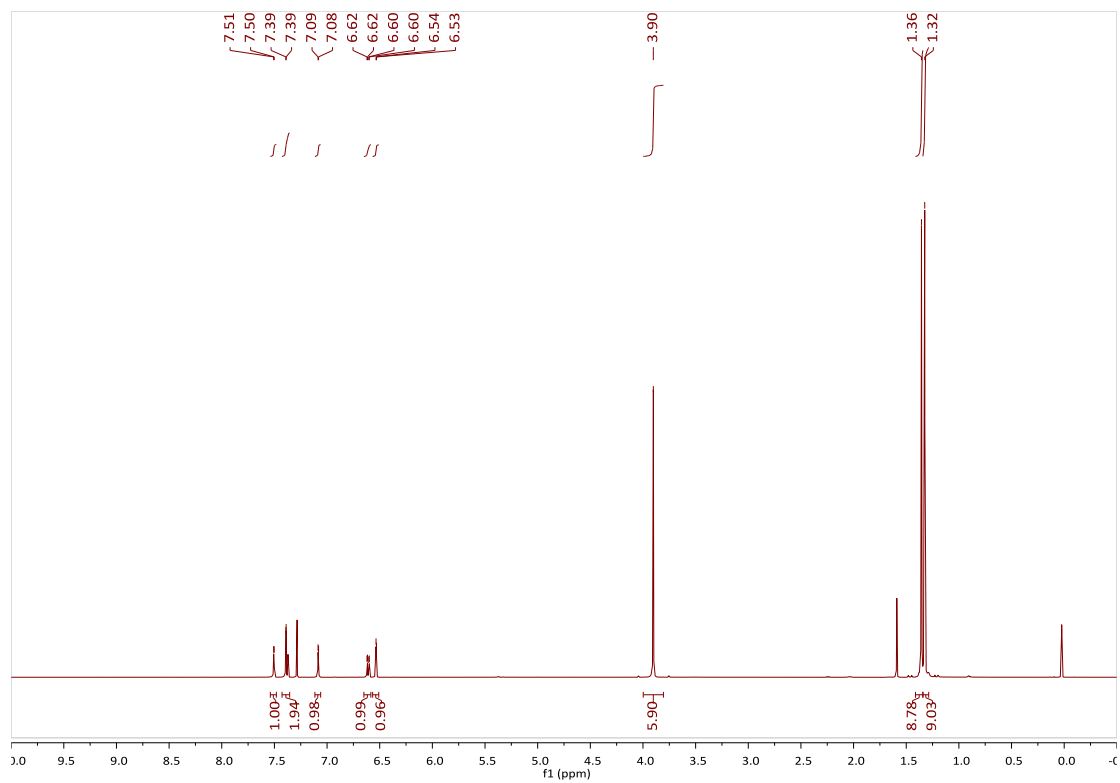
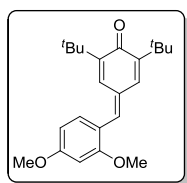
Please refer to next pages

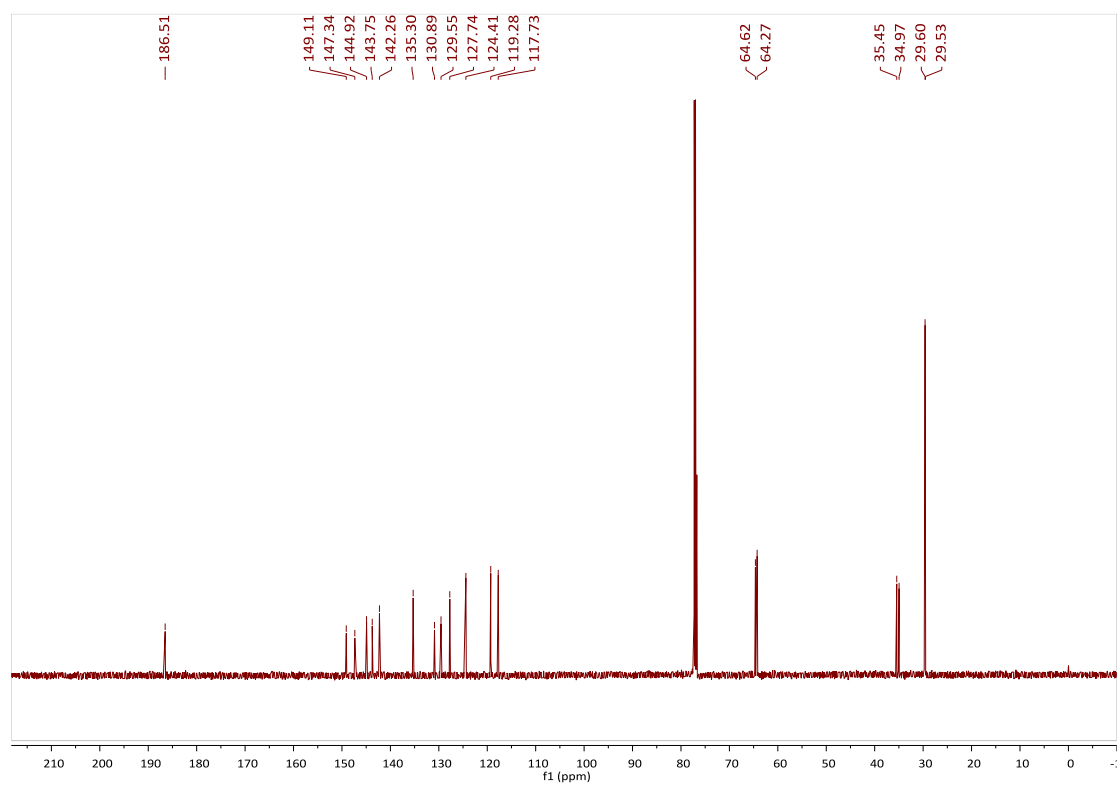
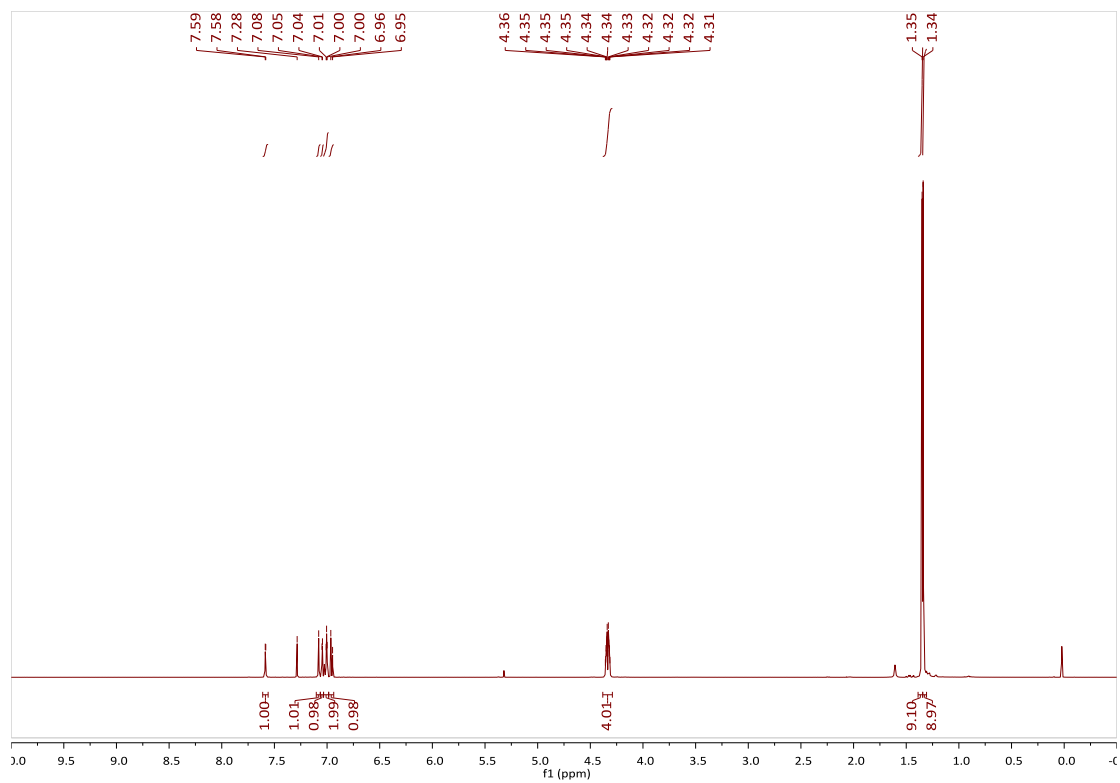
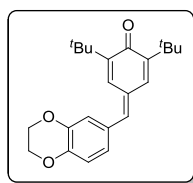


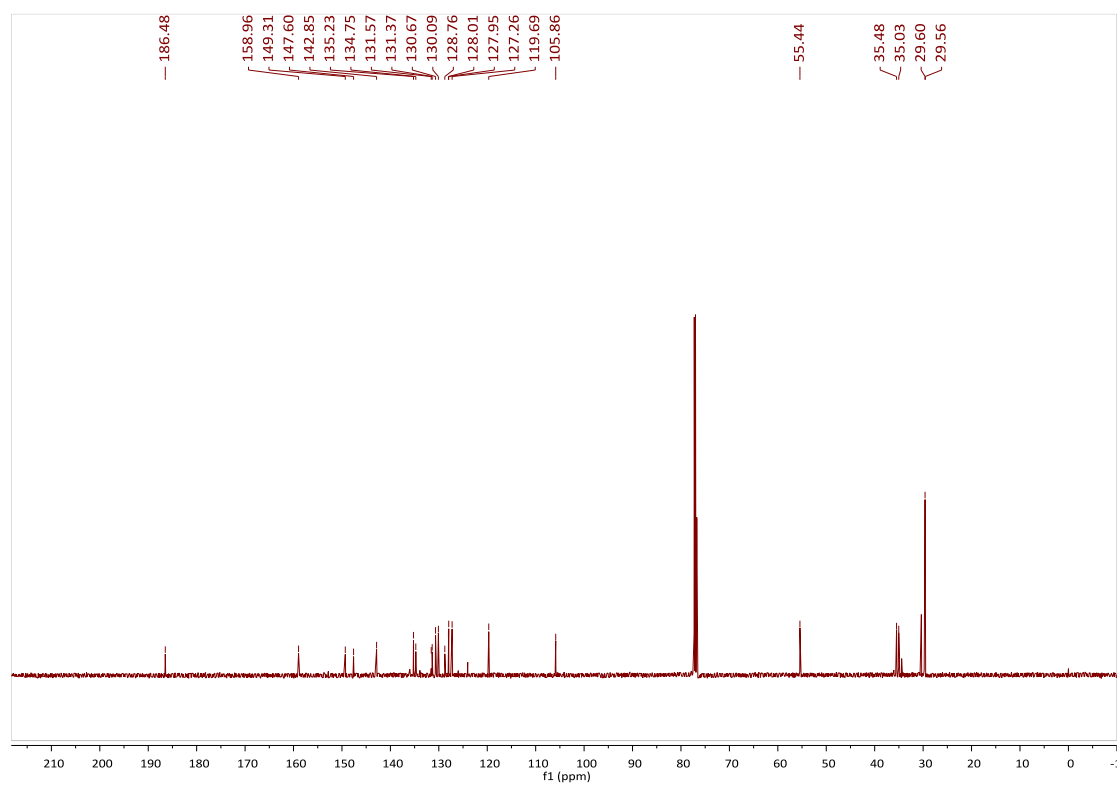
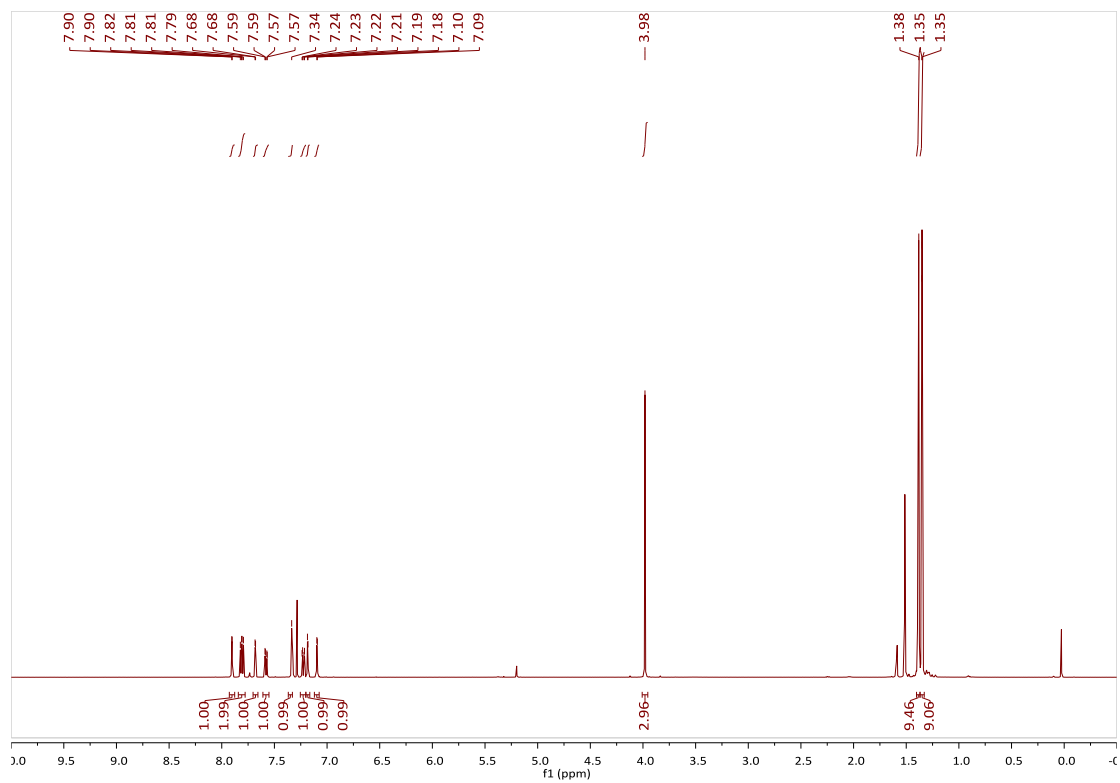
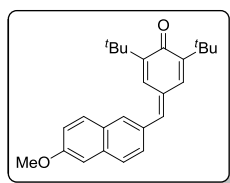


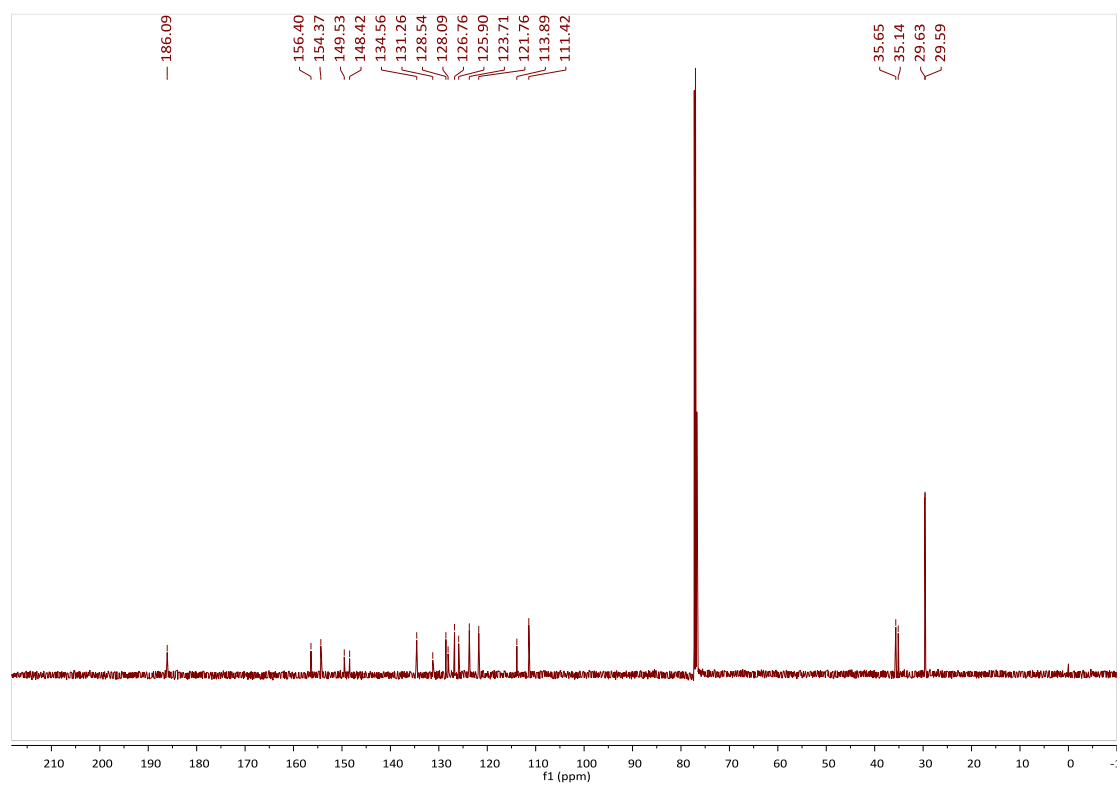
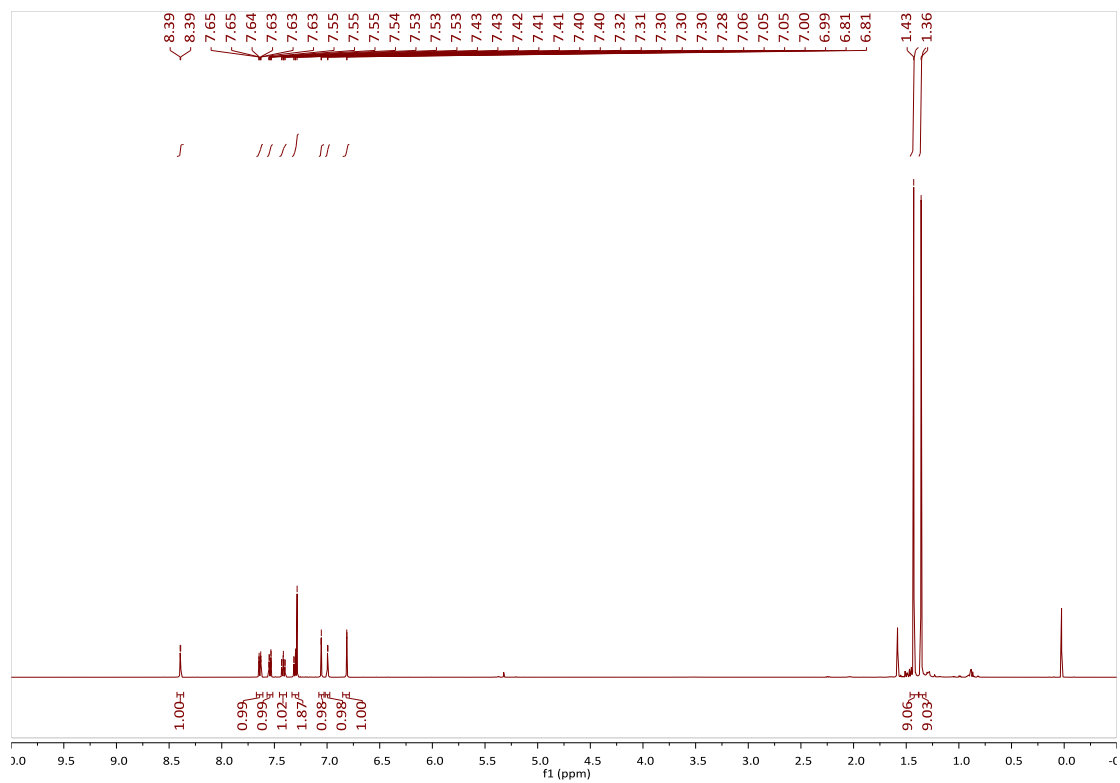
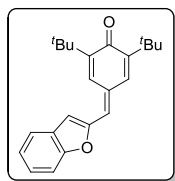


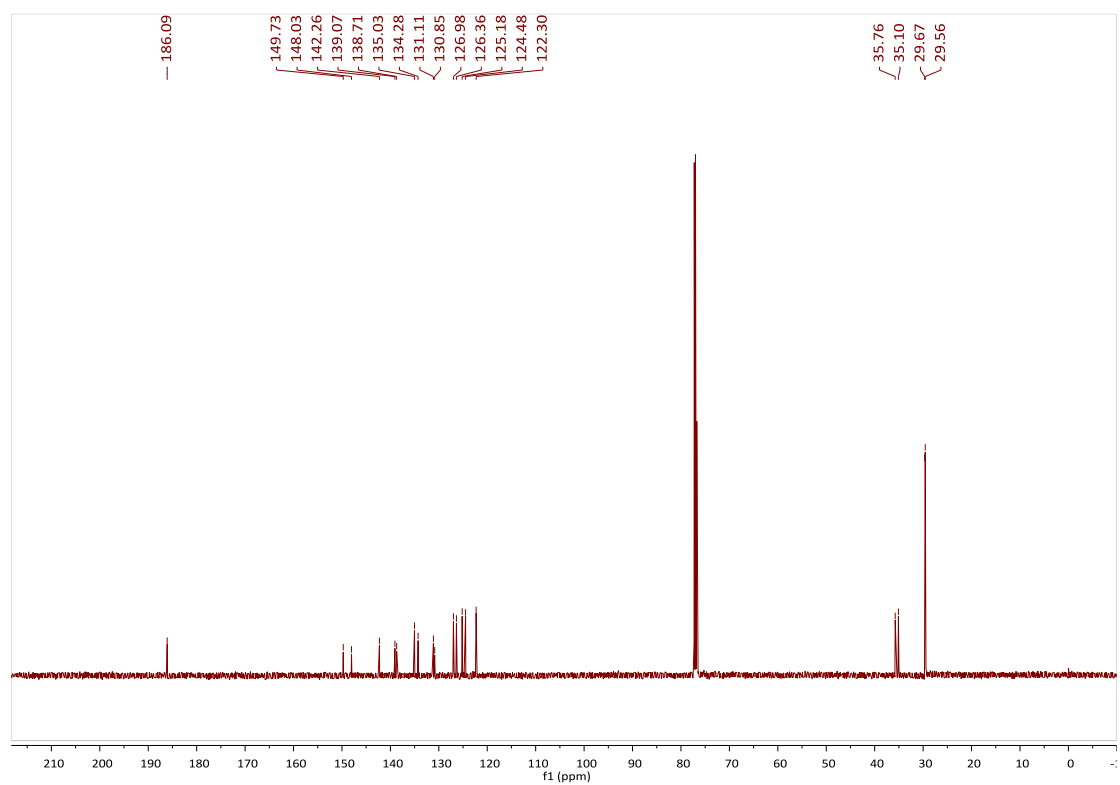
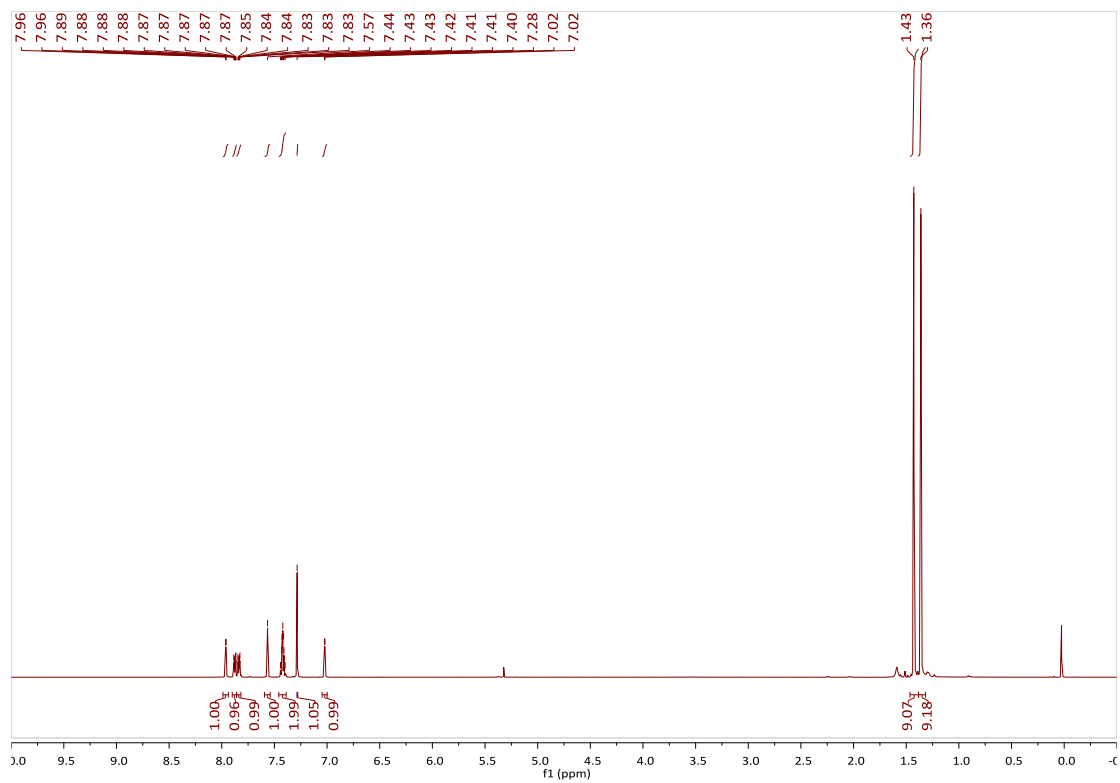
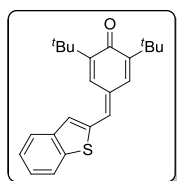


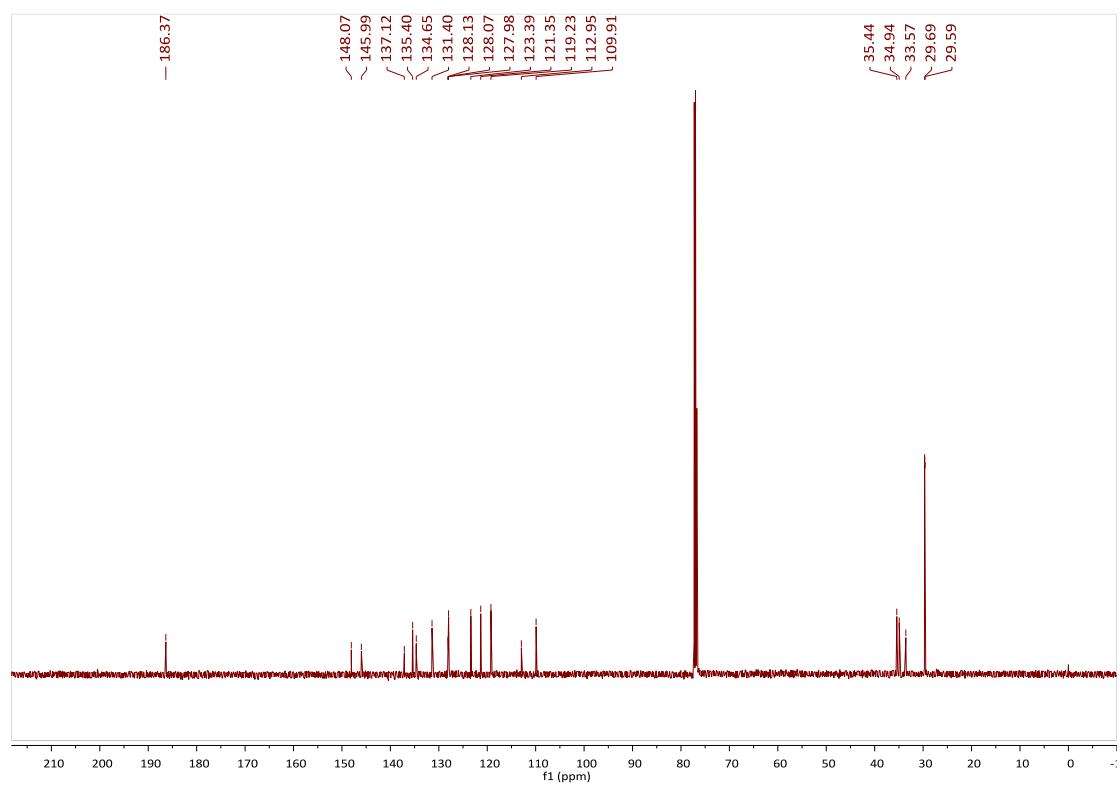
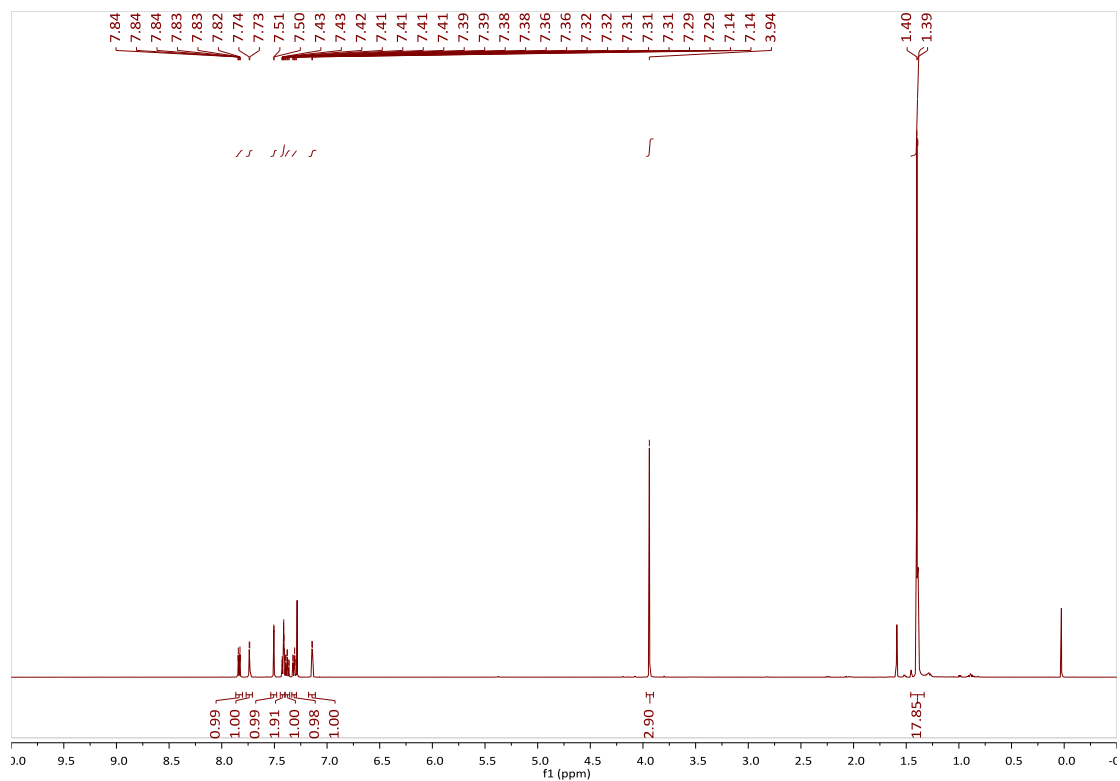
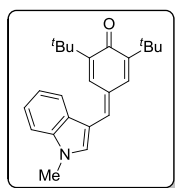


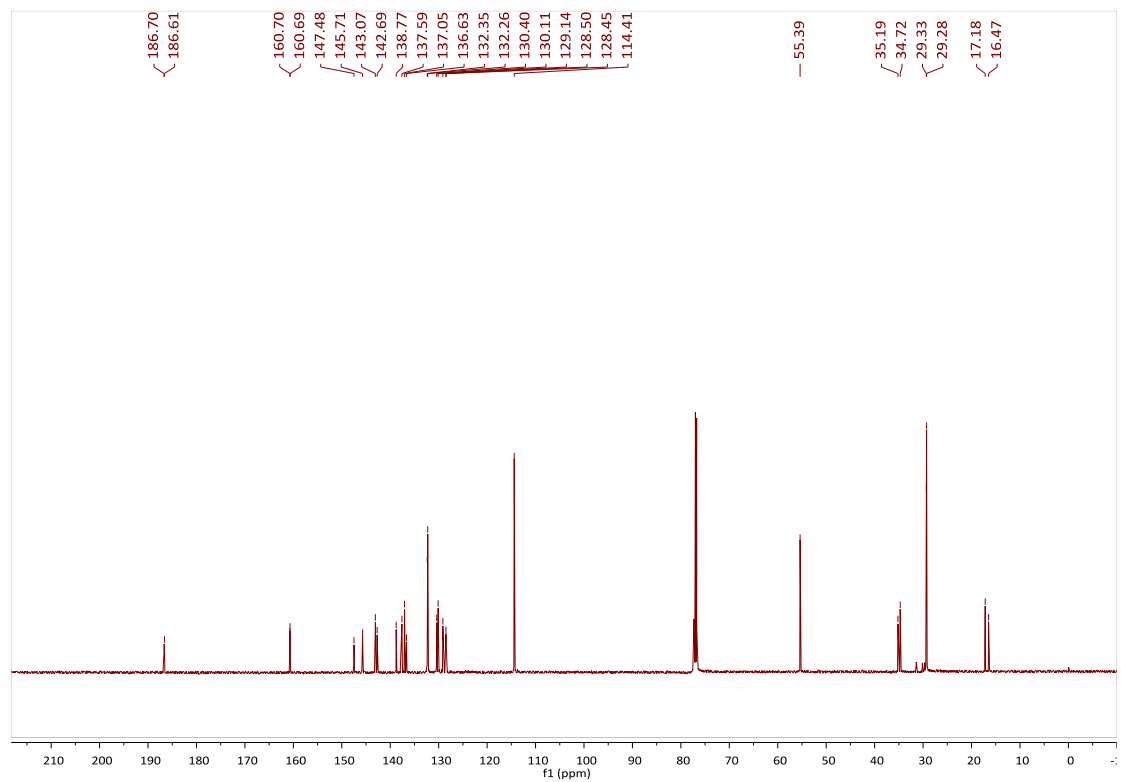
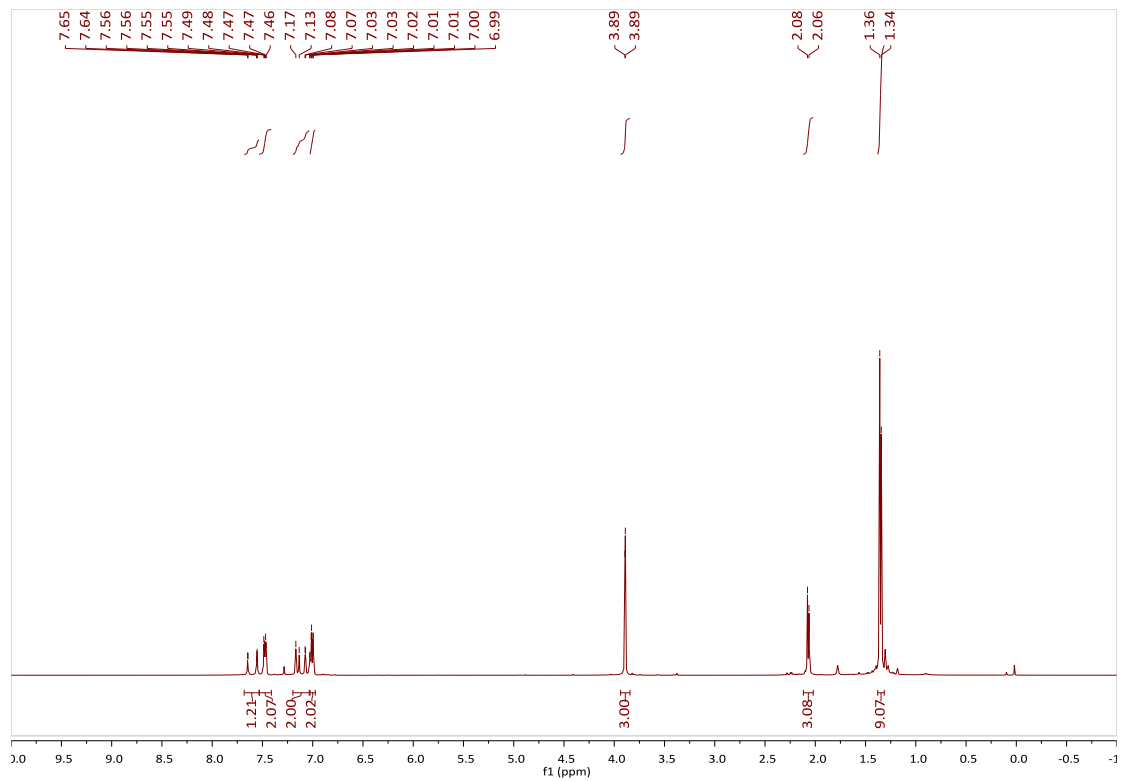
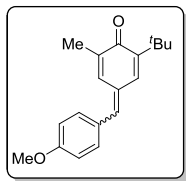


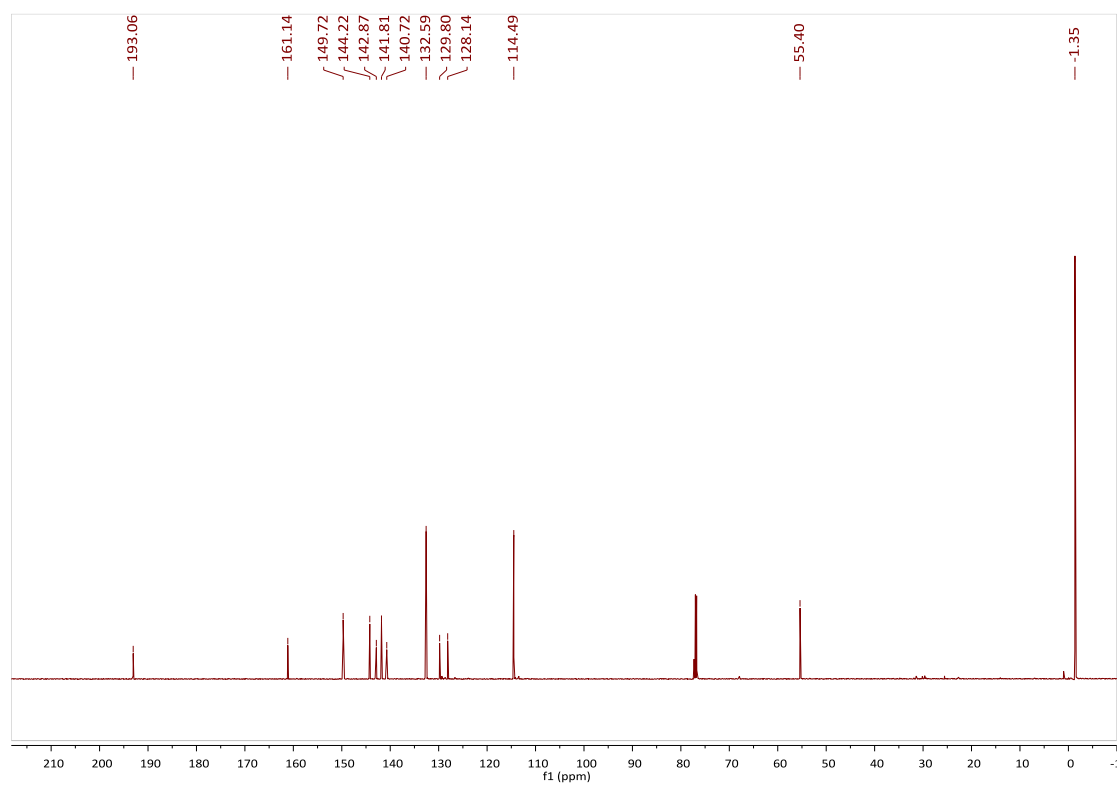
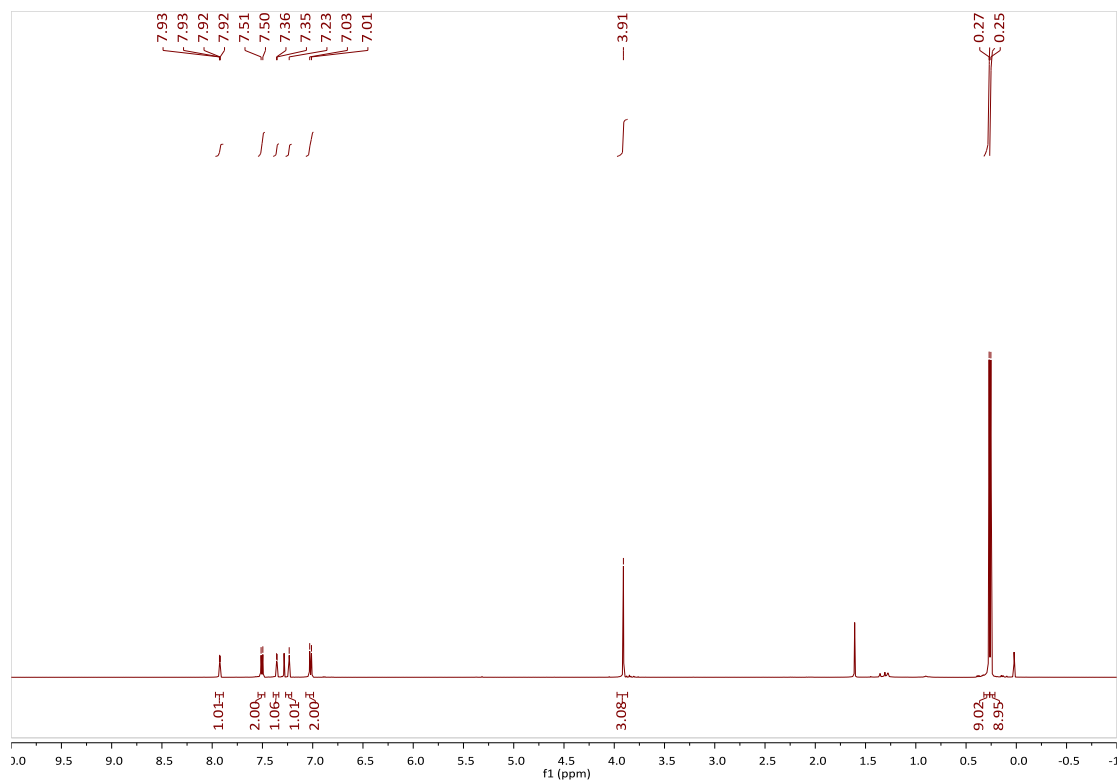
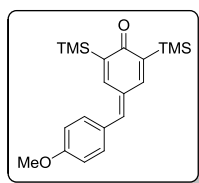


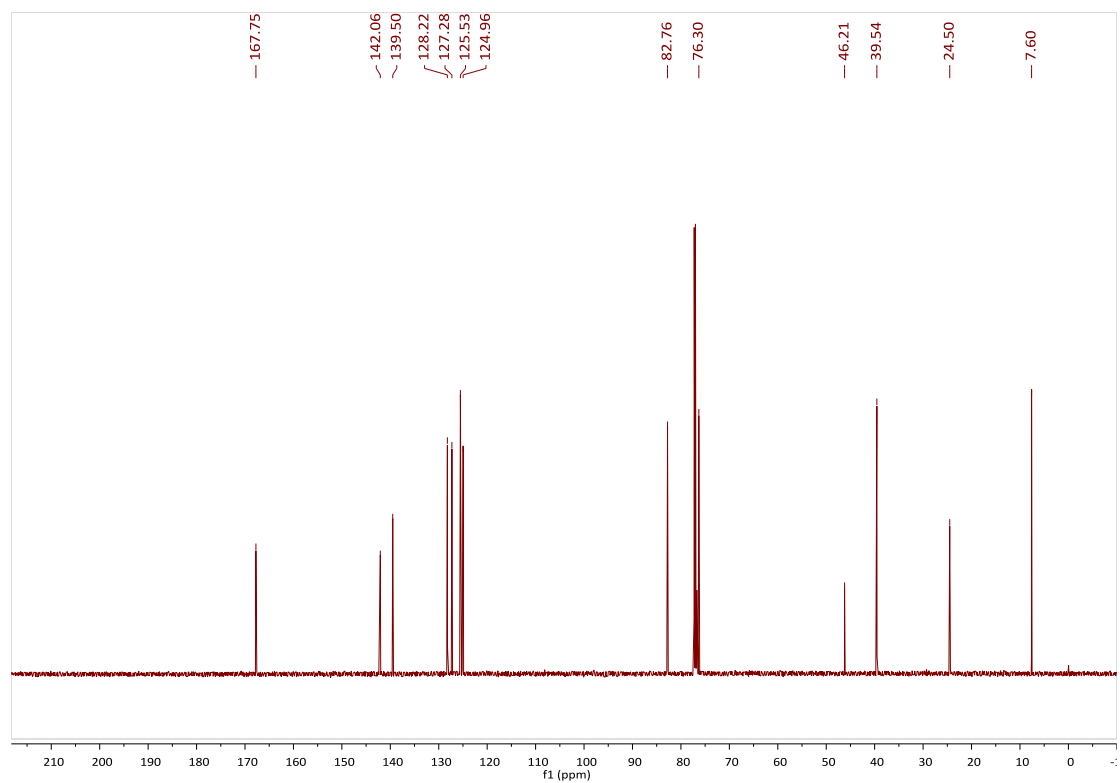
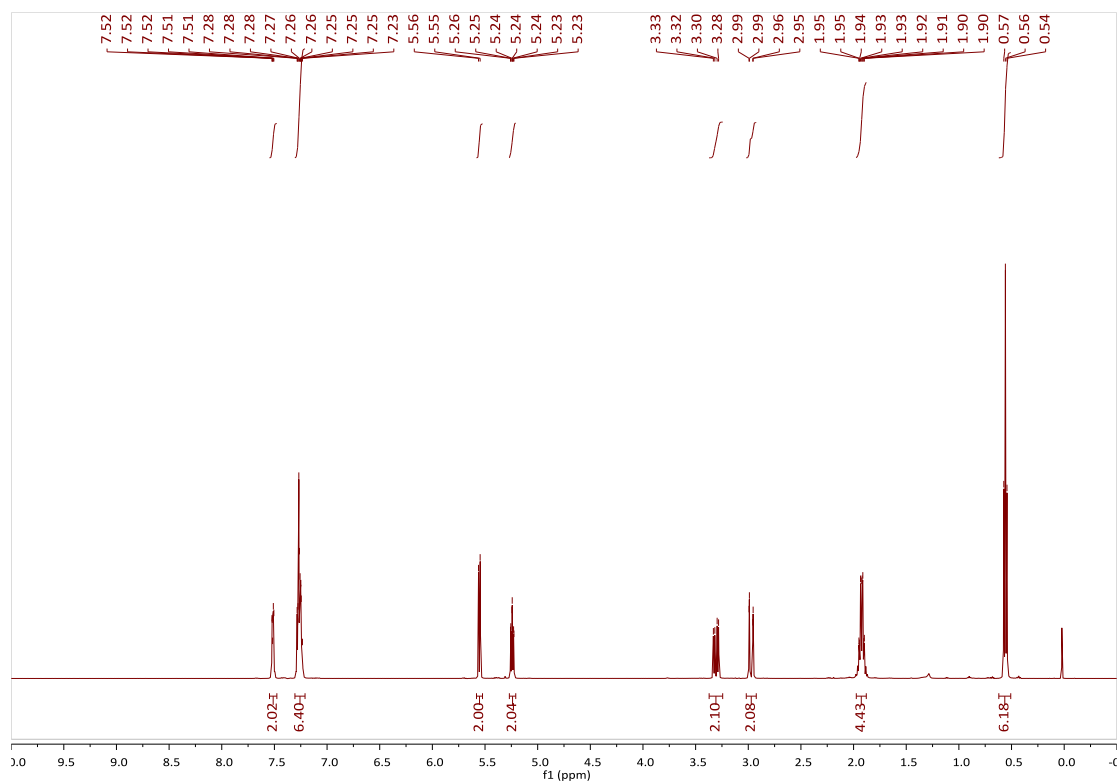
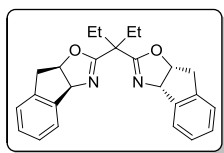


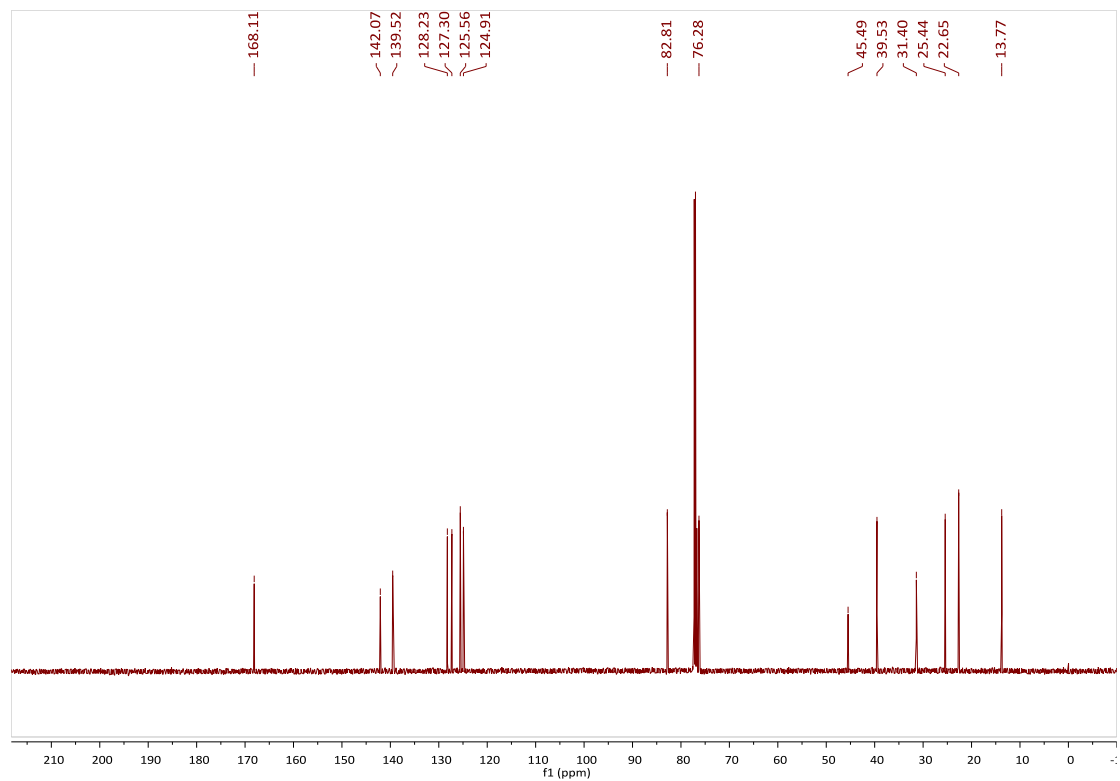
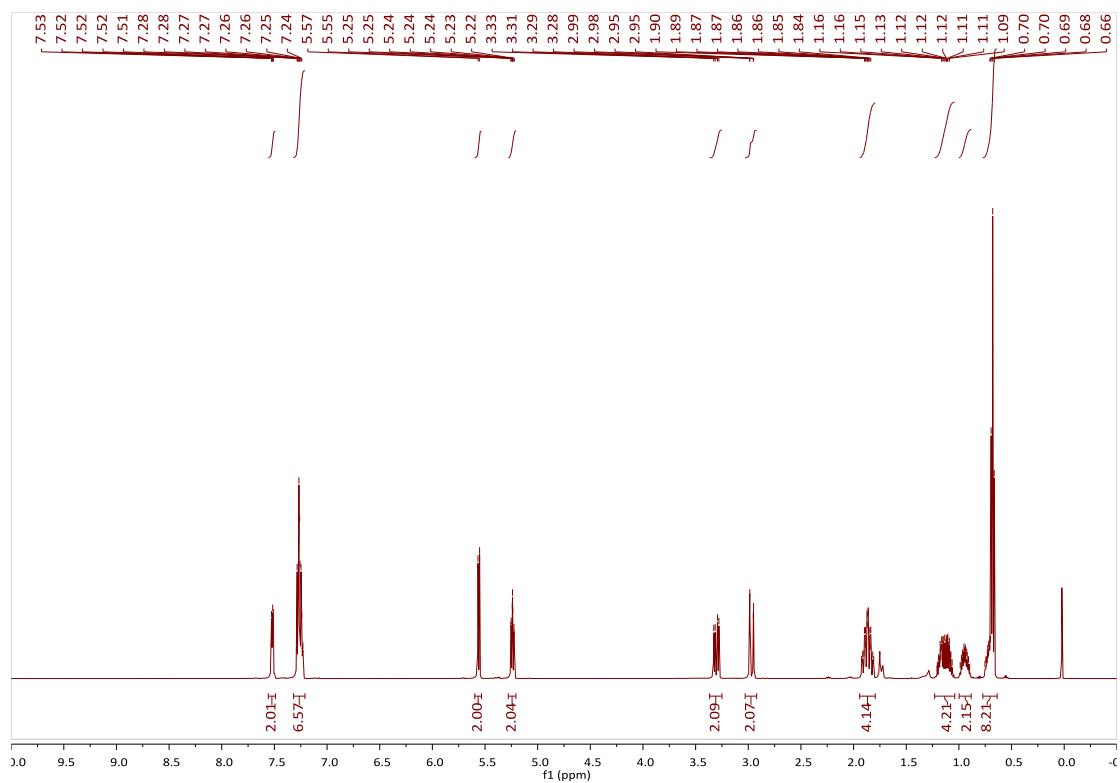
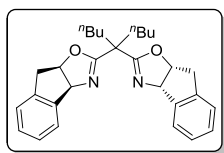


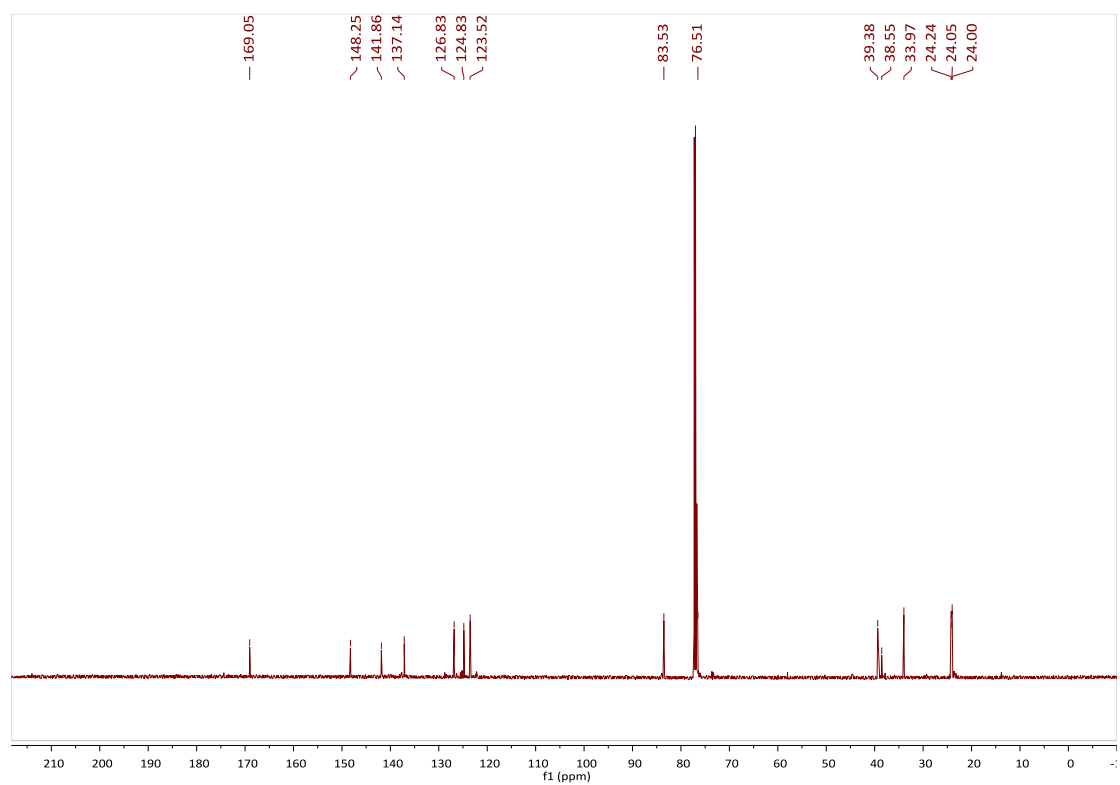
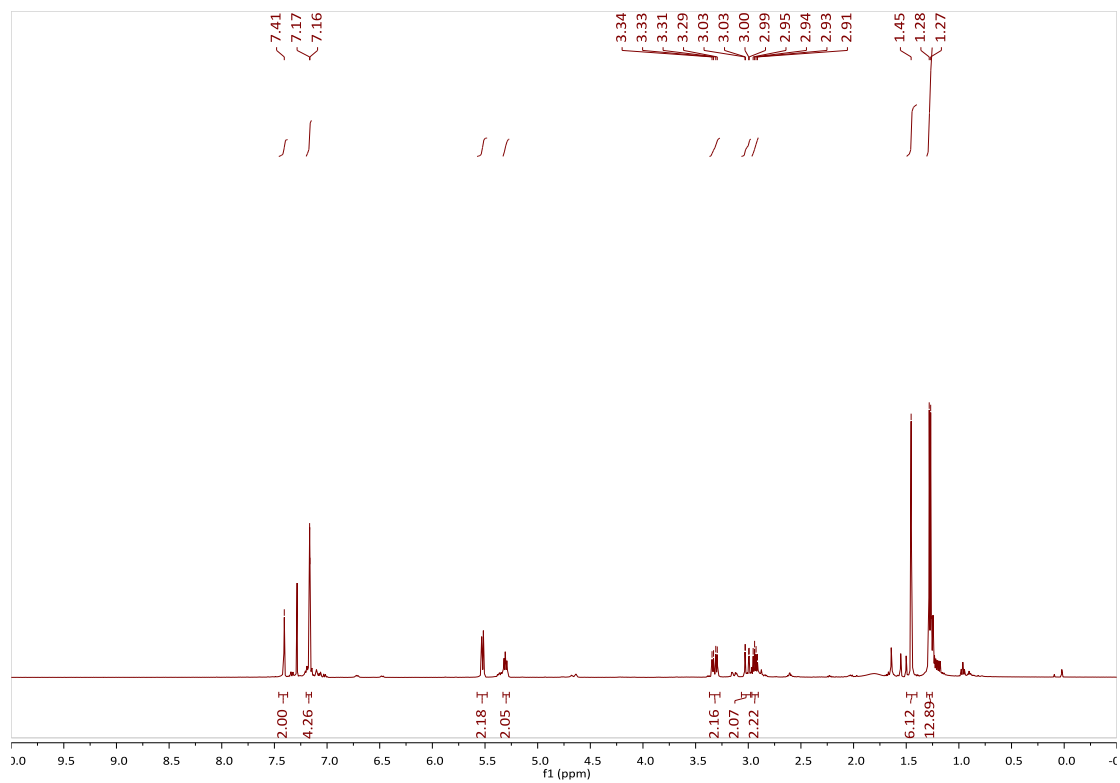
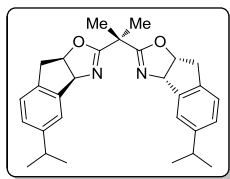


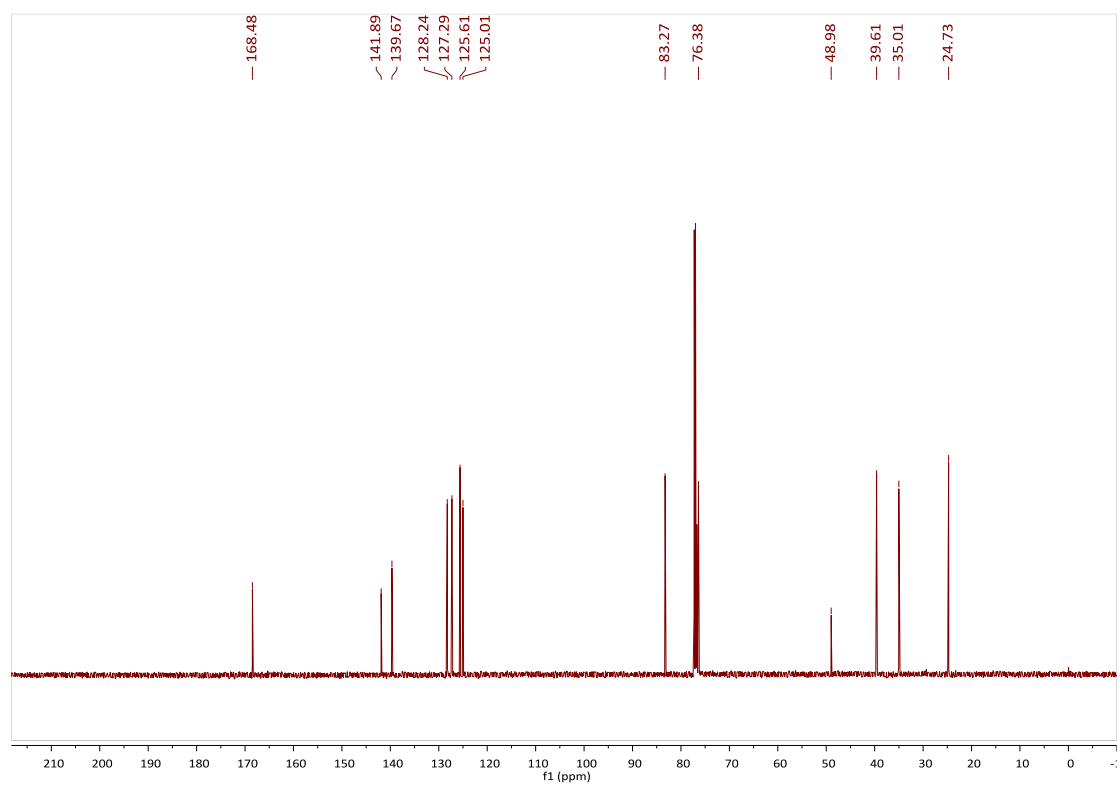
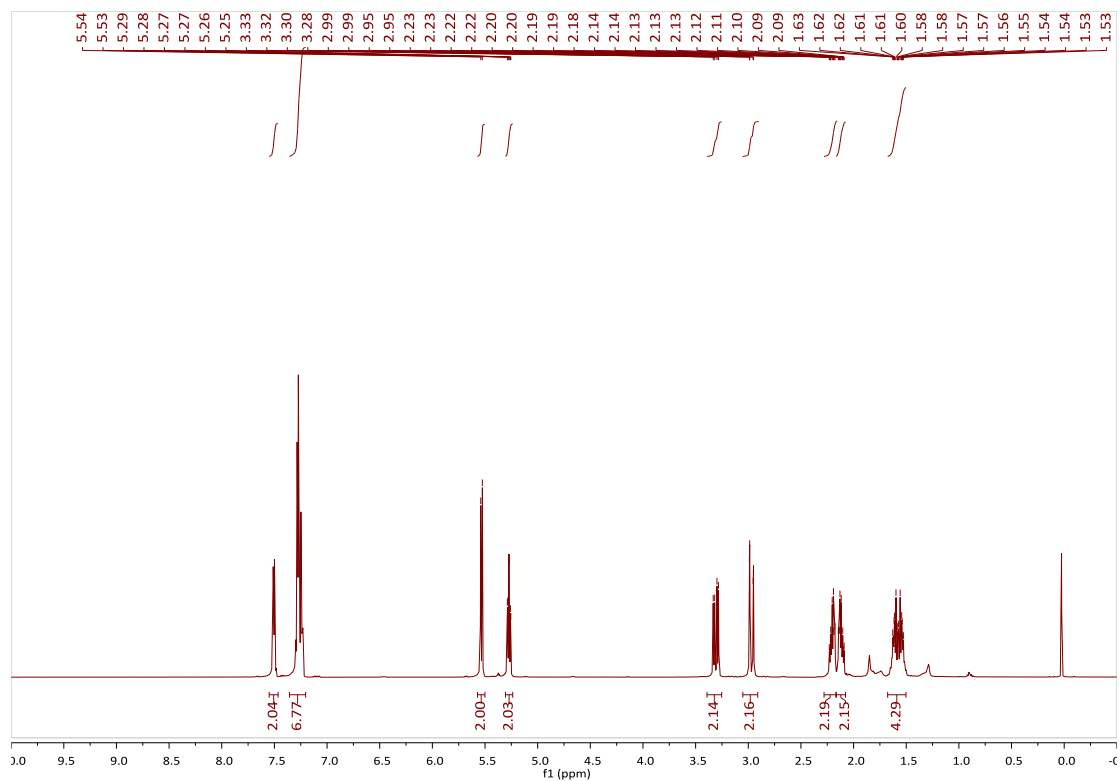


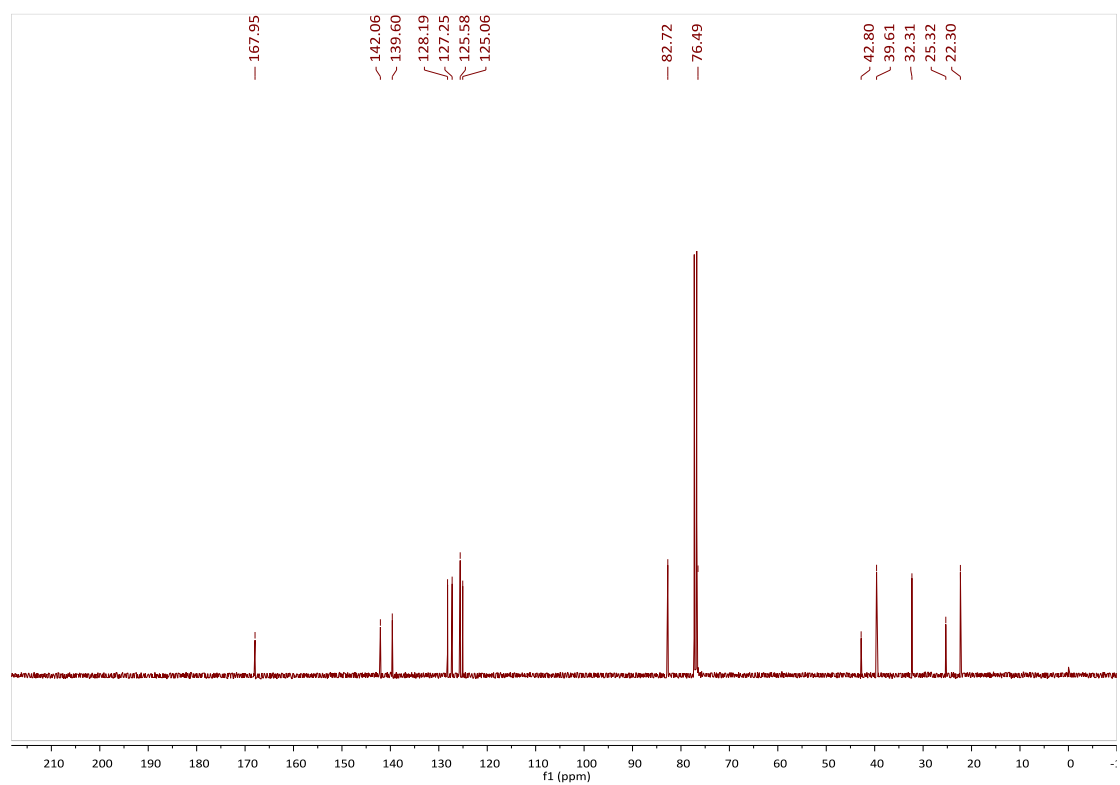
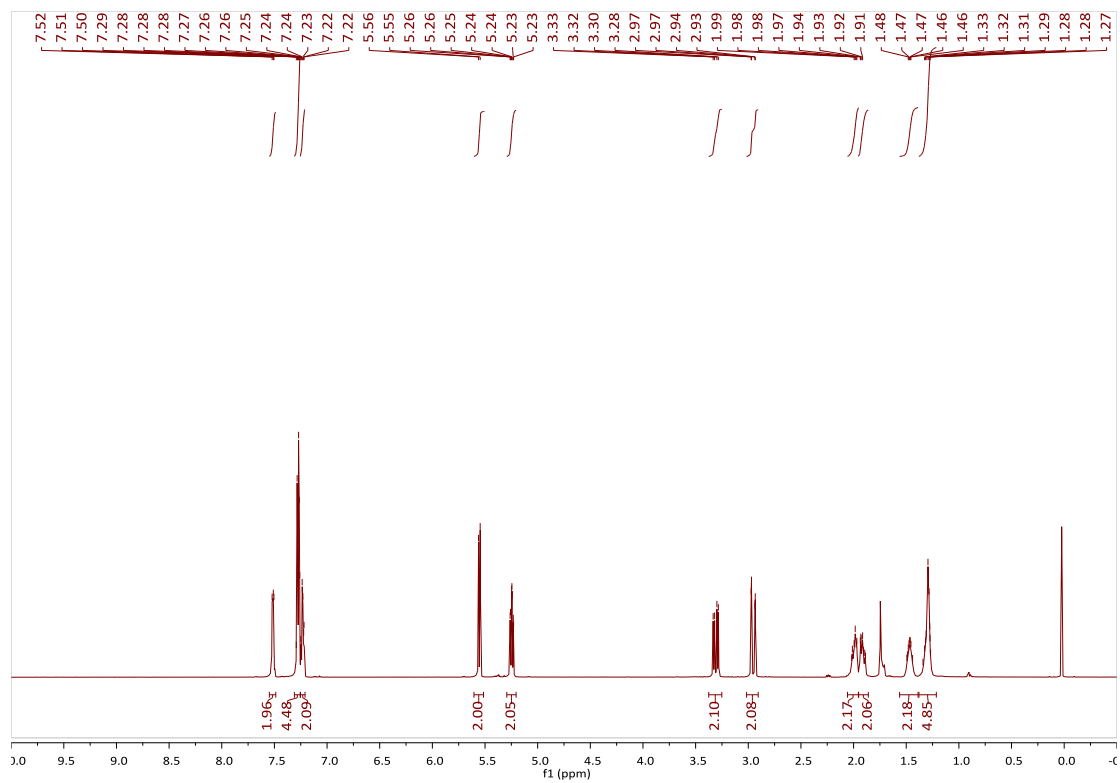
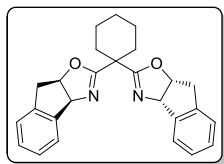


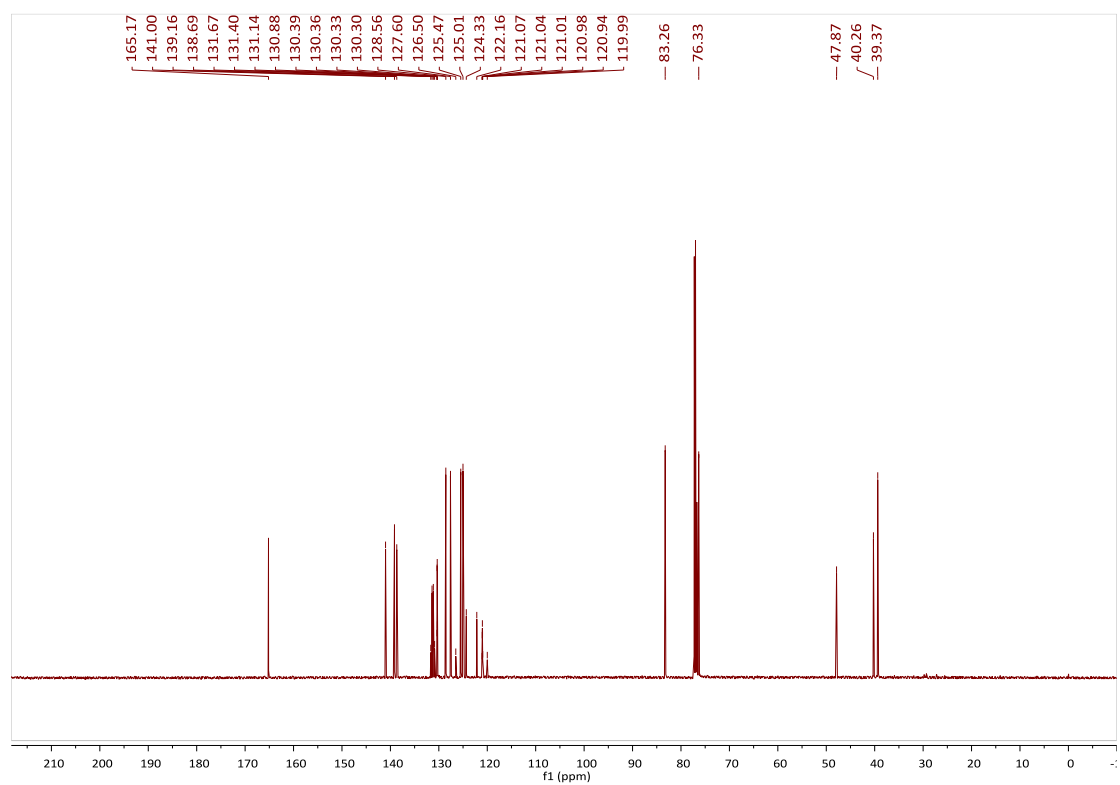
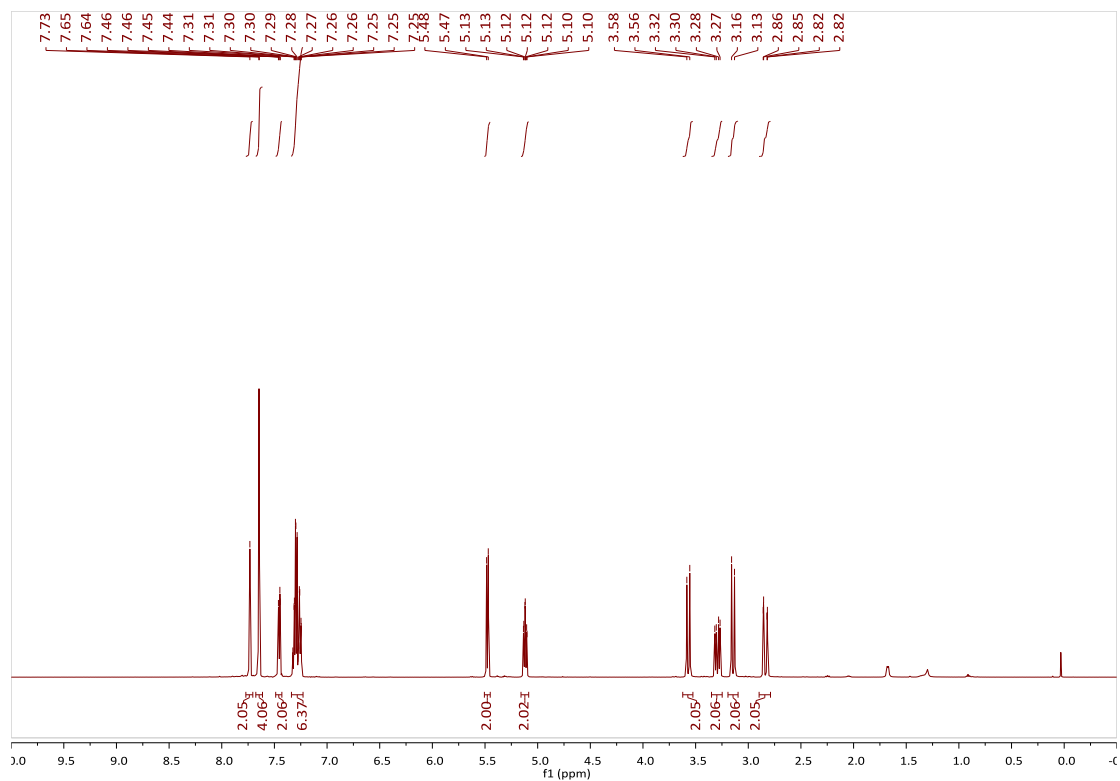
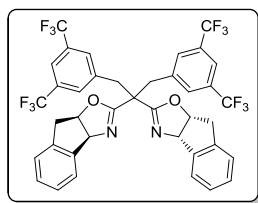


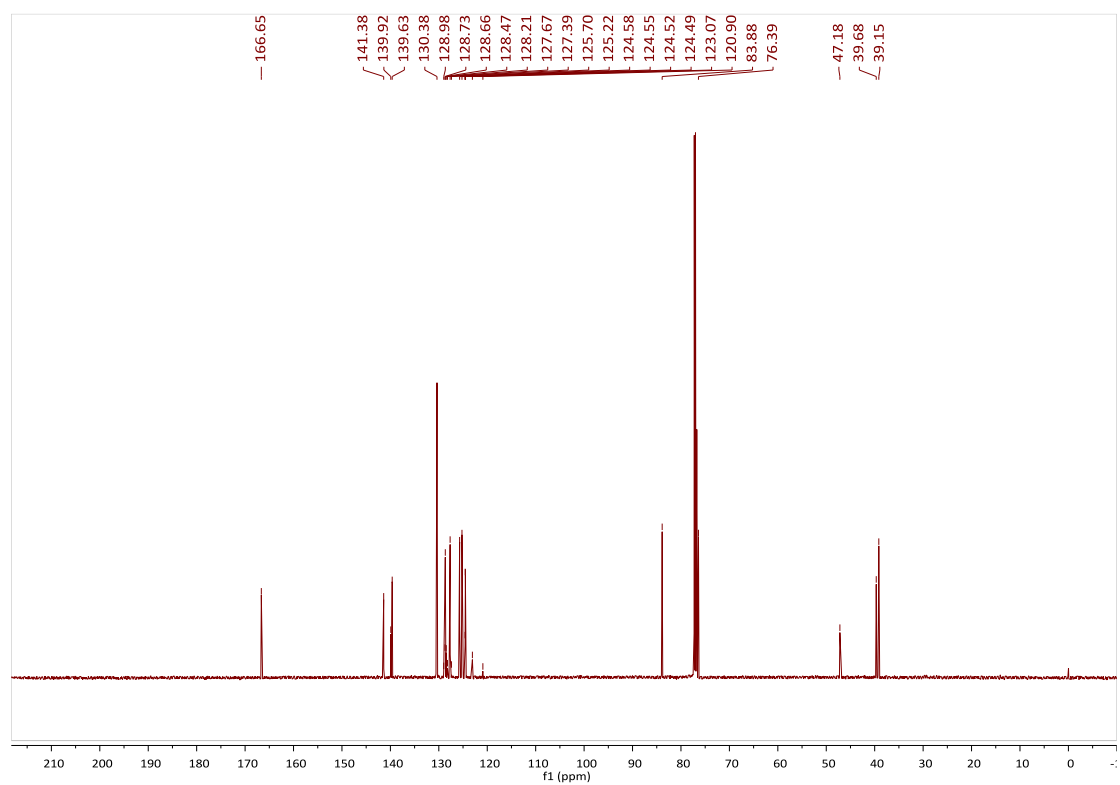
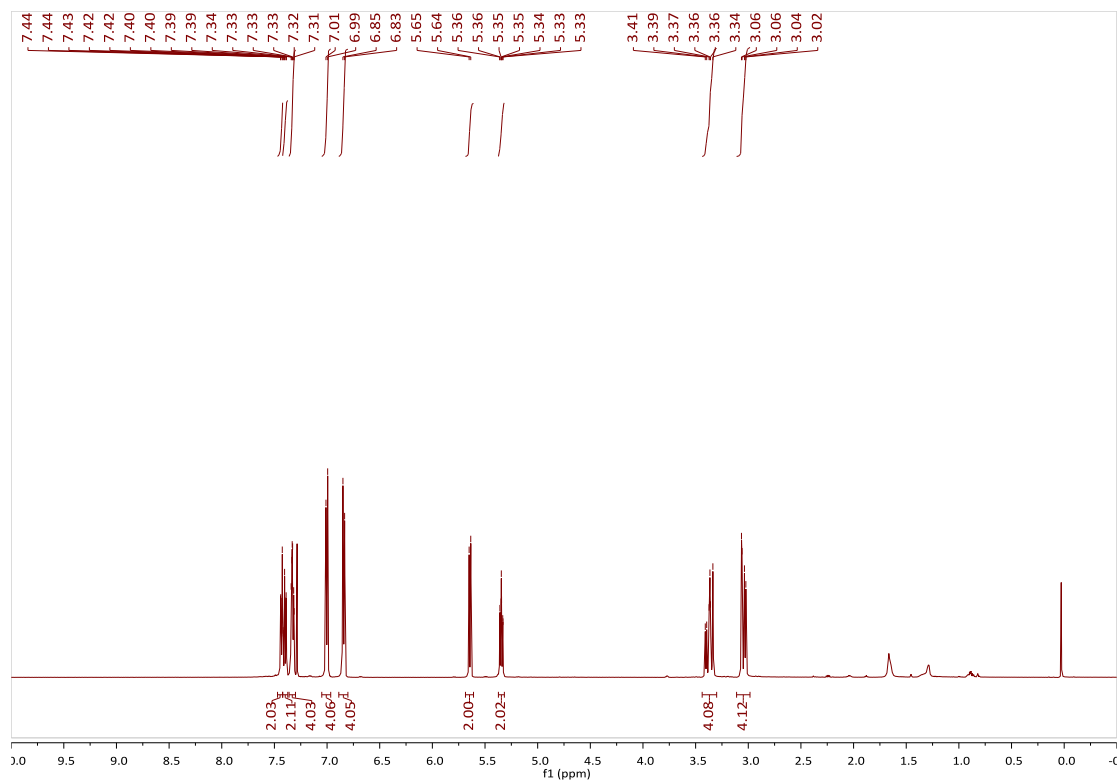
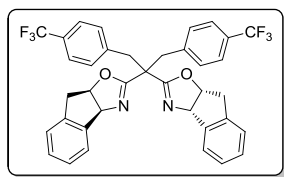


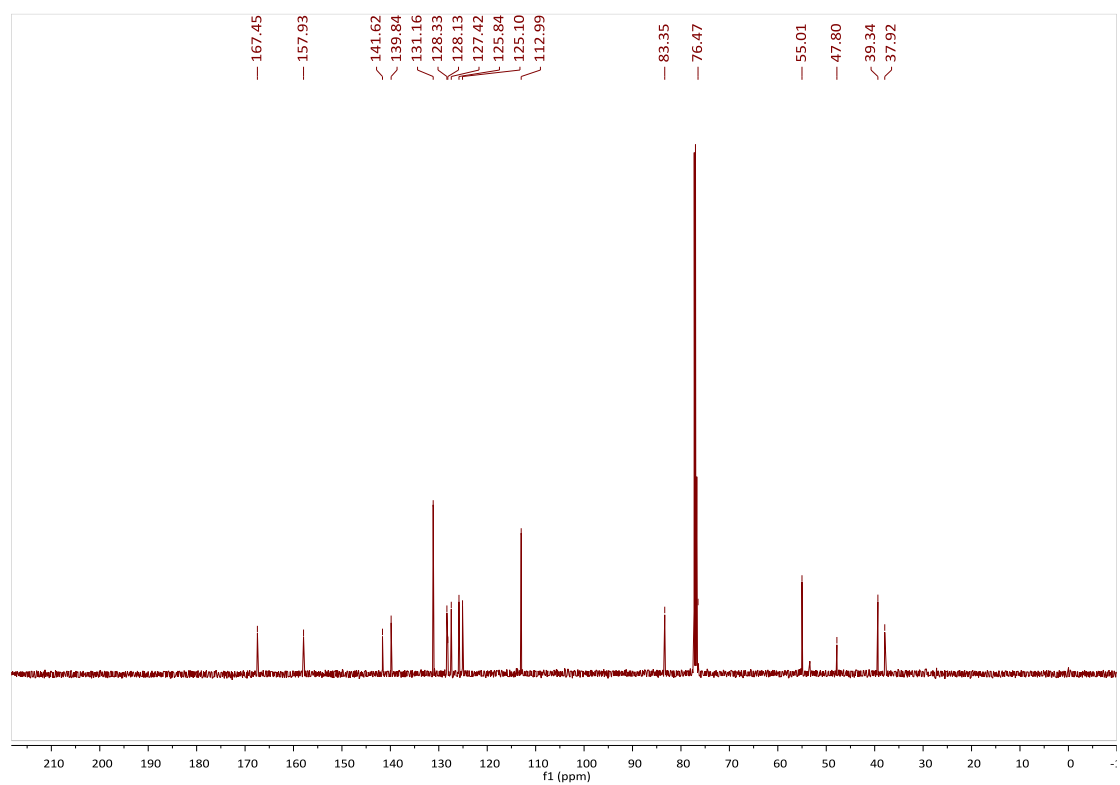
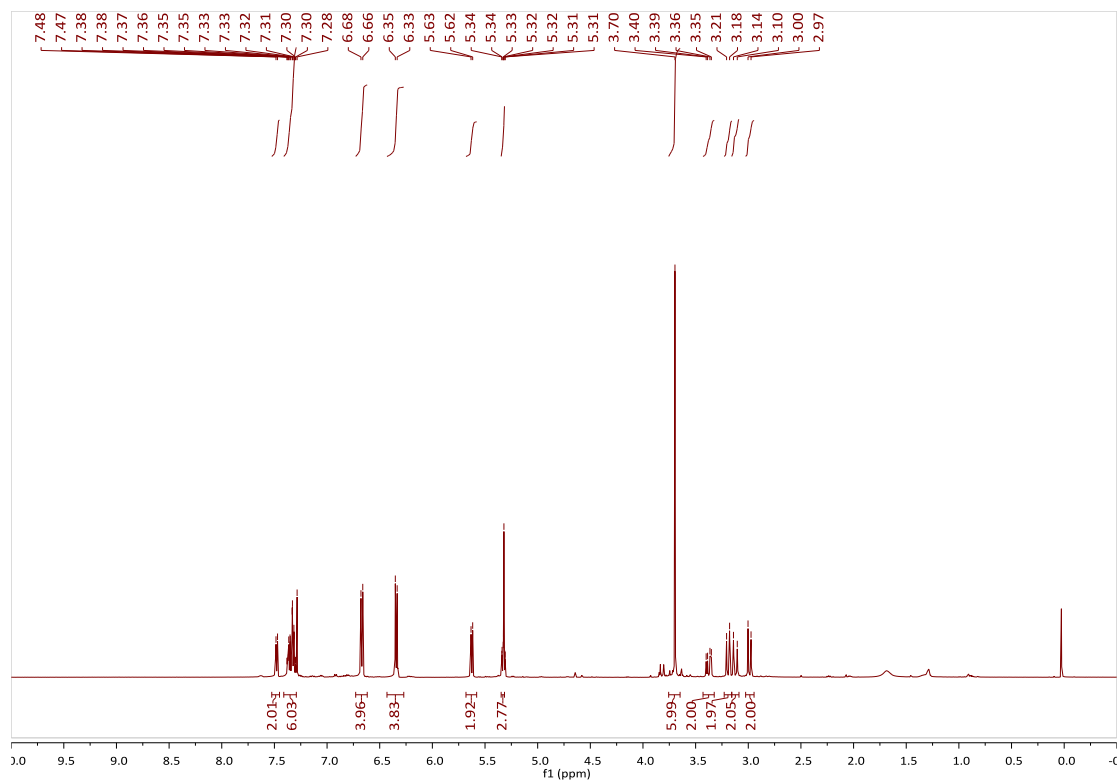
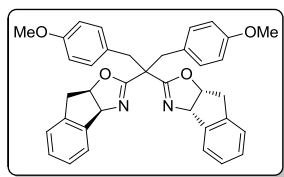


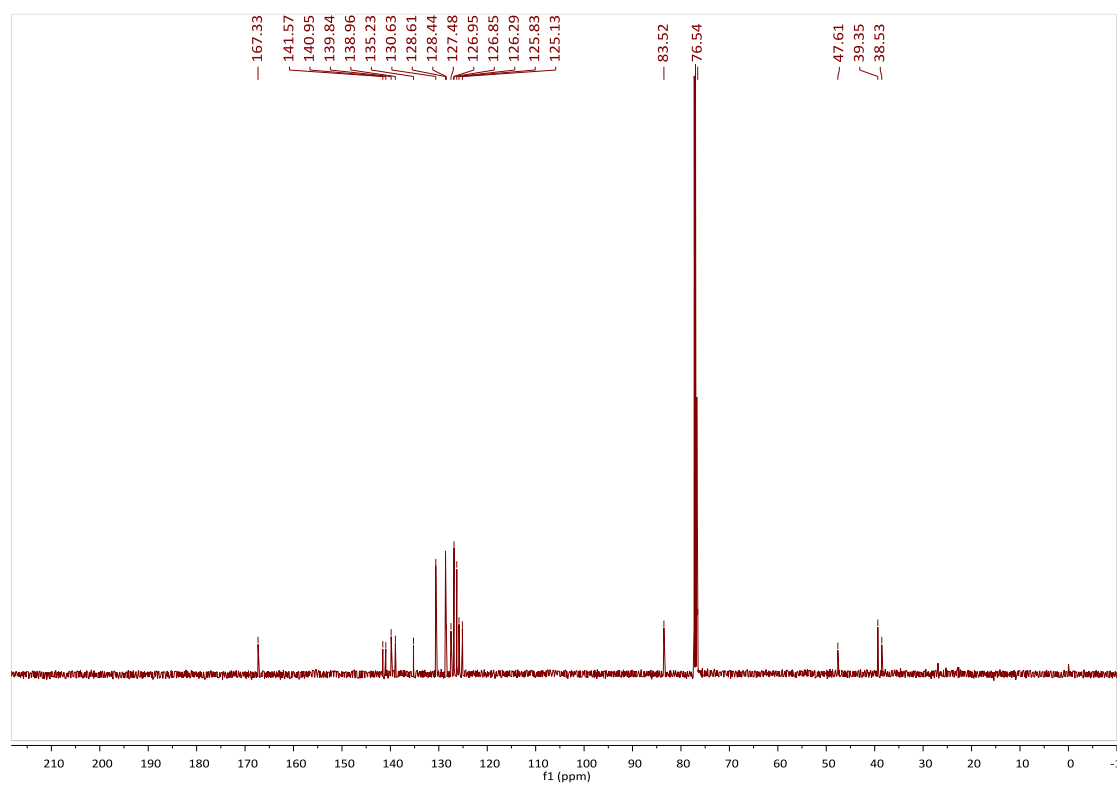
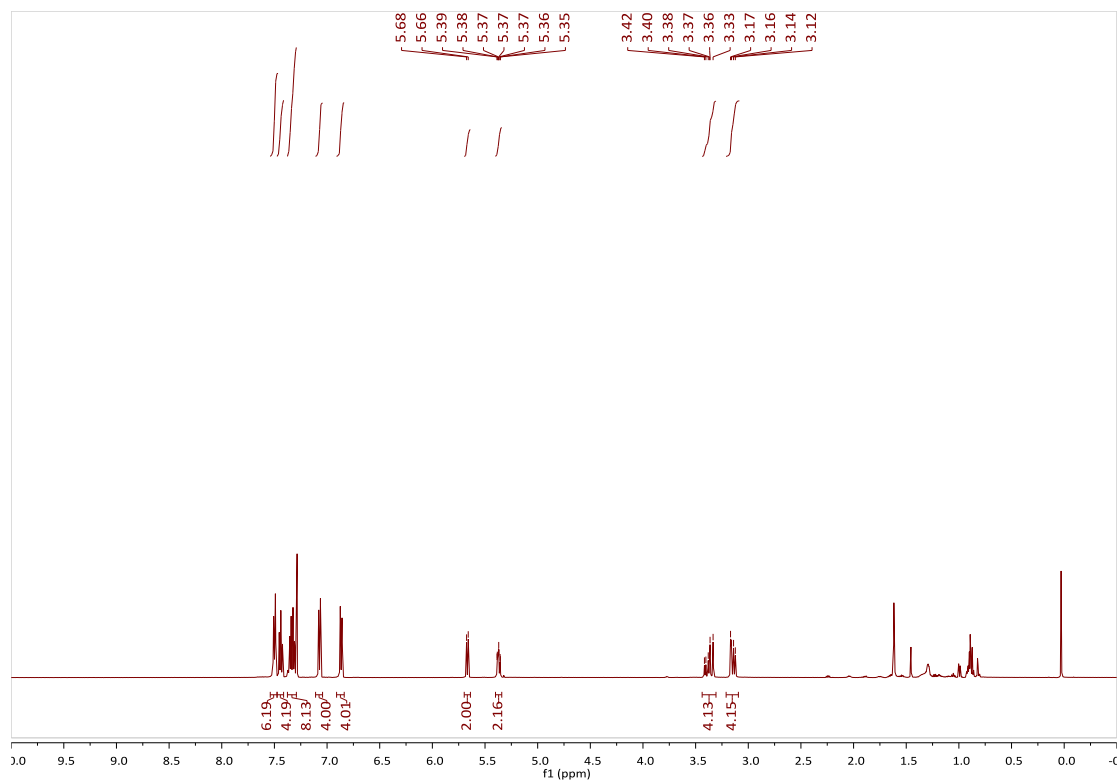
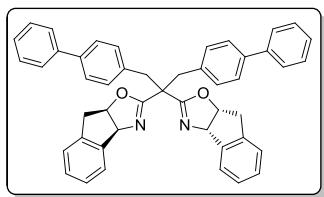


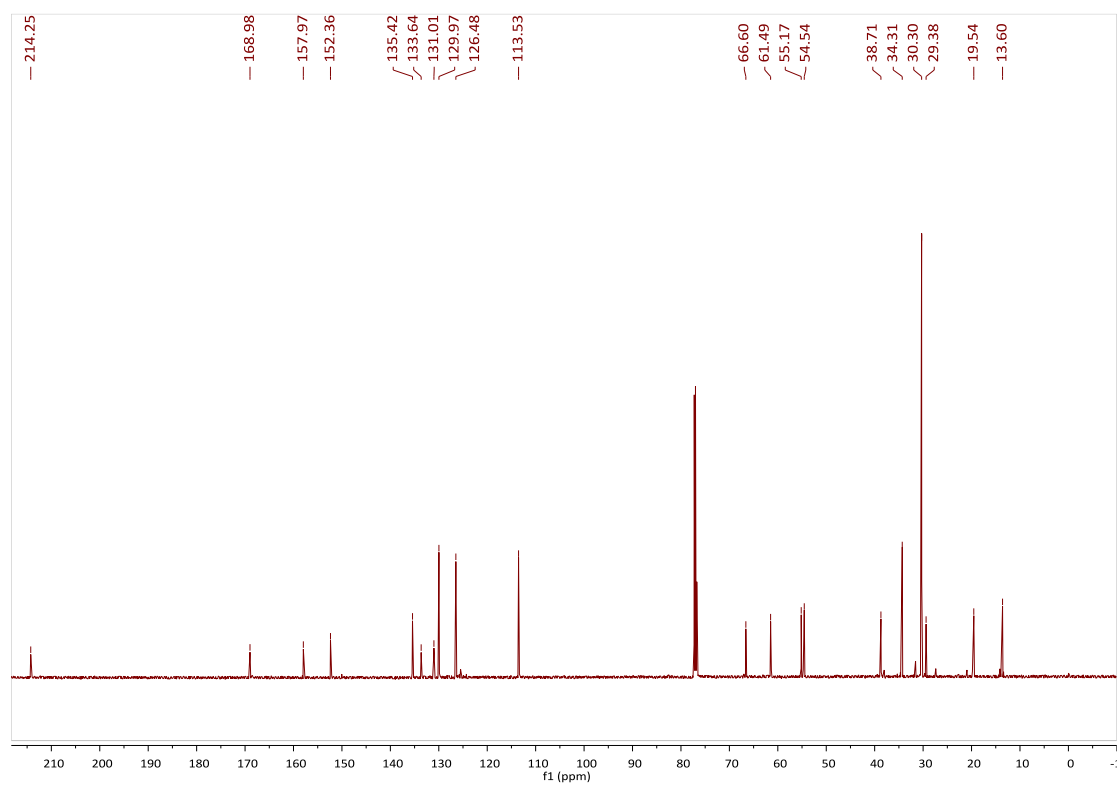
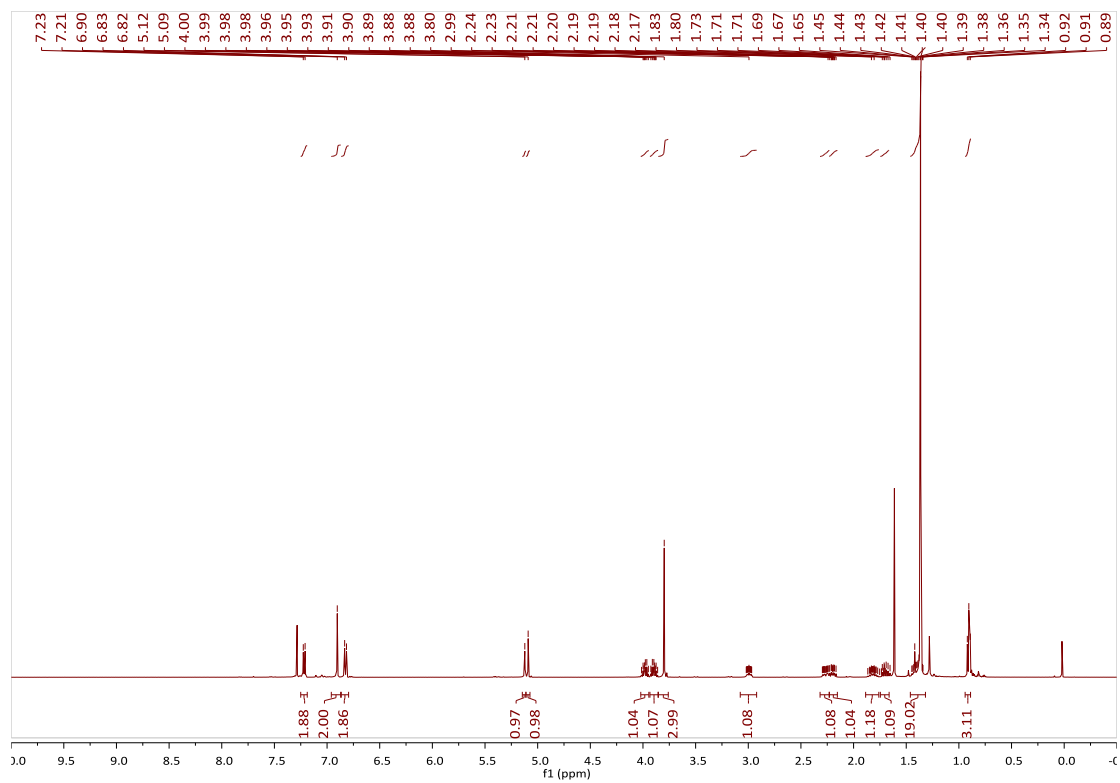
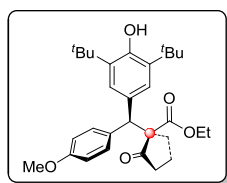


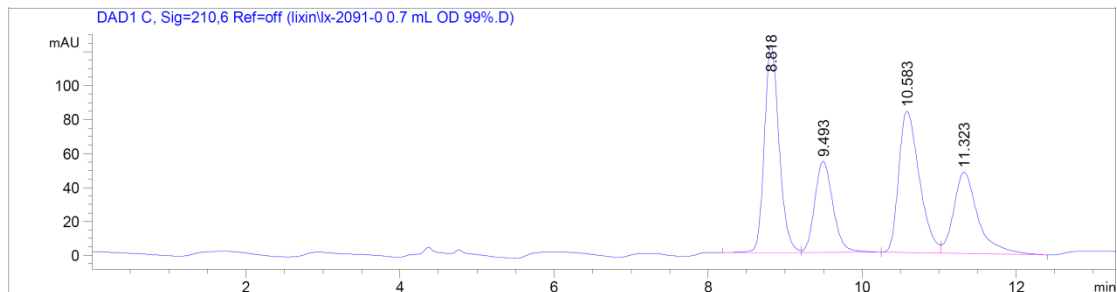
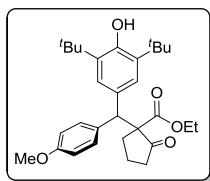




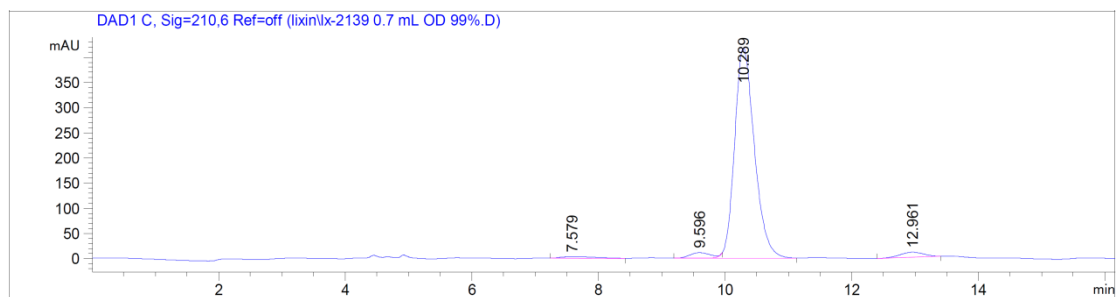
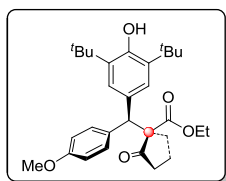




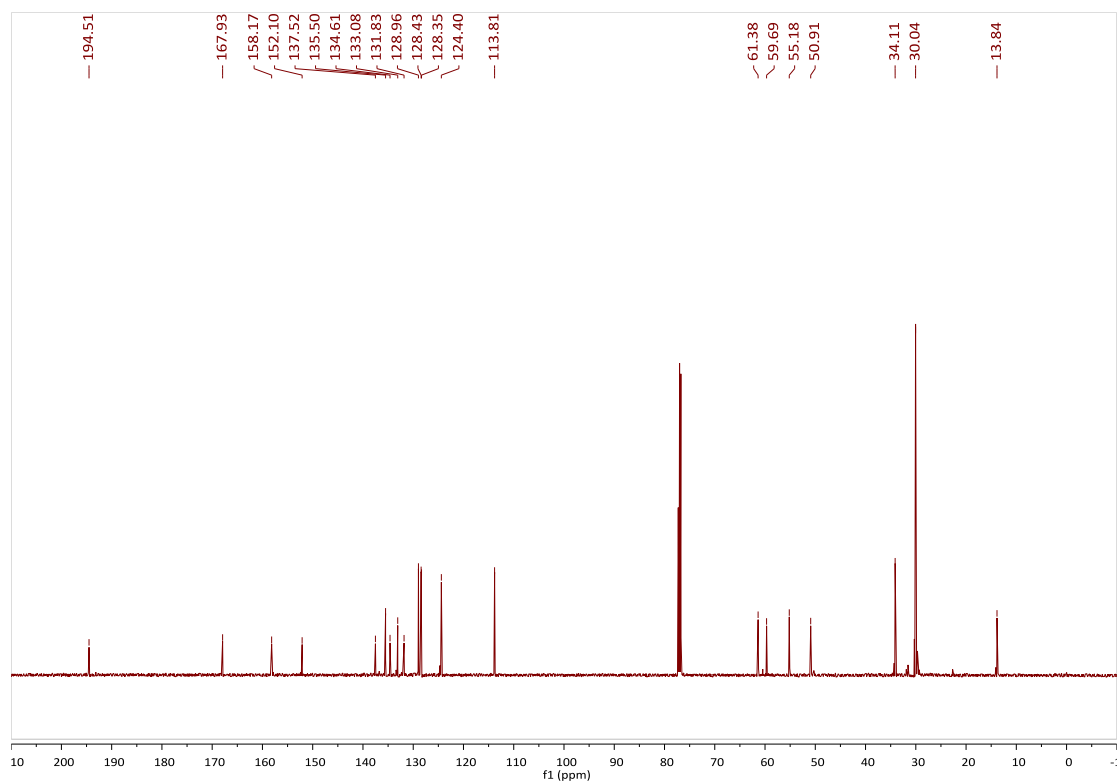
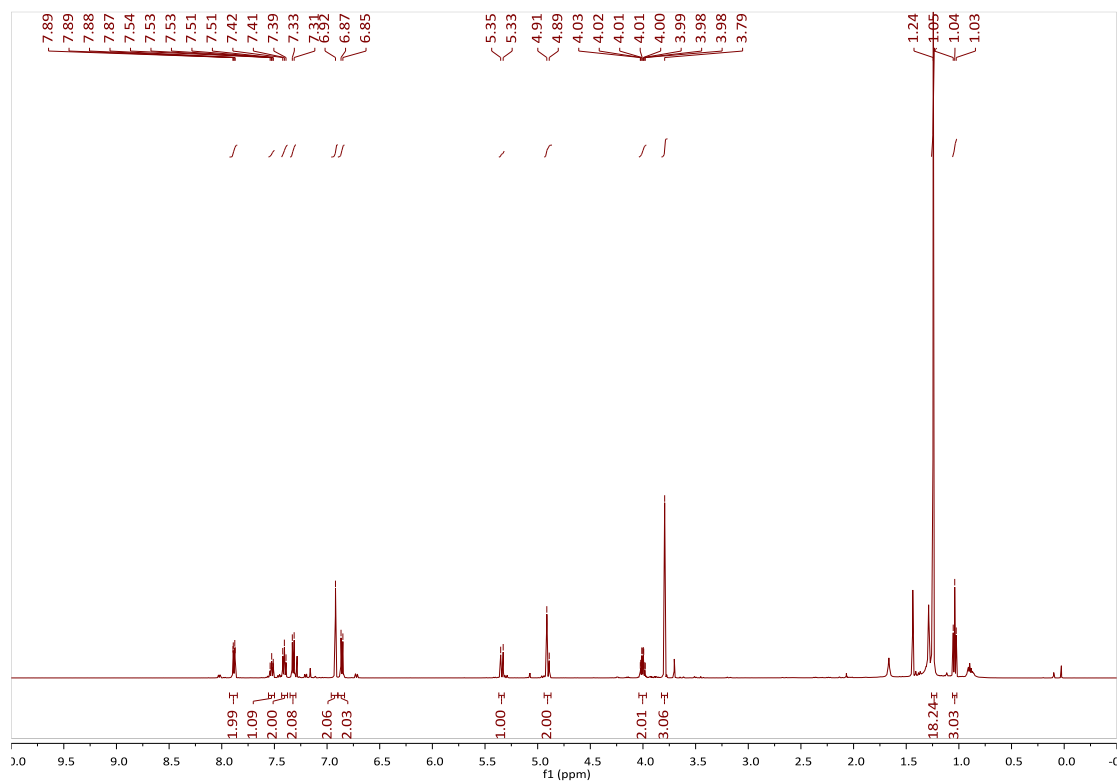
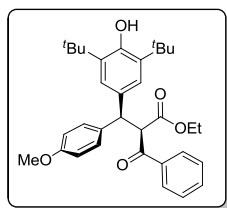


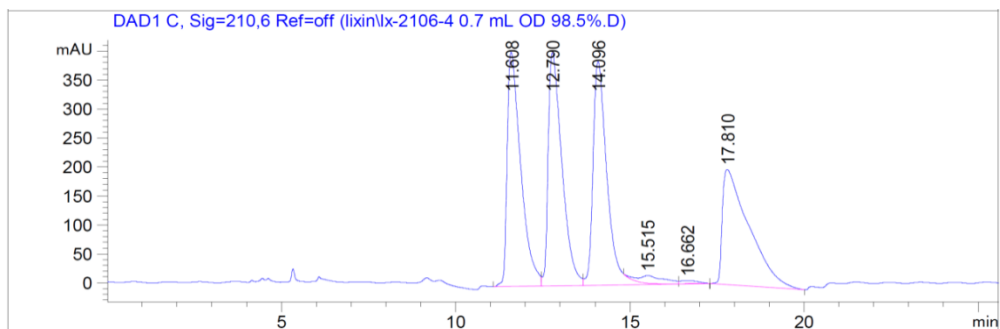
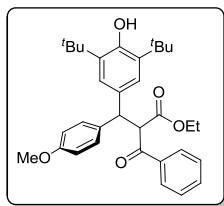


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.818	BV	0.2025	1620.01392	122.35436	31.8096
2	9.493	VB	0.2531	878.31750	53.61618	17.2461
3	10.583	BV	0.2845	1544.20459	83.21940	30.3210
4	11.323	VB	0.3262	1050.31299	47.83245	20.6233

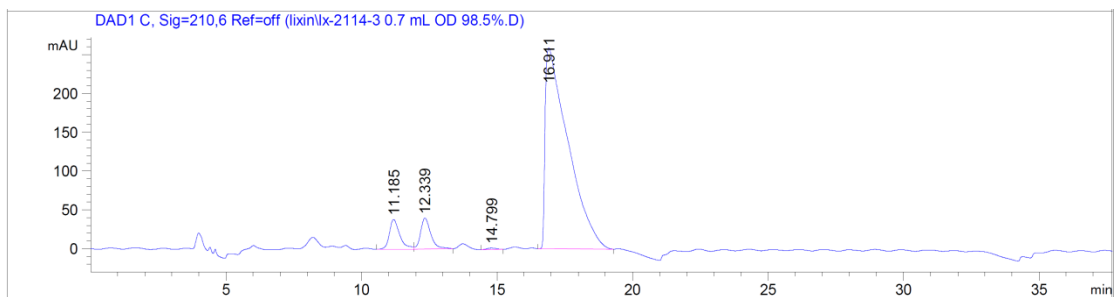
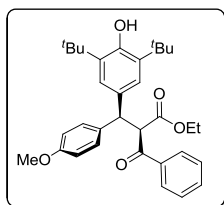


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.579	BB	0.4491	109.58862	3.18734	1.1302
2	9.596	BV E	0.3437	244.46278	11.06776	2.5212
3	10.289	VB R	0.3337	9080.55176	417.53647	93.6514
4	12.961	BB	0.4150	261.52100	10.00333	2.6972

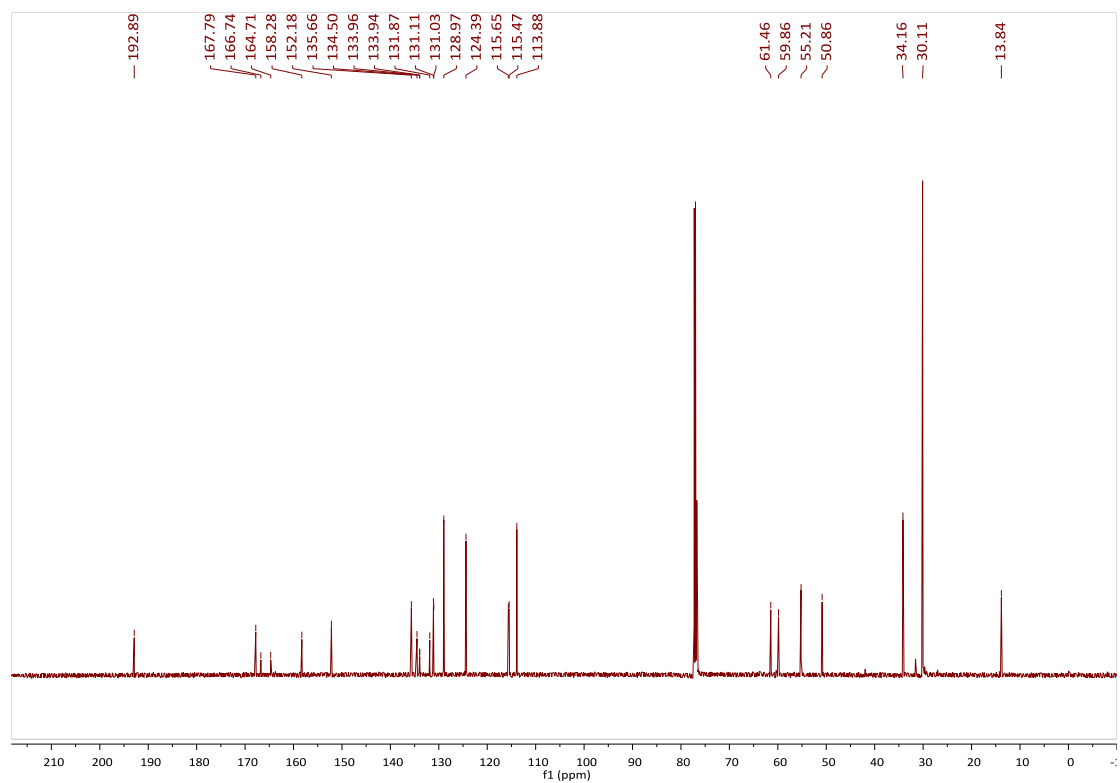
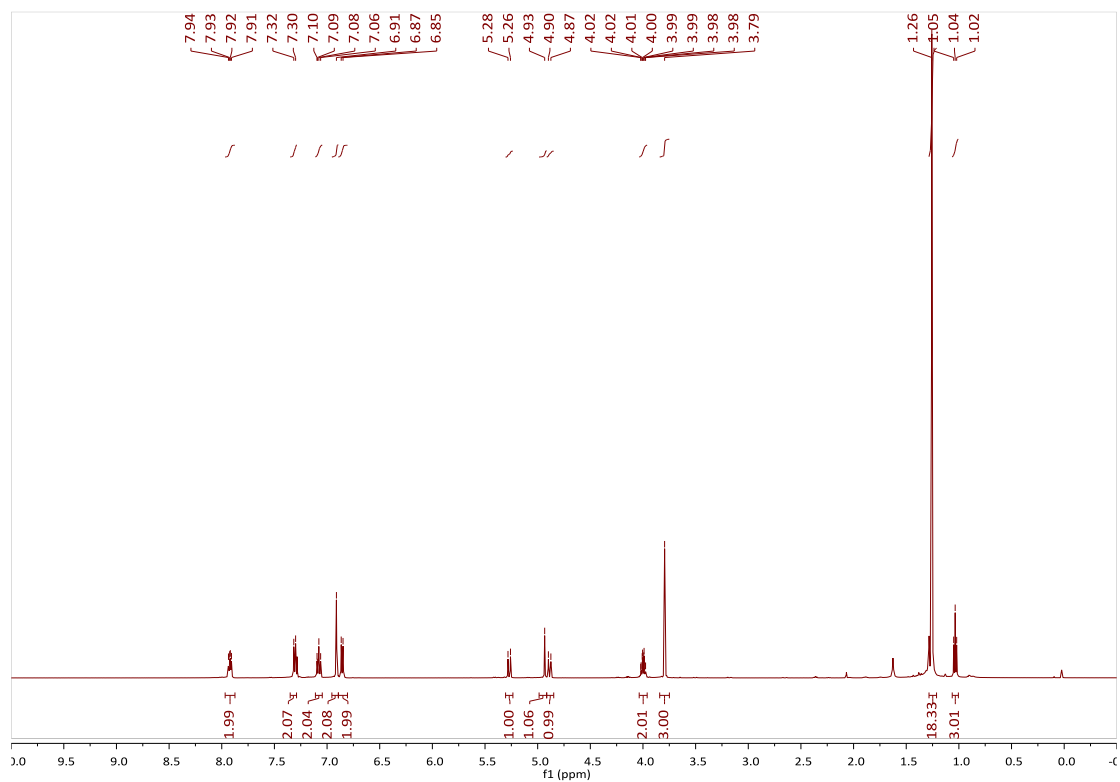
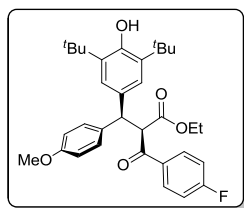


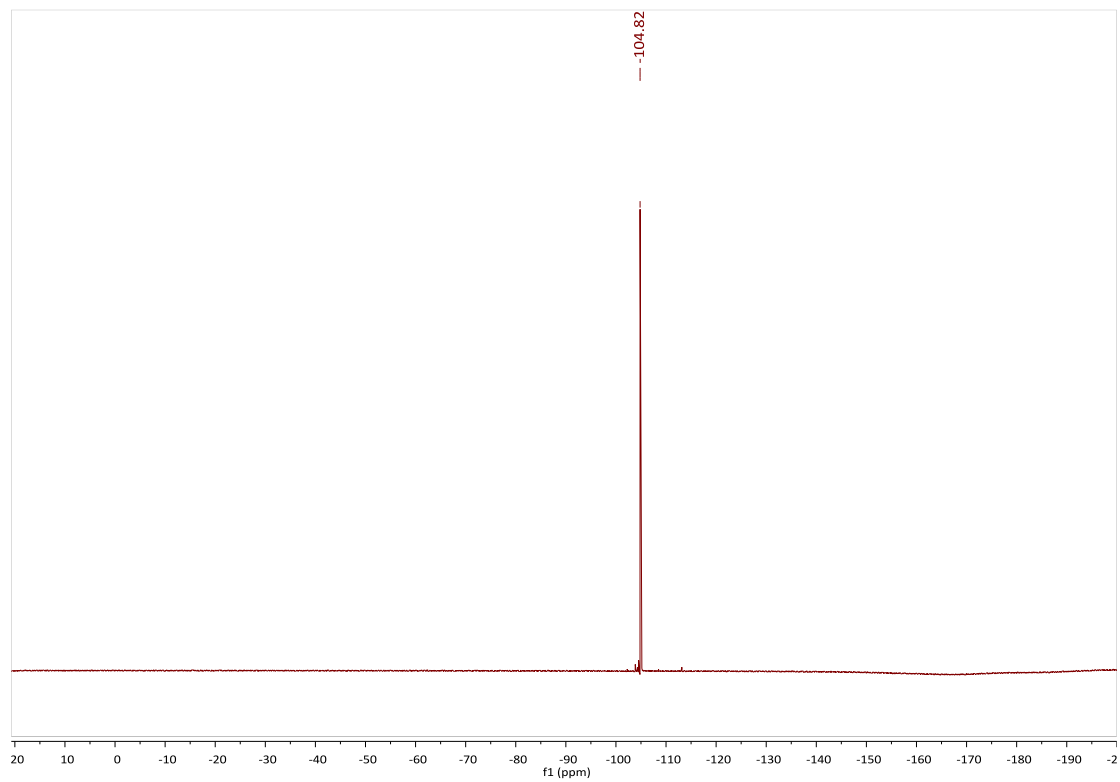
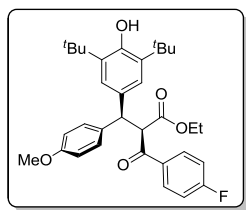


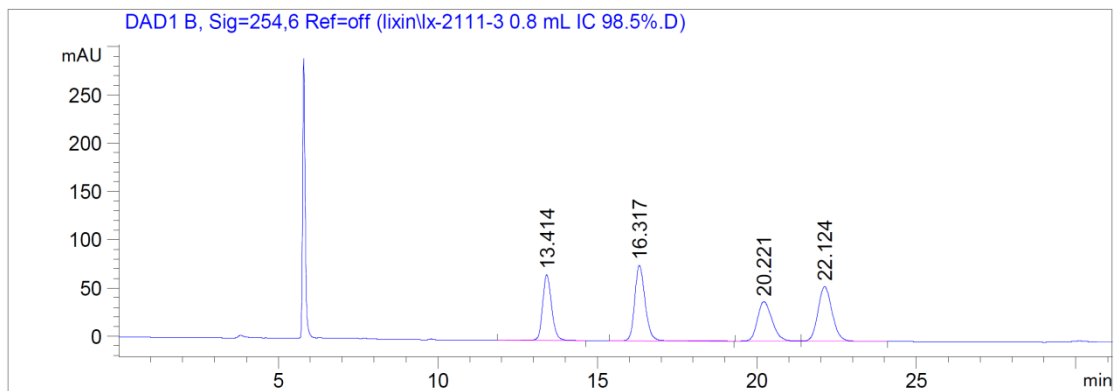
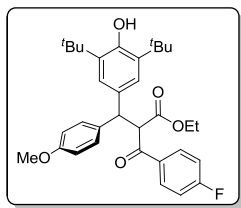
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.608	BV	0.4073	1.09948e4	401.74408	24.8412
2	12.790	VV	0.4259	1.10621e4	400.88791	24.9932
3	14.096	VV R	0.4219	1.07713e4	385.62802	24.3363
4	15.515	VV E	0.6898	688.06812	13.16368	1.5546
5	16.662	VB E	0.5820	181.23712	5.10722	0.4095
6	17.810	BB	0.7394	1.05628e4	198.95833	23.8652



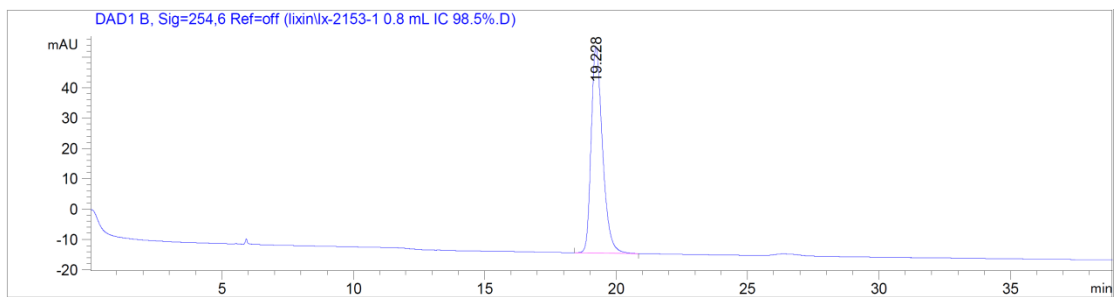
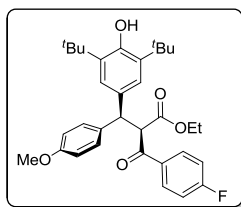
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.185	BV	0.3976	1013.98352	38.20911	5.8679
2	12.339	VB	0.3923	1026.96887	39.63898	5.9430
3	14.799	BB	0.3235	46.98057	1.96111	0.2719
4	16.911	BB	0.7867	1.51923e4	258.84998	87.9172



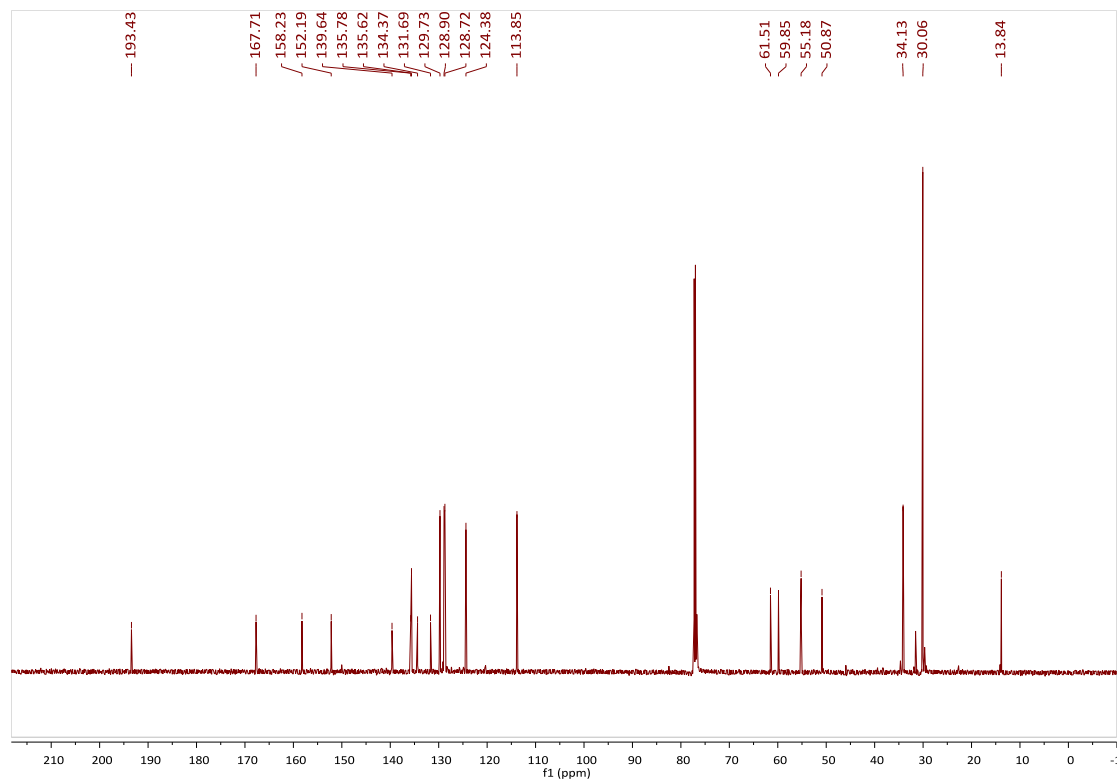
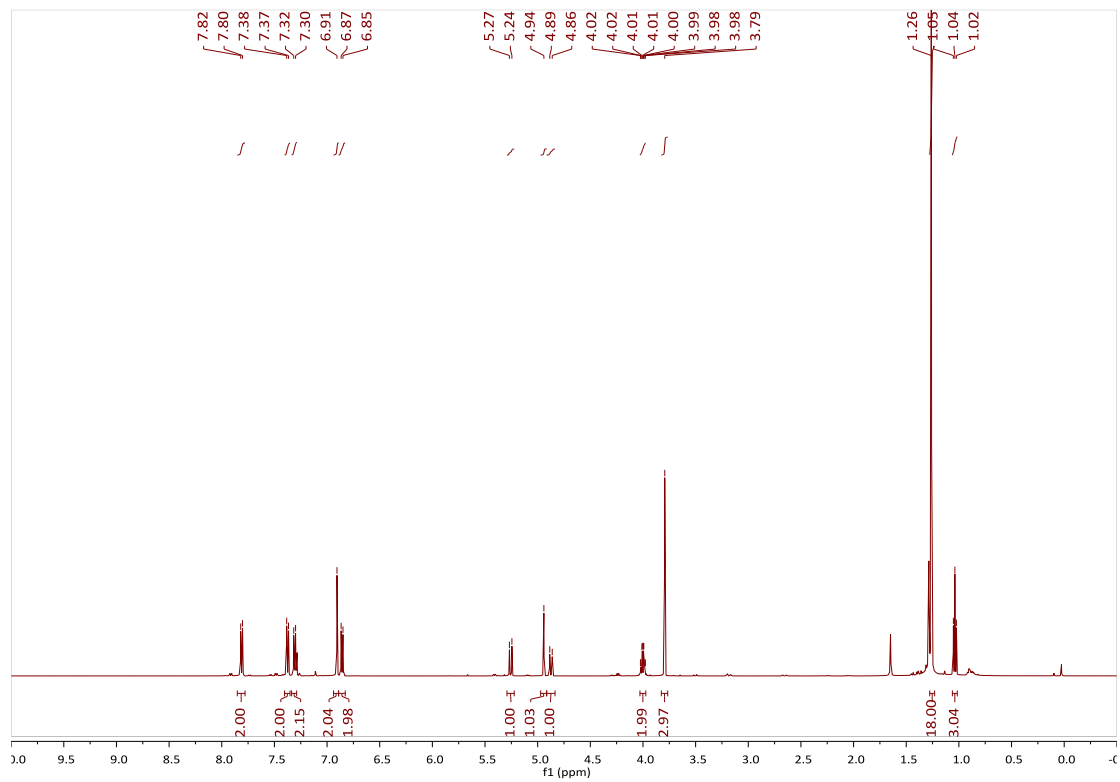
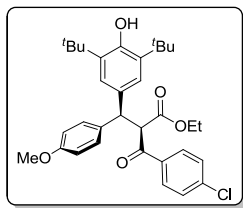


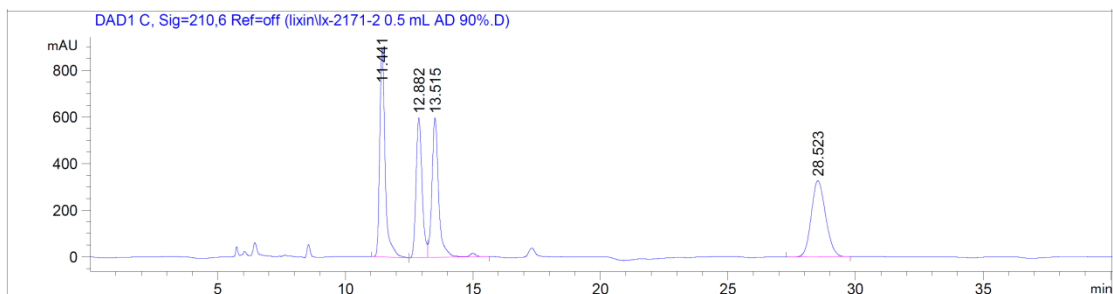
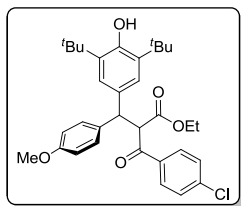


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.414	VB R	0.3087	1329.76343	67.76629	21.5803
2	16.317	BV R	0.3436	1771.35400	78.19429	28.7467
3	20.221	BV	0.4935	1307.29395	40.83018	21.2156
4	22.124	VB	0.4814	1753.53357	56.60907	28.4575

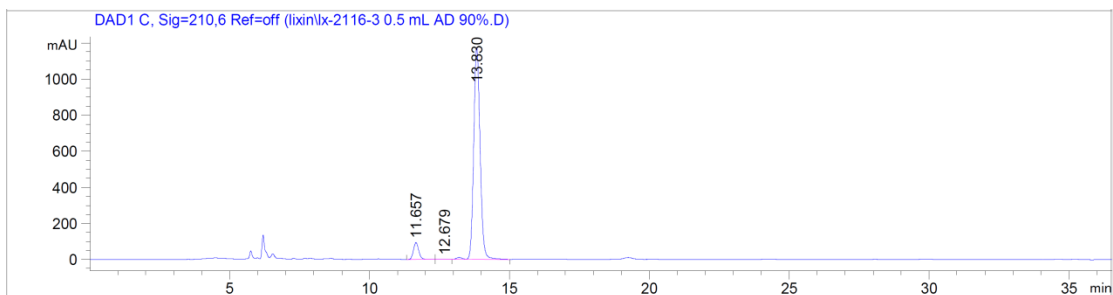
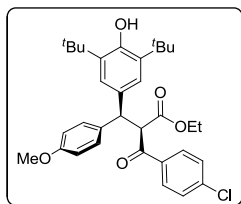


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	19.228	BB	0.4605	2040.50671	67.91088	100.0000

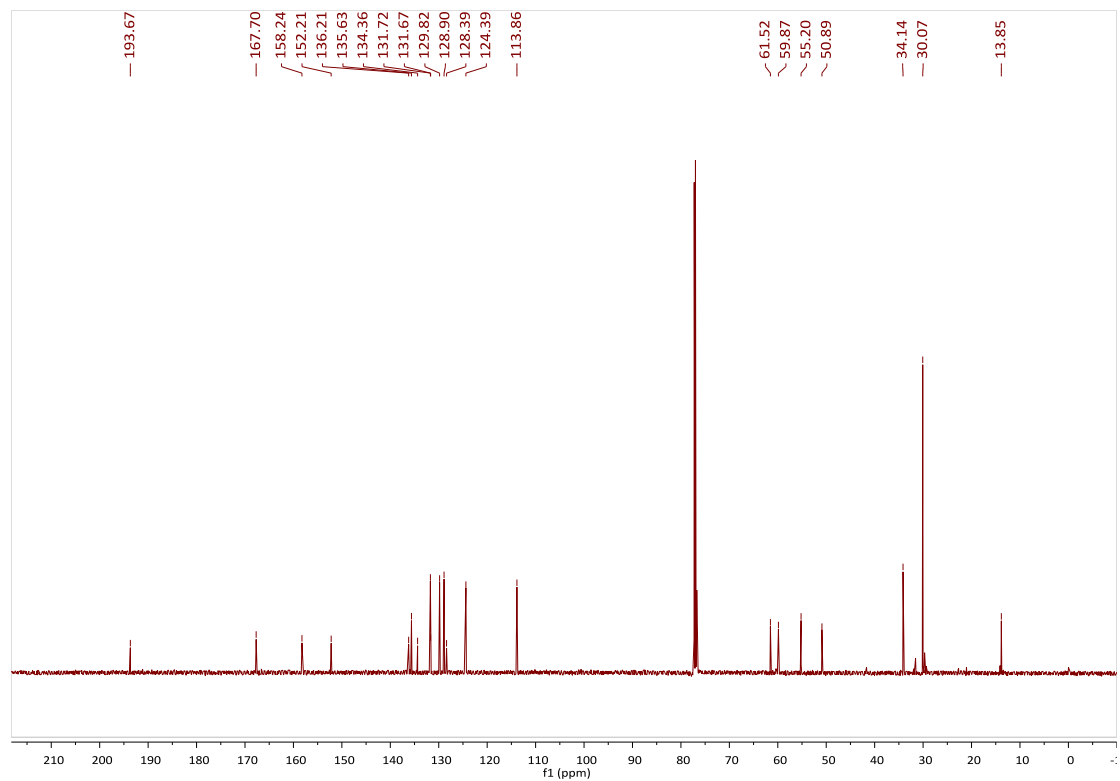
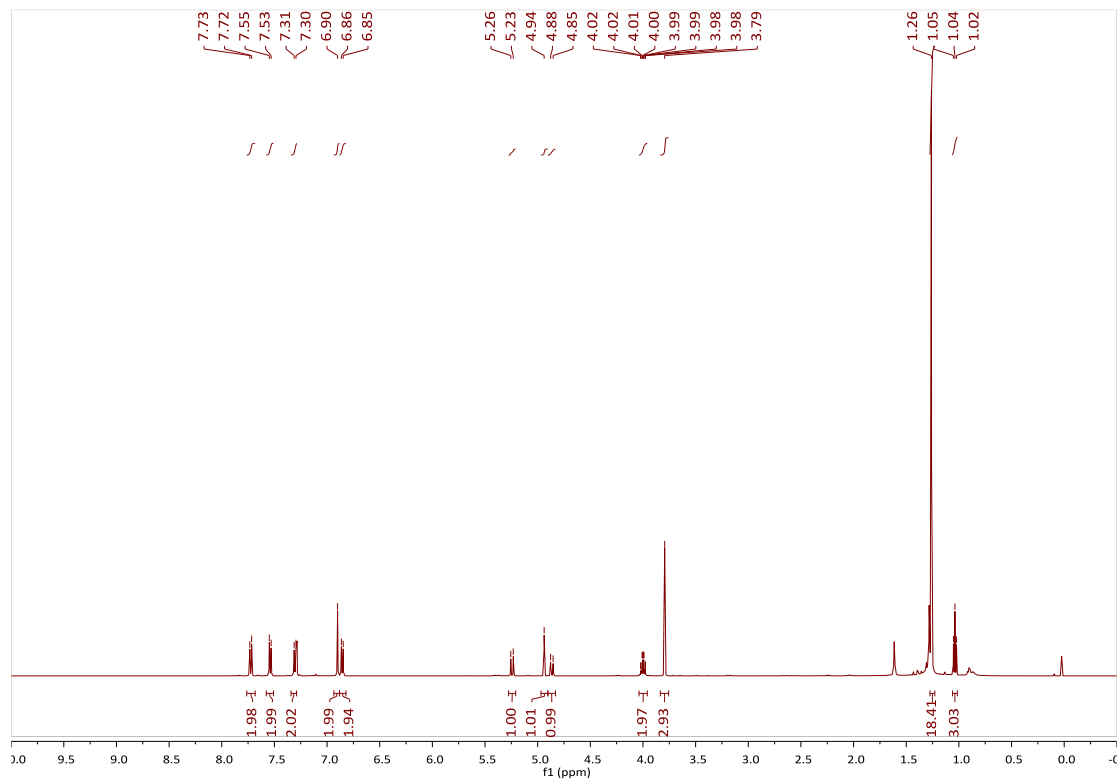
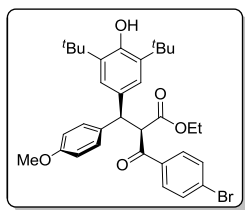


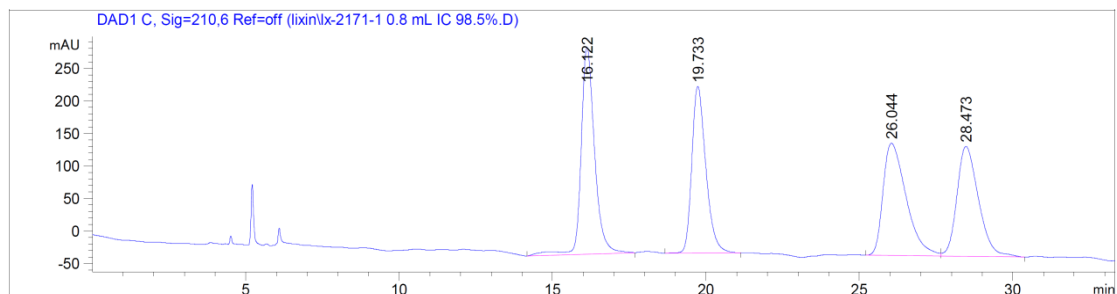
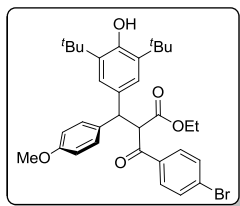


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.441	BB	0.2211	1.31686e4	897.81628	28.0297
2	12.882	BV	0.2519	9863.95508	599.63757	20.9956
3	13.515	VV R	0.2737	1.12122e4	599.60980	23.8654
4	28.523	BB	0.6045	1.27362e4	326.91876	27.1092

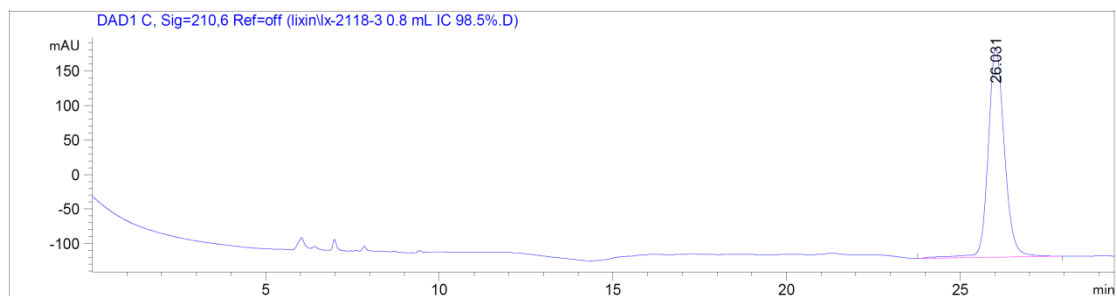
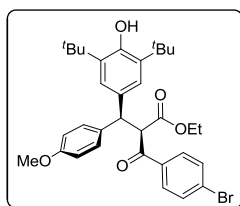


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.657	BB	0.2038	1222.91516	92.77933	6.1172
2	12.679	BV E	0.2358	23.33870	1.37679	0.1167
3	13.830	VB R	0.2468	1.87453e4	1174.19495	93.7661

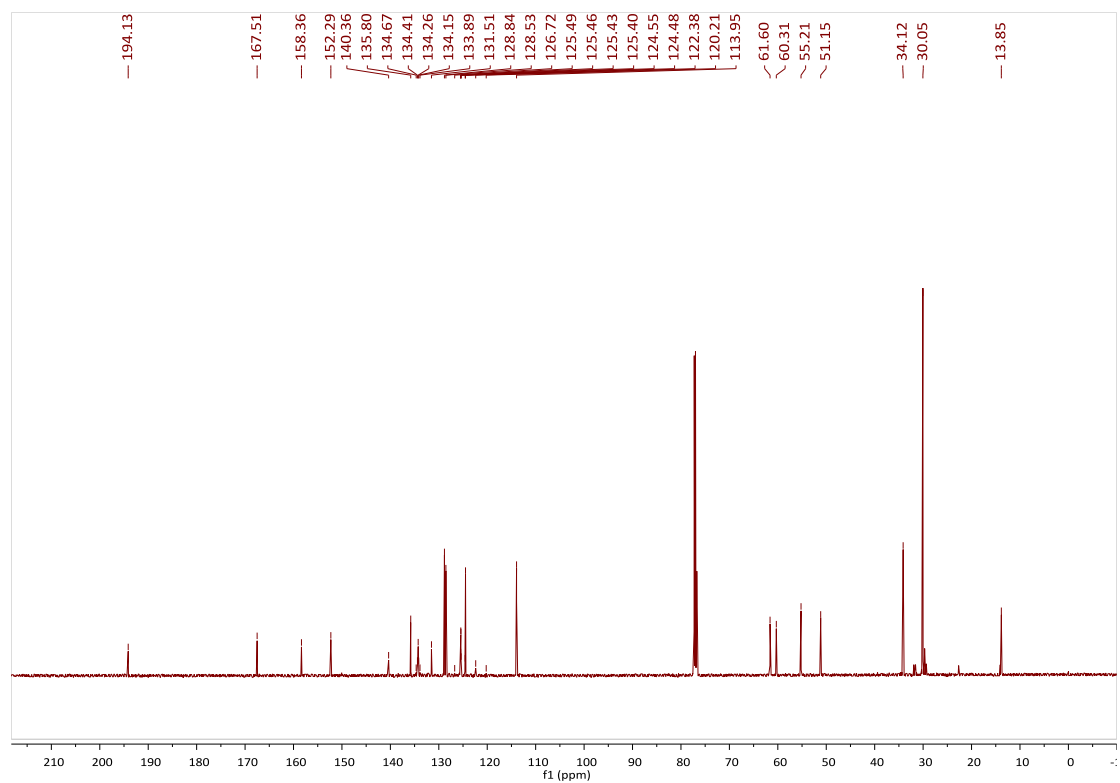
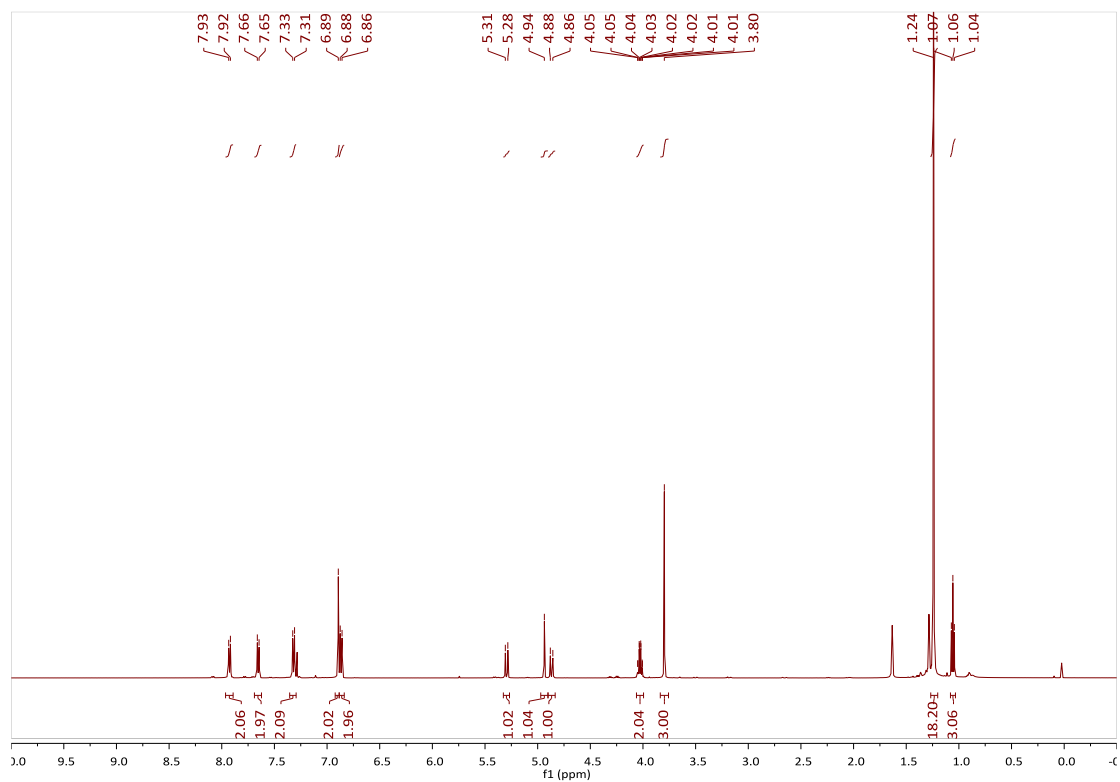
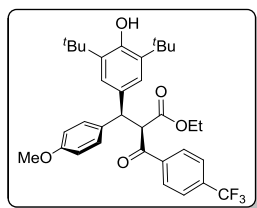


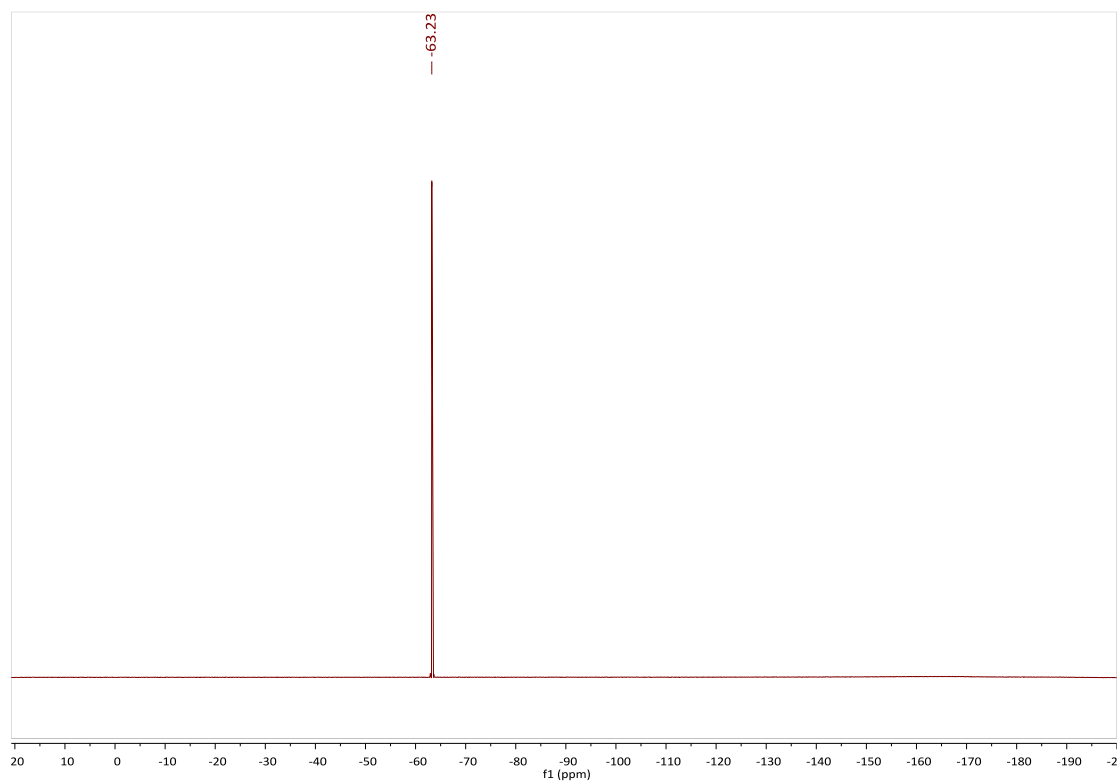
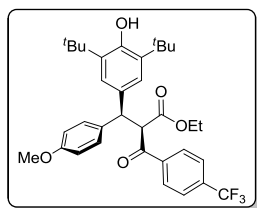


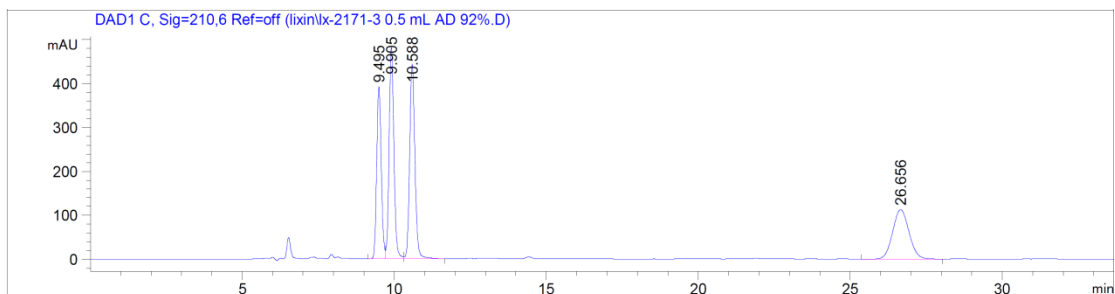
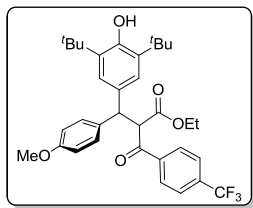
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.122	BB	0.4645	9760.11328	317.63513	27.6911
2	19.733	BB	0.4853	8157.81201	256.30795	23.1451
3	26.044	BV	0.8182	9045.38574	172.38573	25.6633
4	28.473	VB	0.7456	8283.14160	169.06358	23.5006



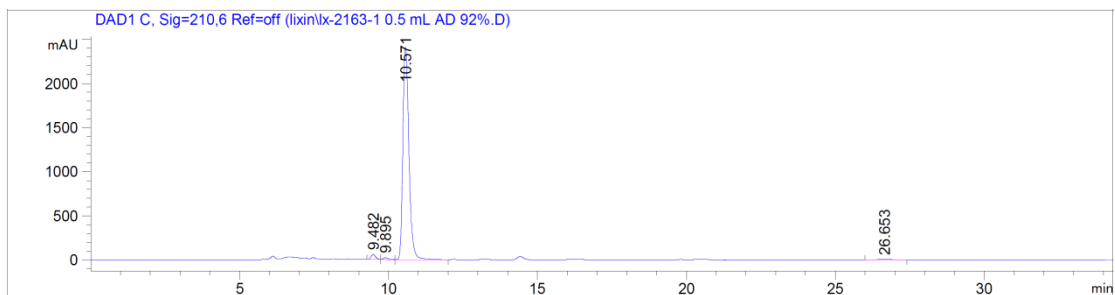
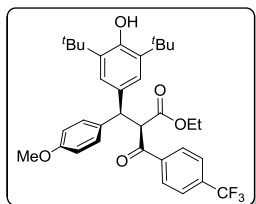
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	26.031	BB	0.4992	9851.46289	303.08517	100.0000



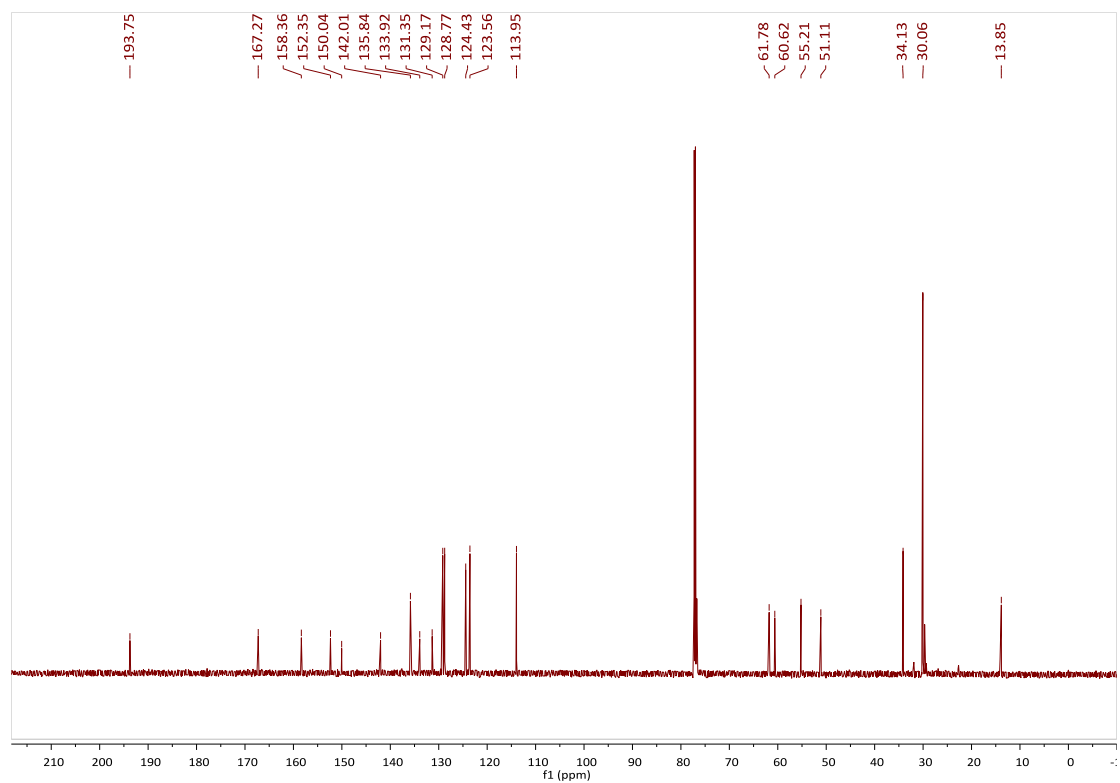
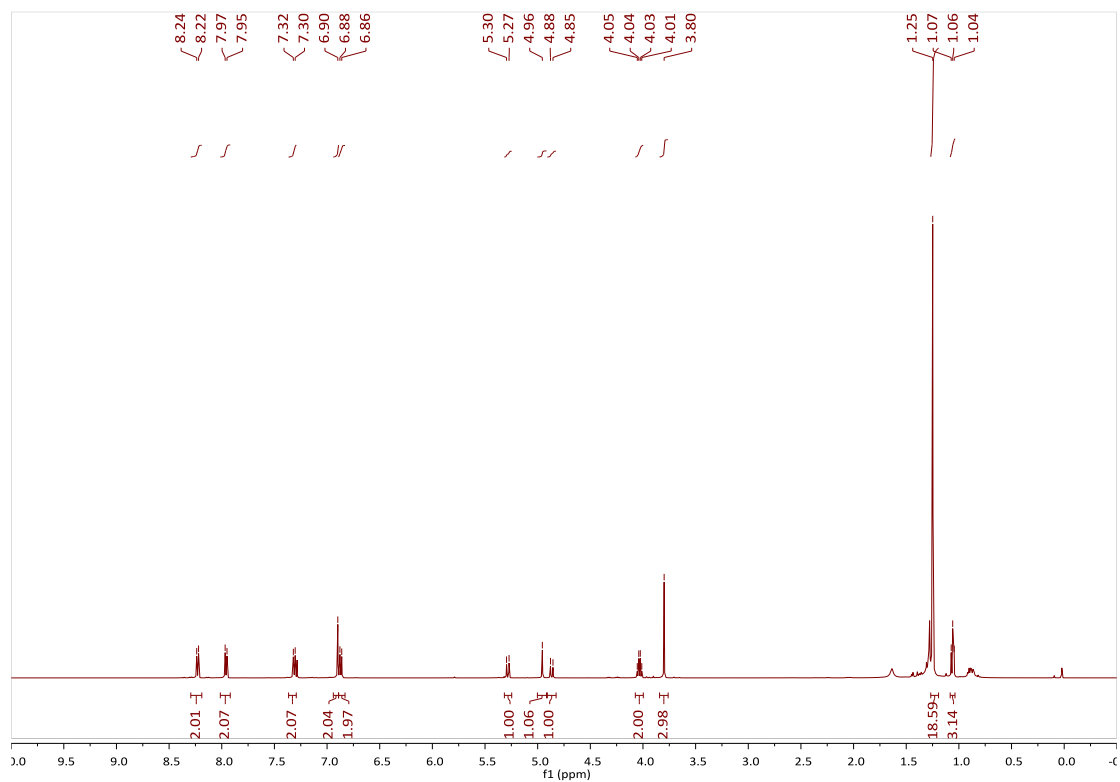
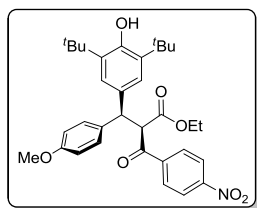


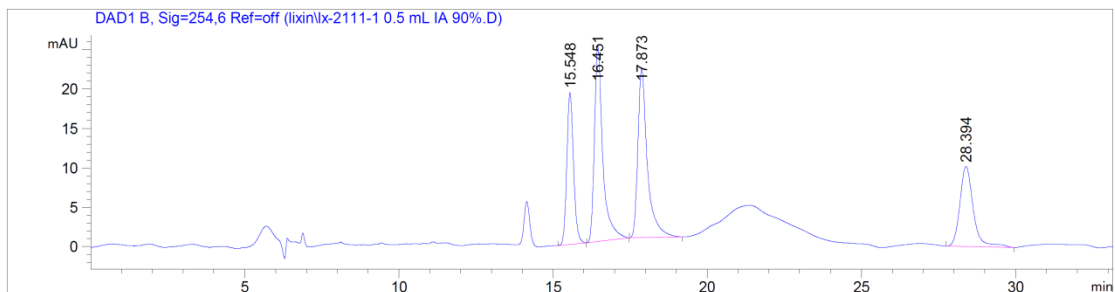
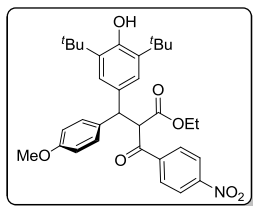


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.495	BV	0.1640	4093.63843	391.55130	21.6057
2	9.905	VV	0.1674	5266.91943	482.15863	27.7981
3	10.588	VB	0.1864	5344.69092	444.06894	28.2085
4	26.656	BB	0.5812	4241.81152	113.20433	22.3877

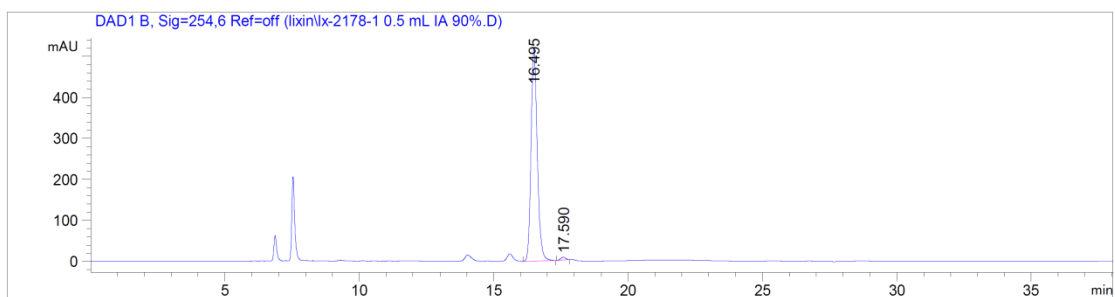
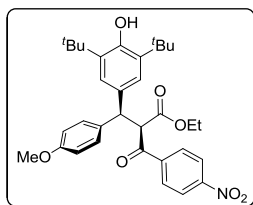


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.482	BV	0.1719	636.51666	57.15864	1.8025
2	9.895	VB	0.1766	249.69833	21.64906	0.7071
3	10.571	BB	0.2200	3.42337e4	2405.36792	96.9412
4	26.653	BB	0.4831	193.96458	5.67012	0.5493

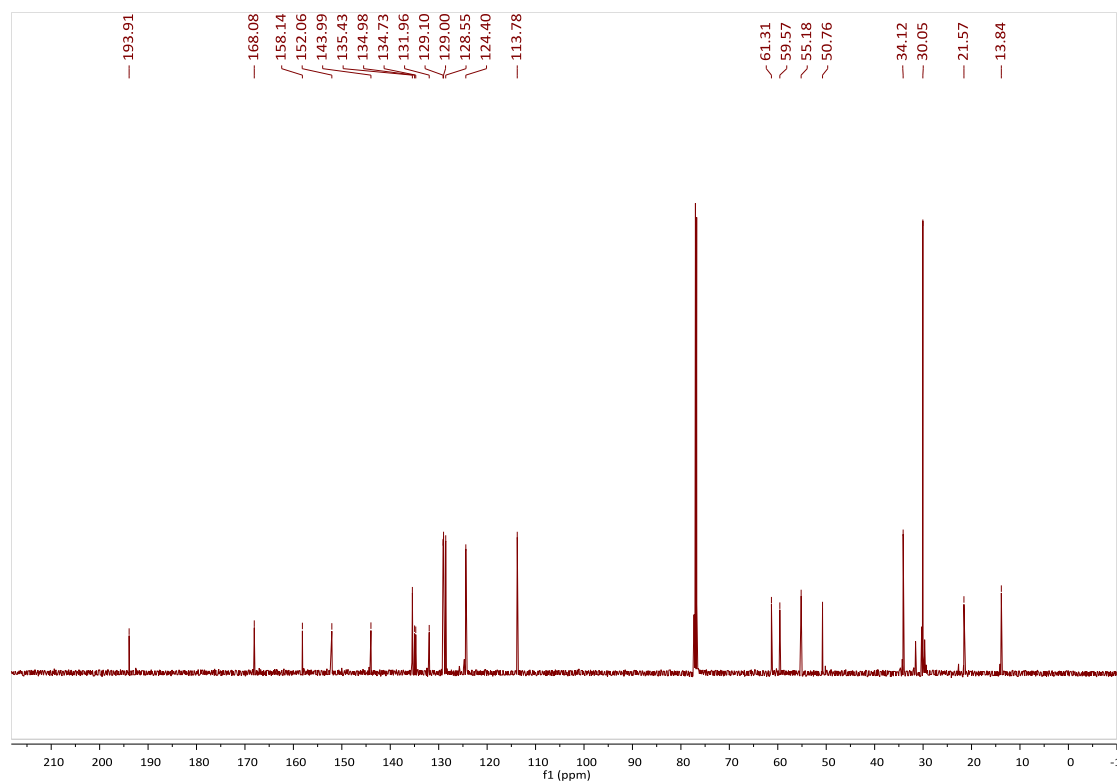
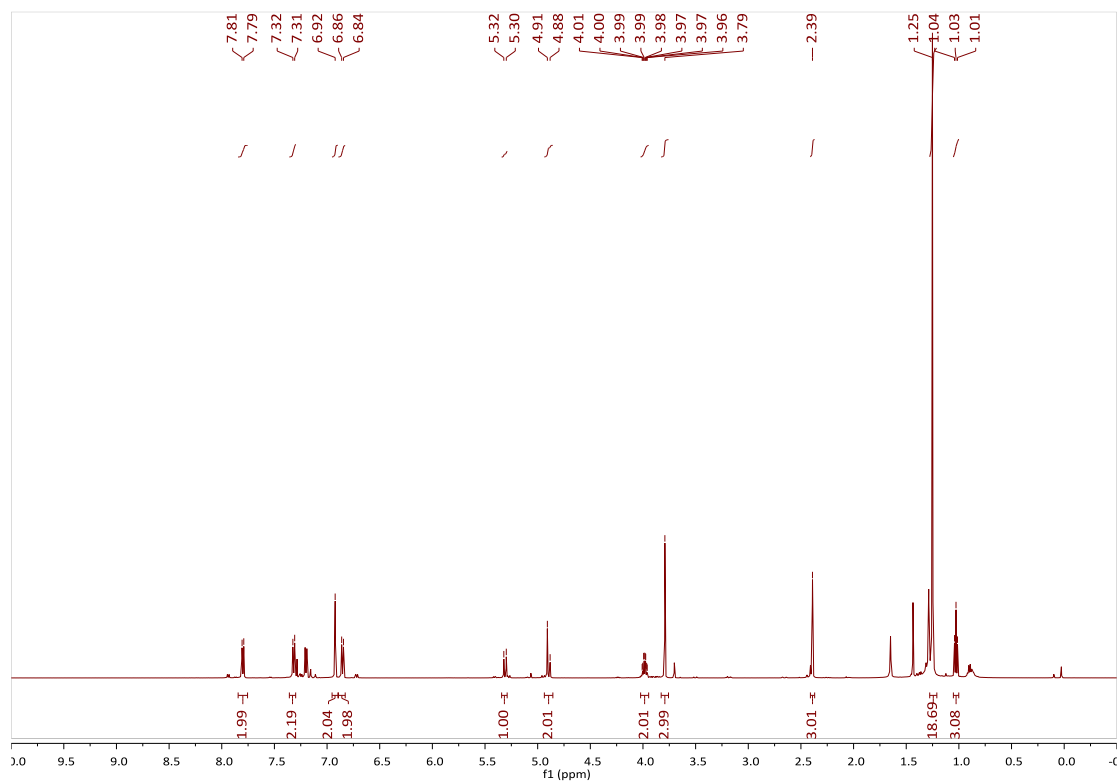
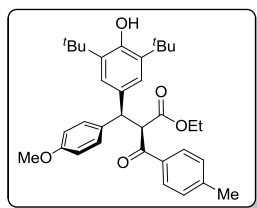


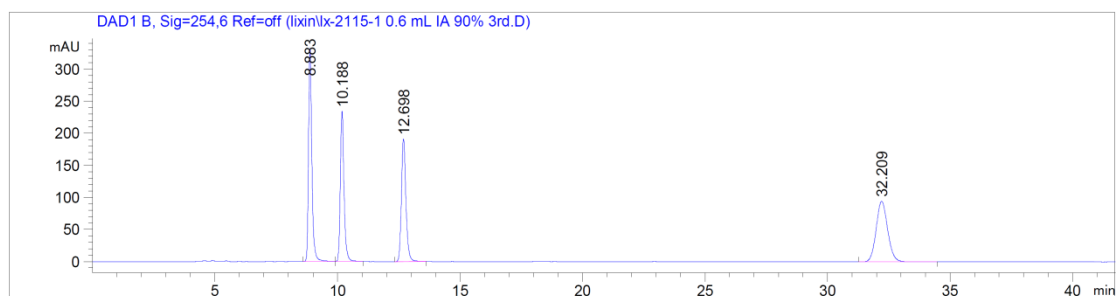
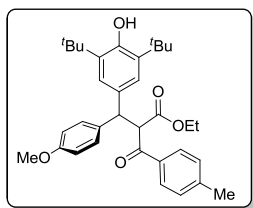


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.548	BB	0.2301	290.73160	19.25895	19.0532
2	16.451	BB	0.2778	468.02454	24.83919	30.6721
3	17.873	BB	0.3164	460.84305	21.46884	30.2015
4	28.394	BB	0.4460	306.29721	10.15161	20.0733

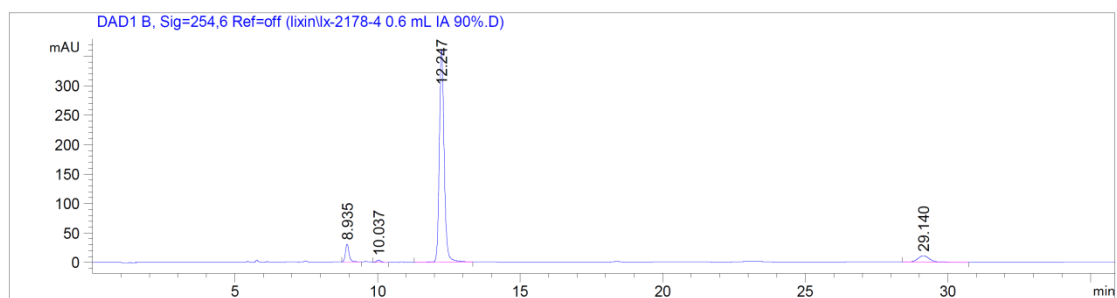
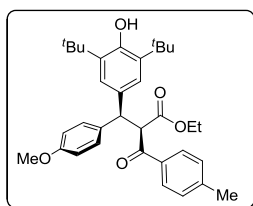


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.495	BB	0.2452	8312.83594	517.93628	99.0109
2	17.590	BB	0.2054	83.04434	6.39733	0.9891

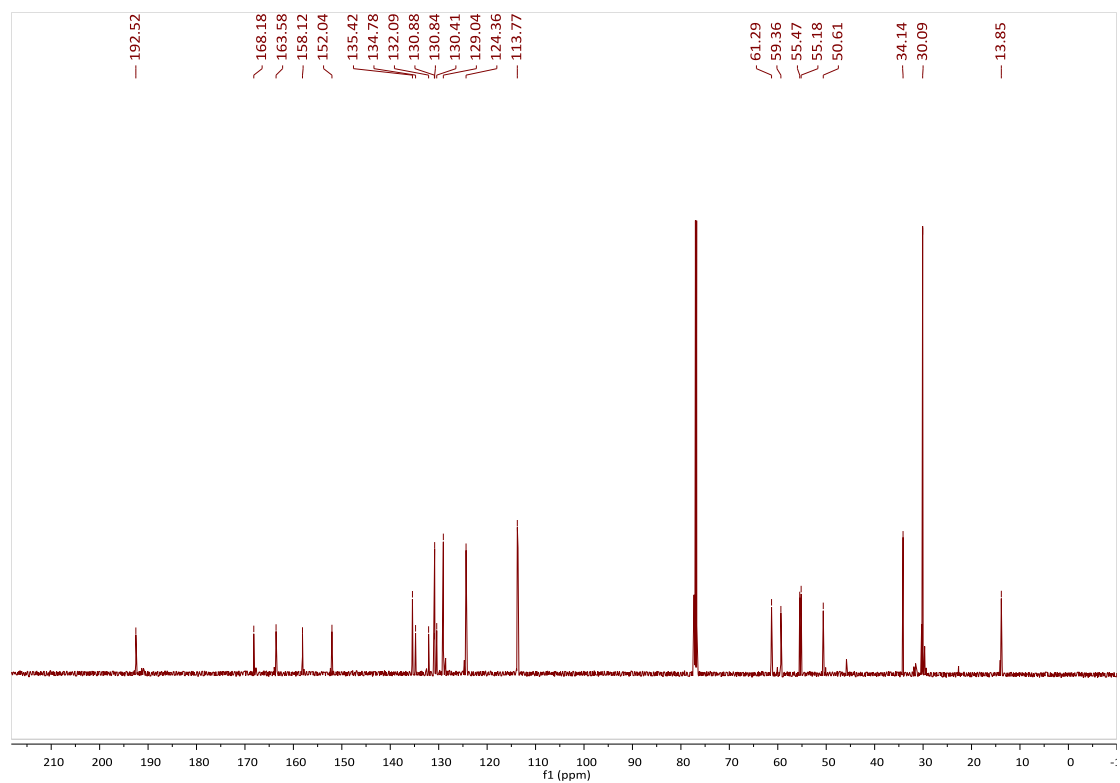
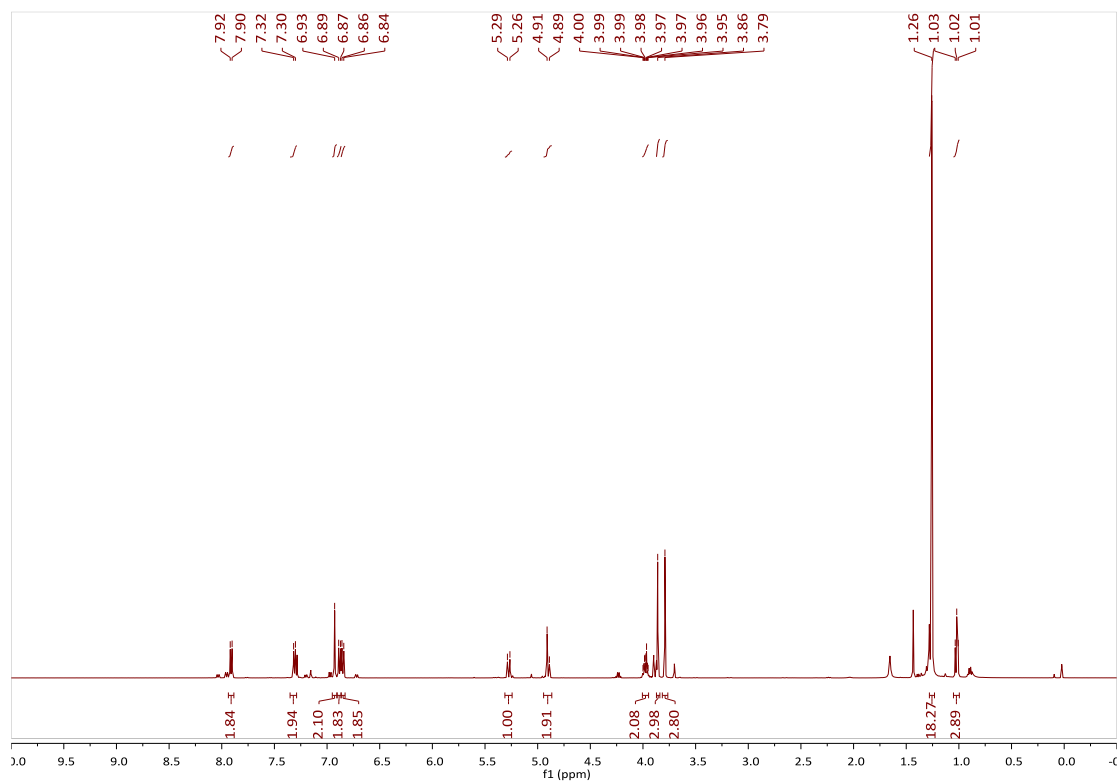
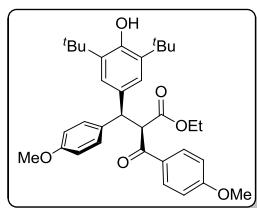


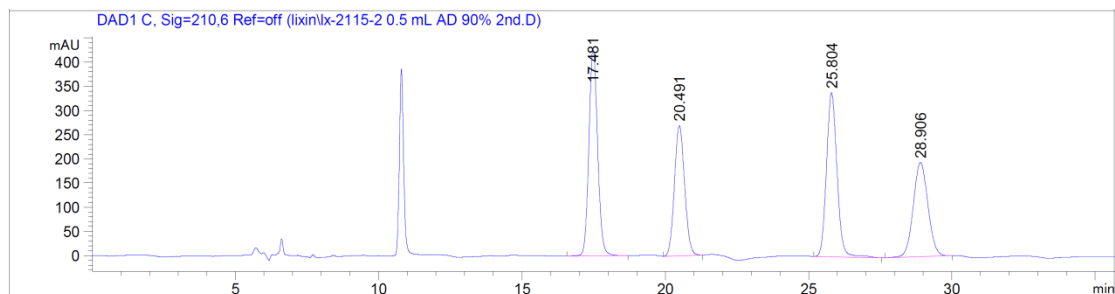
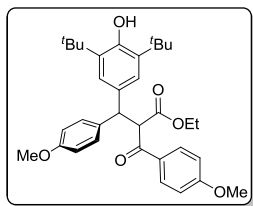


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.883	BB	0.1417	3112.66821	331.08389	28.0387
2	10.188	BB	0.1578	2439.96582	233.71851	21.9791
3	12.698	BB	0.1958	2453.72412	191.05081	22.1030
4	32.209	BB	0.5037	3094.95703	94.60931	27.8792

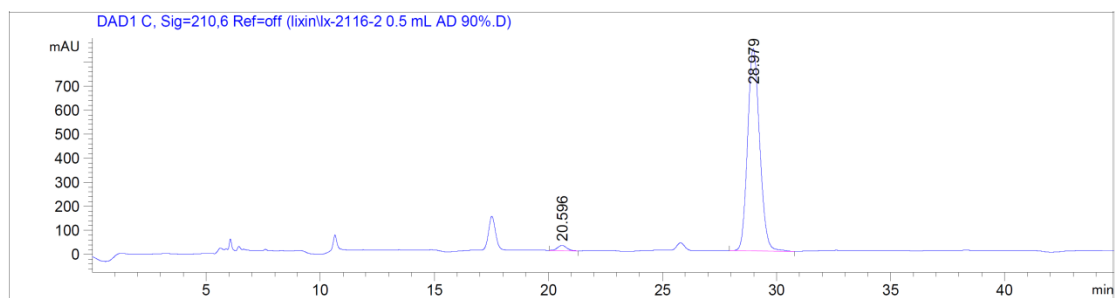
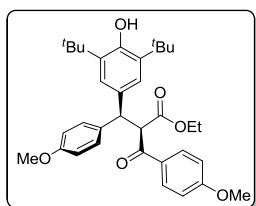


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.935	BB	0.1346	262.45718	29.83787	5.3612
2	10.037	BB	0.1429	31.40182	3.36352	0.6414
3	12.247	BB	0.1824	4286.68359	361.43555	87.5642
4	29.140	BB	0.4359	314.93463	11.00304	6.4332

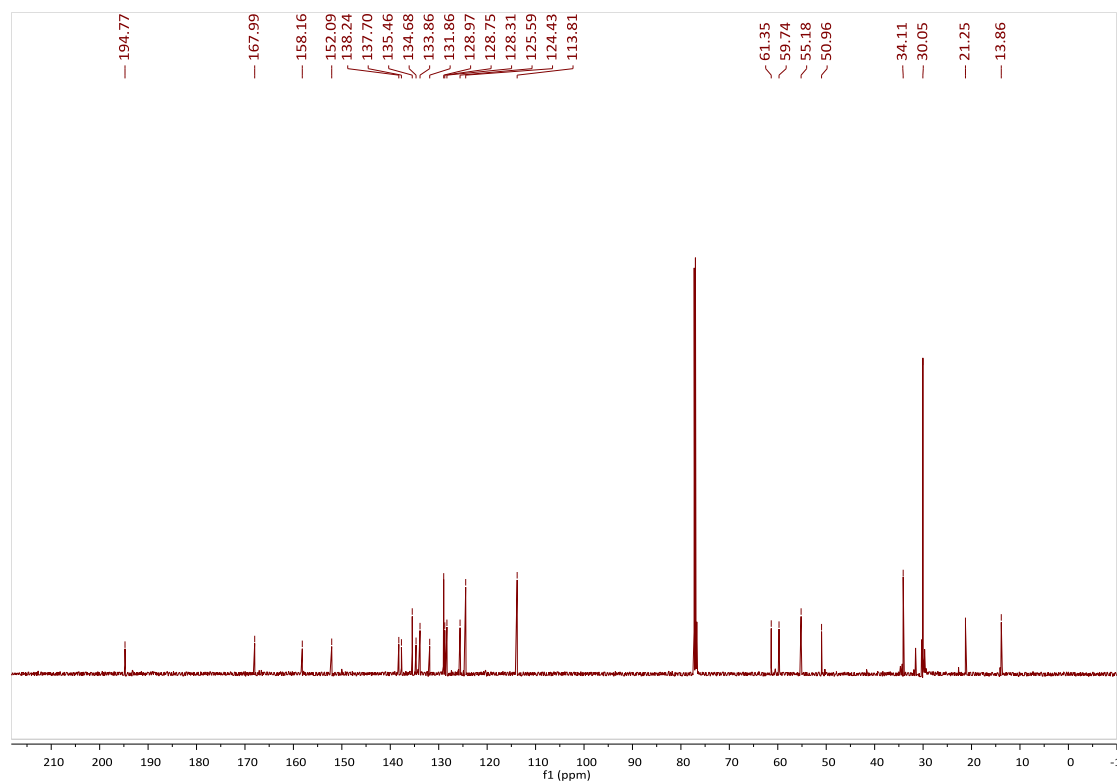
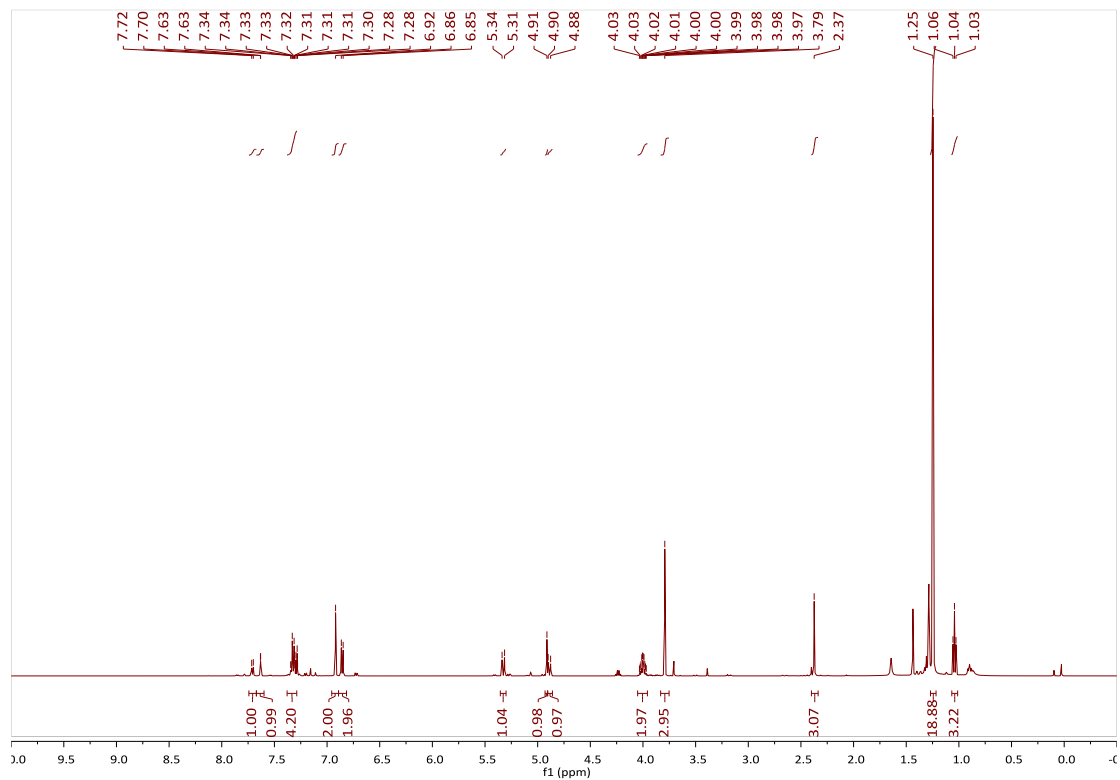
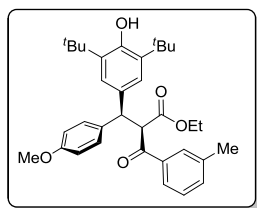


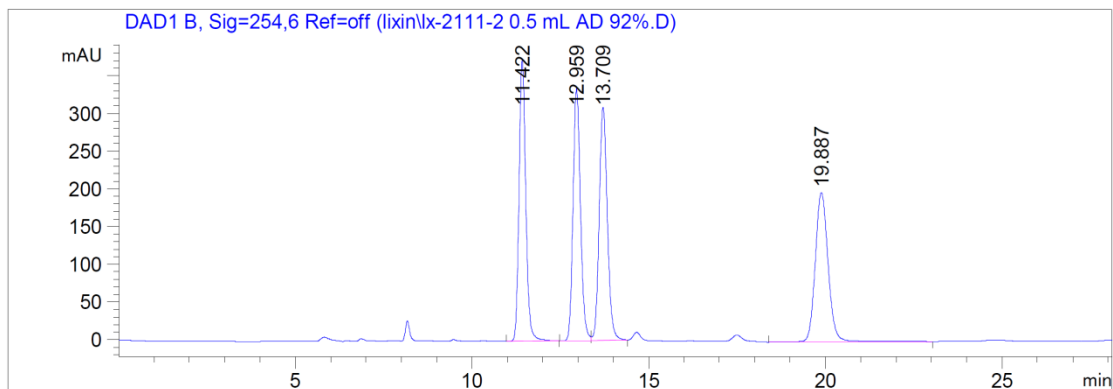
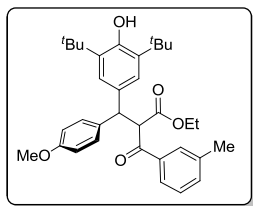


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.481	BB	0.3276	9069.72168	430.88080	28.9274
2	20.491	BB	0.3857	6641.52588	269.35156	21.1828
3	25.804	BB	0.3973	8700.80664	339.10632	27.7508
4	28.906	BB	0.5579	6941.31982	194.70026	22.1390

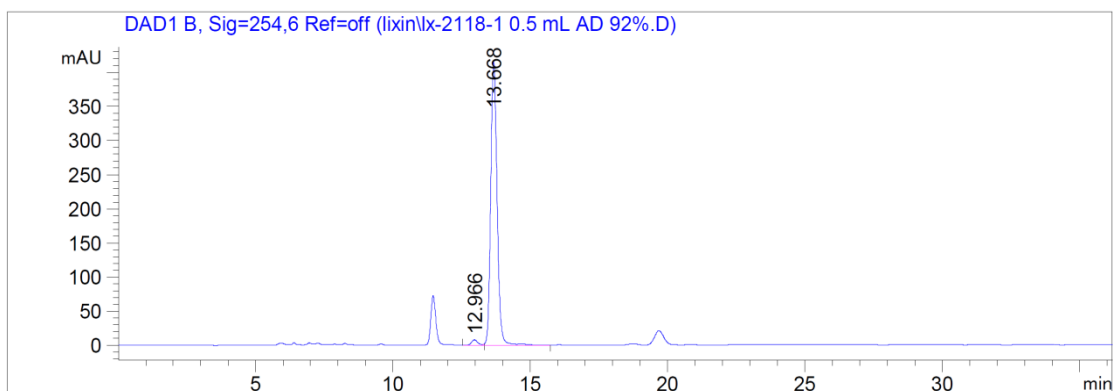
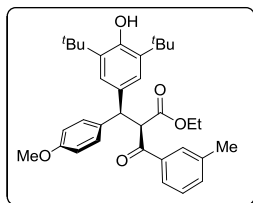


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.596	BB	0.4187	593.37311	21.99978	1.8766
2	28.979	BB	0.5768	3.10263e4	840.27081	98.1234

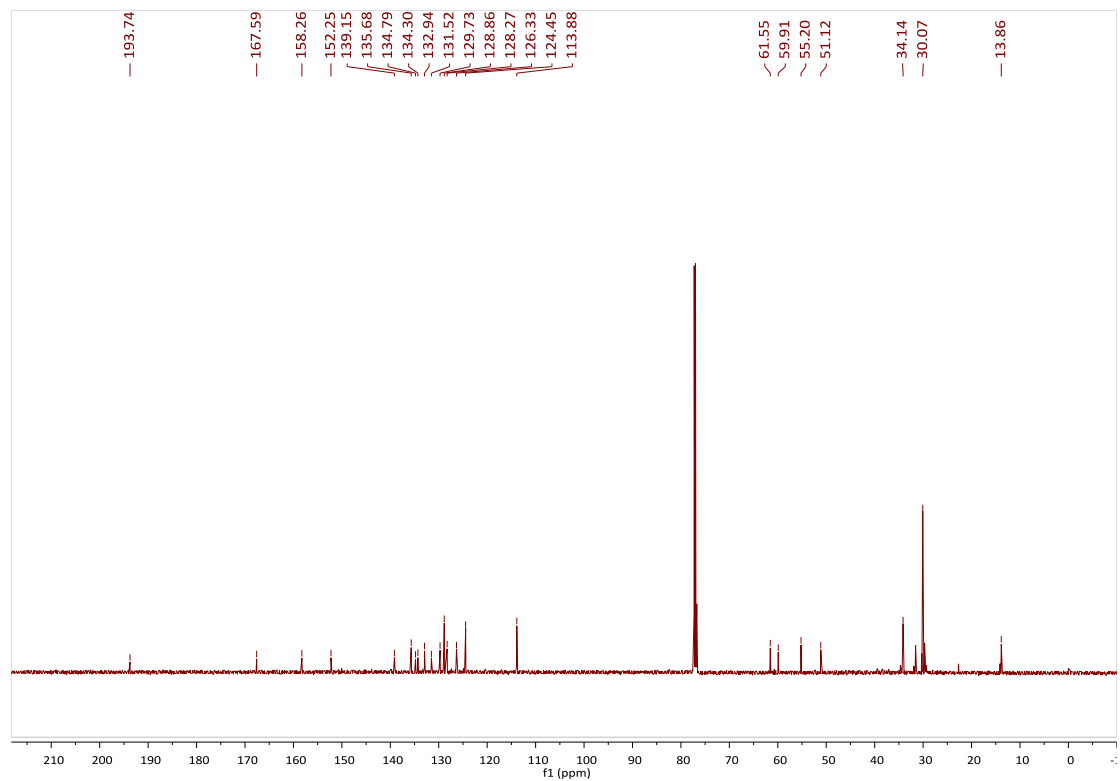
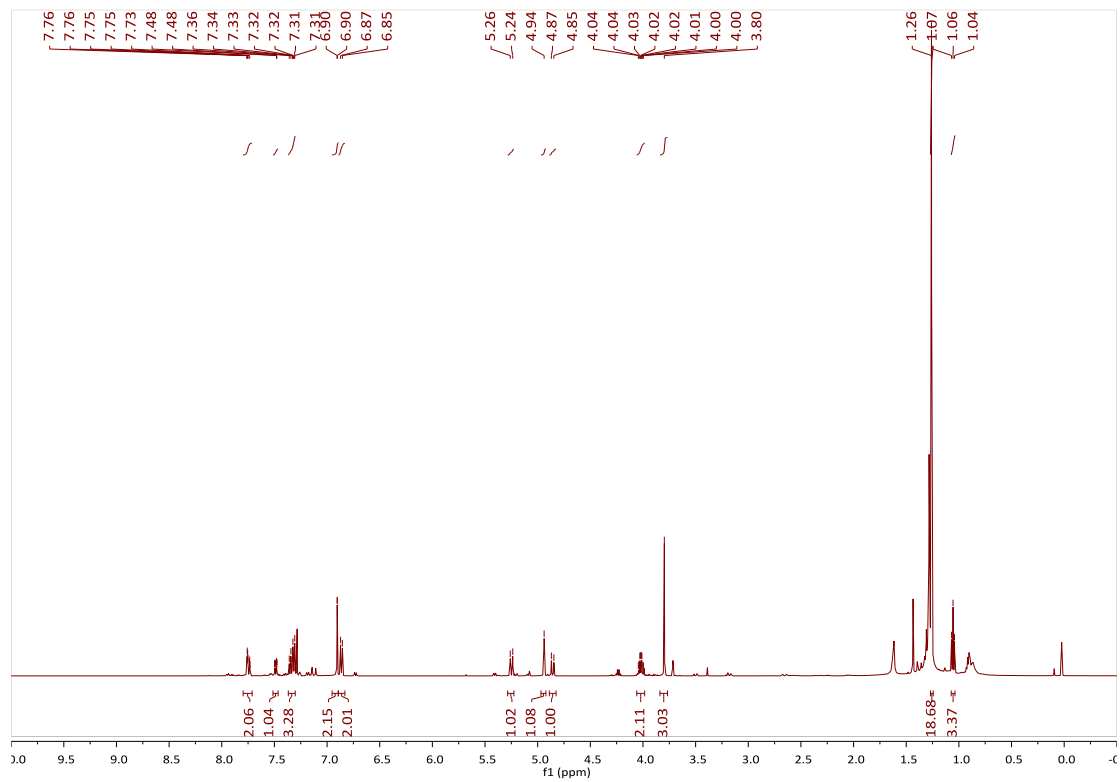
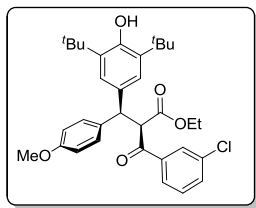


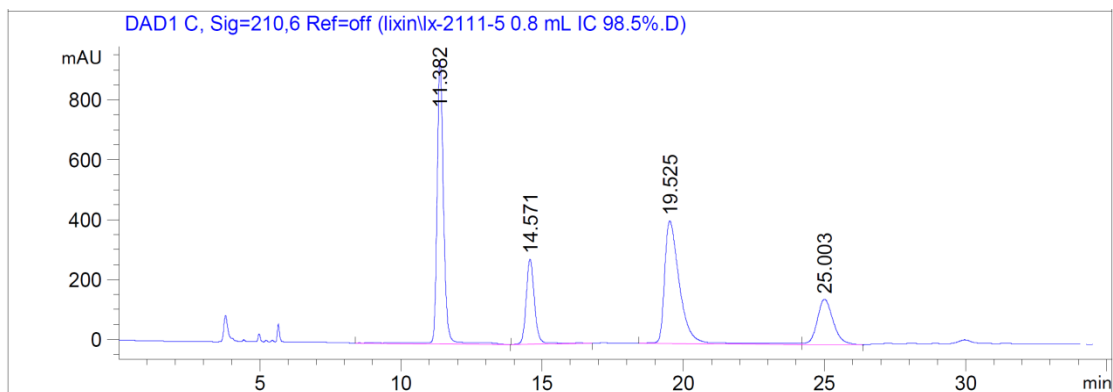
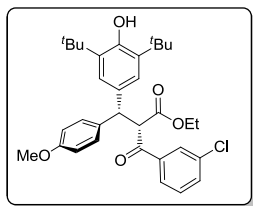


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.422	BB	0.2032	4961.38135	372.95795	25.0187
2	12.959	BV	0.2264	4872.22510	333.61206	24.5692
3	13.709	VB	0.2515	4939.85742	307.32446	24.9102
4	19.887	BB	0.3937	5057.19141	198.15967	25.5019

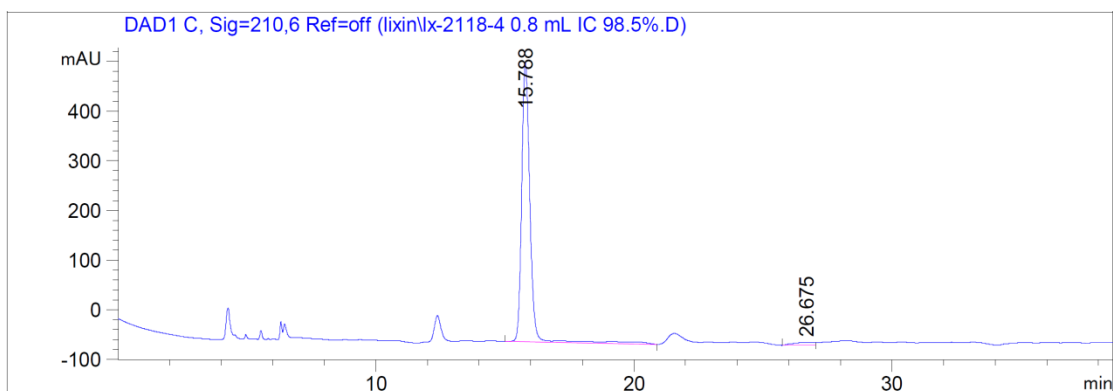
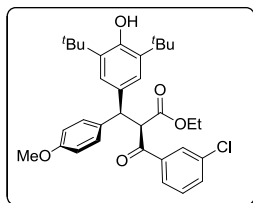


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.966	BV E	0.2424	116.59943	7.62598	1.7135
2	13.668	VV R	0.2431	6688.10889	415.32471	98.2865

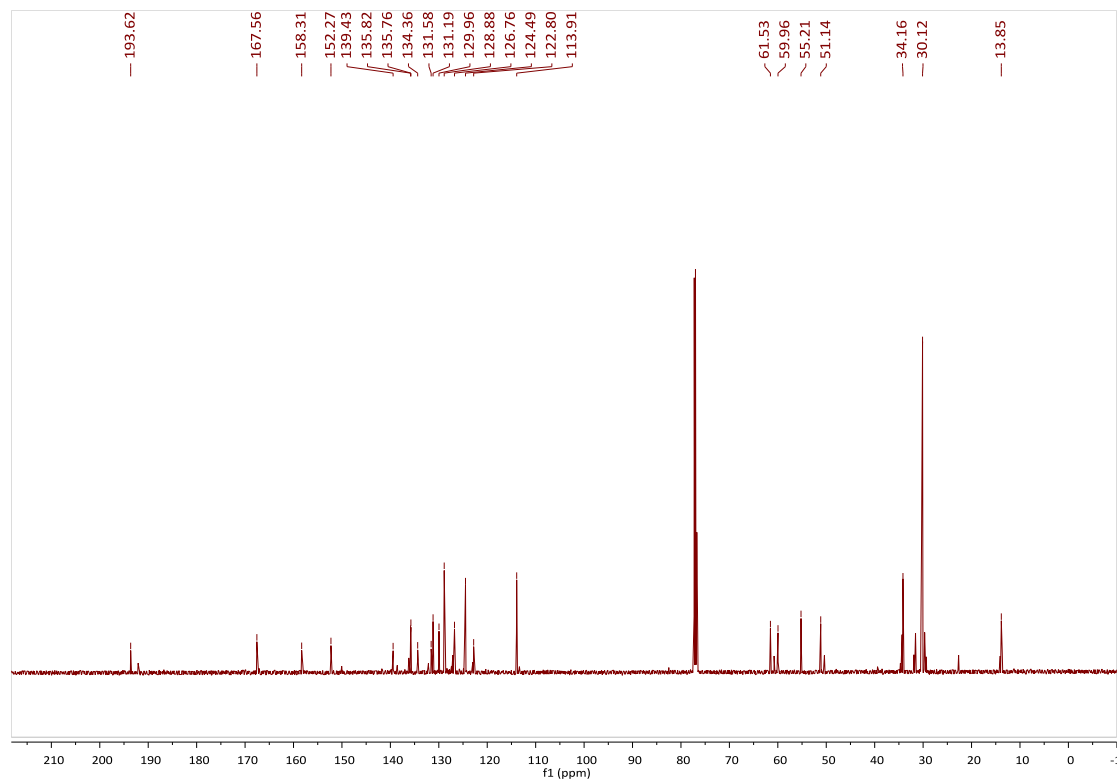
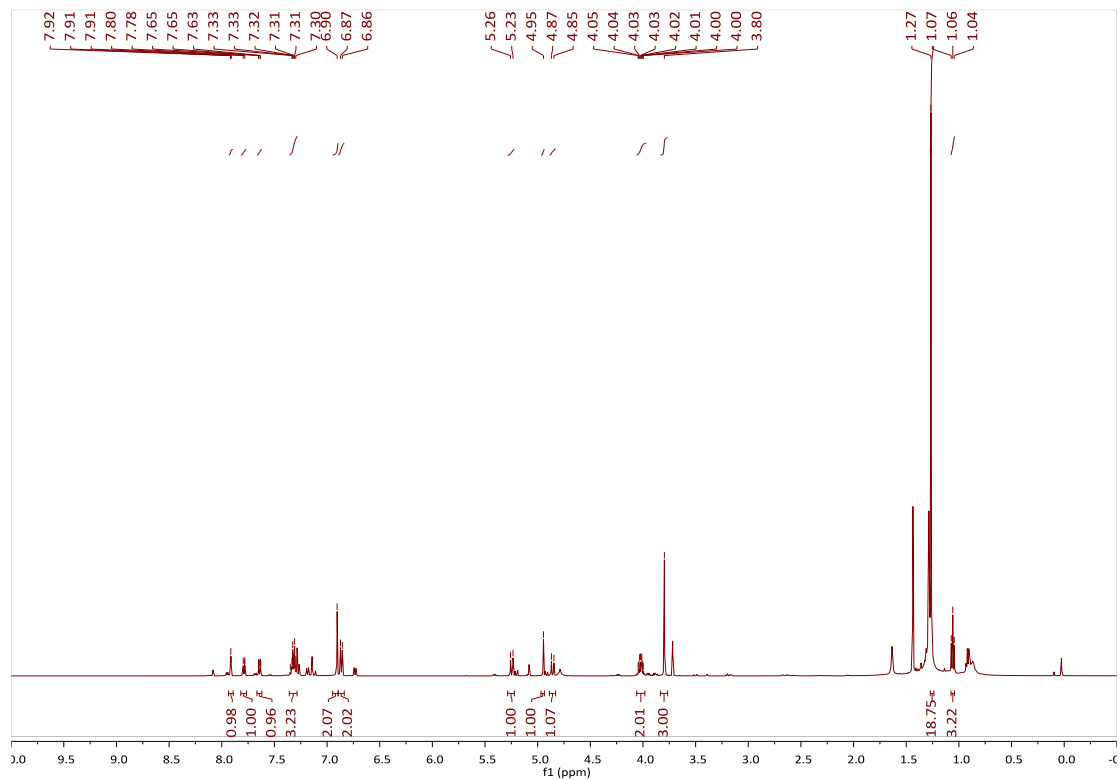
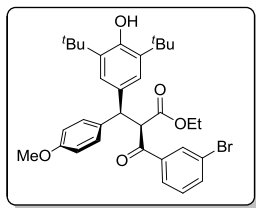


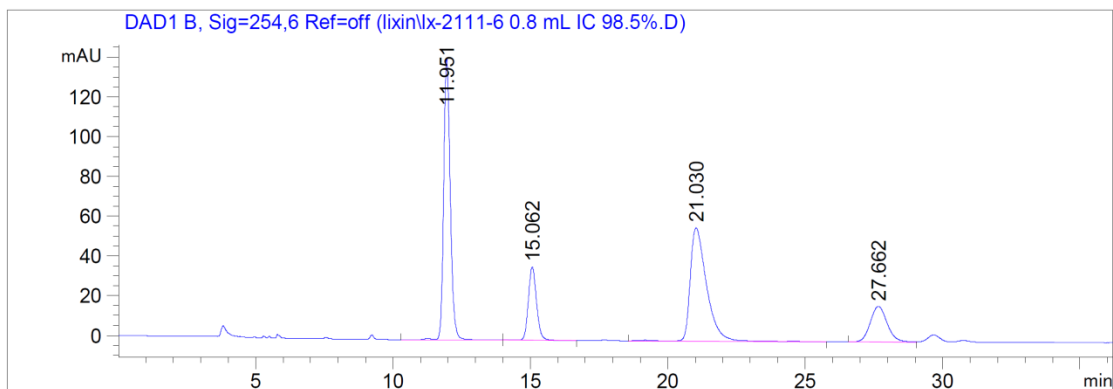
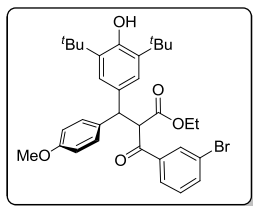


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.382	VV R	0.2411	1.55251e4	944.63605	36.3763
2	14.571	BV R	0.3089	5914.54346	284.38367	13.8582
3	19.525	BV R	0.5397	1.52807e4	409.29648	35.8038
4	25.003	VB	0.6031	5958.71680	151.42682	13.9617

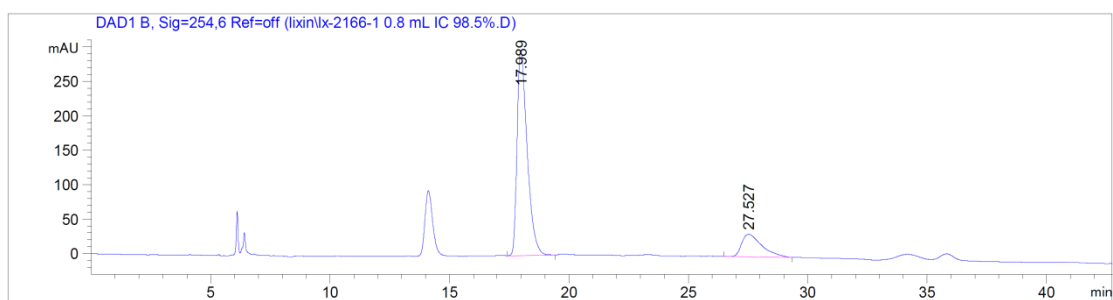
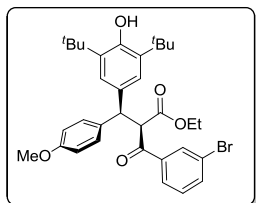


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.788	BV R	0.3297	1.28646e4	563.77795	97.7830
2	26.675	BV	0.8108	291.67194	5.16509	2.2170

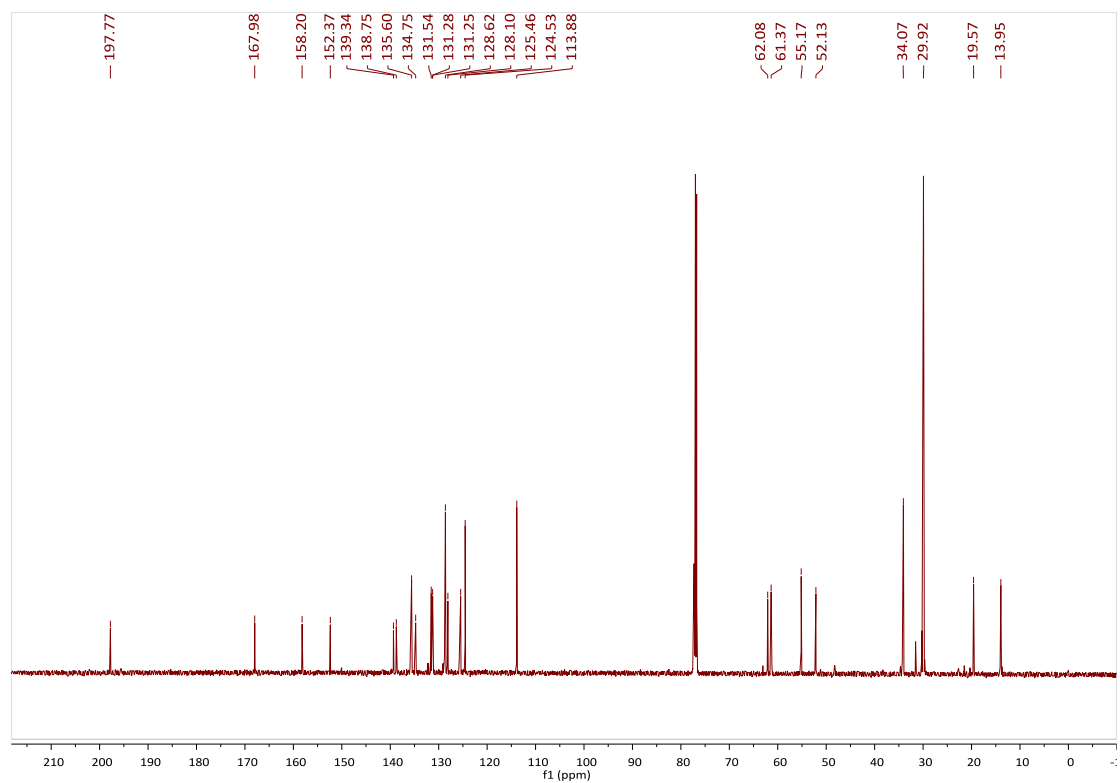


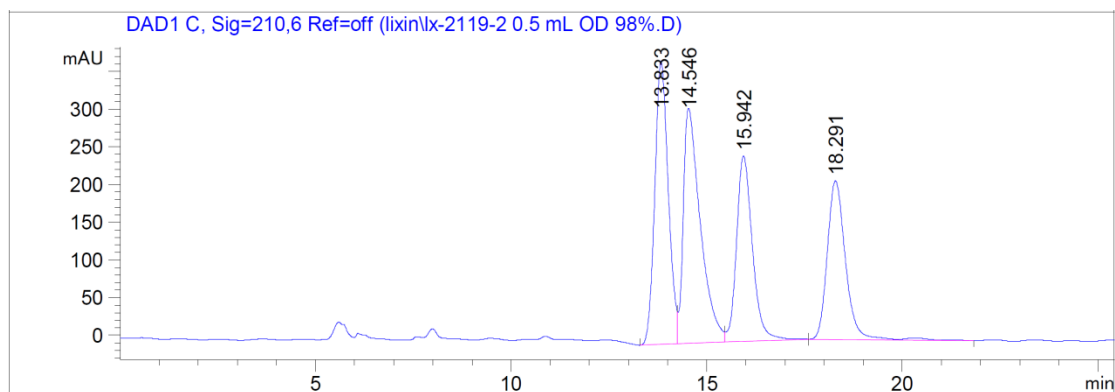
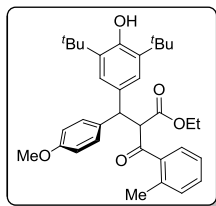


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.951	VB R	0.2590	2374.21875	140.90221	37.8990
2	15.062	VB R	0.3222	768.55597	36.85001	12.2682
3	21.030	VV R	0.6219	2357.91064	56.98749	37.6386
4	27.662	BV	0.6567	763.91736	17.94394	12.1942

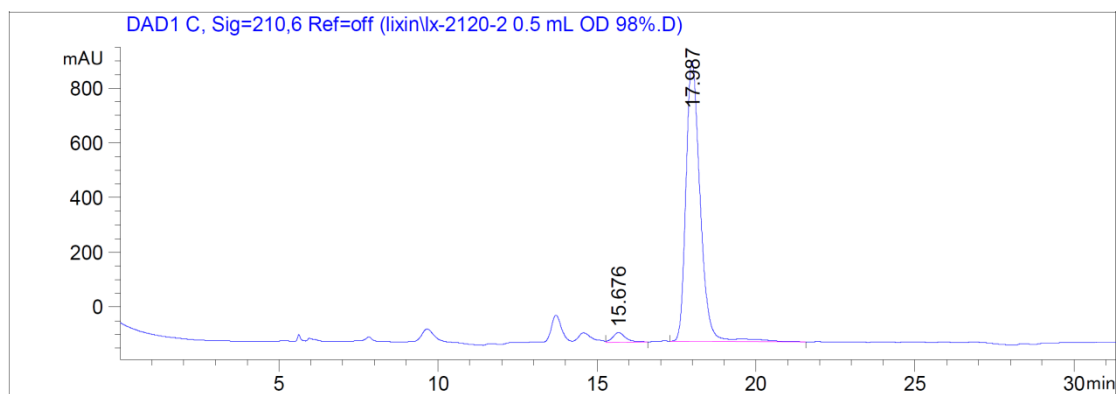
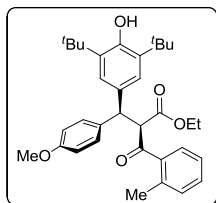


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.989	BB	0.4470	8757.70020	297.87286	81.8043
2	27.527	BB	0.8647	1947.96619	32.80621	18.1957

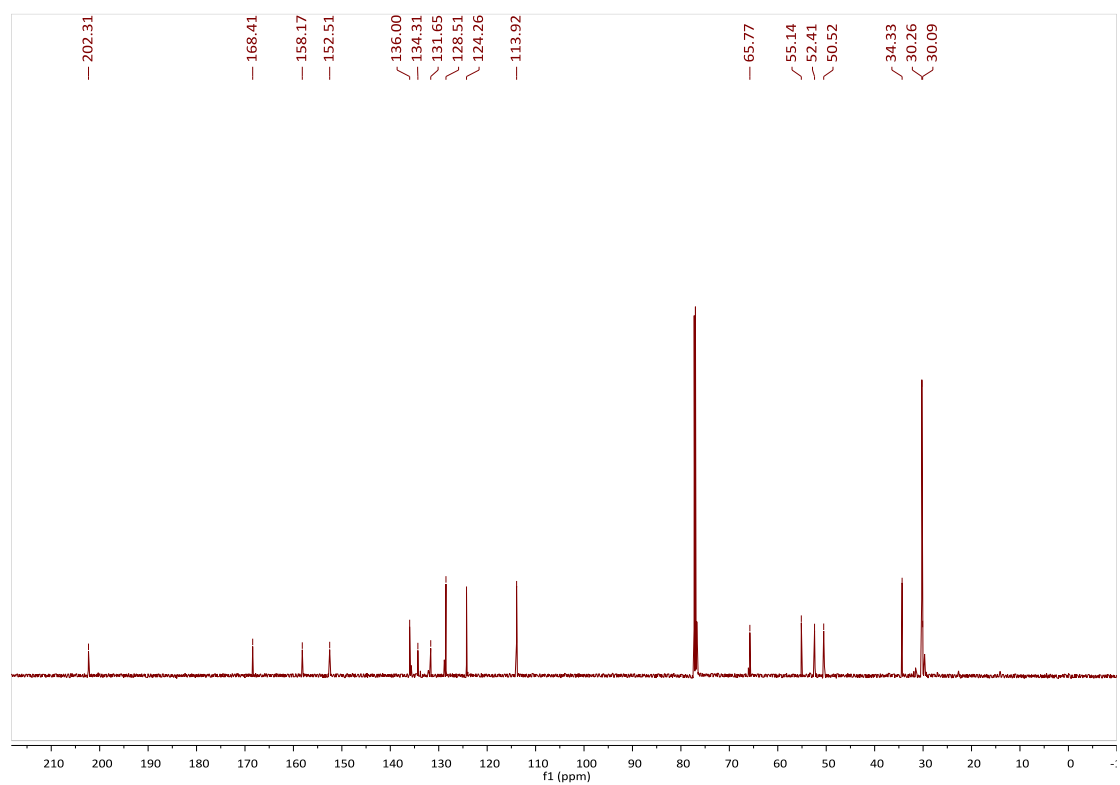
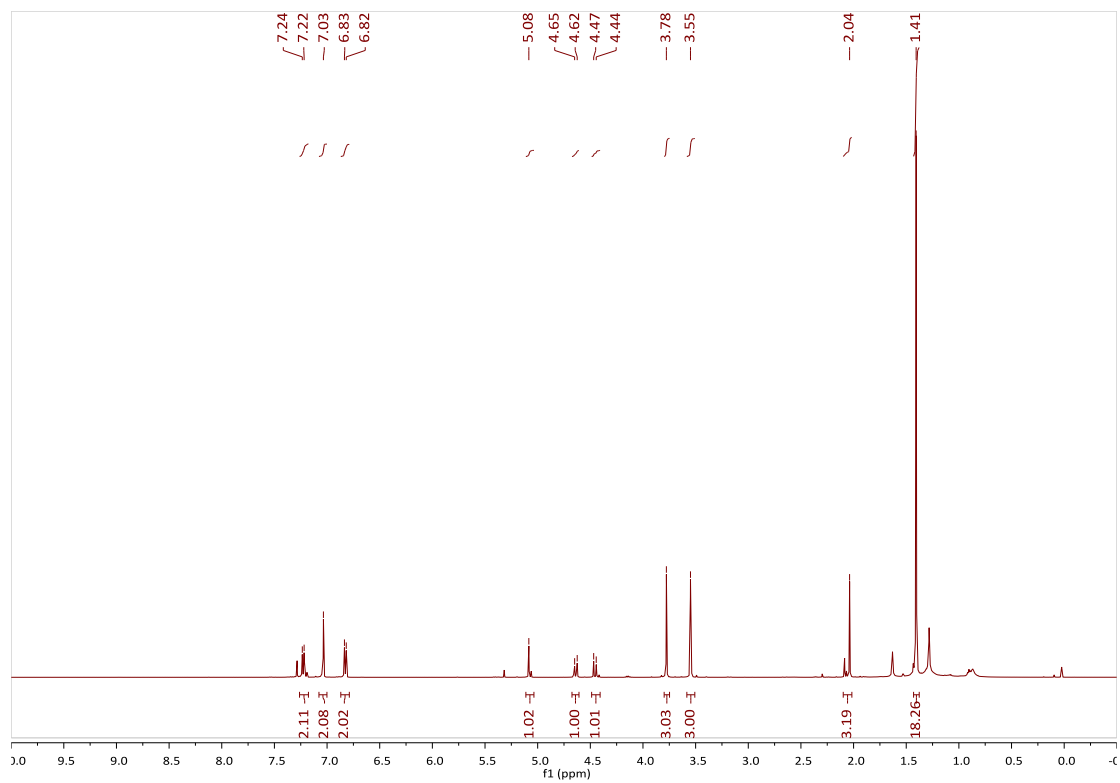
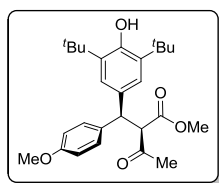


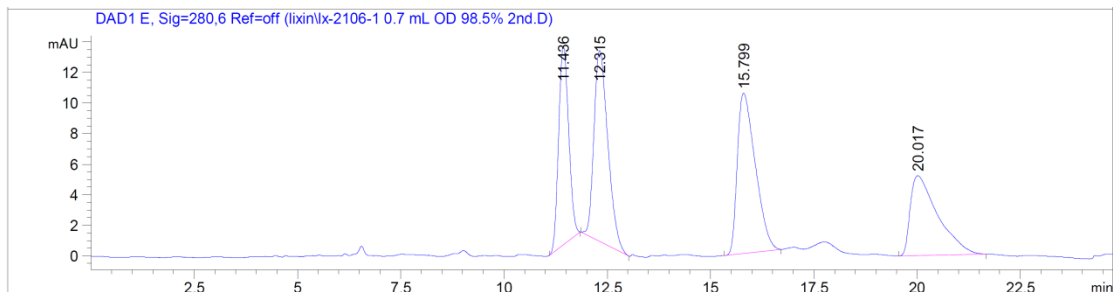
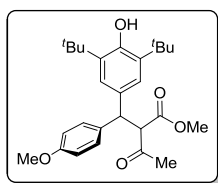


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.833	BV	0.3755	8991.82129	375.30170	27.7951
2	14.546	VV	0.4524	9495.72168	310.84753	29.3527
3	15.942	VB	0.4349	6971.92627	245.83466	21.5513
4	18.291	BV R	0.4964	6890.91699	210.10516	21.3009

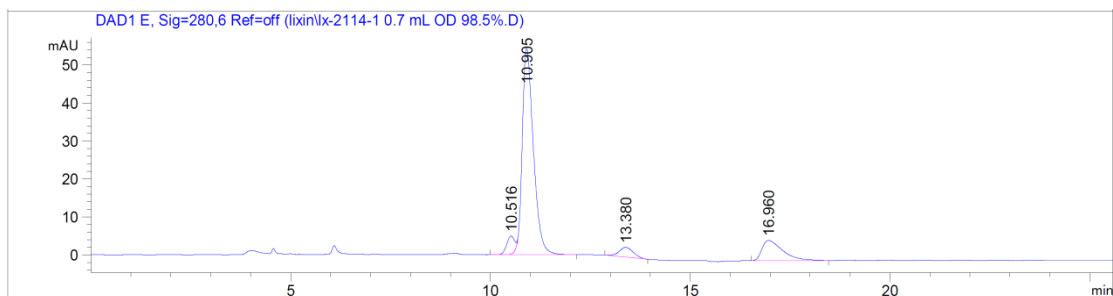
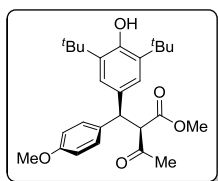


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.676	VB	0.4228	985.88251	35.19396	3.0103
2	17.987	BV R	0.4743	3.17644e4	1022.72363	96.9897

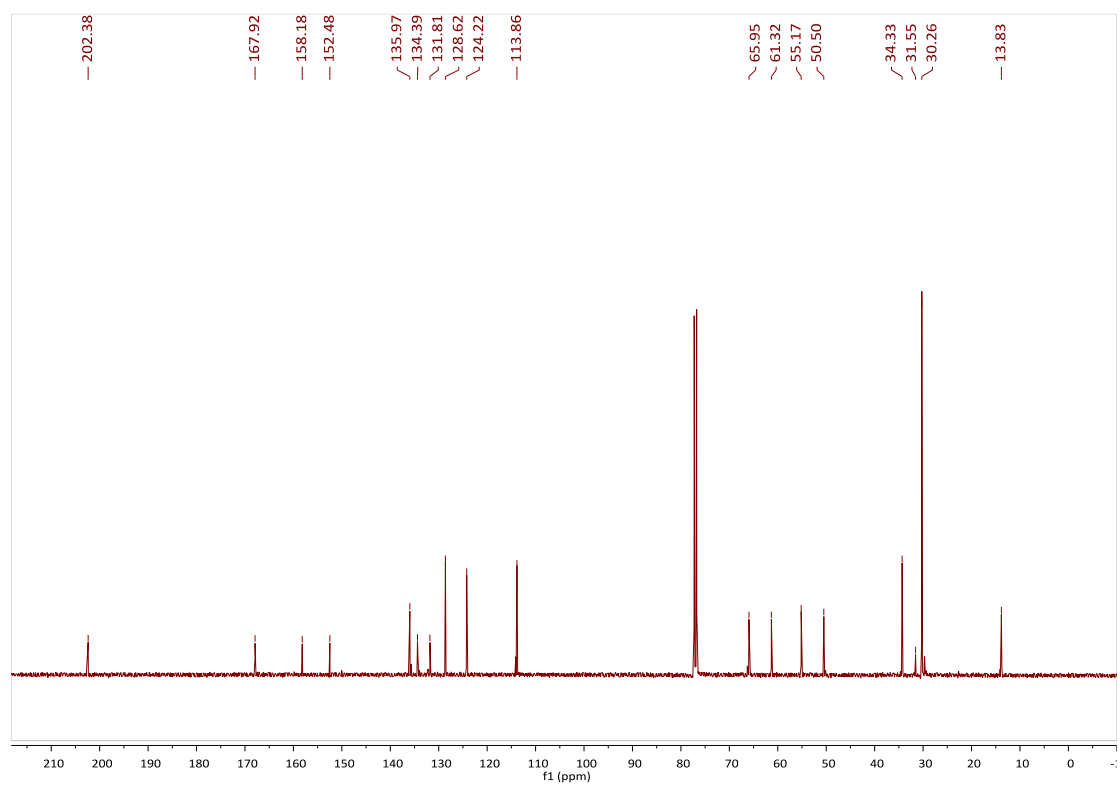
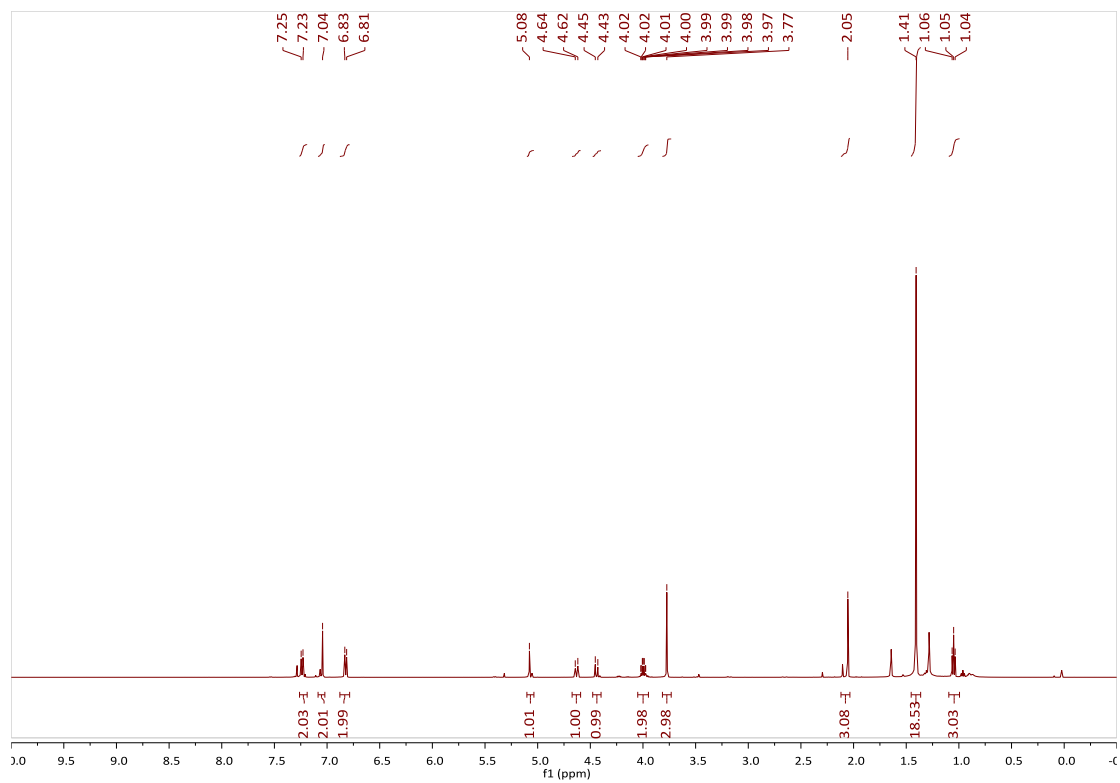
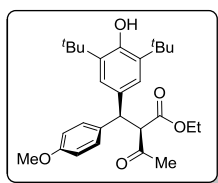


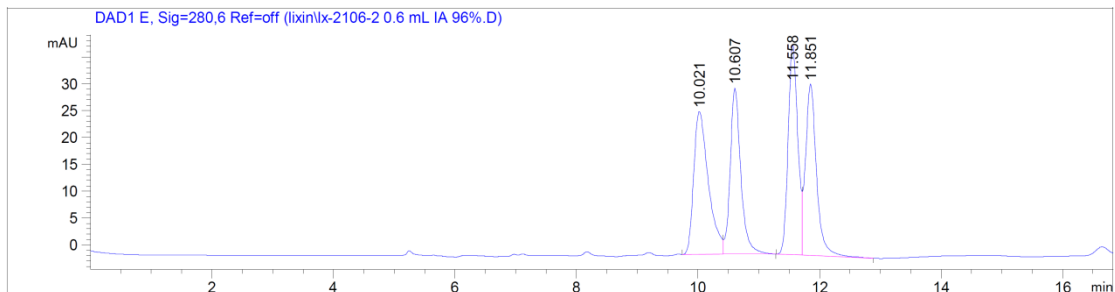
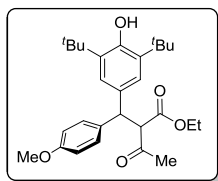


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.436	BB	0.2630	219.33919	12.98876	20.5095
2	12.315	BB	0.3612	292.10883	12.47531	27.3139
3	15.799	BB	0.4487	317.07516	10.48841	29.6484
4	20.017	BB	0.6359	240.92737	5.22547	22.5281

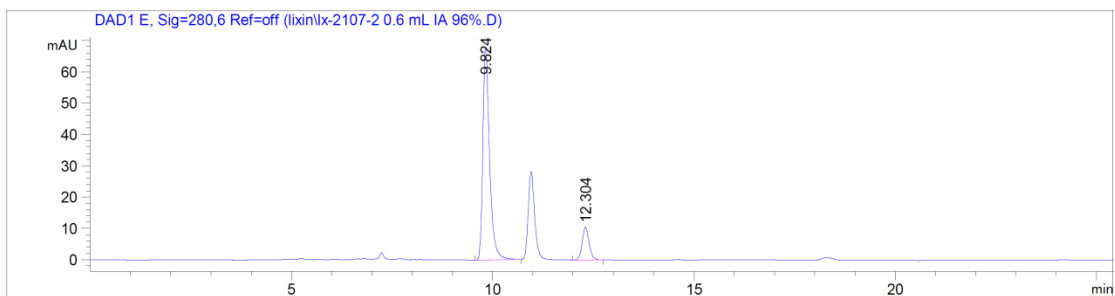
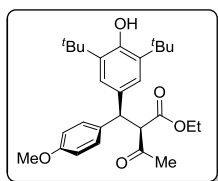


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.516	BV E	0.2096	63.71282	4.71795	4.6259
2	10.905	VB R	0.2949	1059.58069	54.47292	76.9314
3	13.380	BB	0.3730	64.78043	2.59731	4.7034
4	16.960	BB	0.5166	189.23131	5.32526	13.7392

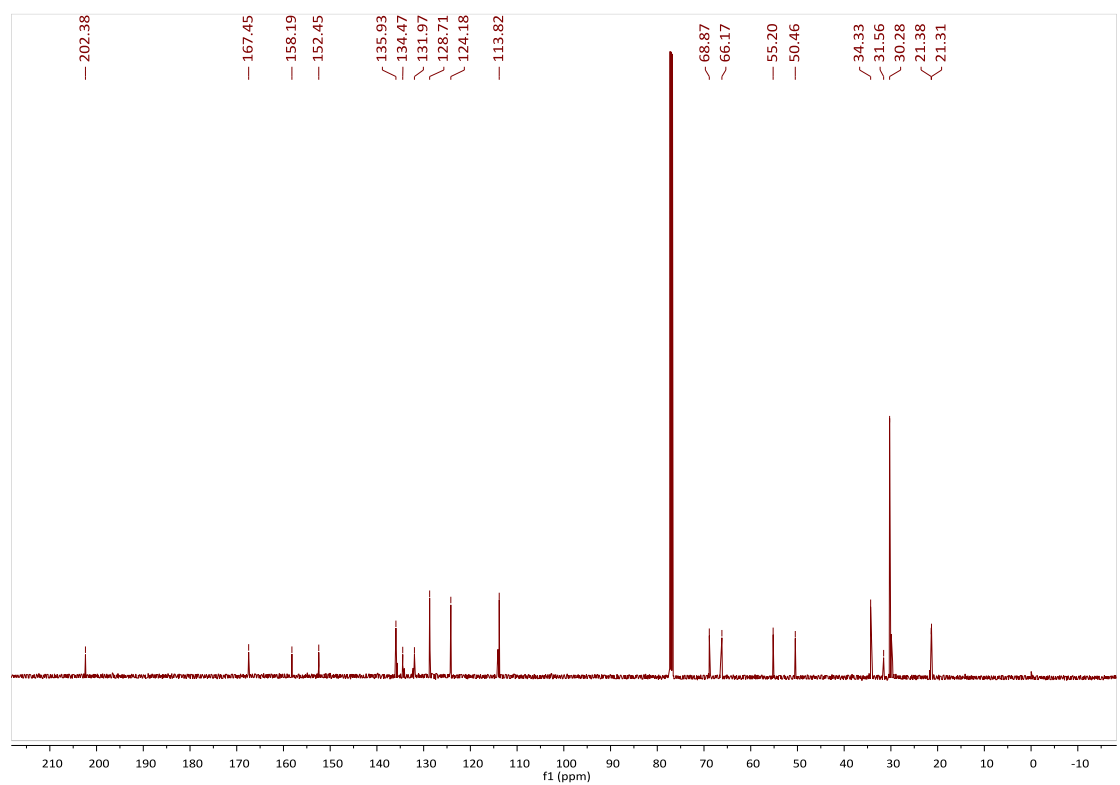
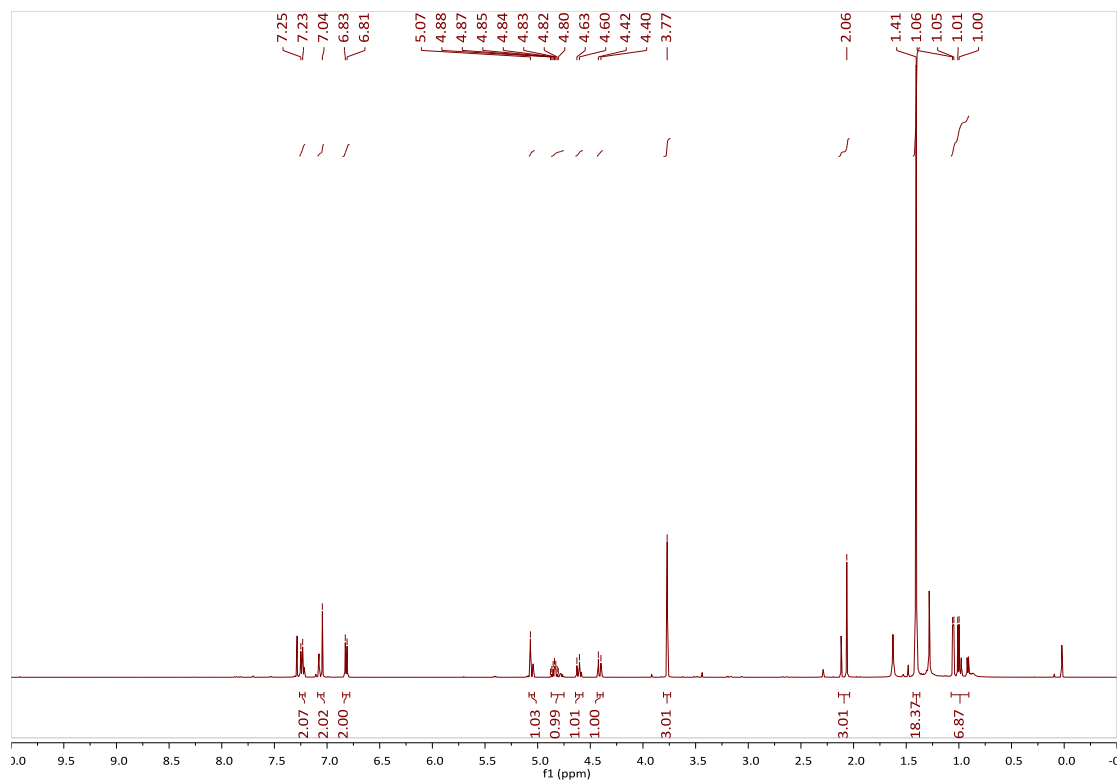
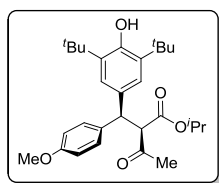


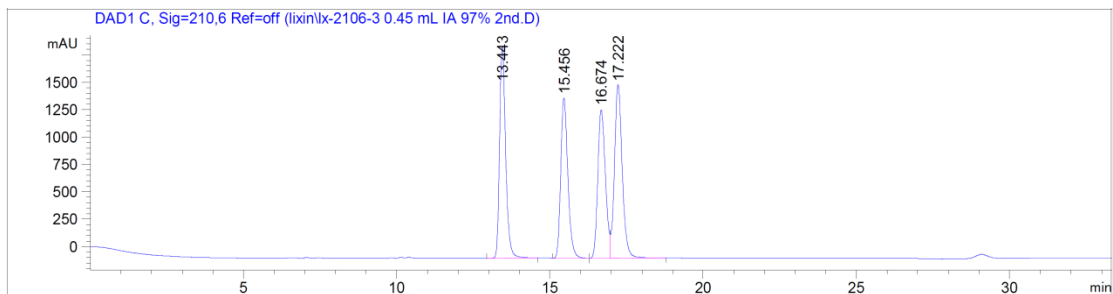
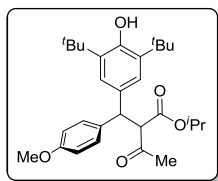


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.021	BV	0.2526	447.91220	26.58543	26.9907
2	10.607	VB	0.1822	376.92108	30.92938	22.7128
3	11.558	BV	0.1688	431.11761	39.04399	25.9787
4	11.851	VB	0.1852	403.55502	31.98929	24.3178

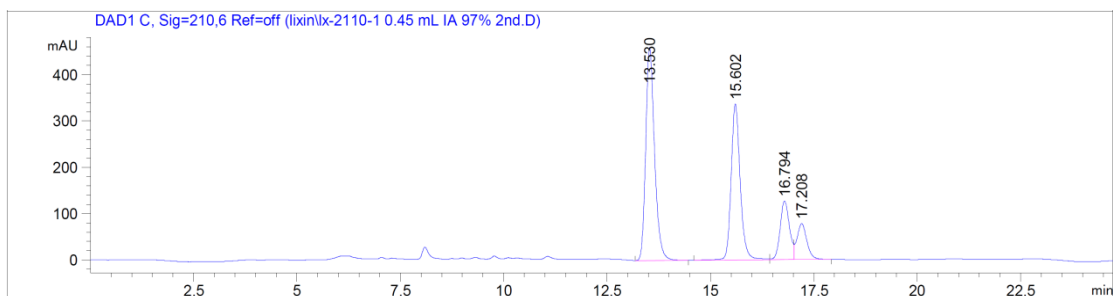
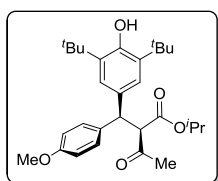


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.824	BB	0.1738	789.80359	67.87210	86.3255
2	12.304	BB	0.1831	125.11005	10.49387	13.6745

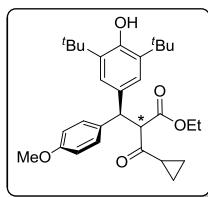




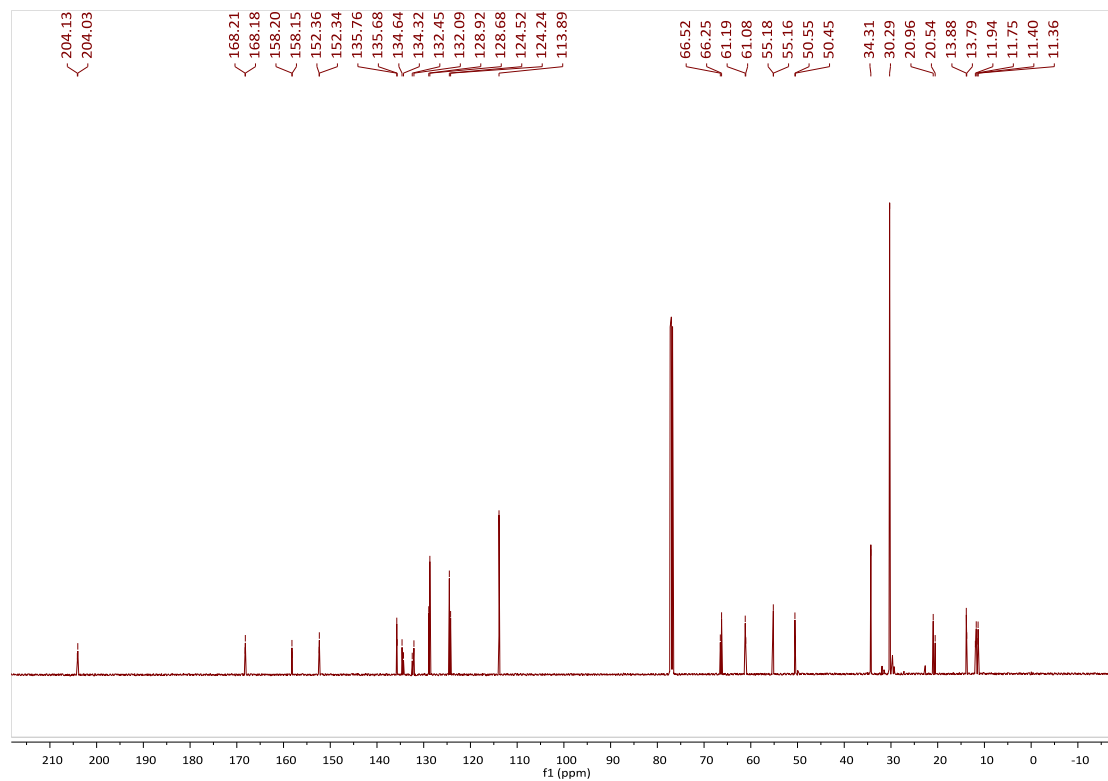
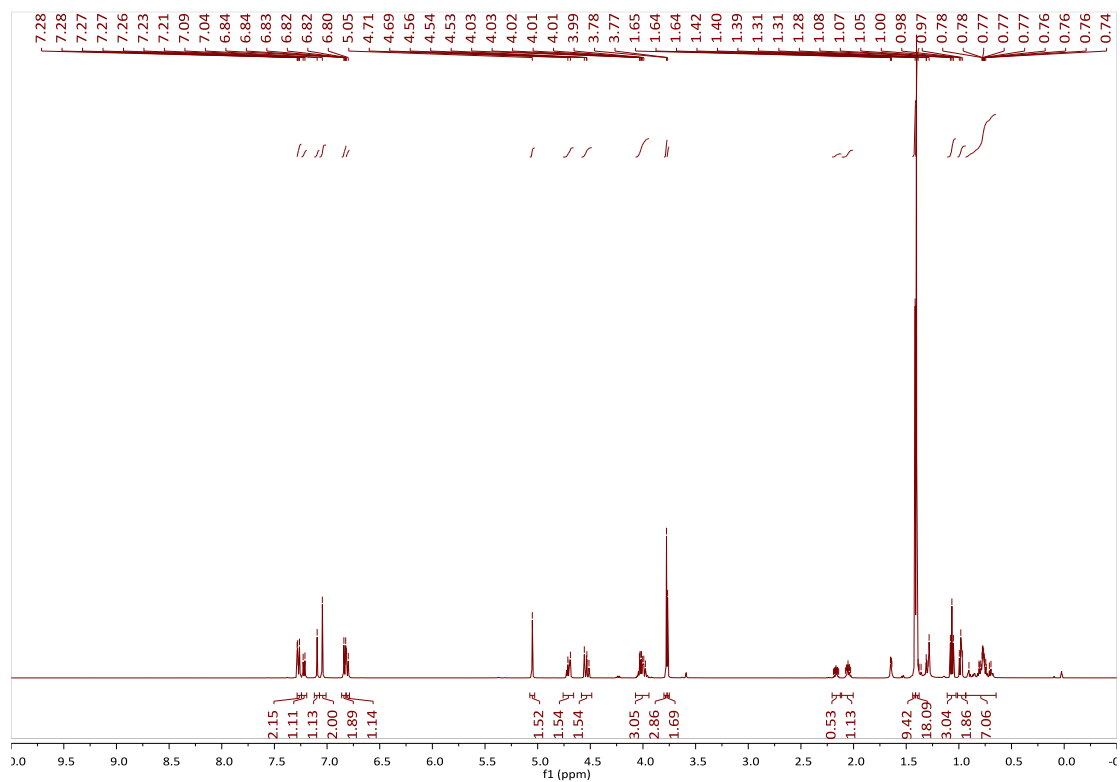
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.443	BB	0.2108	2.67177e4	1937.90088	26.2849
2	15.456	BB	0.2458	2.35157e4	1460.98657	23.1348
3	16.674	BV	0.2669	2.33474e4	1355.93909	22.9693
4	17.222	VB	0.2684	2.80656e4	1586.52917	27.6110

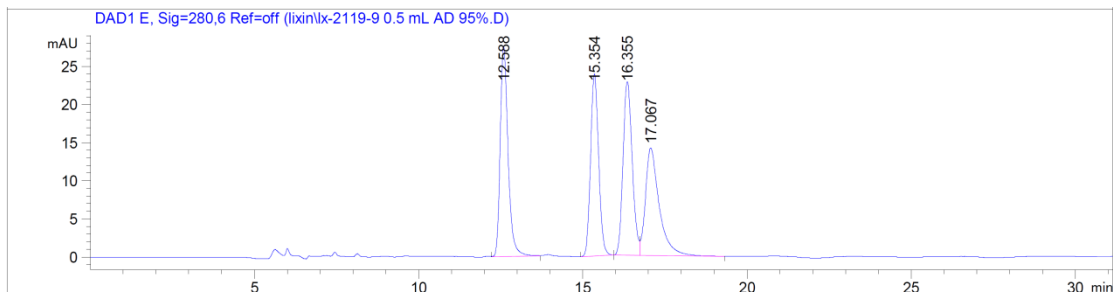
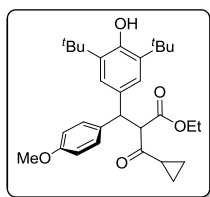


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.530	BB	0.2280	6844.13477	458.81247	44.8408
2	15.602	BV	0.2325	5152.74561	336.78214	33.7593
3	16.794	VV	0.2414	1989.53760	126.53970	13.0349
4	17.208	VB	0.2482	1276.76123	77.49190	8.3650

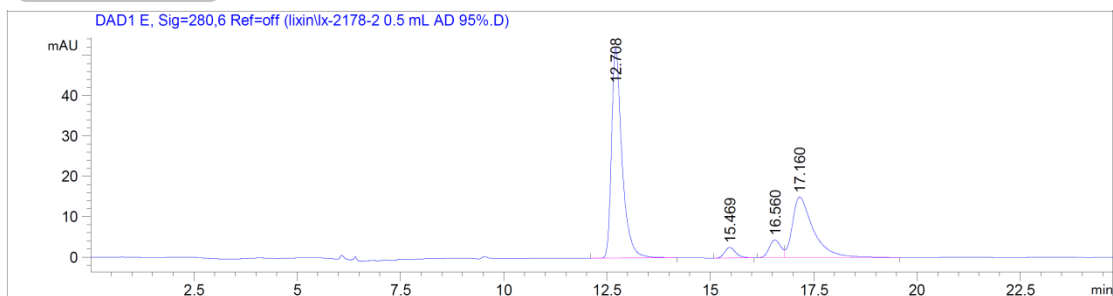
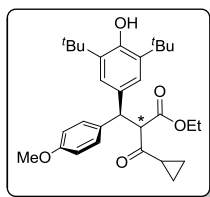


dr = 1.8:1

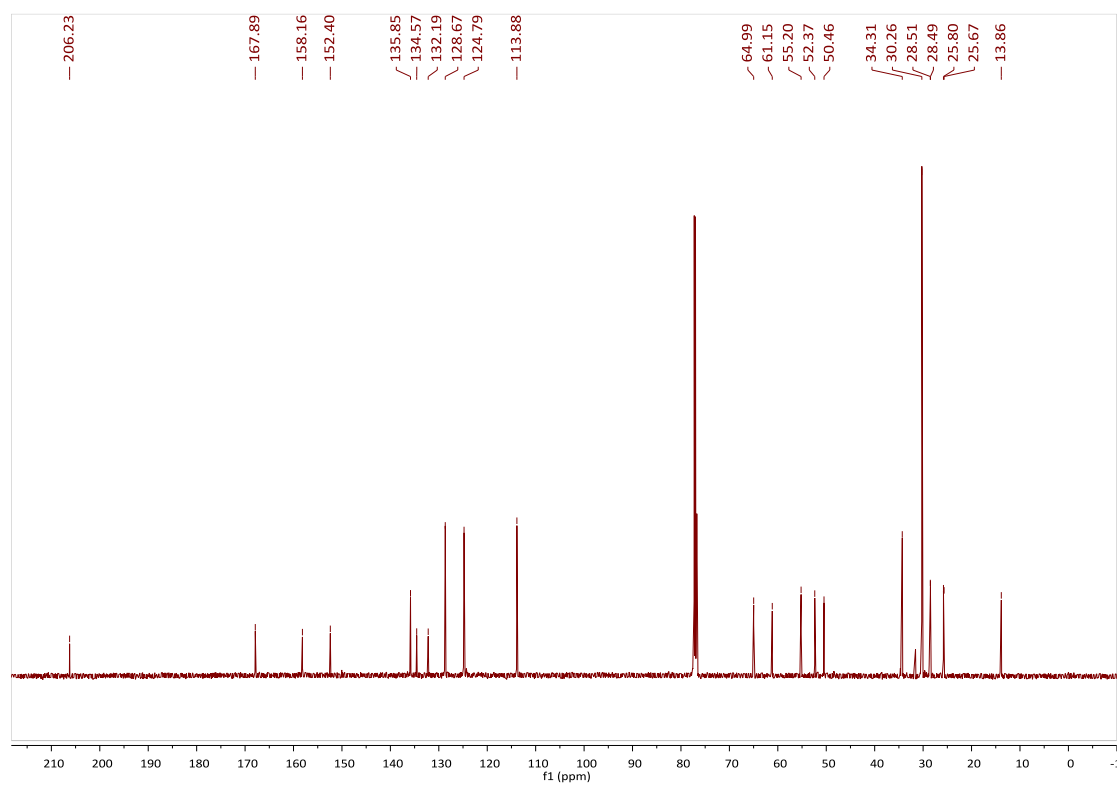
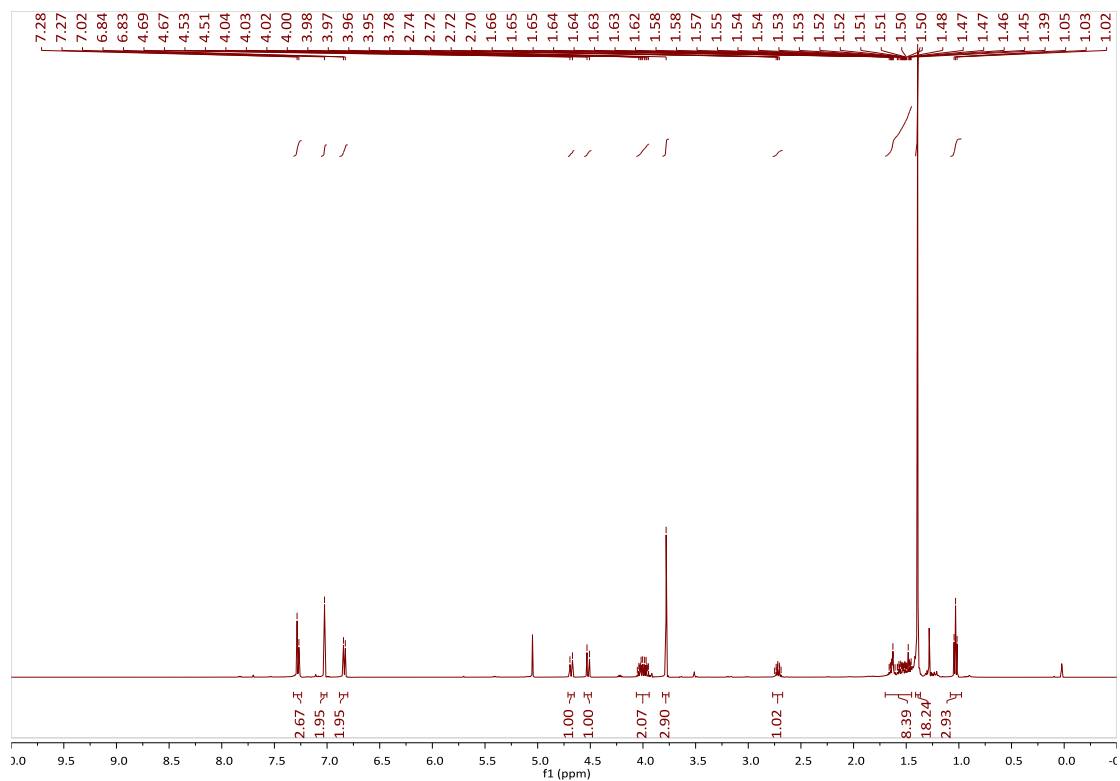
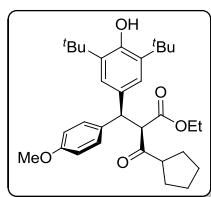


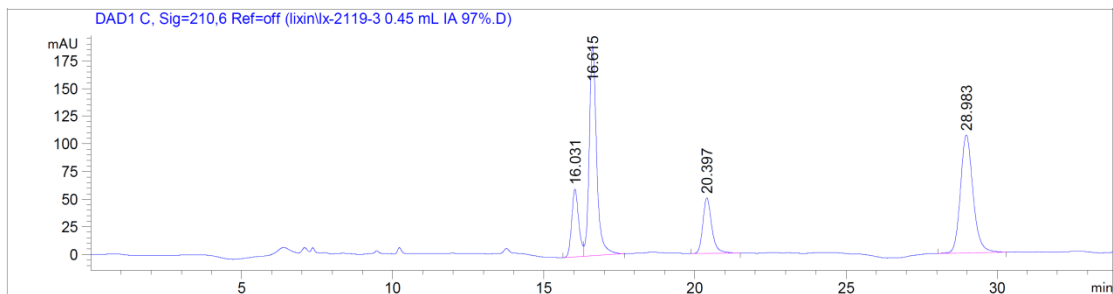
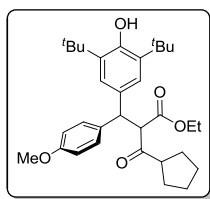


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.588	BB	0.2486	455.50131	27.58817	26.5030
2	15.354	BB	0.2607	406.24695	23.85800	23.6371
3	16.355	BV	0.3037	444.05624	22.75021	25.8370
4	17.067	VB	0.4295	412.87698	14.10403	24.0229

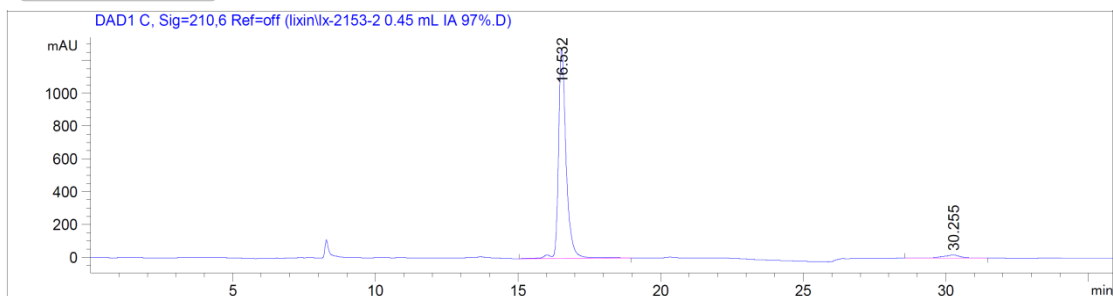
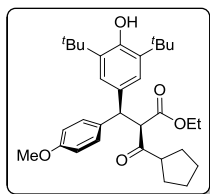


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.708	BB	0.2639	919.29767	52.08566	57.7148
2	15.469	BB	0.2882	49.06168	2.62363	3.0802
3	16.560	BV	0.2975	86.59732	4.44101	5.4367
4	17.160	VB	0.5190	537.87042	15.04872	33.7683

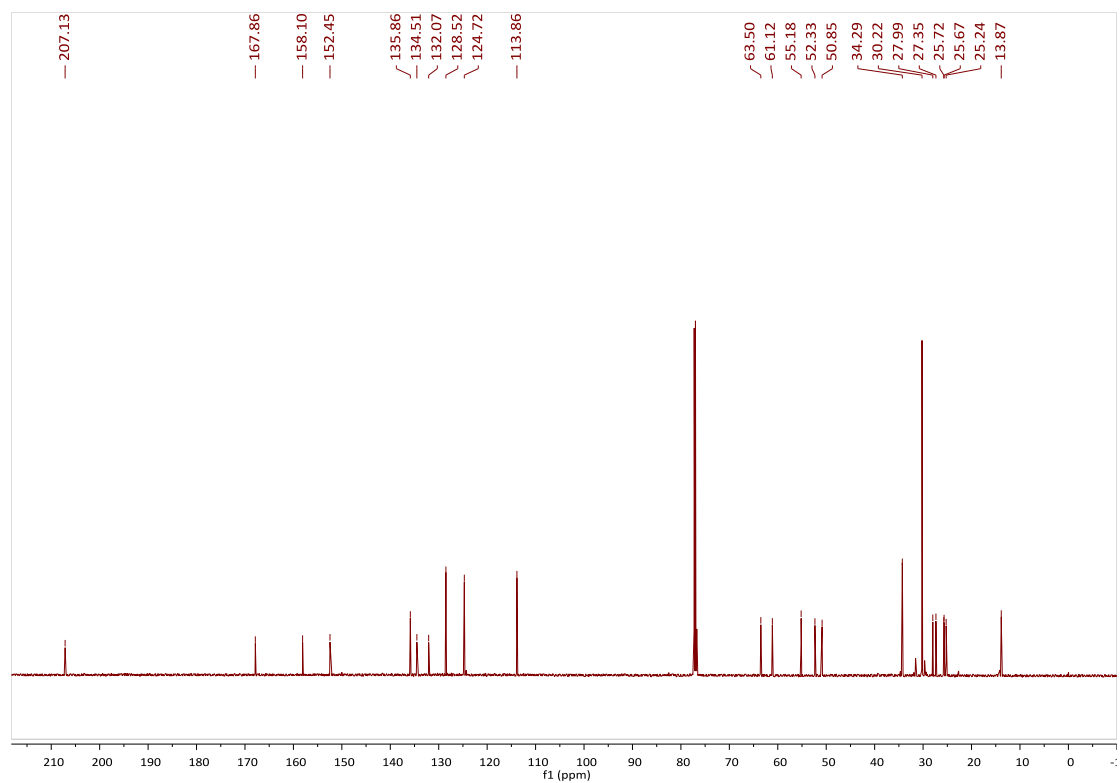
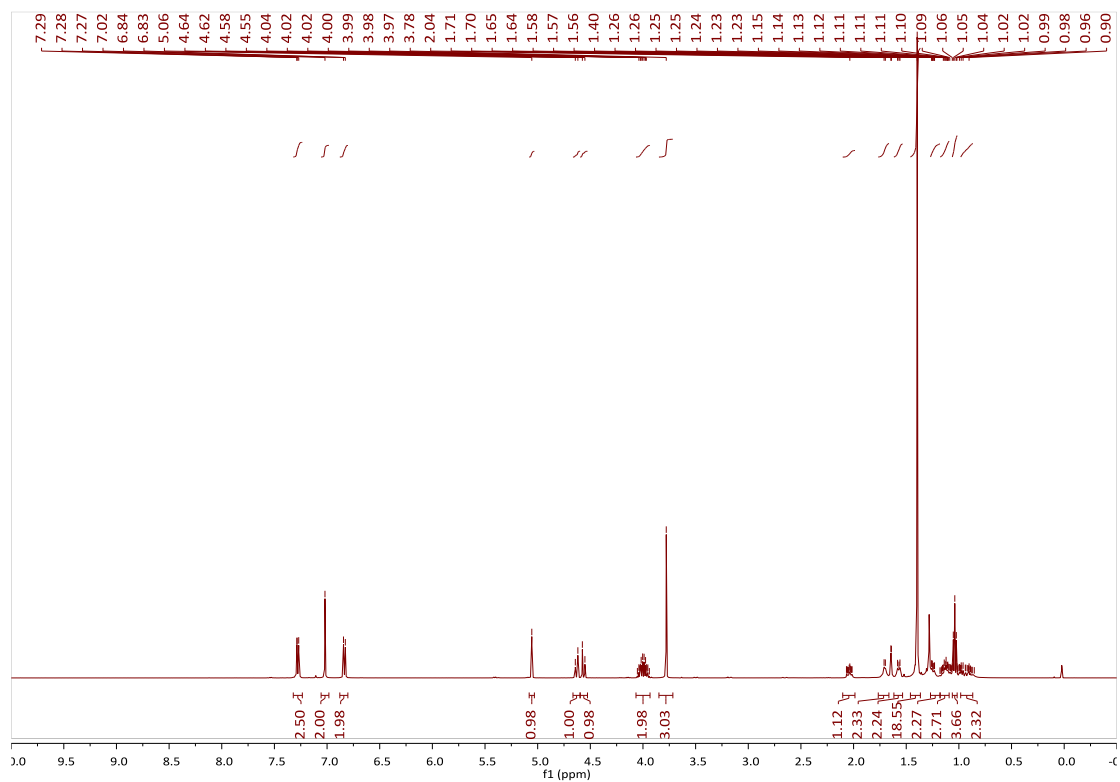
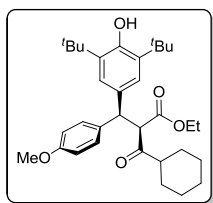


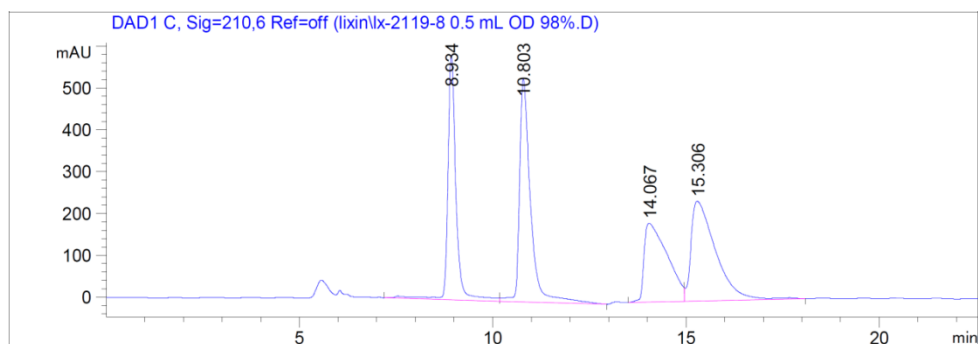
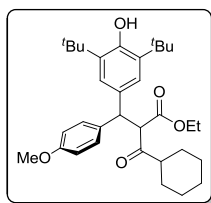


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.031	BV	0.2465	987.44672	61.10079	11.8594
2	16.615	VB	0.2559	3210.76123	189.24934	38.5619
3	20.397	BB	0.3113	1042.77161	50.40765	12.5239
4	28.983	BB	0.4377	3085.27881	106.58026	37.0548

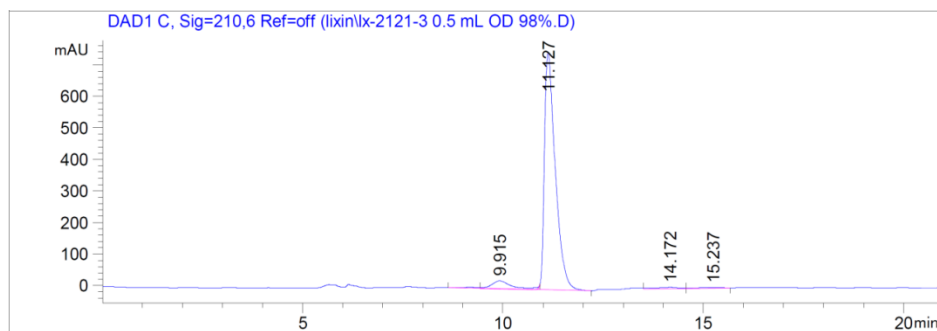
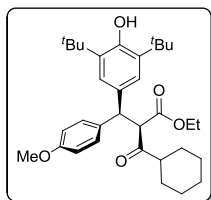


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.532	VB R	0.2728	2.37779e4	1282.13757	96.7913
2	30.255	BB	0.6084	788.26190	18.01918	3.2087

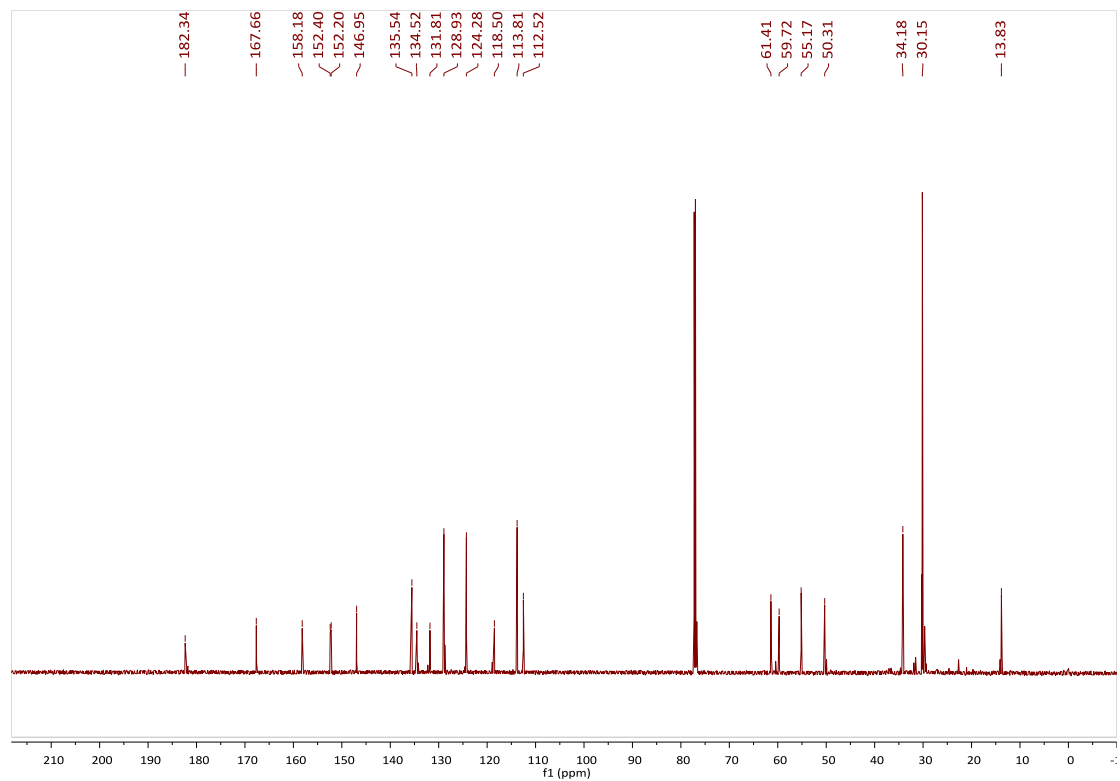
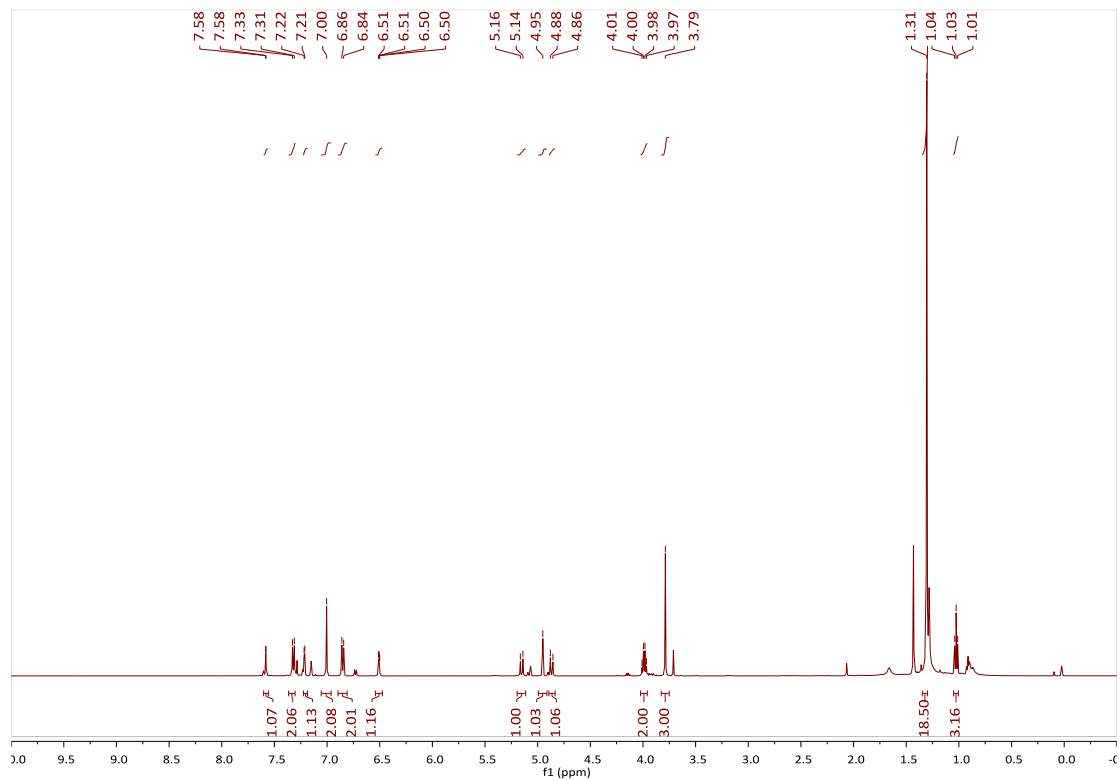
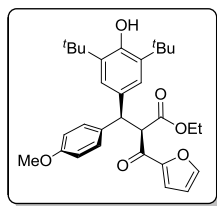


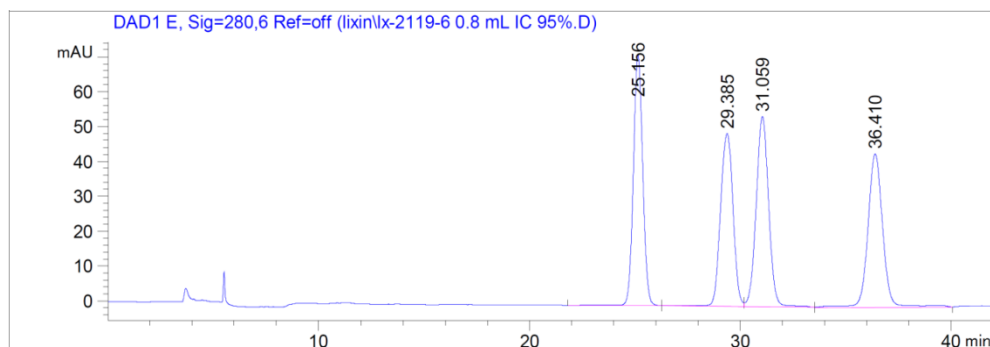
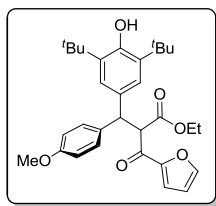


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.934	VV R	0.2163	8610.02148	574.67969	22.8665
2	10.803	VB	0.2999	1.06124e4	524.86365	28.1845
3	14.067	BV	0.7054	7870.21094	187.62021	20.9017
4	15.306	VV R	0.6655	1.05608e4	237.95599	28.0473

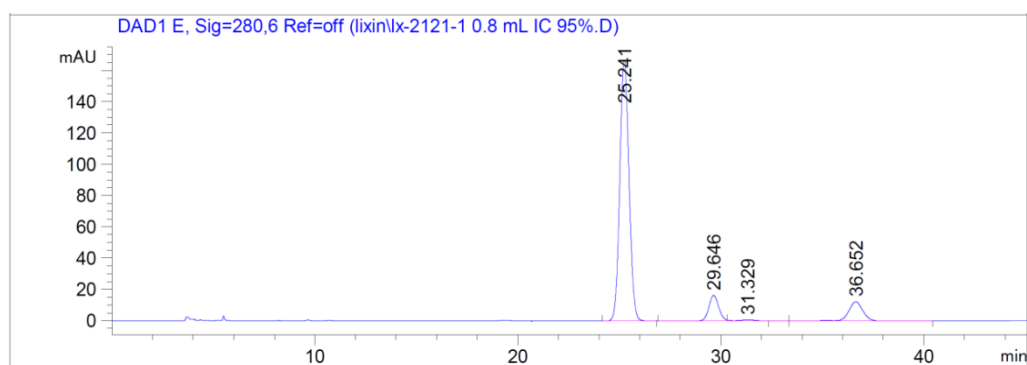
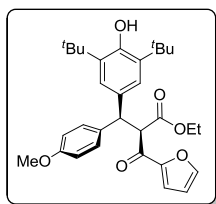


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.915	VV E	0.5352	930.60742	25.17933	6.0059
2	11.127	VB R	0.2844	1.42488e4	749.33350	91.9573
3	14.172	VV	0.5725	226.44160	5.19516	1.4614
4	15.237	VB	0.7503	89.15880	1.58974	0.5754

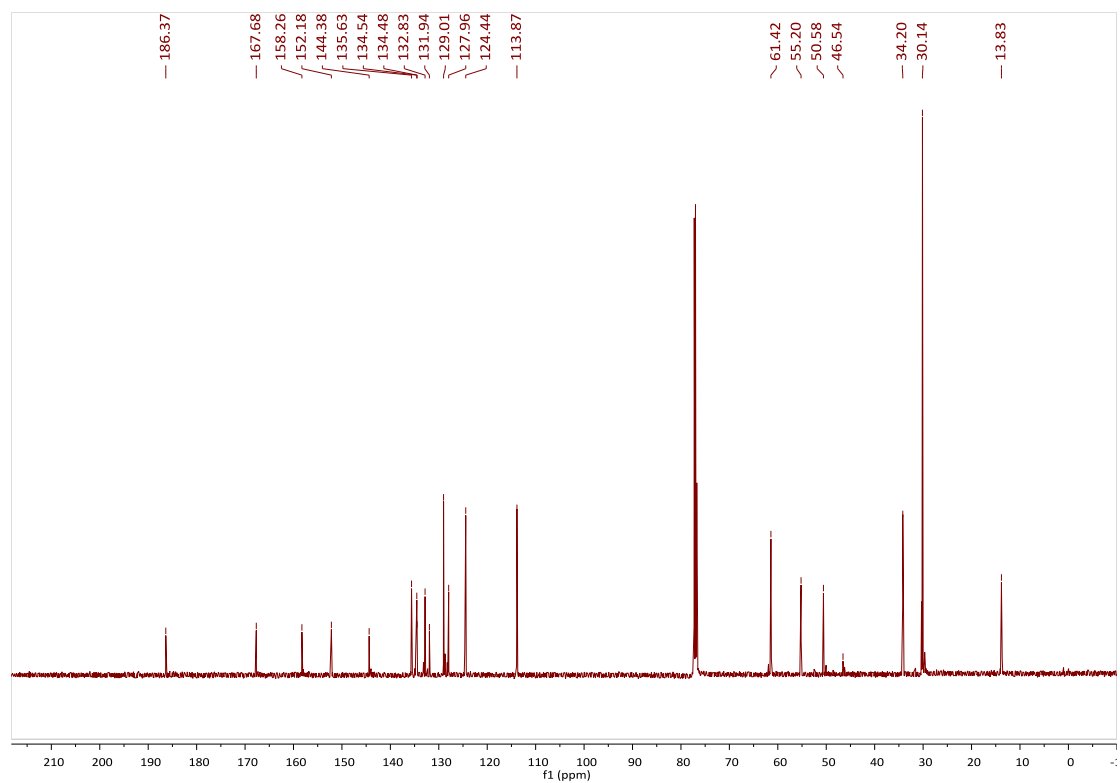
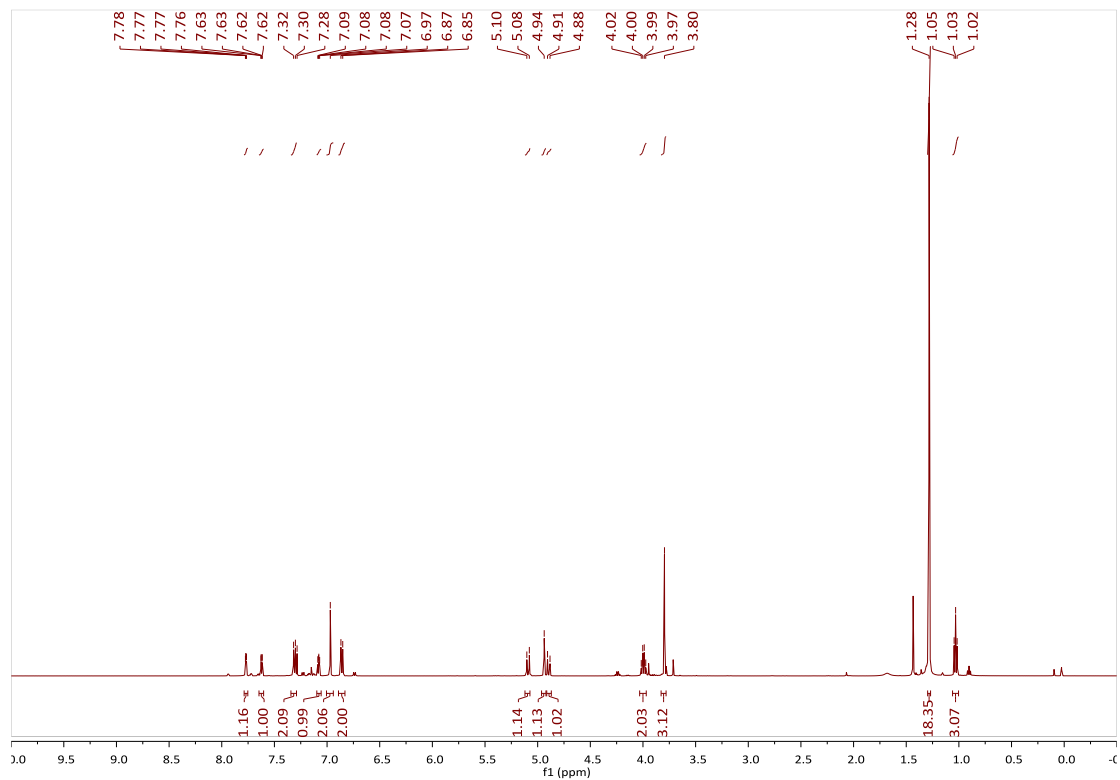
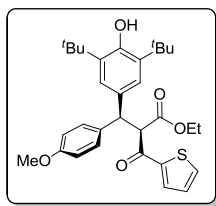


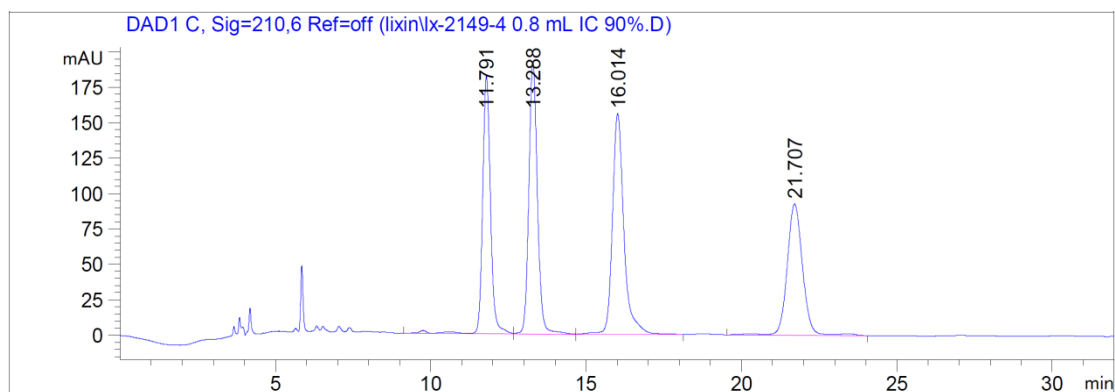
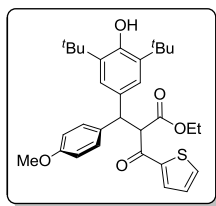


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.156	VB R	0.4774	2216.85913	71.80289	25.5820
2	29.385	VV R	0.6629	2047.67358	49.49503	23.6296
3	31.059	VB	0.6338	2251.16431	54.50805	25.9779
4	36.410	BV R	0.7516	2149.99976	43.91474	24.8105

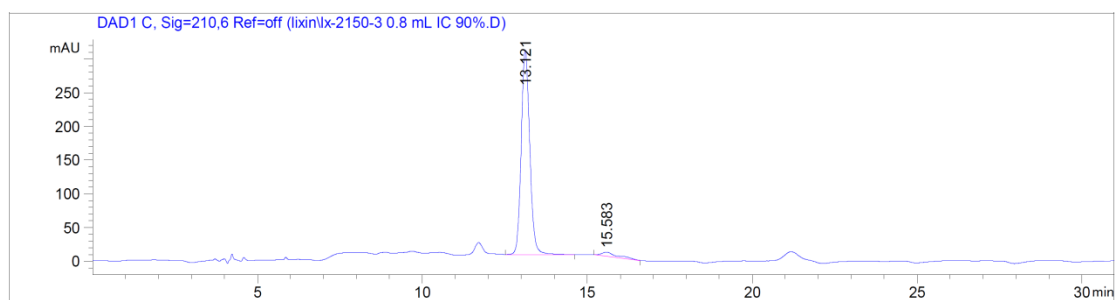
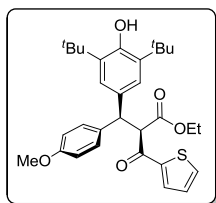


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.241	BB	0.4876	5259.70215	166.91177	81.0169
2	29.646	VV R	0.5312	569.17609	16.34356	8.7672
3	31.329	VV E	0.6921	42.69526	8.95732e-1	0.6576
4	36.652	VV R	0.7285	620.52881	12.29725	9.5582

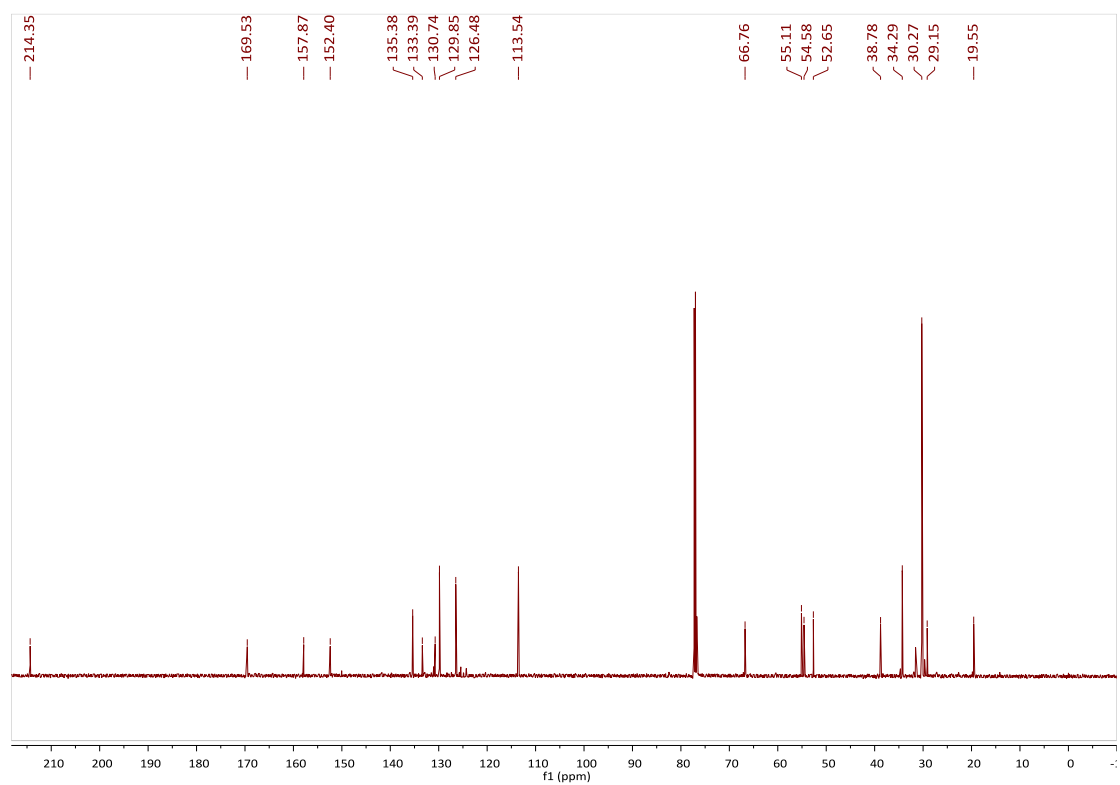
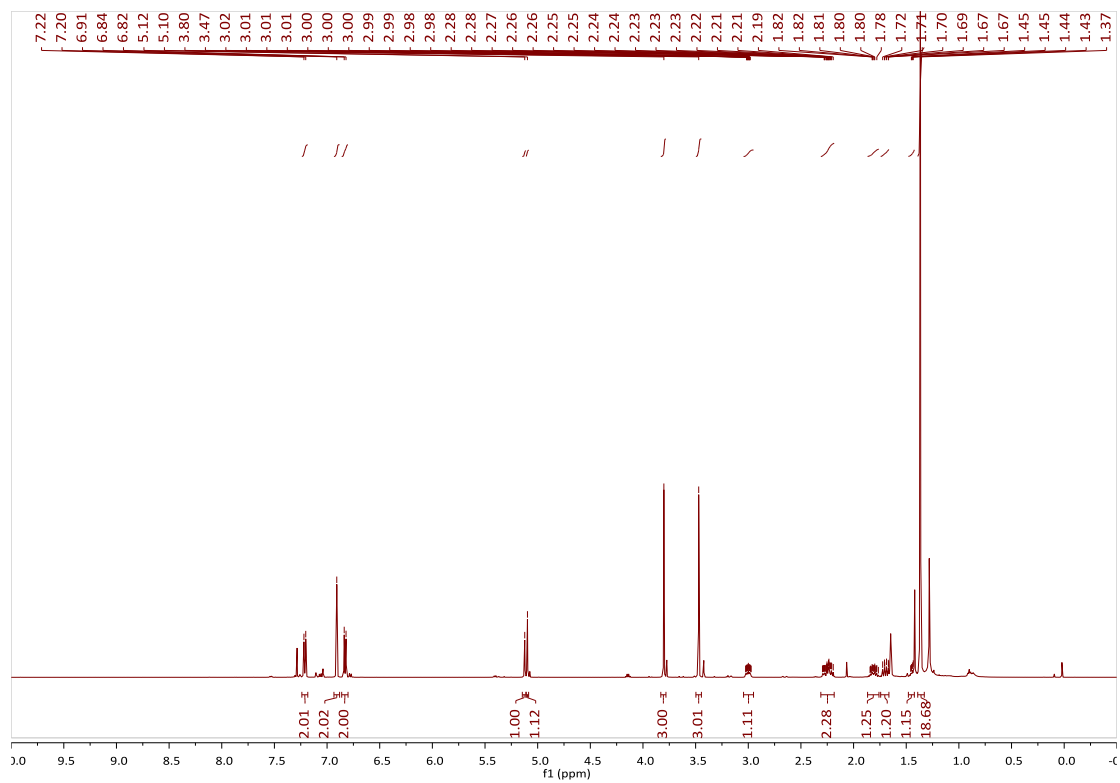
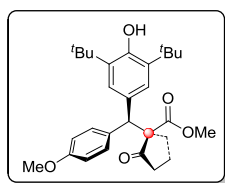


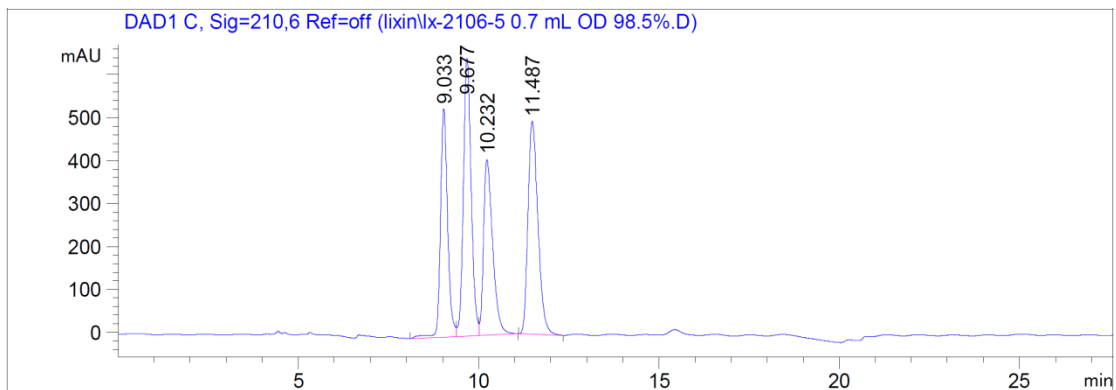
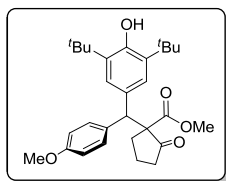


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.791	VV R	0.2727	3244.83936	181.34914	22.8505
2	13.288	VB	0.2960	3688.12354	192.08798	25.9722
3	16.014	BV R	0.3908	4039.87671	155.67432	28.4493
4	21.707	VV R	0.5341	3227.43701	92.72589	22.7280

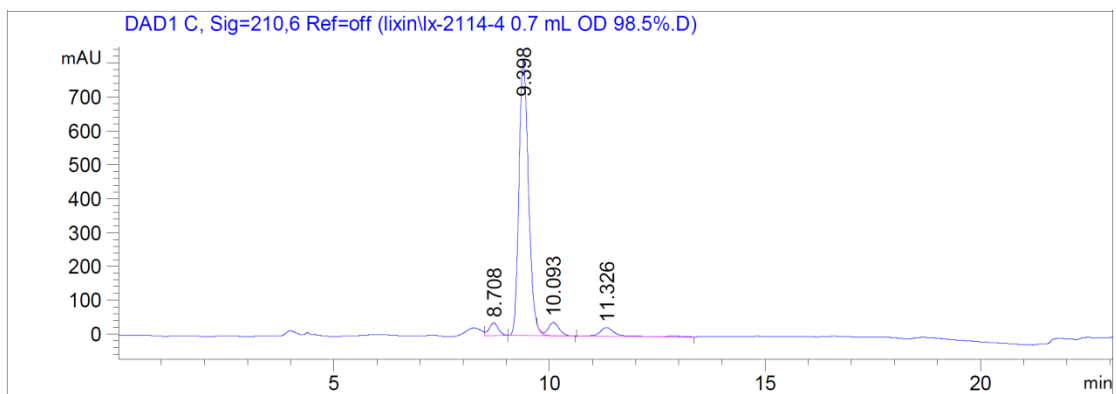
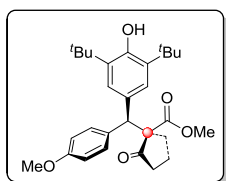


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.121	BB	0.2783	5458.13770	302.85736	96.4085
2	15.583	BB	0.4814	203.33443	5.88032	3.5915

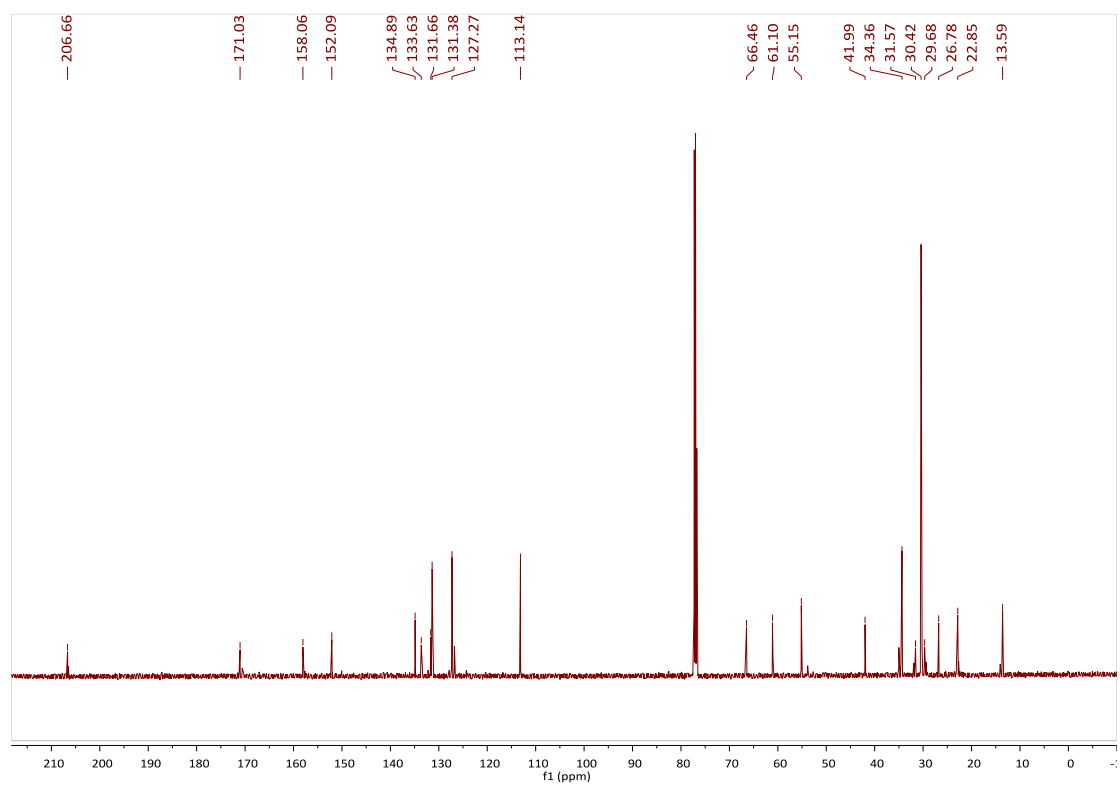
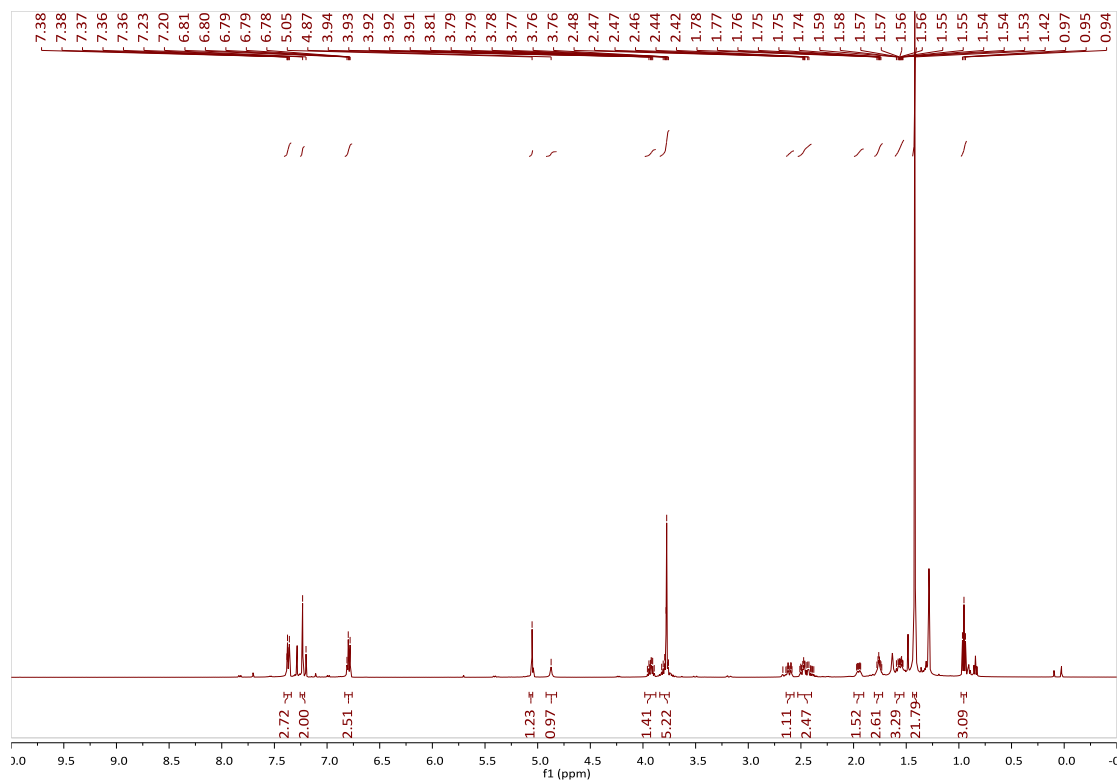
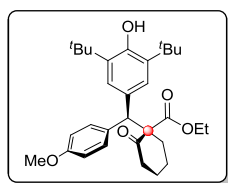


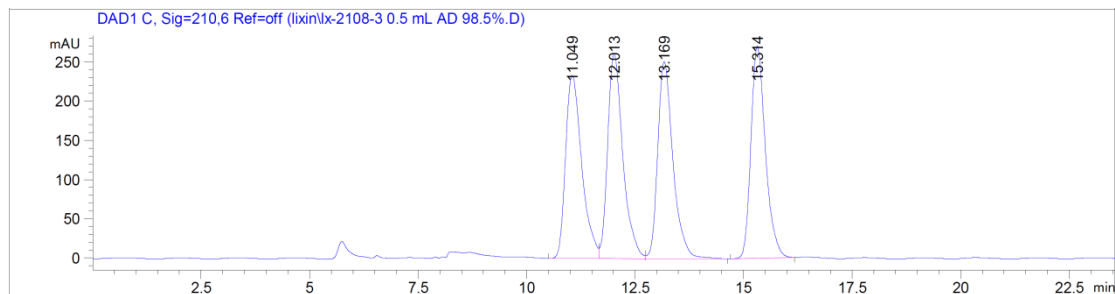
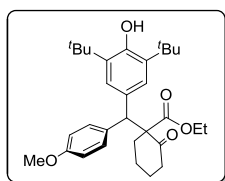


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.033	BV	0.2098	7346.66553	529.58002	21.7026
2	9.677	VV	0.2408	9741.04004	642.86279	28.7758
3	10.232	VB	0.2703	7230.87354	408.89154	21.3606
4	11.487	BB	0.3048	9532.89551	494.76224	28.1609

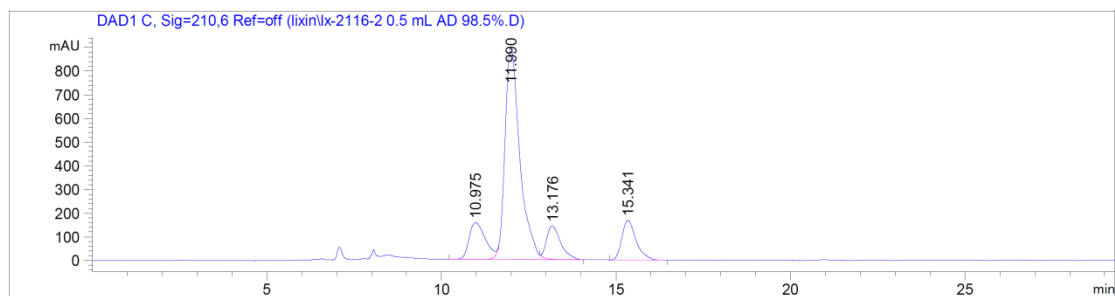
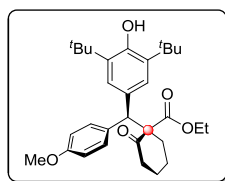


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.708	VB	0.2304	554.89728	37.12251	3.8228
2	9.398	BV R	0.2460	1.25797e4	806.24609	86.6641
3	10.093	VB E	0.2798	698.29895	39.19778	4.8107
4	11.326	BV R	0.3603	682.57336	25.95677	4.7024

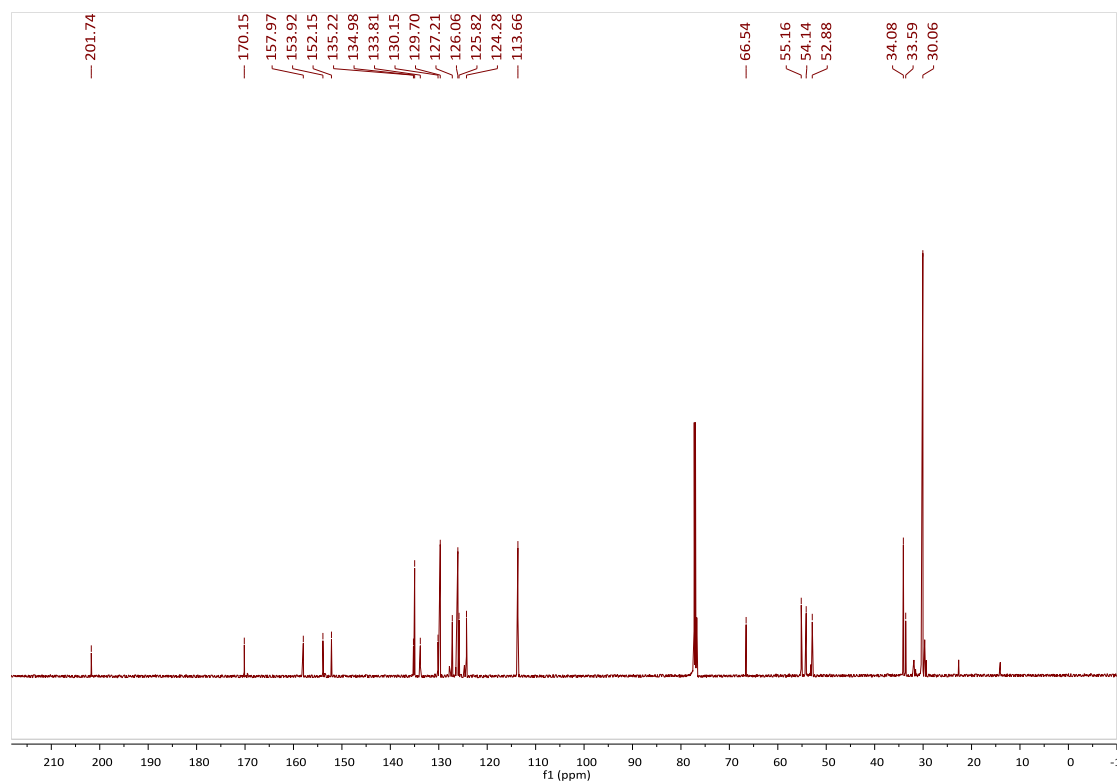
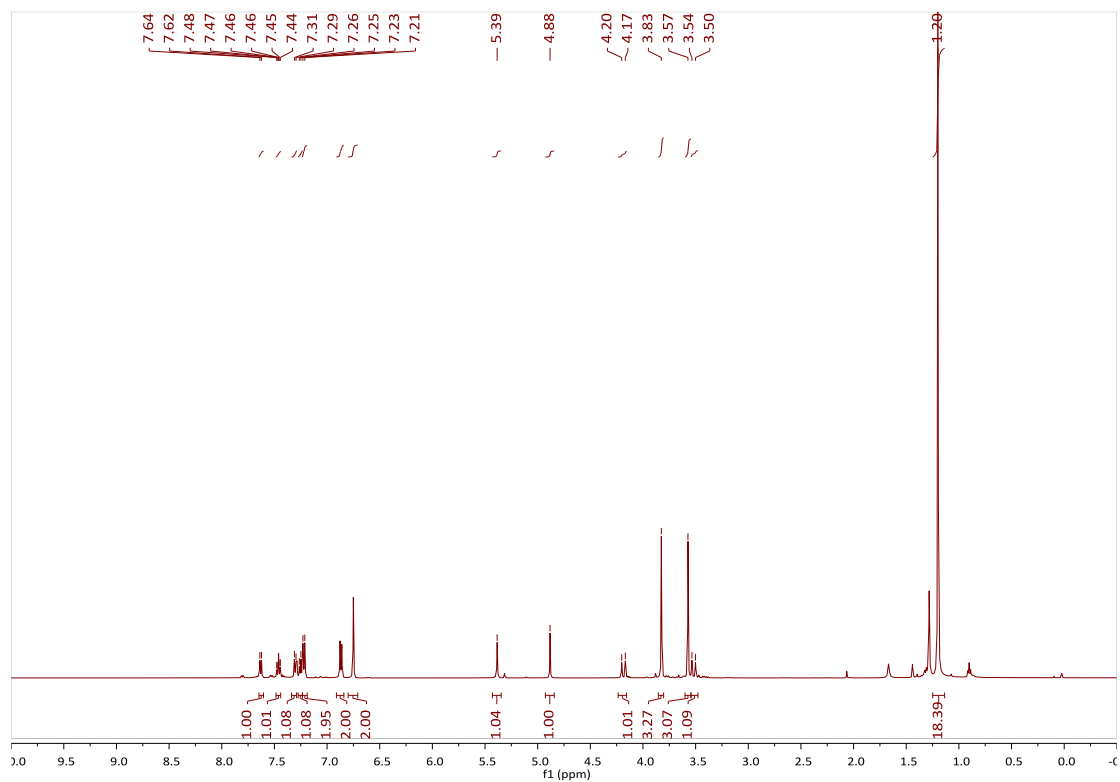
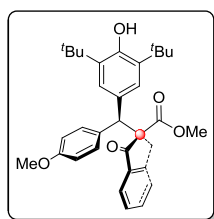


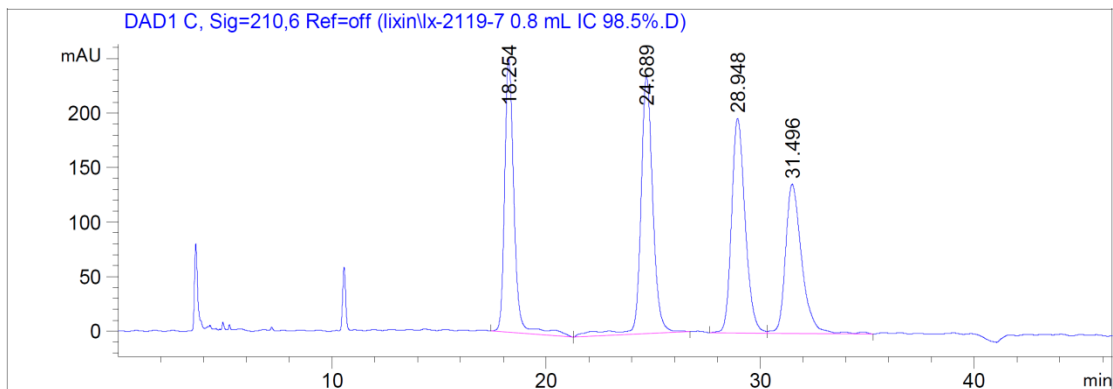
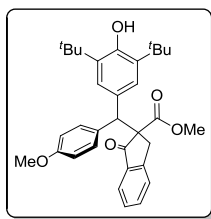


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.049	BV	0.4003	6059.26465	233.83890	24.3556
2	12.013	VV	0.3727	6401.92188	262.30228	25.7329
3	13.169	VB	0.3757	6157.46387	251.48016	24.7503
4	15.314	BB	0.3537	6259.67236	270.82025	25.1612

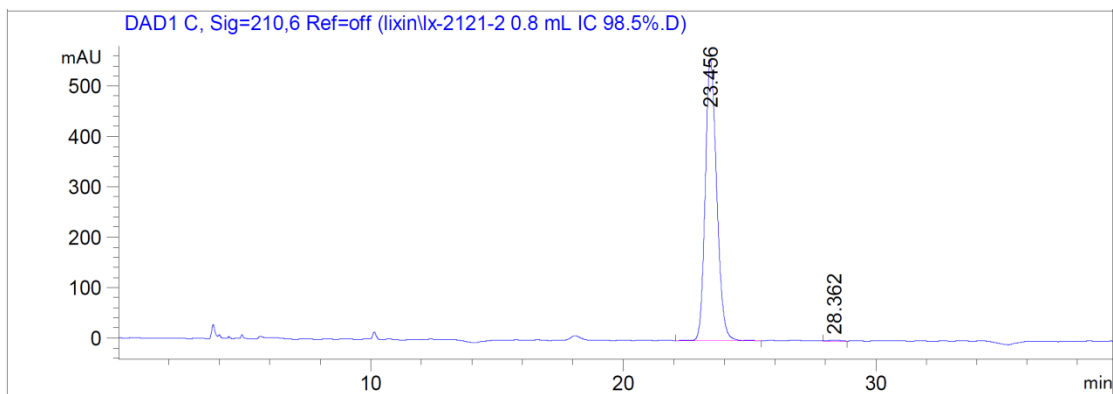
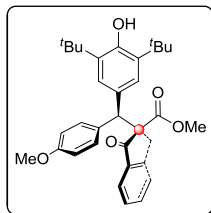


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.975	BV E	0.5033	4999.48633	154.58099	12.3626
2	11.990	VV R	0.4555	2.67411e4	892.58423	66.1247
3	13.176	VB E	0.4261	3943.36963	141.93524	9.7510
4	15.341	BB	0.4327	4756.49756	167.81361	11.7617

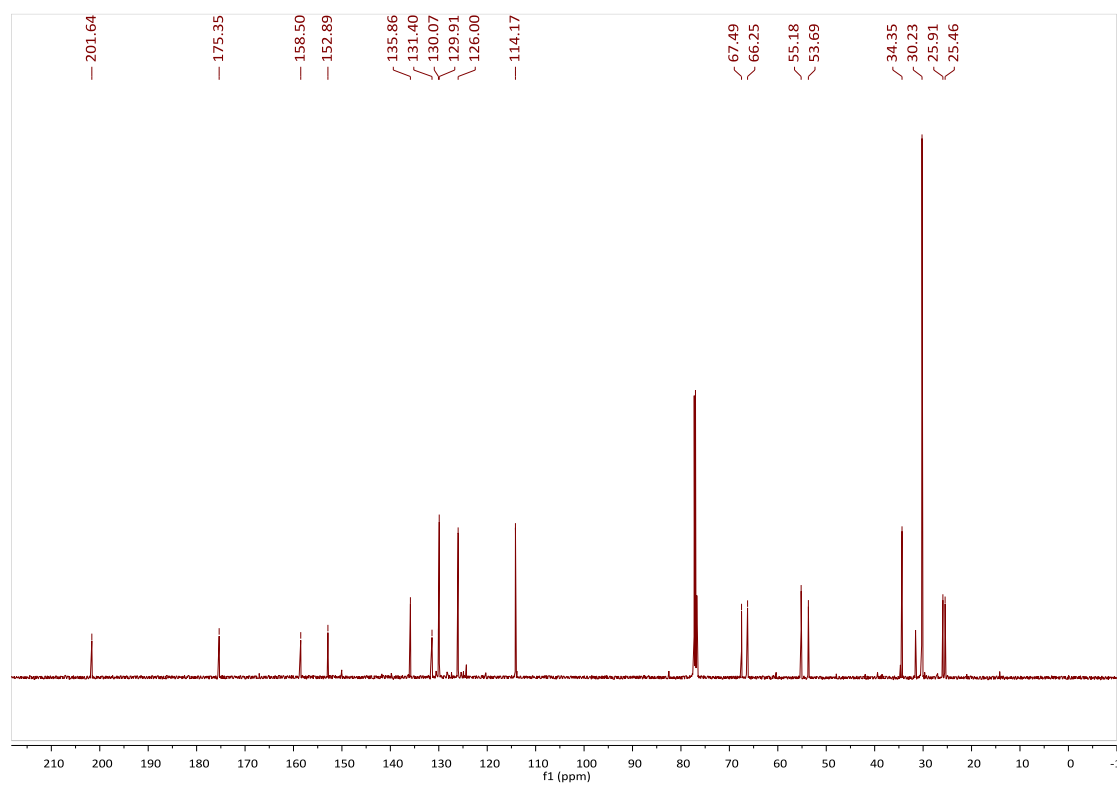
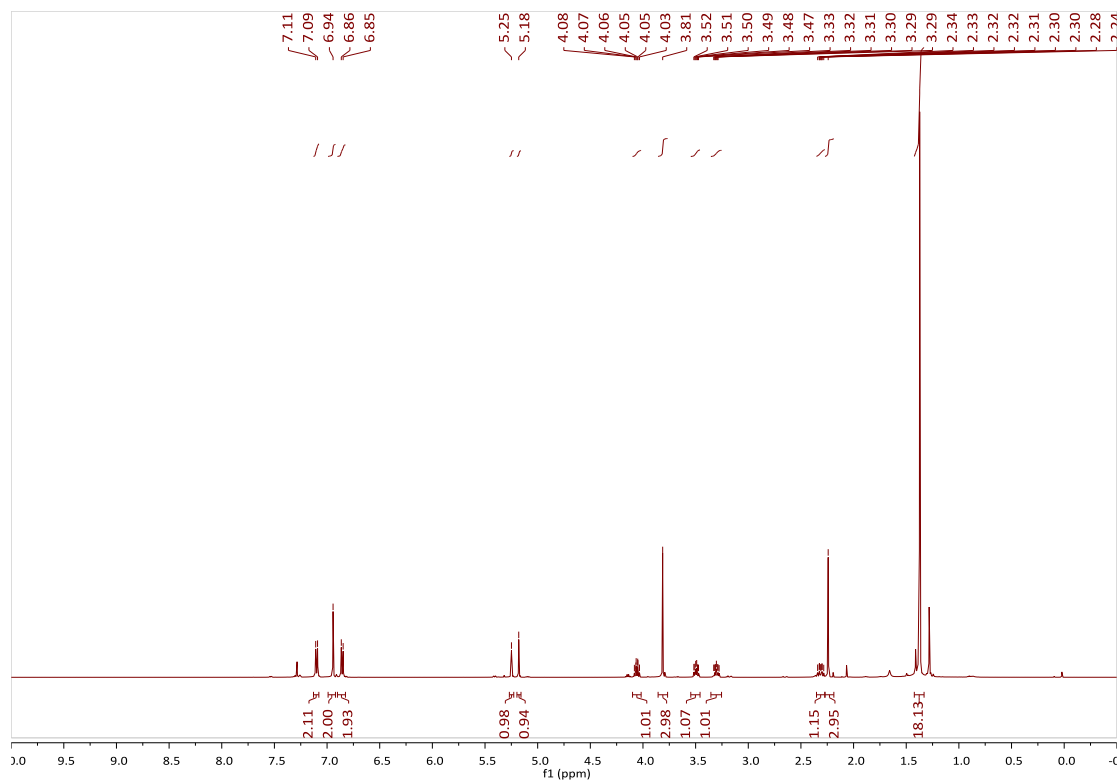
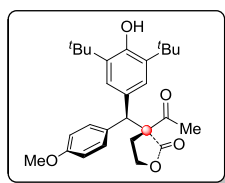


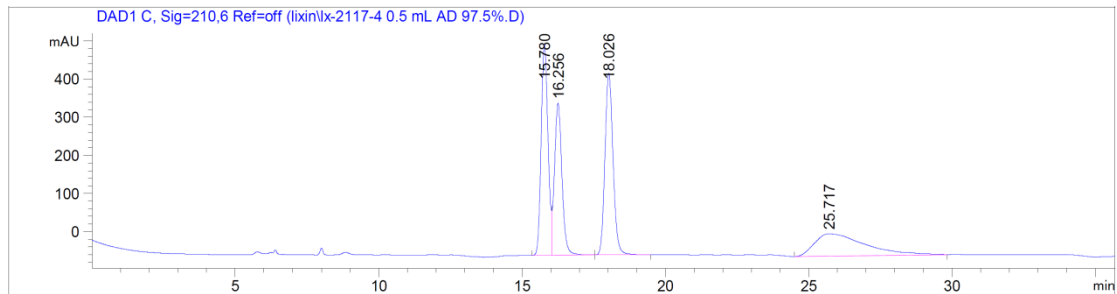
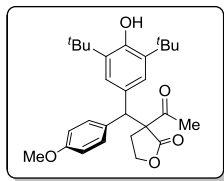


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.254	BV R	0.4534	7784.59326	251.17899	23.5461
2	24.689	VV R	0.5823	9371.14063	236.10056	28.3450
3	28.948	BV	0.6818	8664.12500	196.72520	26.2064
4	31.496	VV R	0.7931	7241.19922	136.72217	21.9025

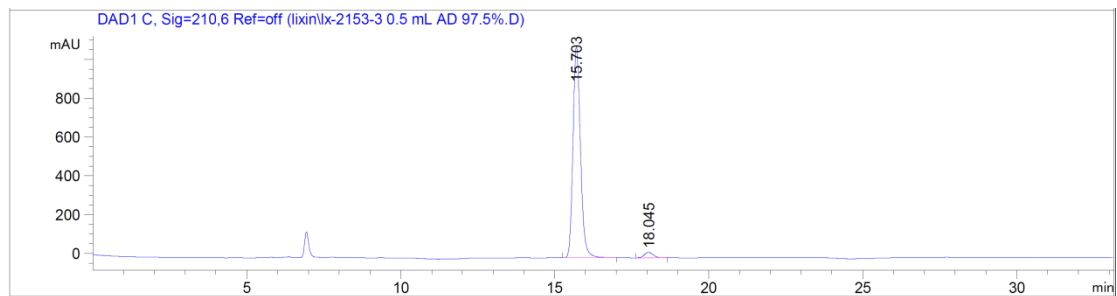
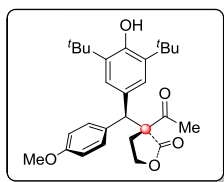


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.456	VV R	0.4898	1.76296e4	556.12042	99.5860
2	28.362	VV	0.5225	73.29155	2.30813	0.4140

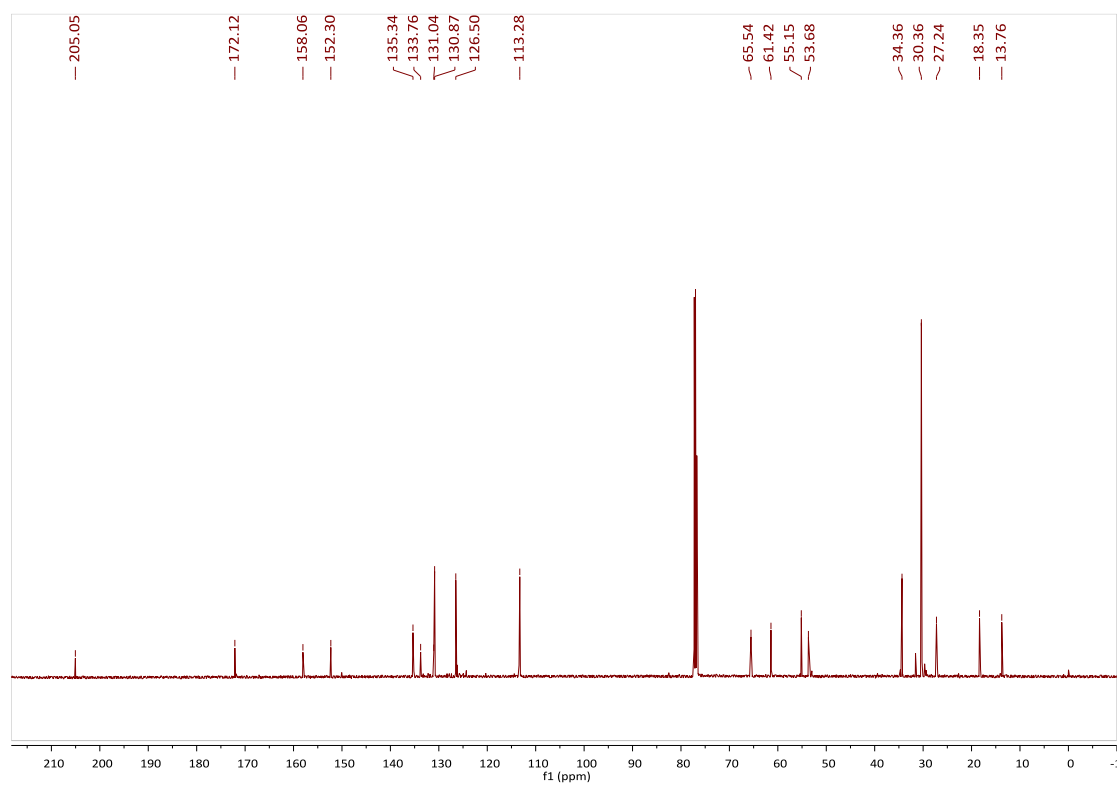
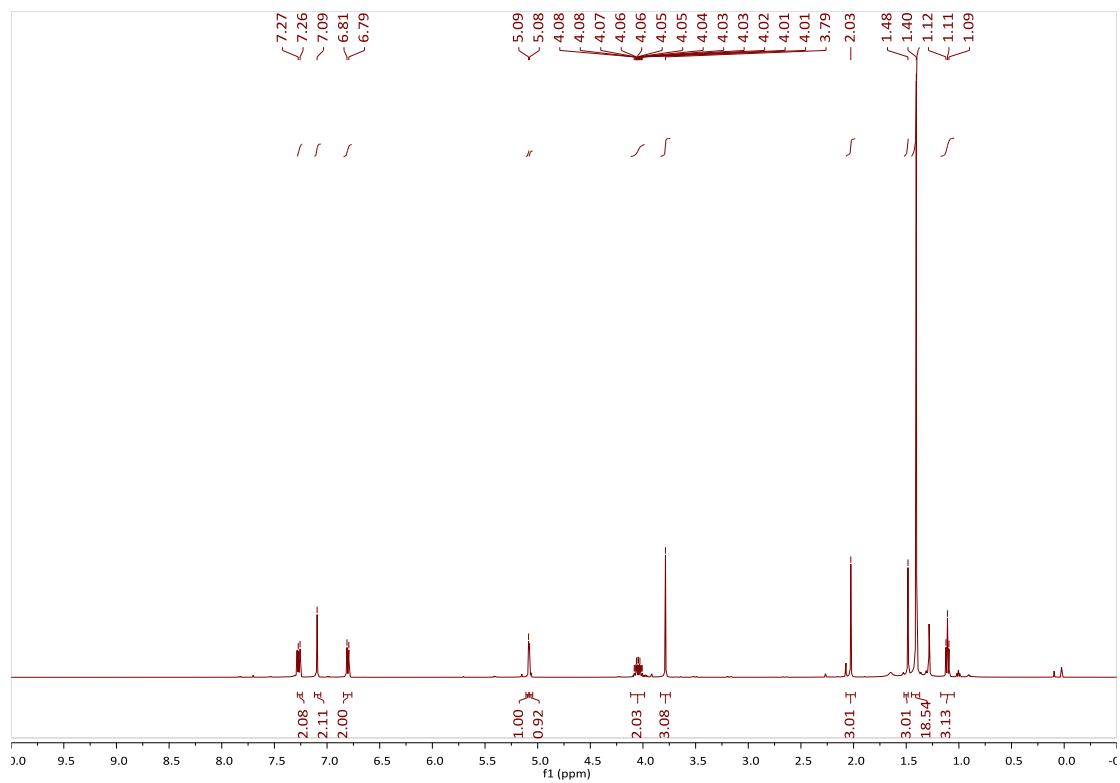
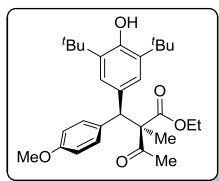


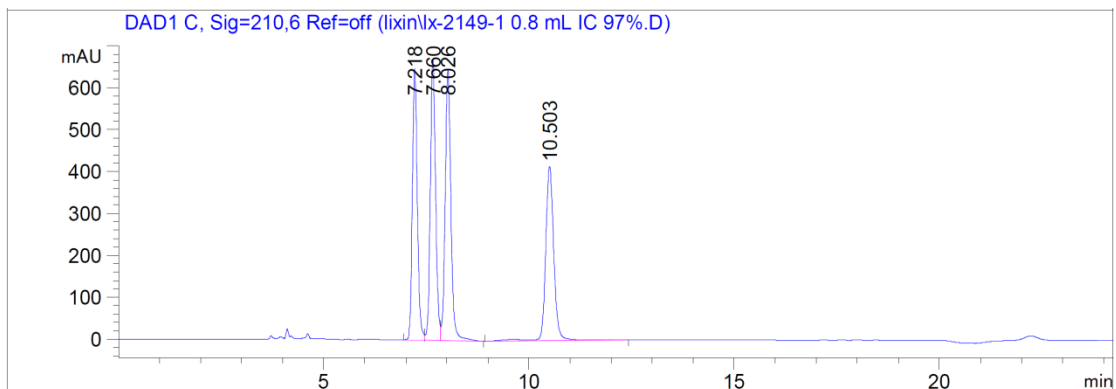
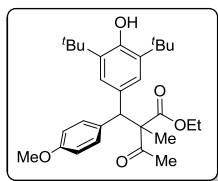


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.780	BV	0.2566	9148.44336	554.07855	27.8570
2	16.256	VB	0.2764	7250.90137	398.22513	22.0790
3	18.026	BB	0.3031	9349.63867	476.18875	28.4696
4	25.717	BB	1.5779	7091.76660	58.10468	21.5944

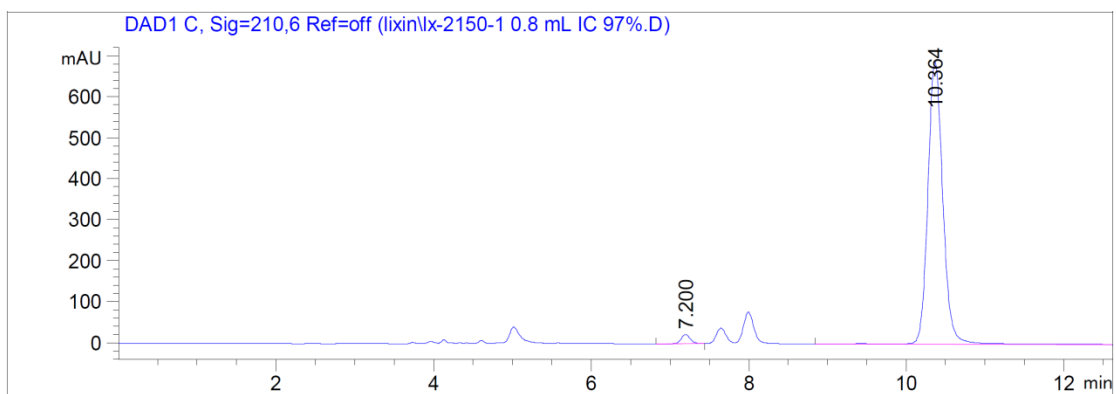
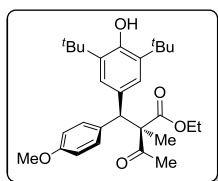


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.703	BB	0.2607	1.83171e4	1086.64856	97.0229
2	18.045	BB	0.3073	562.05084	28.35166	2.9771

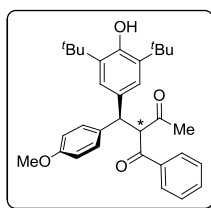




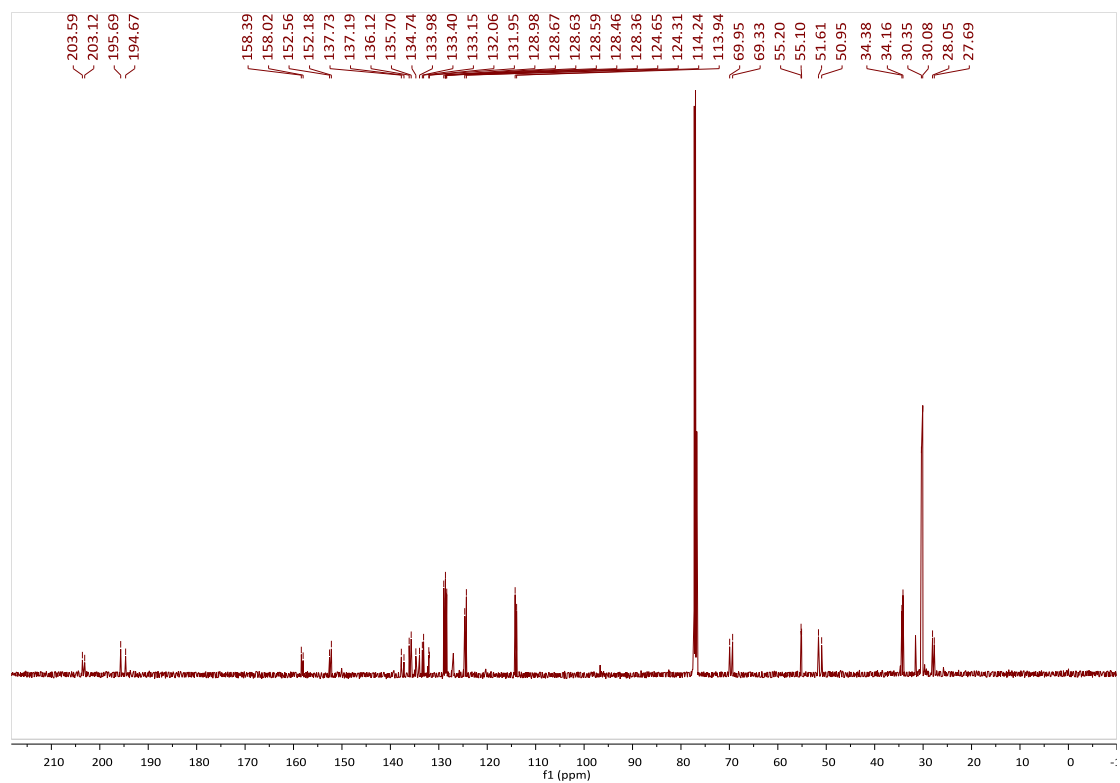
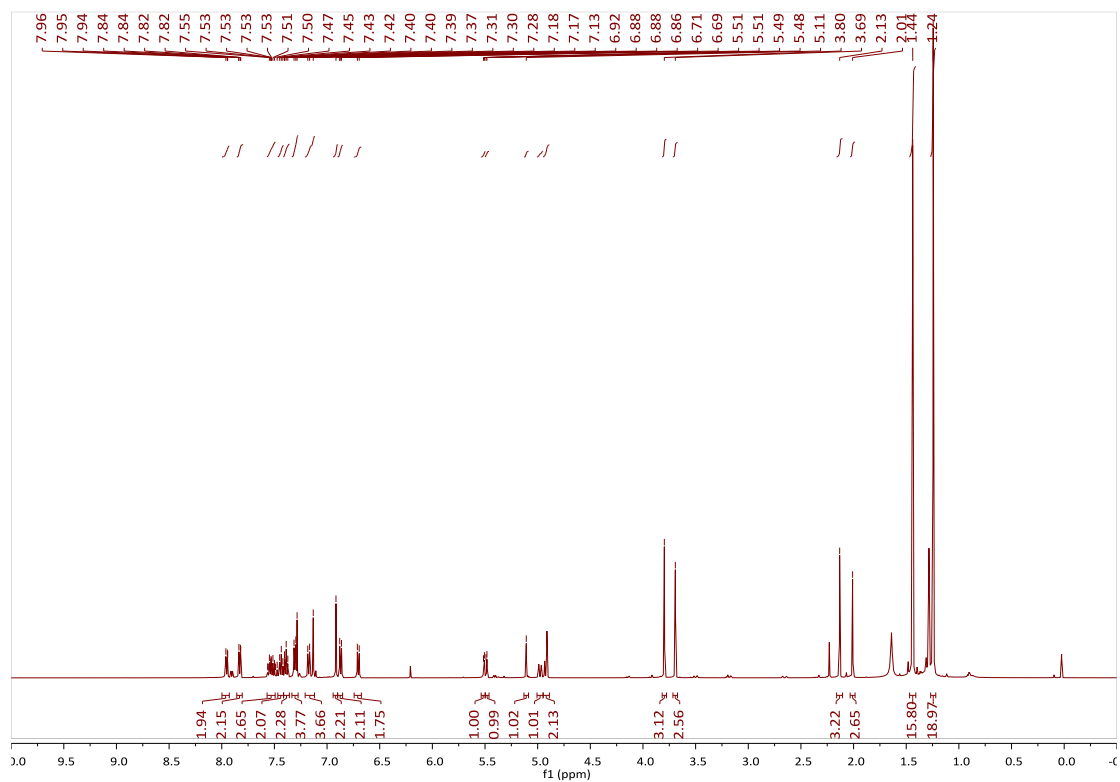
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.218	BV	0.1305	5422.11523	642.33398	23.0219
2	7.660	VV	0.1453	5985.21338	663.26019	25.4128
3	8.026	VB	0.1472	6280.74805	636.06702	26.6676
4	10.503	VV R	0.2078	5863.87549	414.65347	24.8976

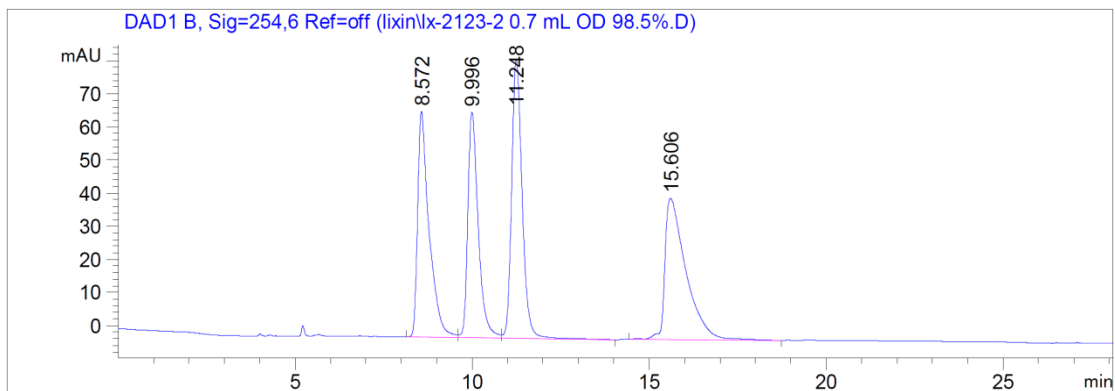
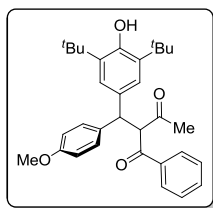


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.200	BB	0.1289	183.22093	22.06487	1.9377
2	10.364	VV R	0.2051	9272.56445	688.70886	98.0623

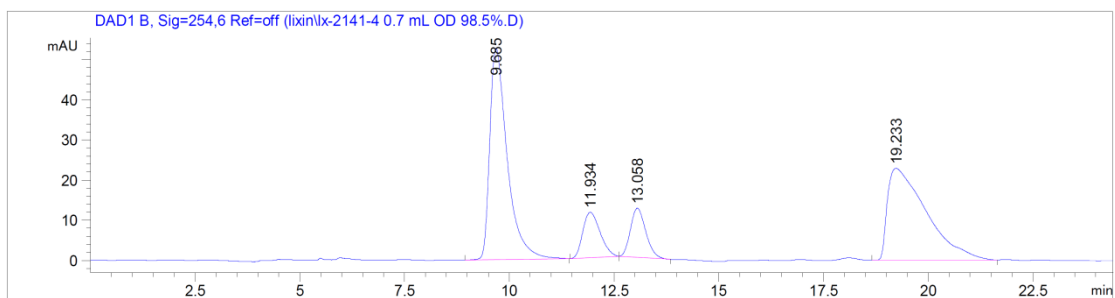
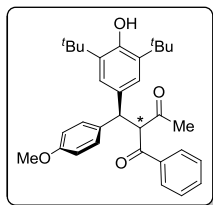


dr = 1.2:1

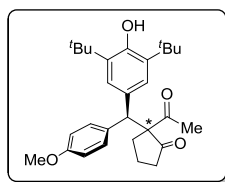




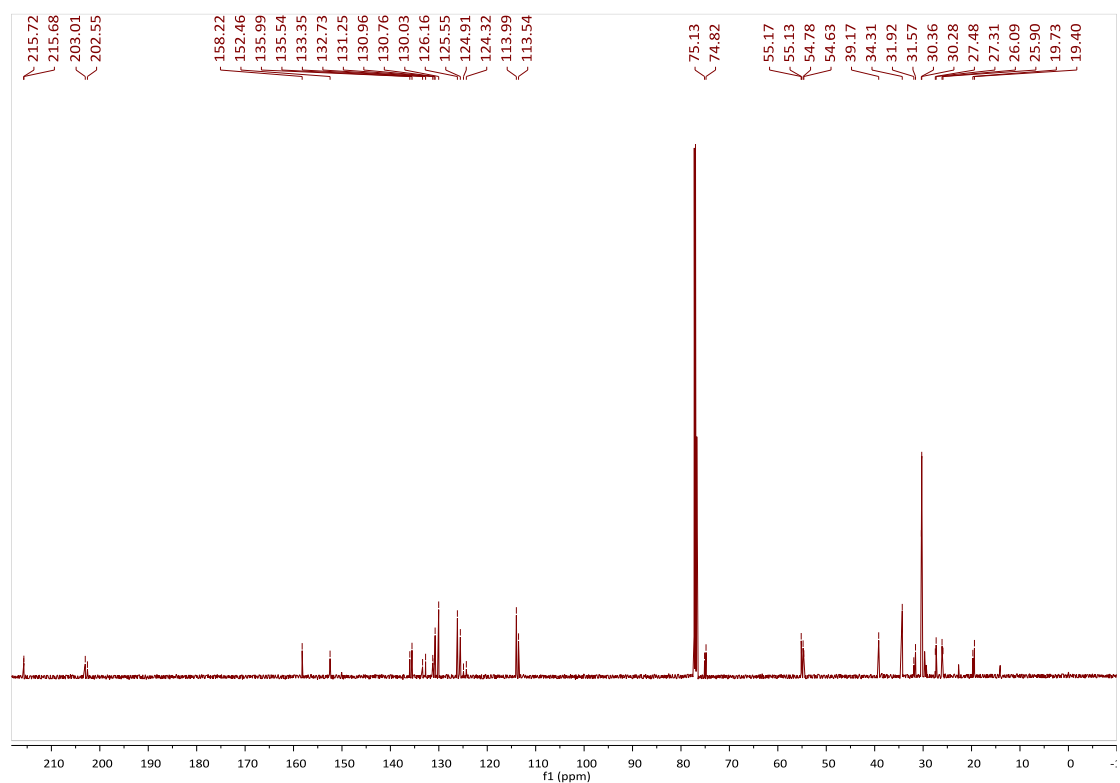
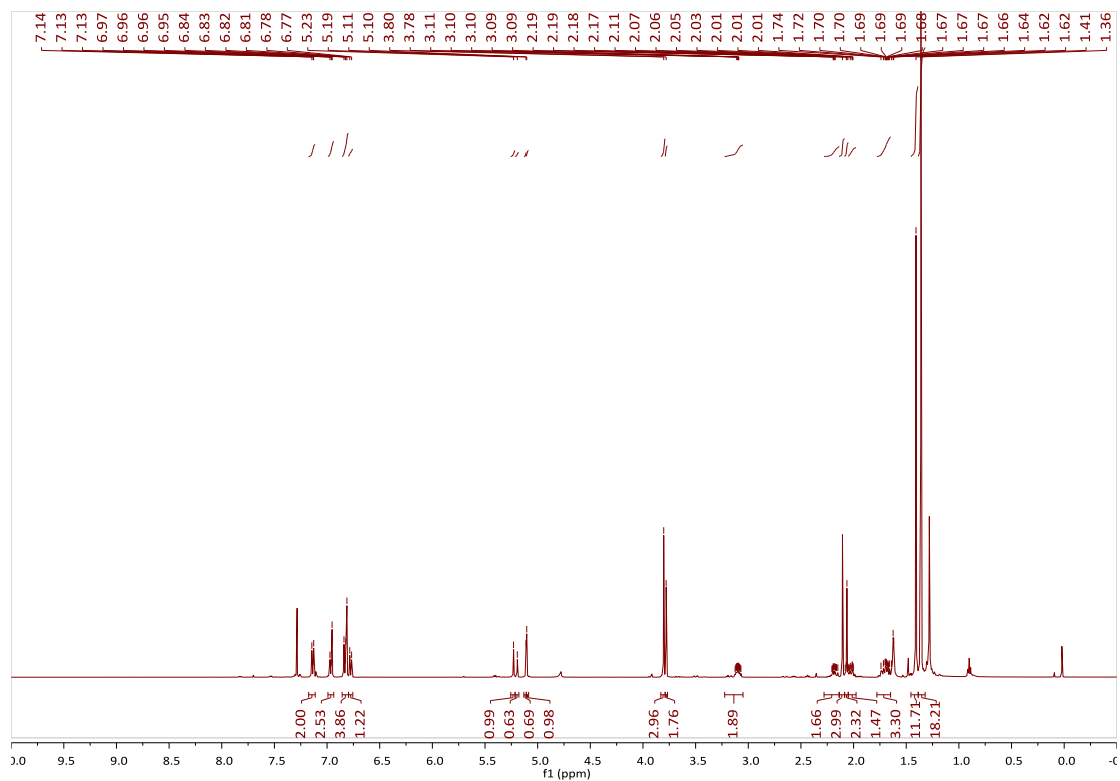
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.572	BV	0.3270	1531.86768	67.96443	23.7829
2	9.996	VV	0.3107	1392.34302	68.03885	21.6167
3	11.248	VB	0.3208	1740.41443	84.31390	27.0207
4	15.606	VB R	0.6035	1776.41760	42.74687	27.5797

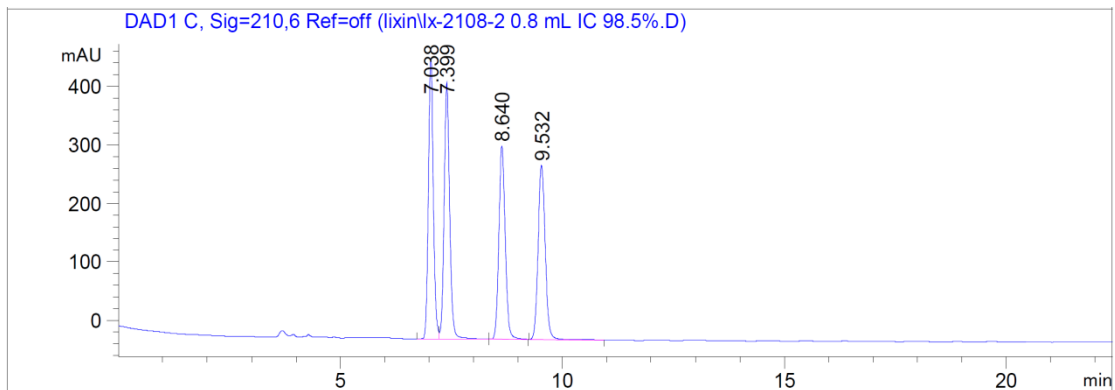
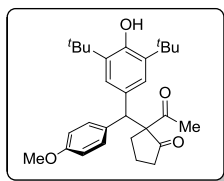


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.685	BB	0.4371	1531.35327	52.67975	42.0714
2	11.934	BB	0.4445	323.41205	11.28021	8.8852
3	13.058	BB	0.3906	310.82974	12.22462	8.5395
4	19.233	BB	0.8751	1474.29651	22.89889	40.5039

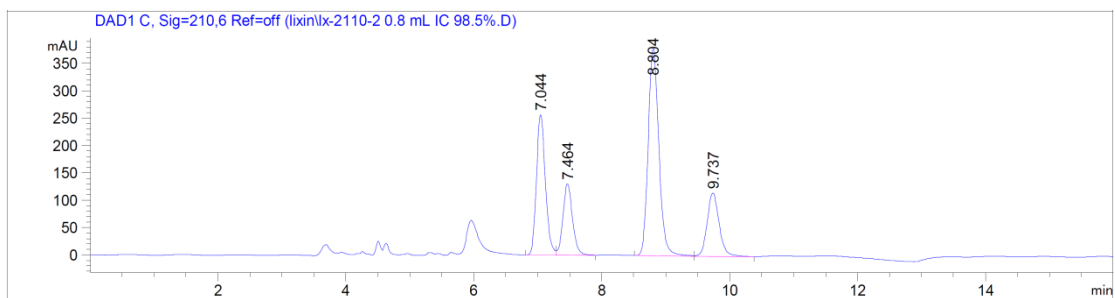
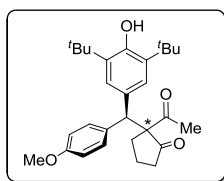


dr = 1.6:1

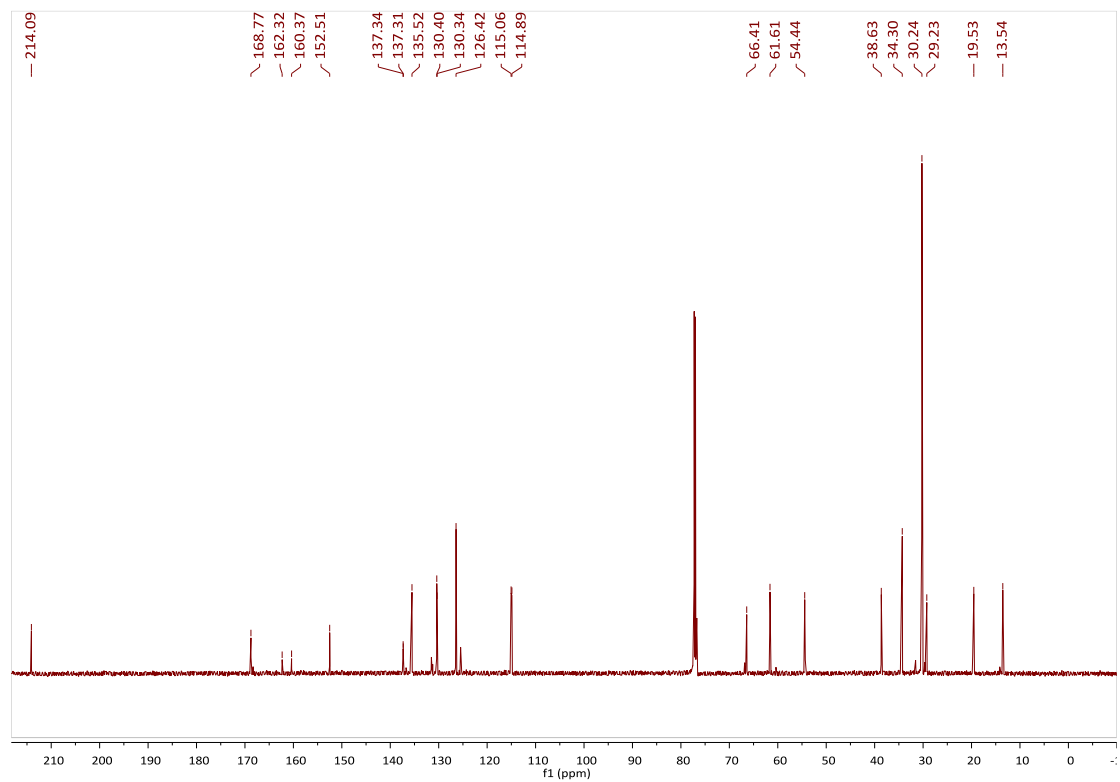
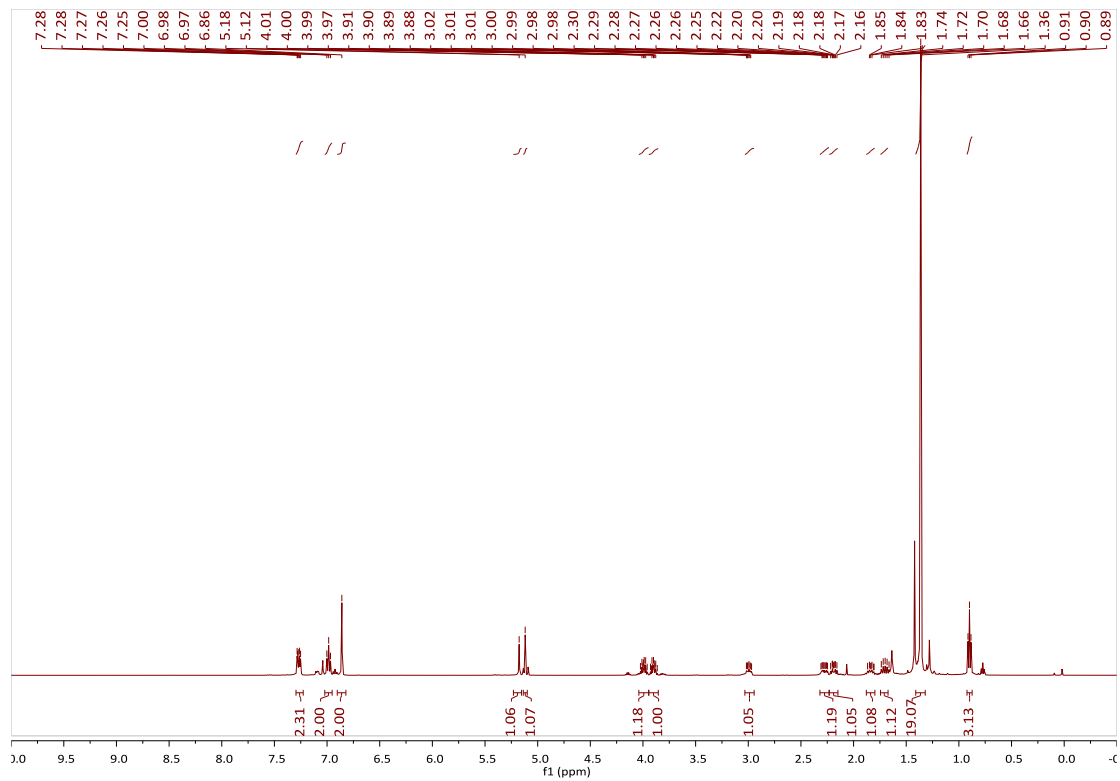
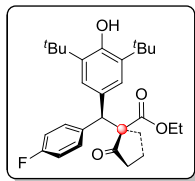


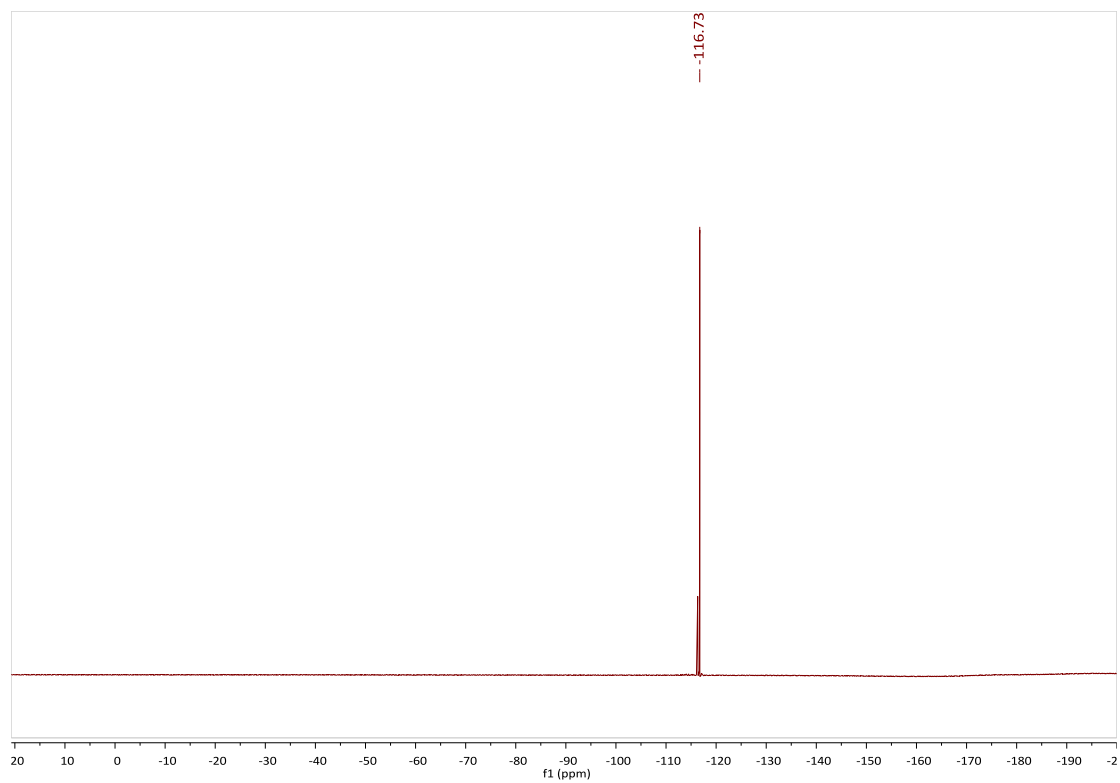
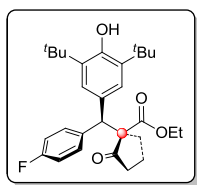


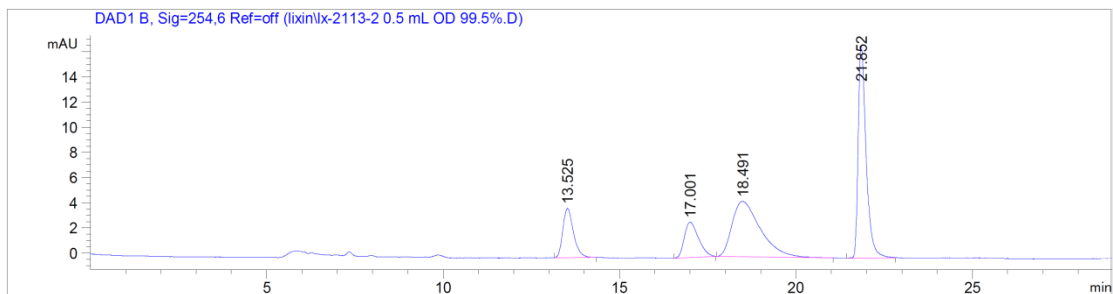
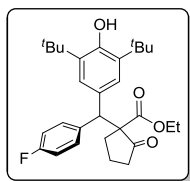
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.038	BV	0.1238	3716.73828	472.14755	26.2695
2	7.399	VB	0.1425	3814.45435	434.18027	26.9601
3	8.640	BB	0.1655	3297.90186	327.45908	23.3092
4	9.532	BV R	0.1710	3319.41211	295.61563	23.4612



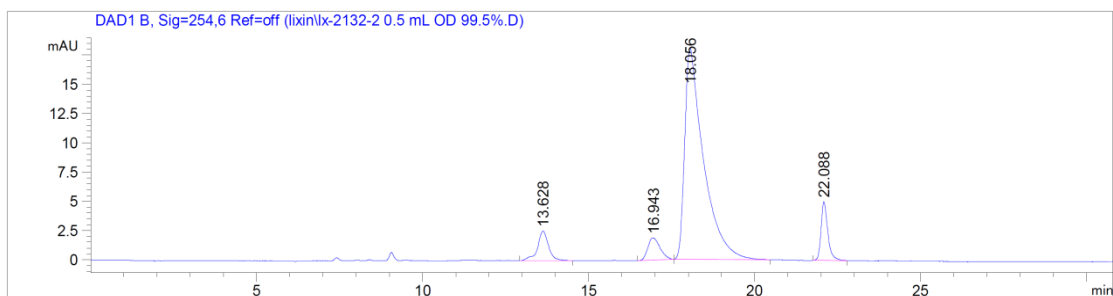
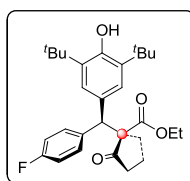
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.044	BV	0.1497	2496.10767	256.17279	25.5715
2	7.464	VB	0.1593	1352.56592	130.13994	13.8564
3	8.804	BV	0.1795	4407.53906	379.38504	45.1532
4	9.737	VB	0.1998	1505.09204	115.68549	15.4190



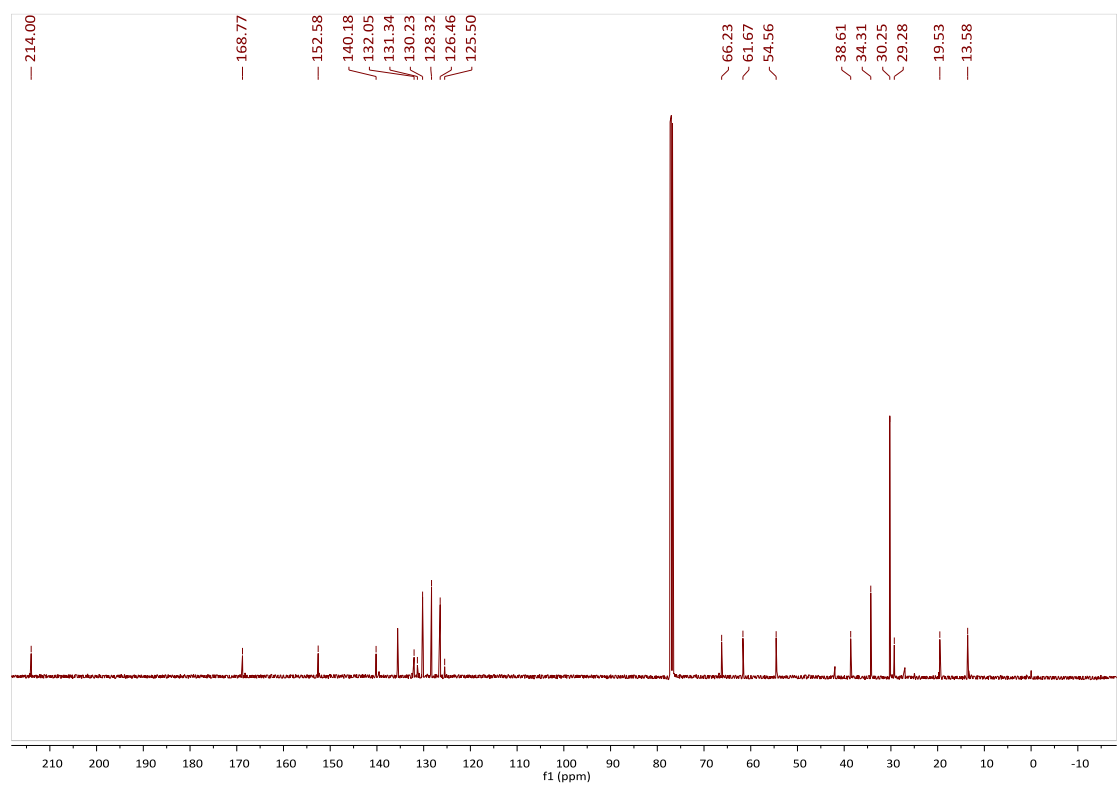
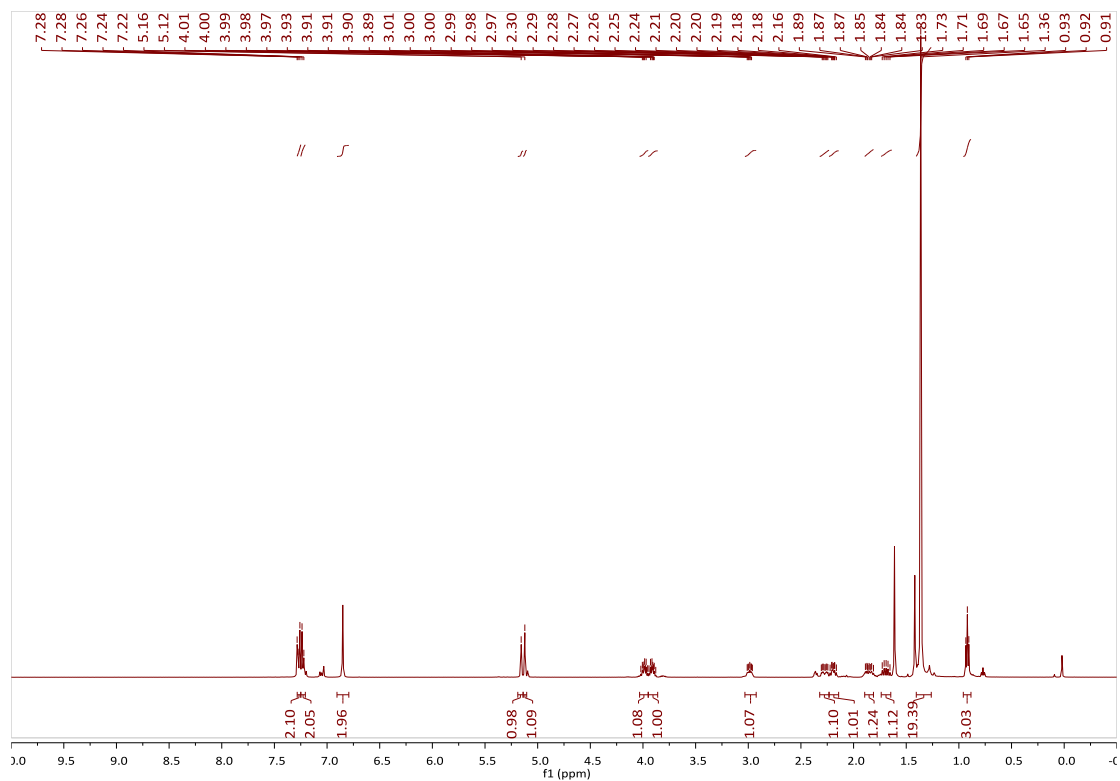
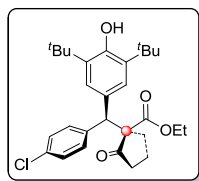


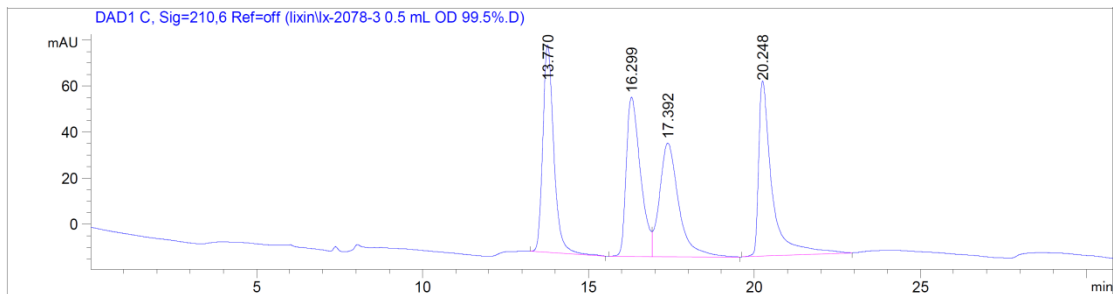
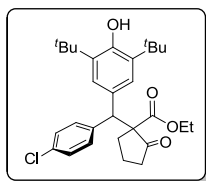


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.525	BB	0.3157	82.45230	3.91588	12.2556
2	17.001	BB	0.4021	78.40158	2.82229	11.6535
3	18.491	BB	0.7199	246.21324	4.40666	36.5967
4	21.852	BB	0.2419	265.70749	16.85353	39.4943

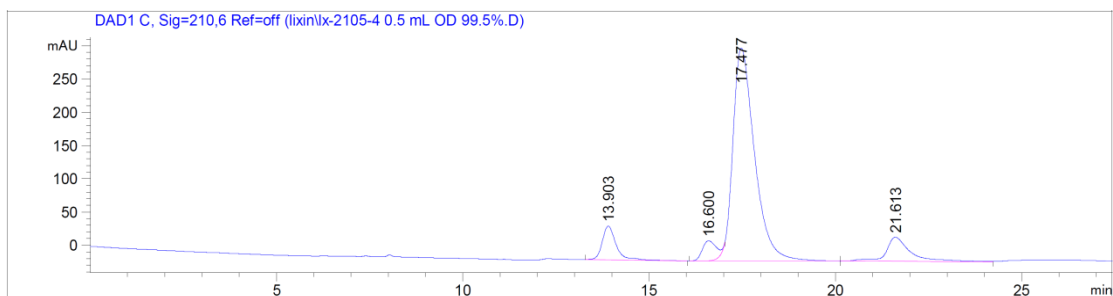
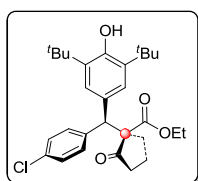


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.628	BB	0.3347	58.76923	2.53257	6.6019
2	16.943	BB	0.3620	49.13311	1.92379	5.5195
3	18.056	BB	0.5457	711.26233	18.05146	79.9009
4	22.088	BB	0.2148	71.01564	5.02774	7.9777

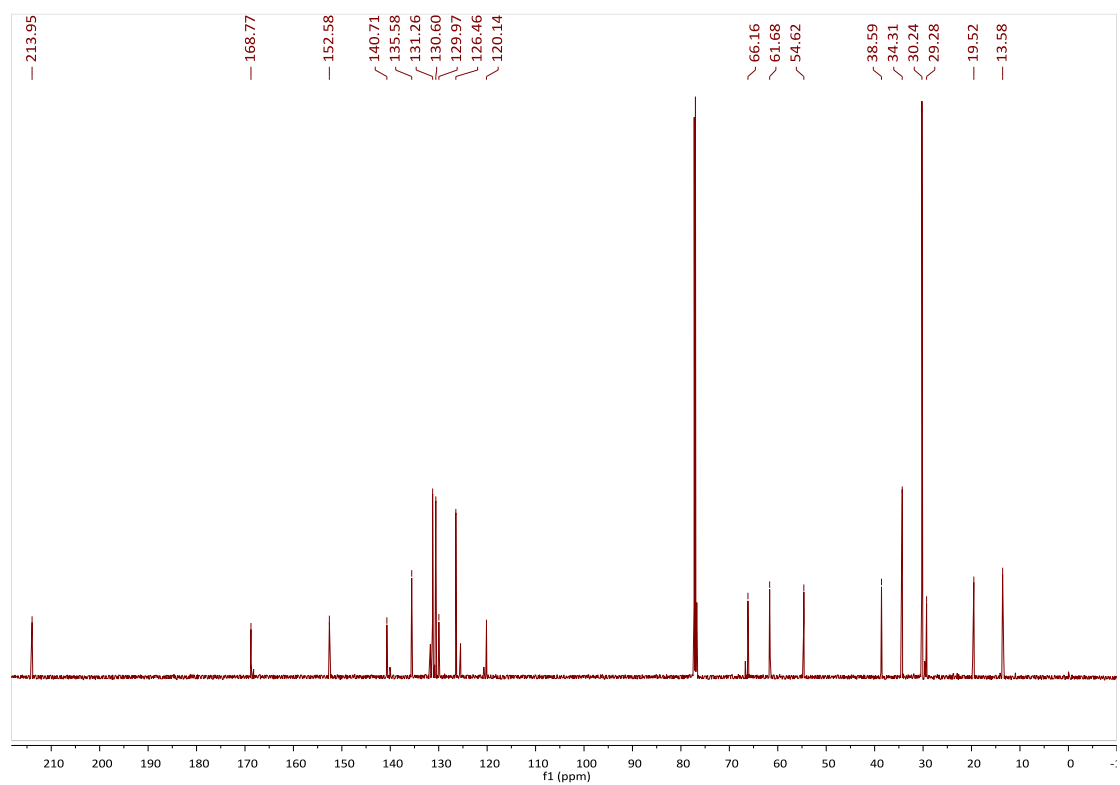
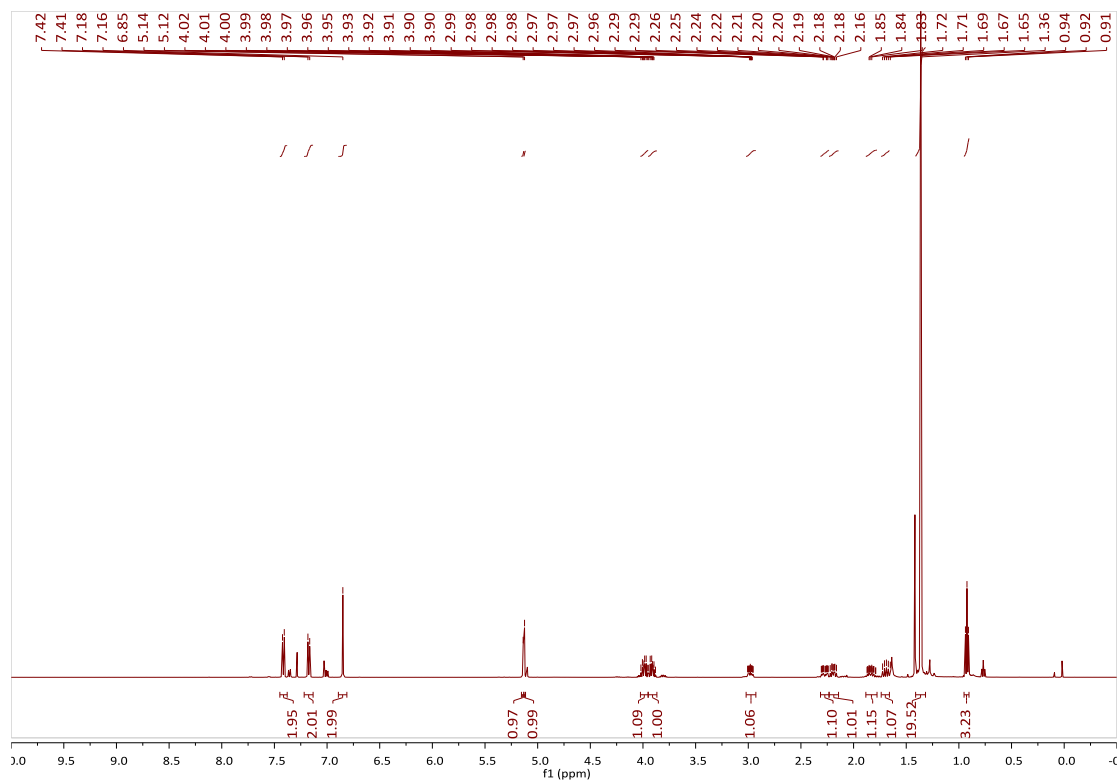
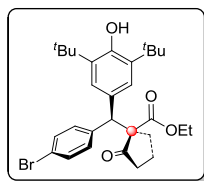


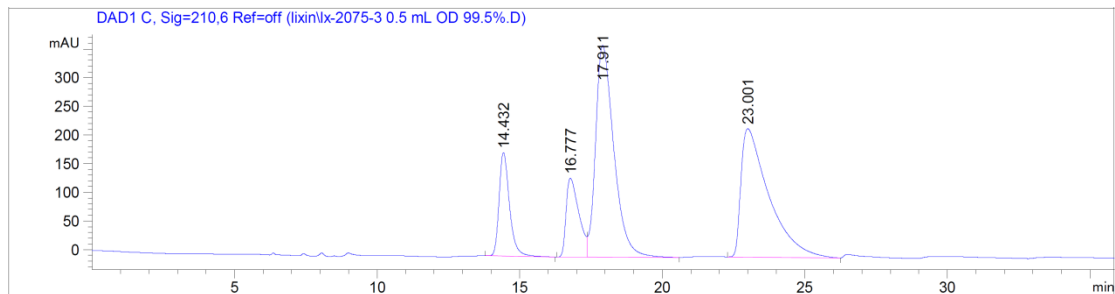
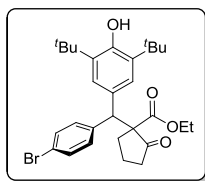


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.770	BB	0.3504	2068.84351	89.94075	25.1248
2	16.299	BV	0.4551	2054.40747	69.05700	24.9495
3	17.392	VB	0.6011	1977.74463	49.18896	24.0185
4	20.248	BB	0.4057	2133.27588	75.95226	25.9073

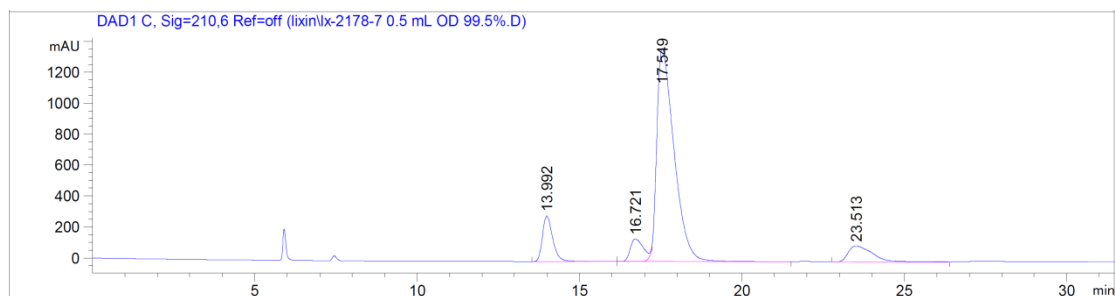
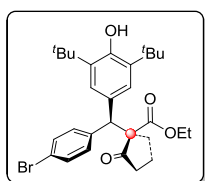


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.903	BB	0.3878	1310.78467	50.67213	7.8056
2	16.600	BV E	0.4036	765.38818	29.80852	4.5578
3	17.477	VB R	0.6180	1.30746e4	320.48593	77.8576
4	21.613	BB	0.6438	1642.17957	36.29714	9.7790

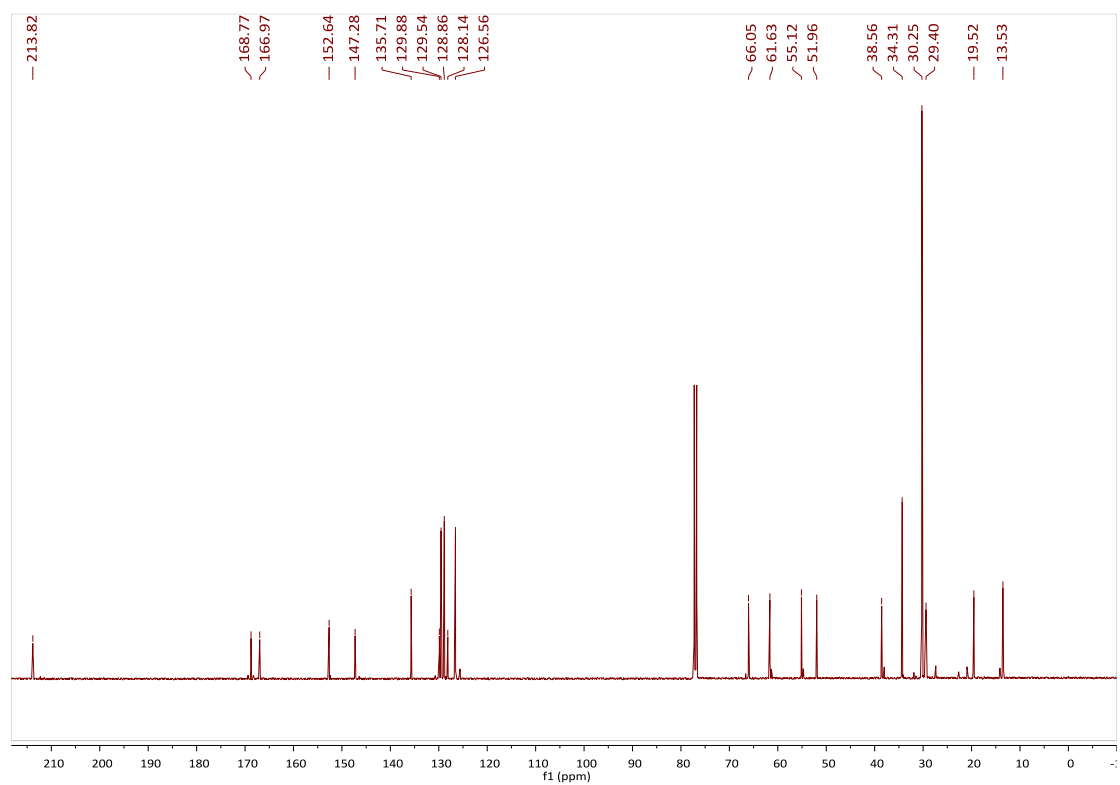
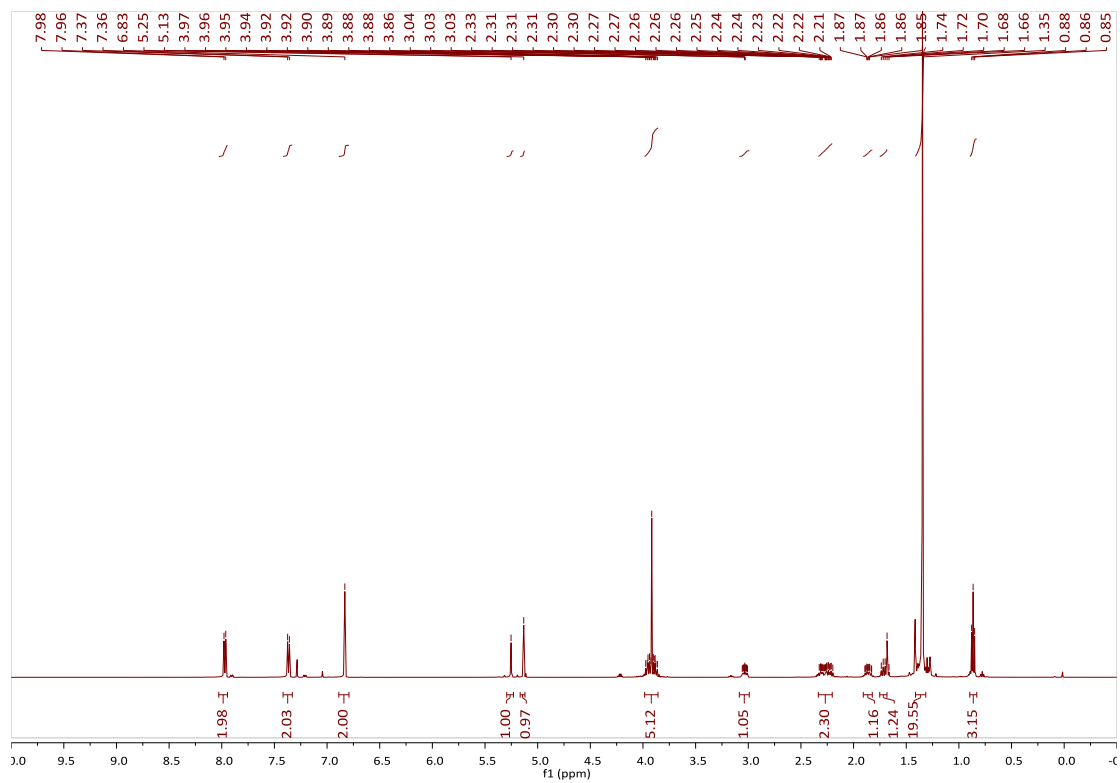
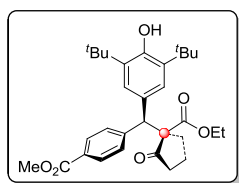


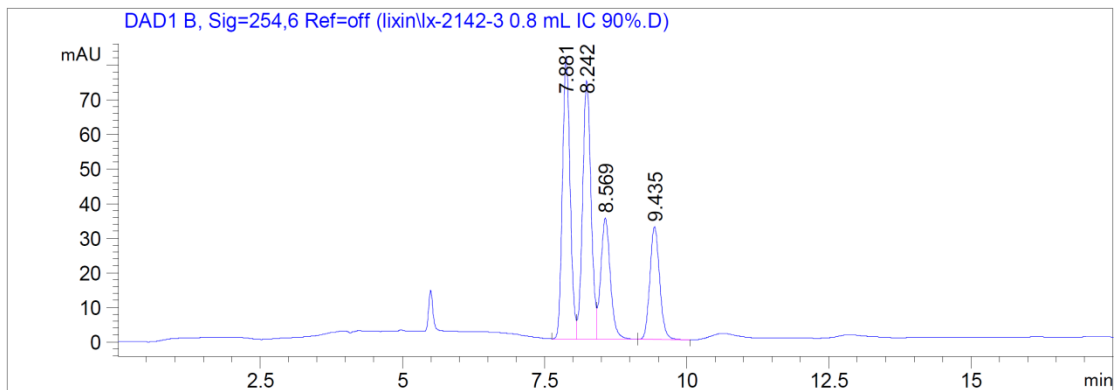
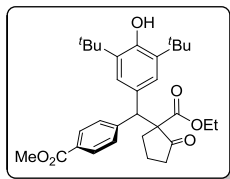


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.432	BB	0.3877	4611.97510	180.73631	11.3733
2	16.777	BV	0.4697	4282.09668	138.11496	10.5598
3	17.911	VB	0.6797	1.64766e4	369.88248	40.6319
4	23.001	BB	0.9649	1.51803e4	223.91840	37.4351

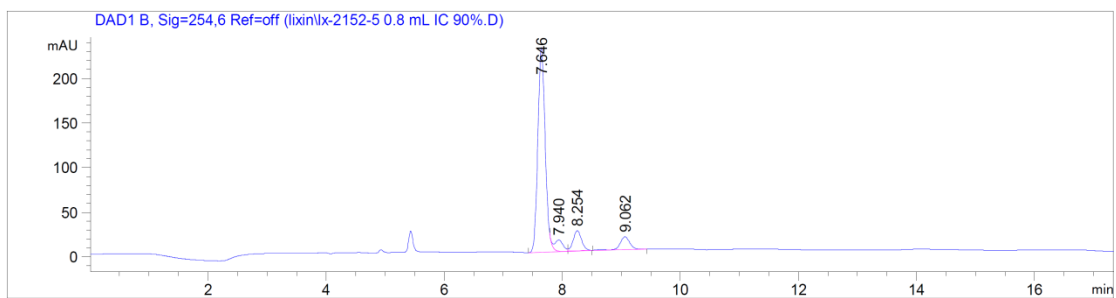
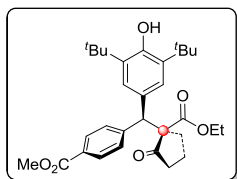


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.992	BB	0.3377	6566.94971	294.95740	9.7823
2	16.721	BV E	0.4320	4037.18921	145.37434	6.0139
3	17.549	VB R	0.5617	5.11689e4	1376.42908	76.2222
4	23.513	BB	0.7424	5358.21191	103.77435	7.9817

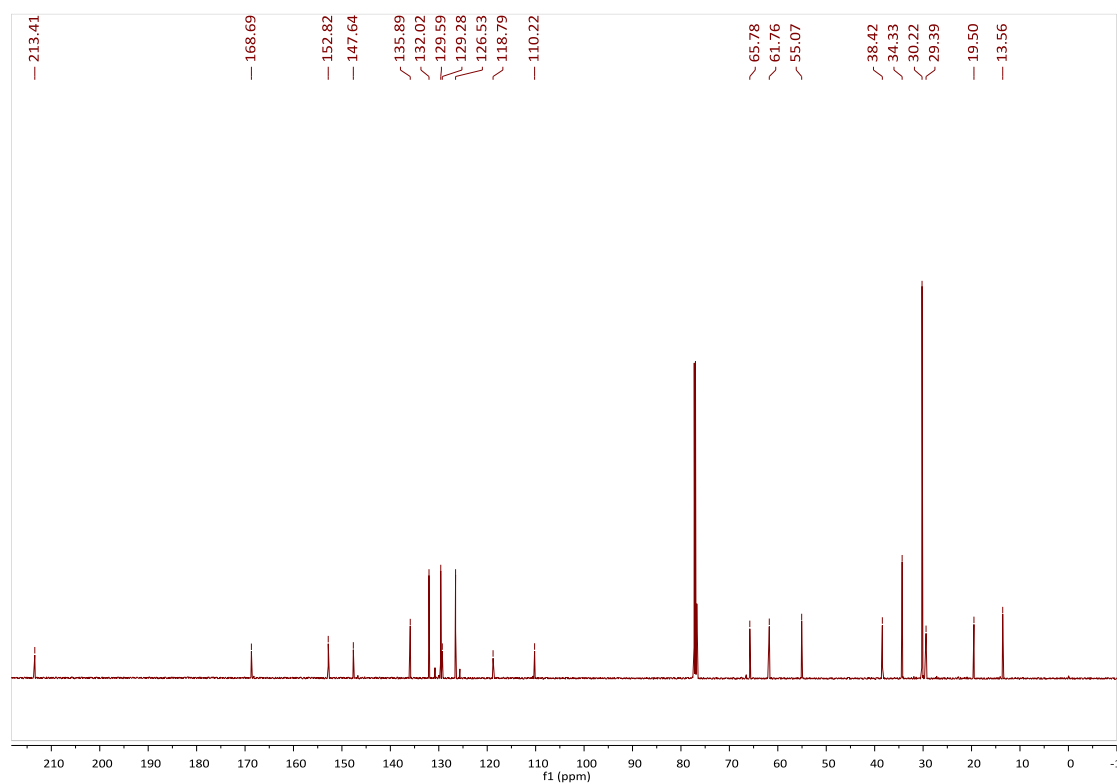


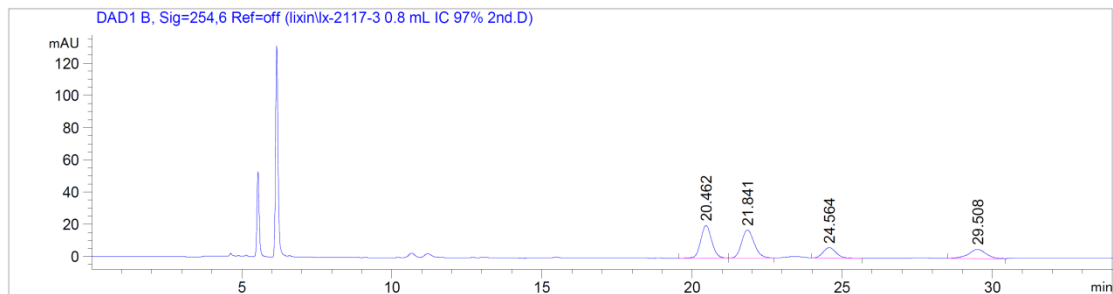
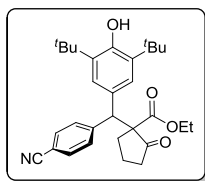


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.881	BV	0.1508	766.04126	80.67302	32.6879
2	8.242	VV	0.1625	774.88220	73.82061	33.0651
3	8.569	VB	0.1776	410.50931	34.81165	17.5169
4	9.435	BB	0.1892	392.06885	32.40253	16.7300

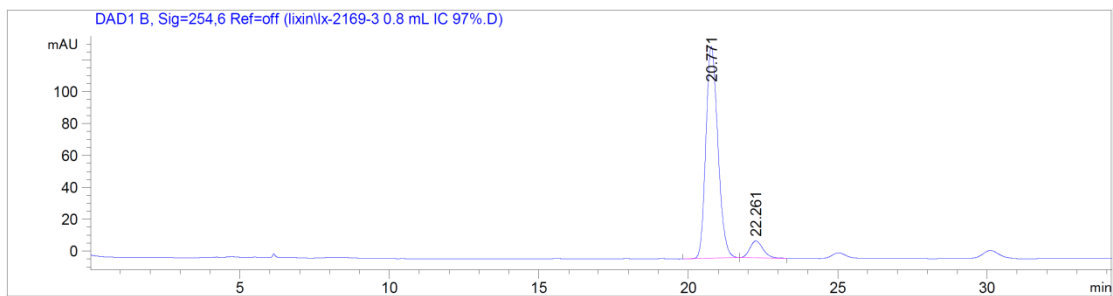
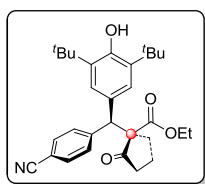


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.646	BV R	0.1359	1998.84216	228.93124	79.6863
2	7.940	VV E	0.1428	119.81644	12.61357	4.7766
3	8.254	VB E	0.1528	222.33044	22.59768	8.8635
4	9.062	BB	0.1761	167.39993	14.56363	6.6736

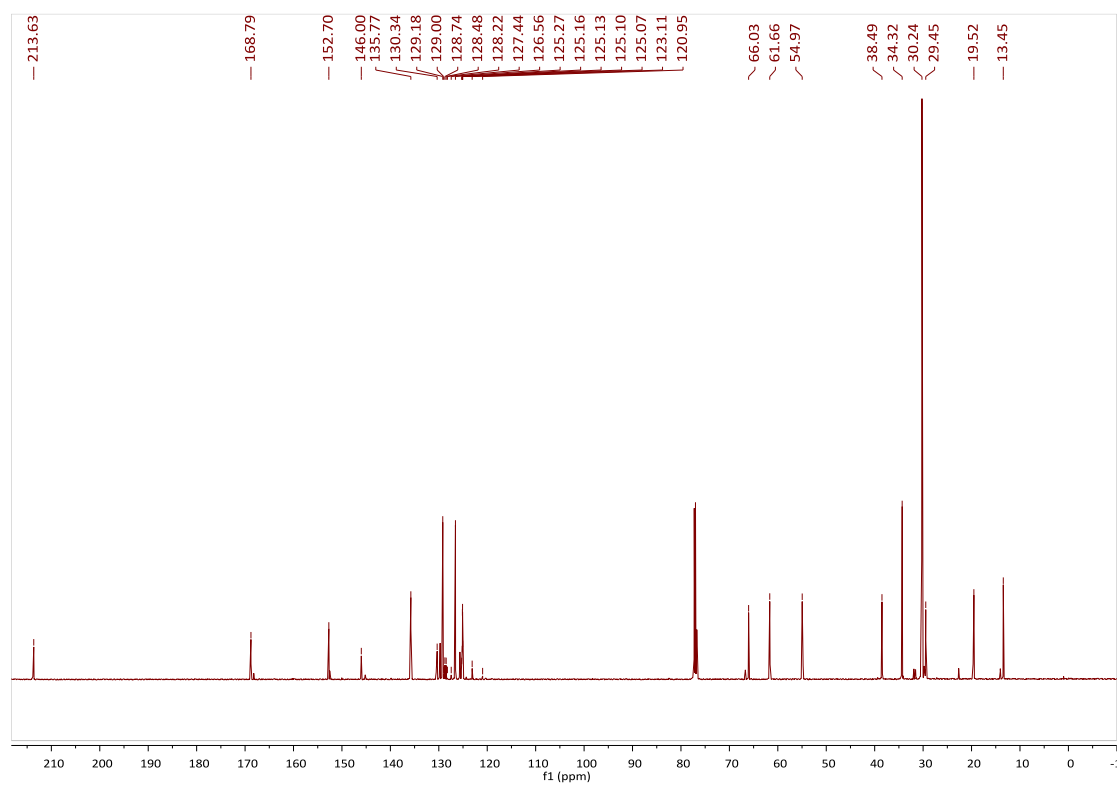
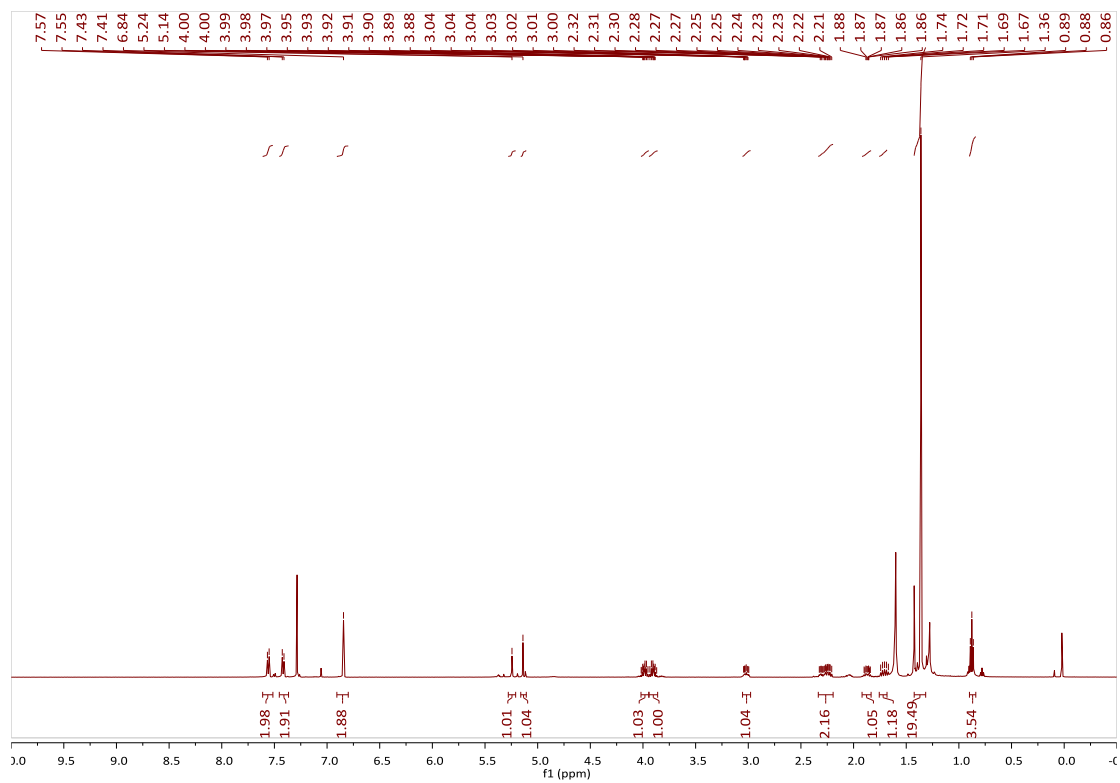
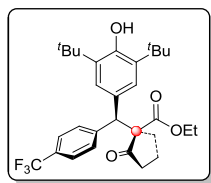


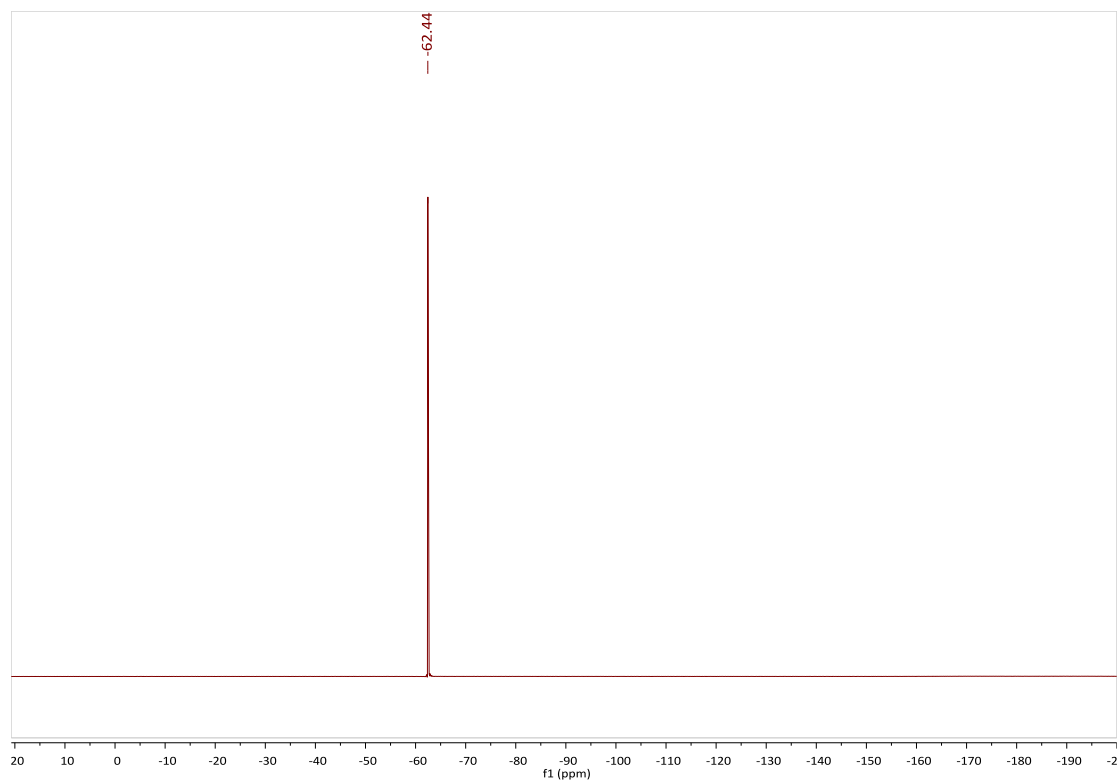
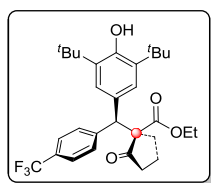


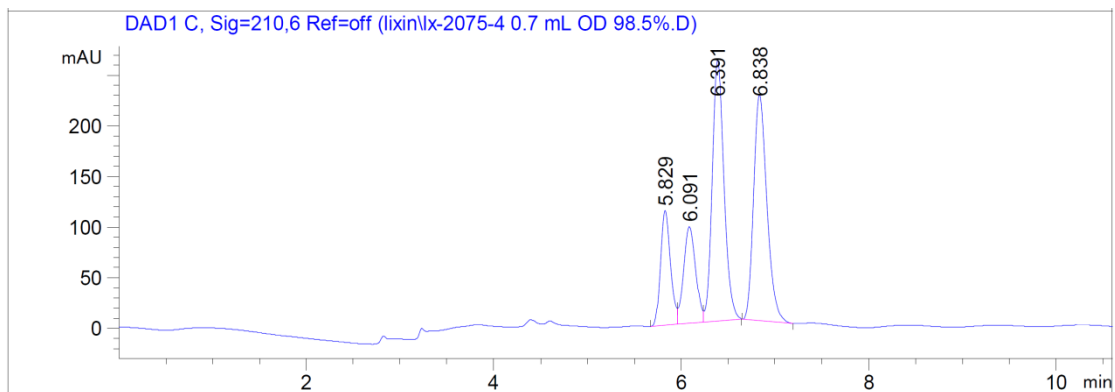
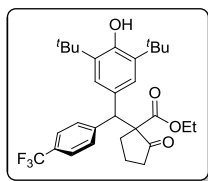
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.462	BB	0.3950	516.47723	20.28951	35.8235
2	21.841	BB	0.4490	506.97284	17.44513	35.1643
3	24.564	BB	0.4614	195.68358	6.53348	13.5729
4	29.508	BB	0.5839	222.59216	5.64611	15.4393



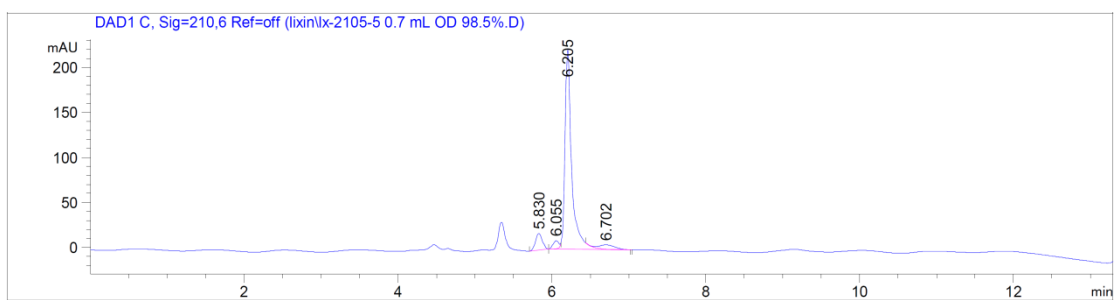
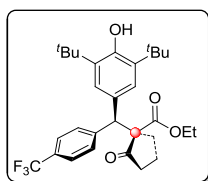
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.771	BB	0.4336	3707.22388	132.83463	92.0810
2	22.261	BB	0.4693	318.82248	10.52896	7.9190



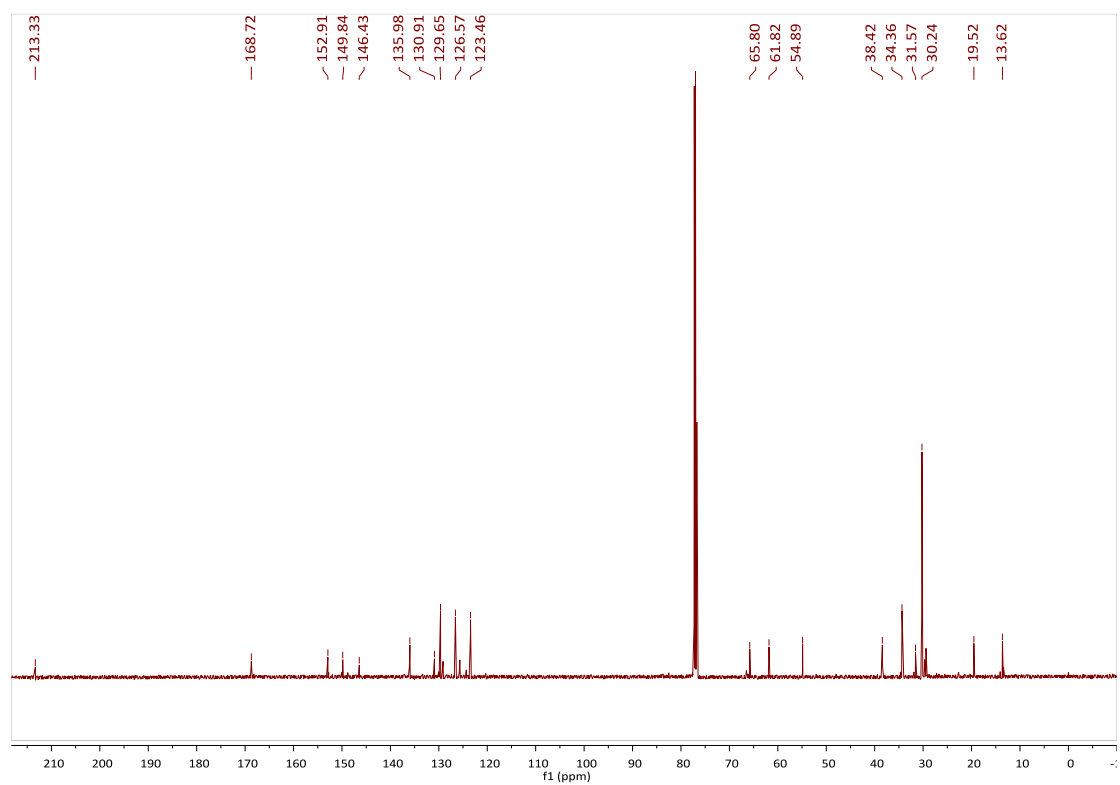
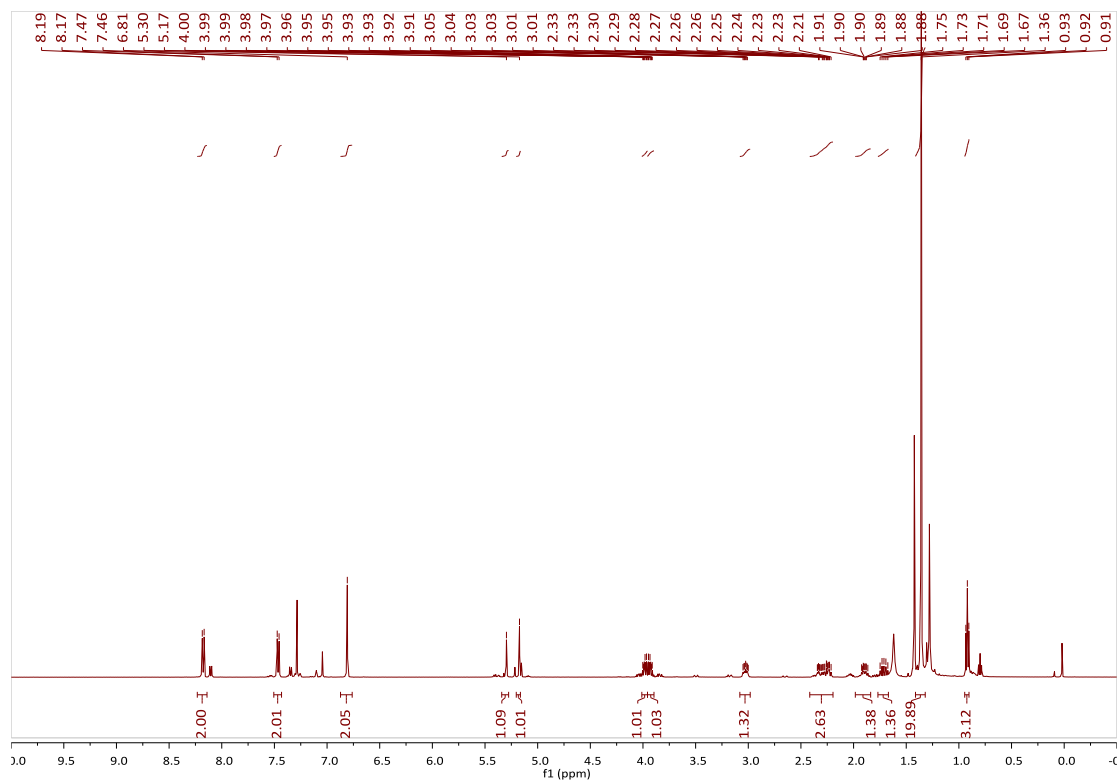
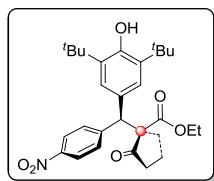


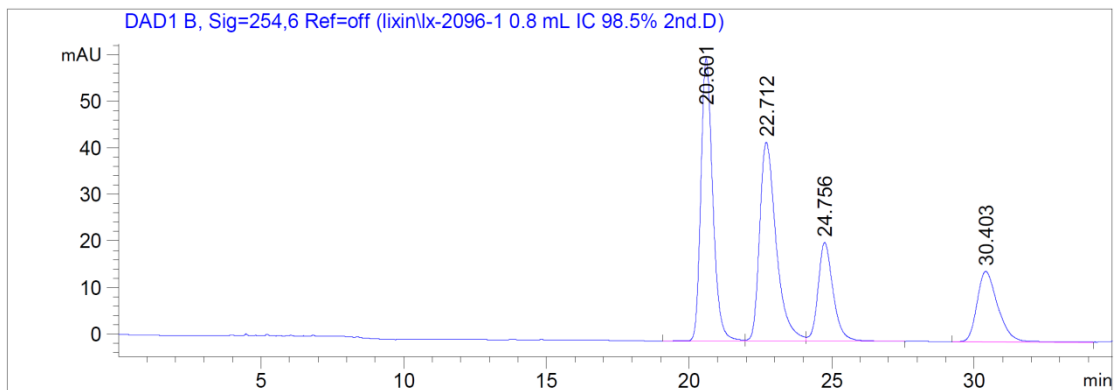
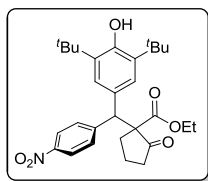


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.829	BV	0.1187	73.68540	9.91421	12.2623
2	6.091	VV	0.1445	74.13377	8.27458	12.3370
3	6.391	VB	0.1441	228.19540	25.57241	37.9751
4	6.838	BB	0.1580	224.89366	22.22635	37.4256

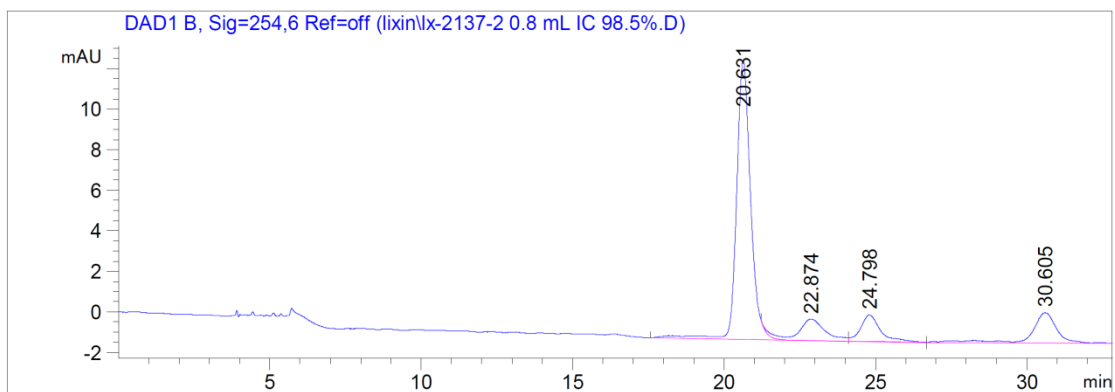
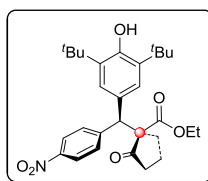


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.830	BB	0.0962	111.98220	18.09220	7.1169
2	6.055	BV E	0.0781	44.27112	8.89284	2.8136
3	6.205	VV R	0.0871	1348.55347	221.40514	85.7055
4	6.702	VB E	0.2218	68.66701	4.77505	4.3640

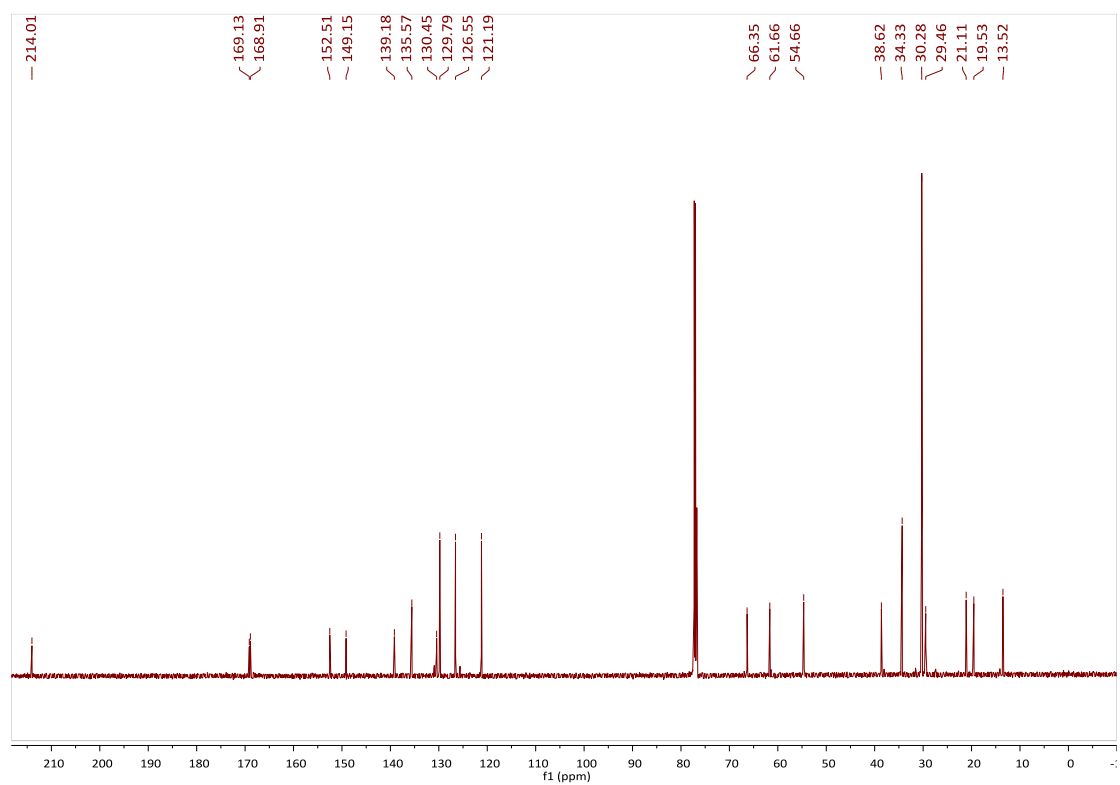
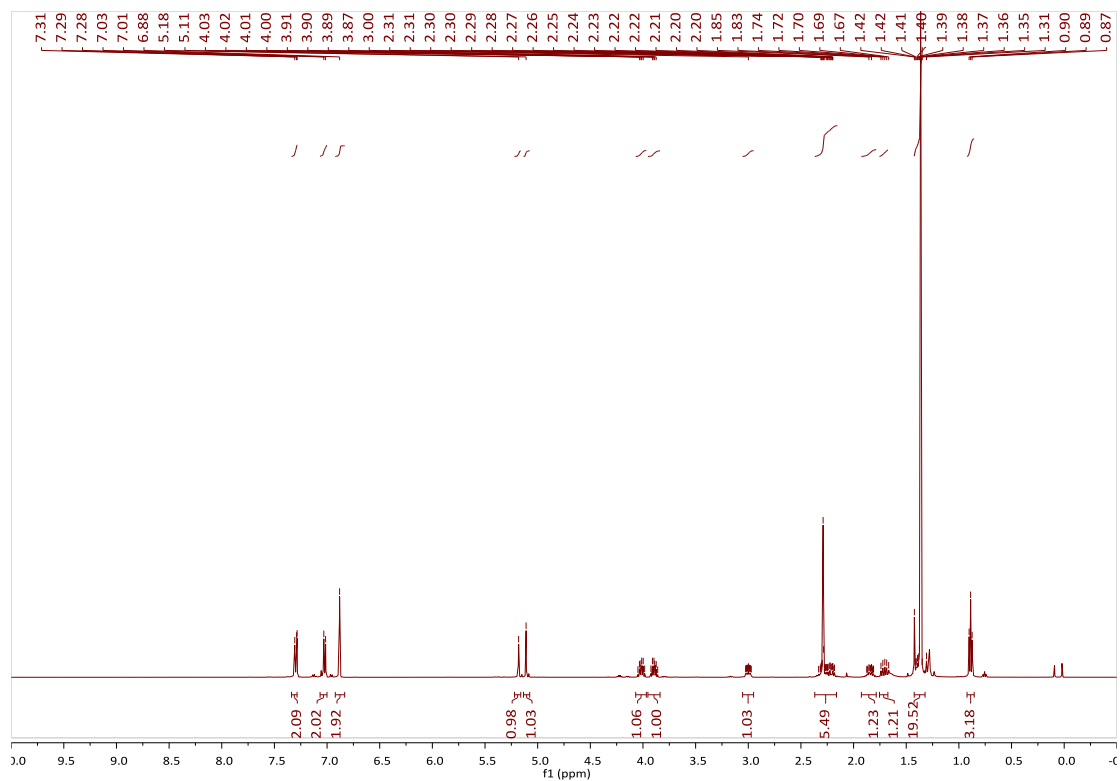
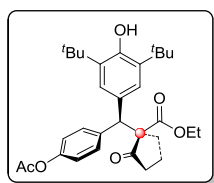


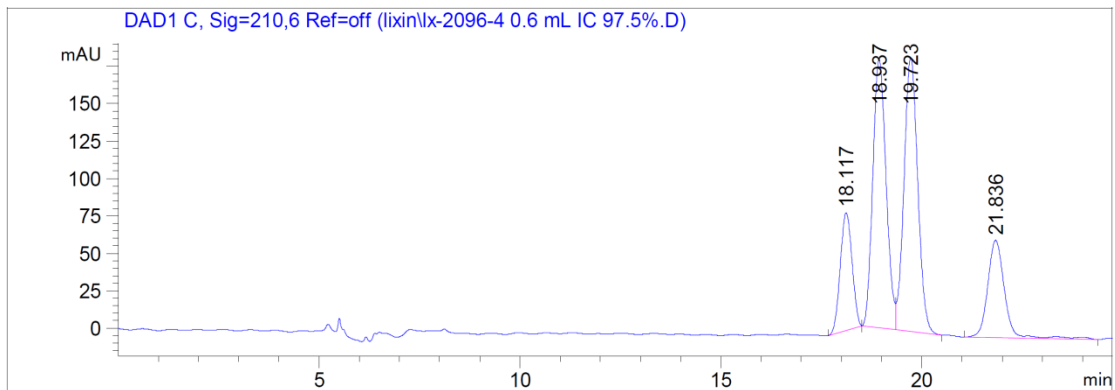
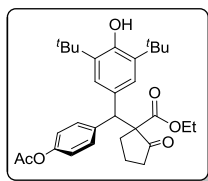


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.601	VV R	0.4426	1771.11353	60.85490	34.9785
2	22.712	VV	0.6176	1737.47388	42.80026	34.3141
3	24.756	VB	0.5627	791.25043	21.23731	15.6268
4	30.403	BV R	0.7710	763.59644	15.11681	15.0806

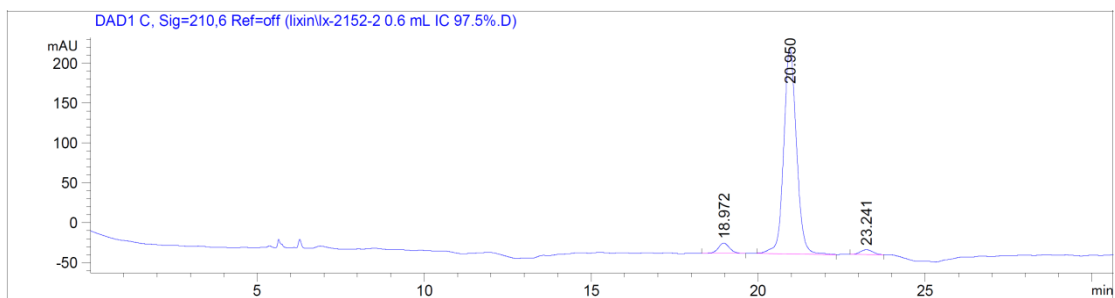
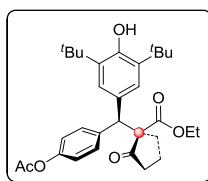


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.631	VV R	0.4870	447.75009	13.78463	67.6644
2	22.874	VV E	0.8921	65.53629	1.05592	9.9039
3	24.798	VB E	0.6636	60.23436	1.31197	9.1027
4	30.605	VV R	0.7704	88.20069	1.50067	13.3290

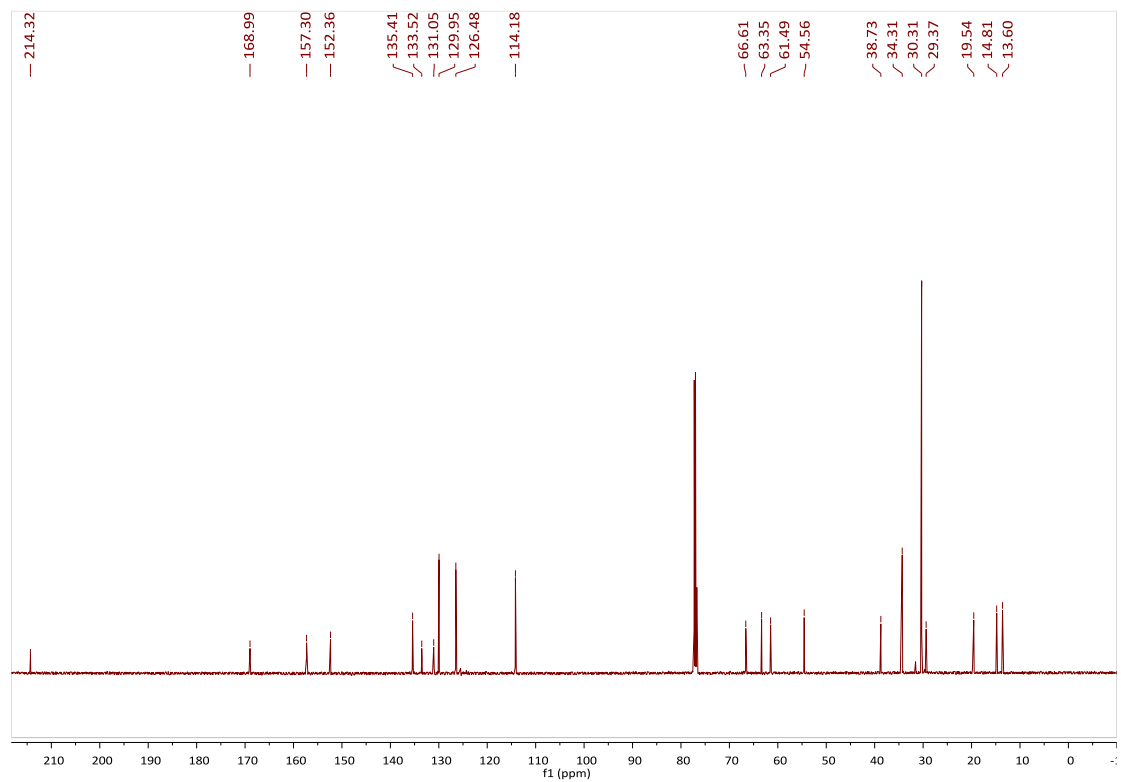
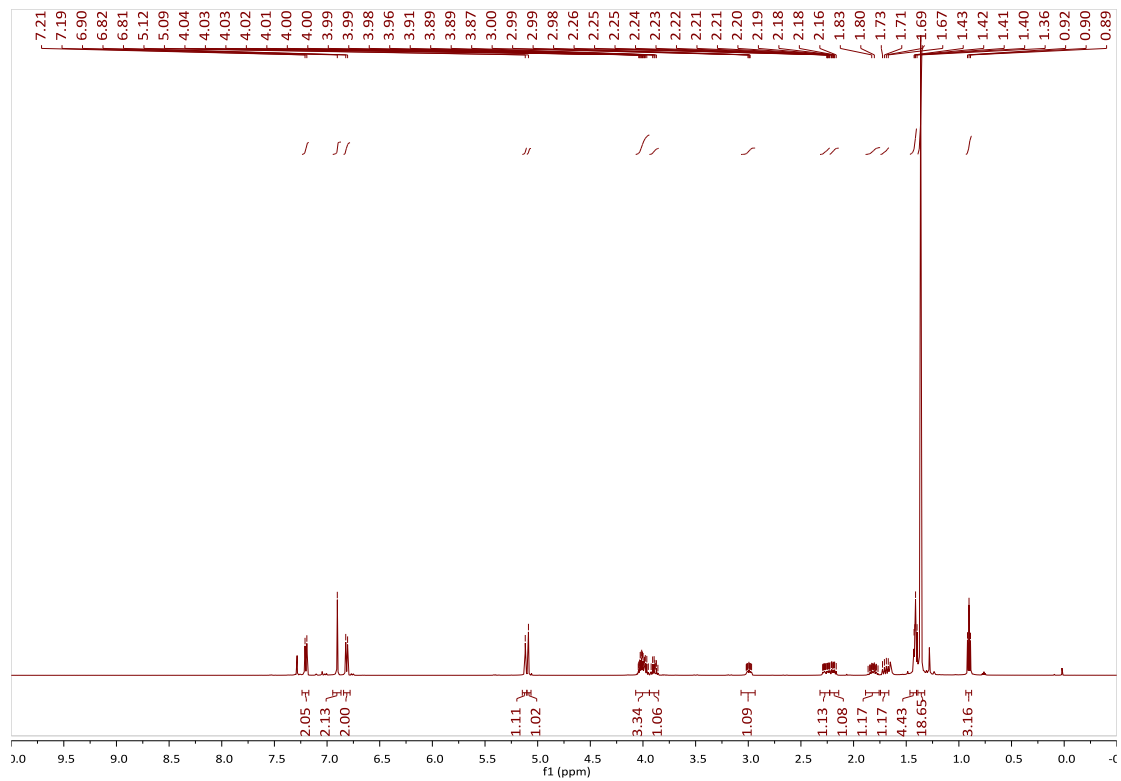
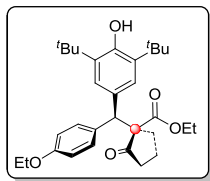


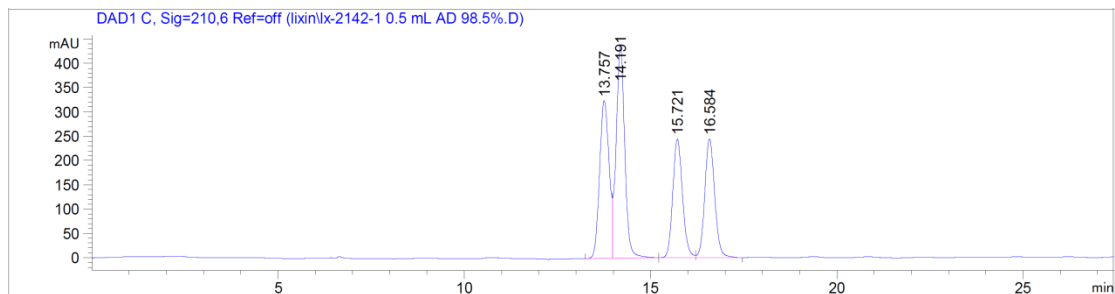
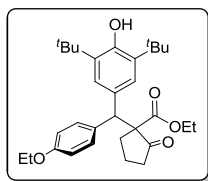


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.117	BB	0.3262	1603.70190	78.55562	13.3672
2	18.937	BV	0.3643	4123.07422	179.29413	34.3667
3	19.723	VB	0.3741	4362.26758	182.99480	36.3605
4	21.836	BV R	0.4470	1908.24207	64.97588	15.9056

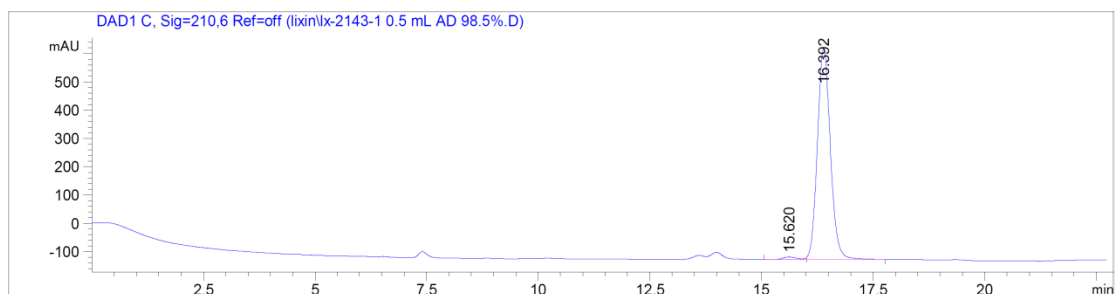
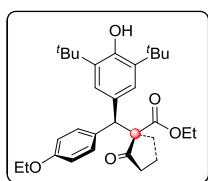


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.972	BB	0.3650	313.11130	13.09260	4.3047
2	20.950	BB	0.4065	6806.86914	257.38055	93.5825
3	23.241	BB	0.3826	153.67906	6.12845	2.1128

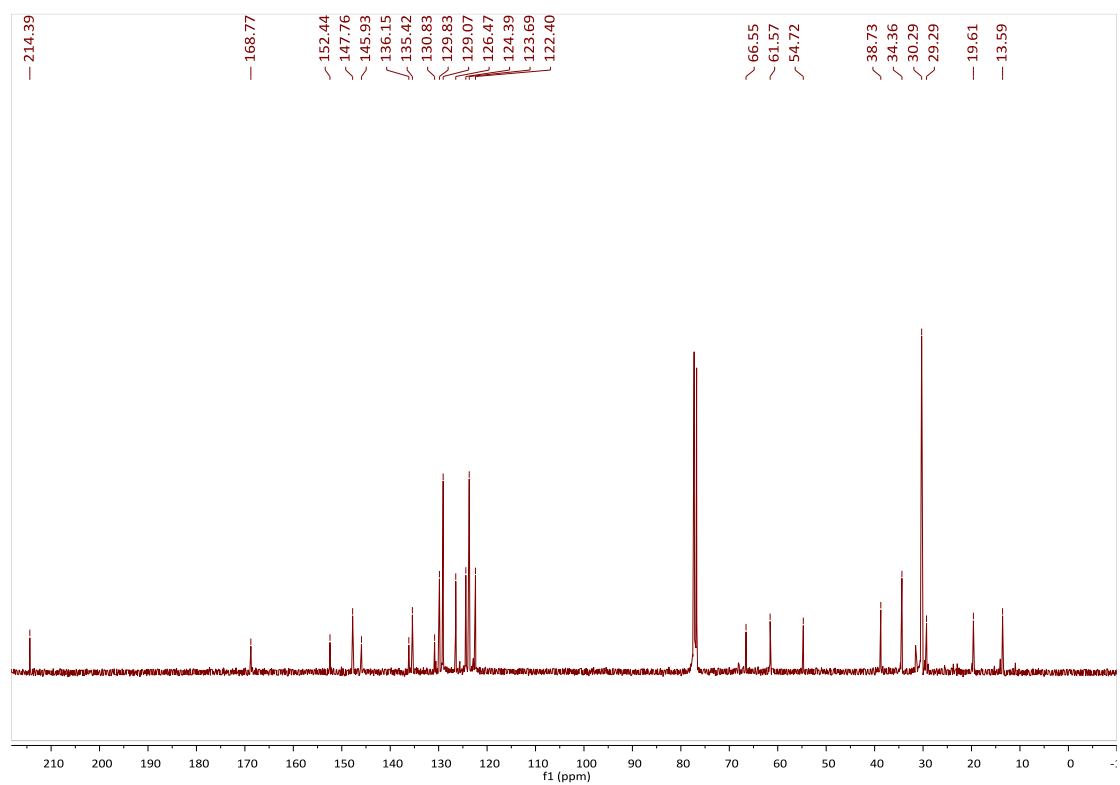
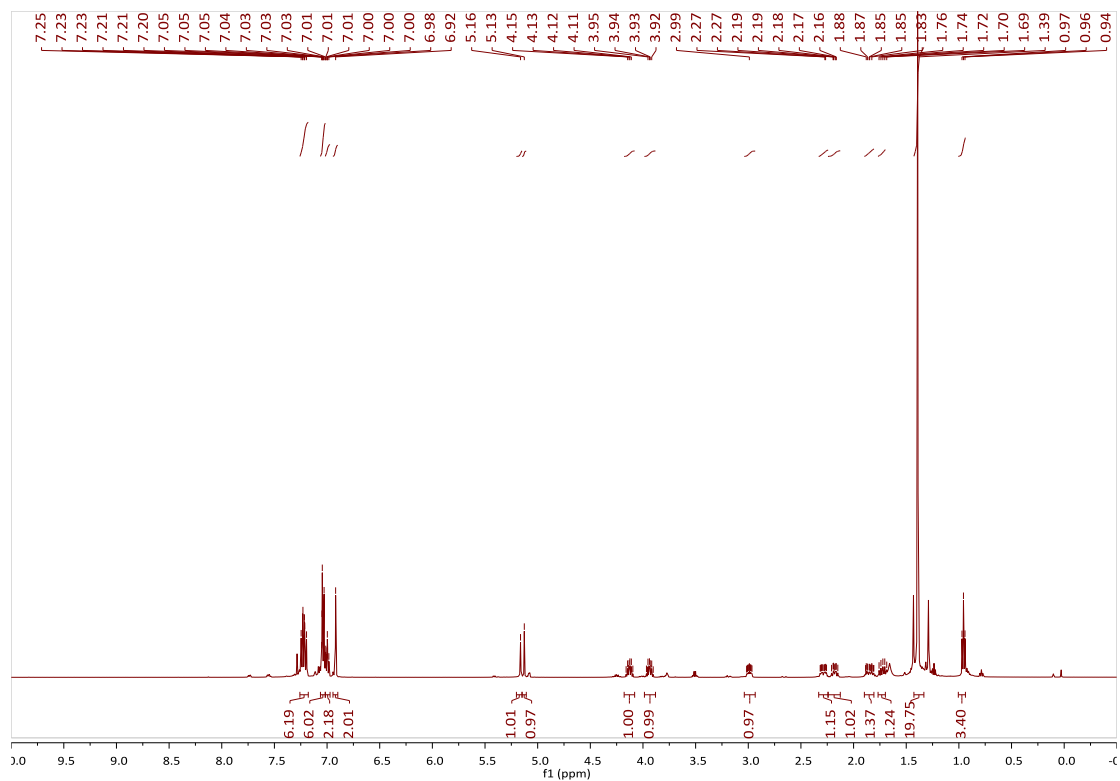
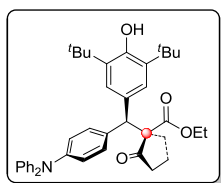


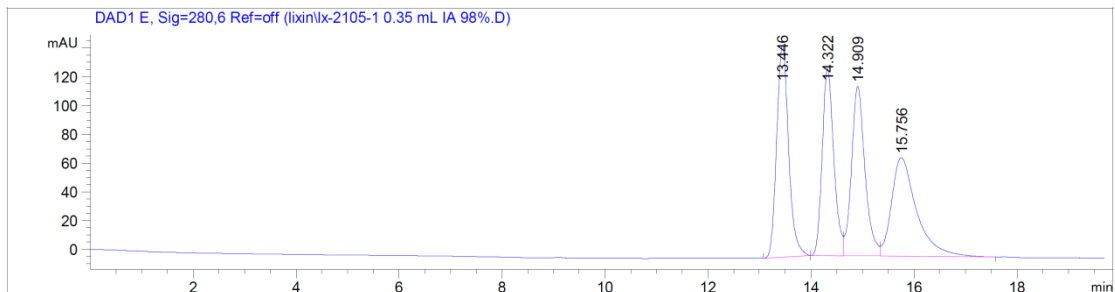
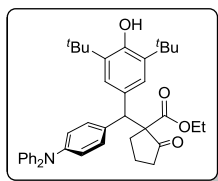


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.757	BV	0.2727	5750.36035	324.58197	26.4570
2	14.191	VB	0.2442	7047.83252	436.82874	32.4266
3	15.721	BV	0.2794	4419.53955	243.89597	20.3340
4	16.584	VB	0.2858	4516.96924	244.24625	20.7823

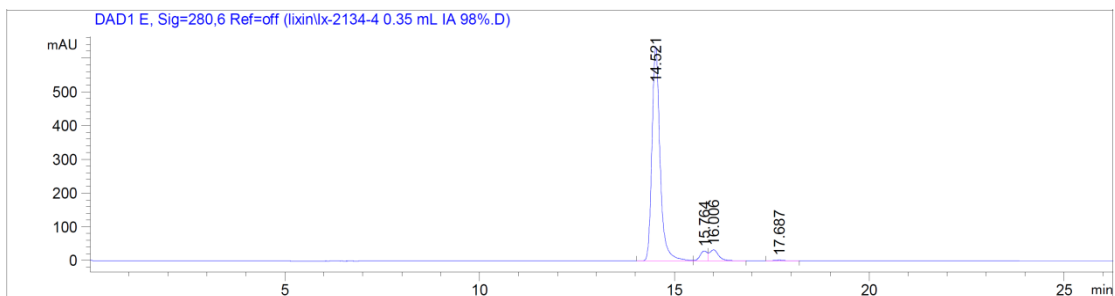
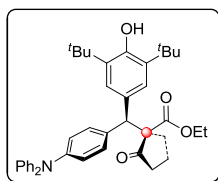


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.620	BV E	0.3187	199.53831	9.51499	1.3028
2	16.392	VB R	0.3144	1.51167e4	746.05170	98.6972

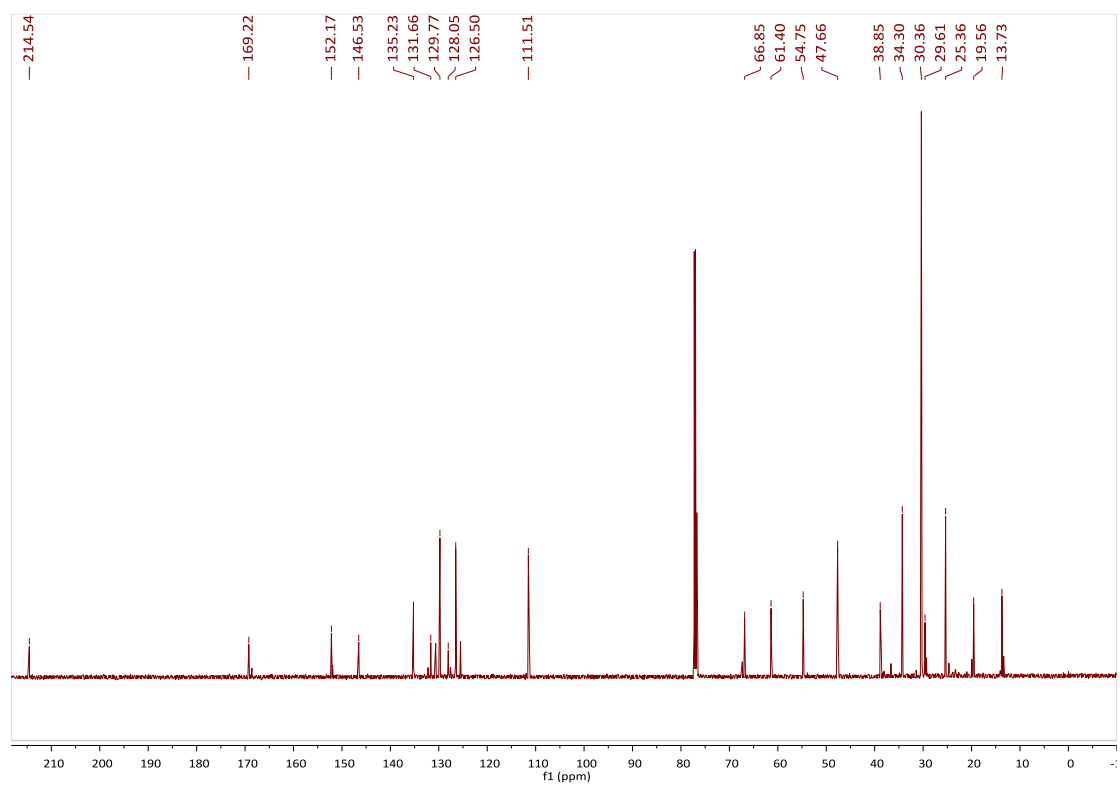
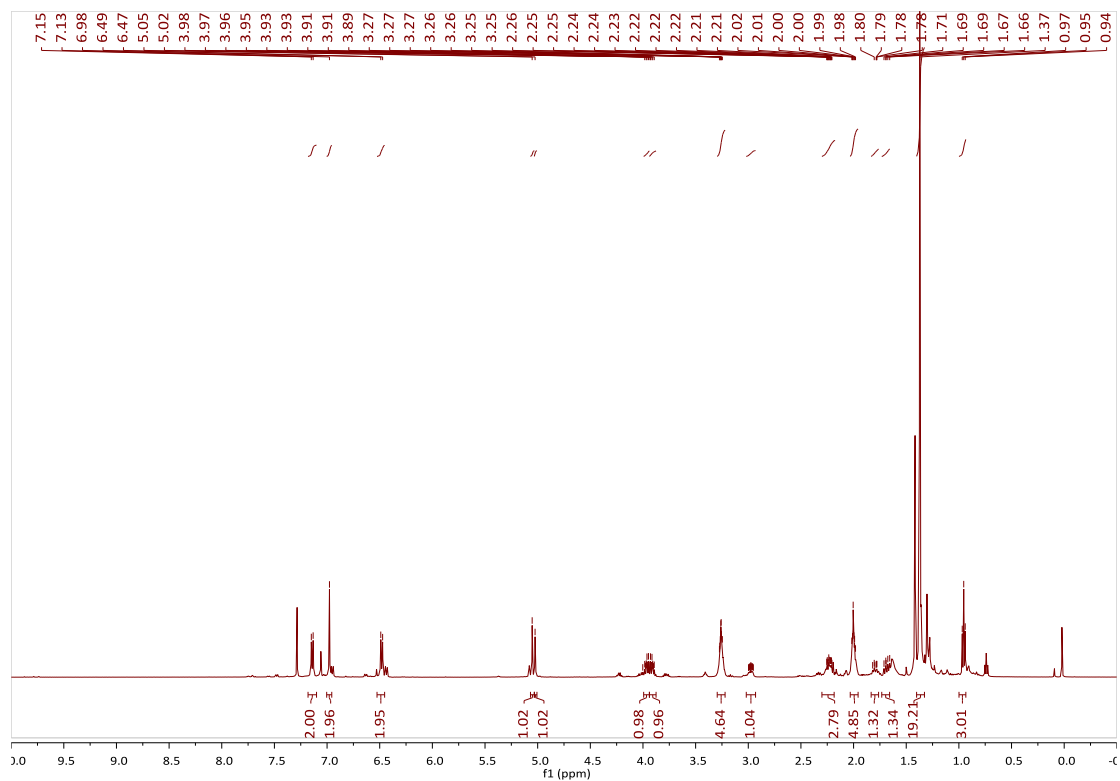
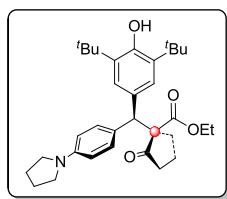


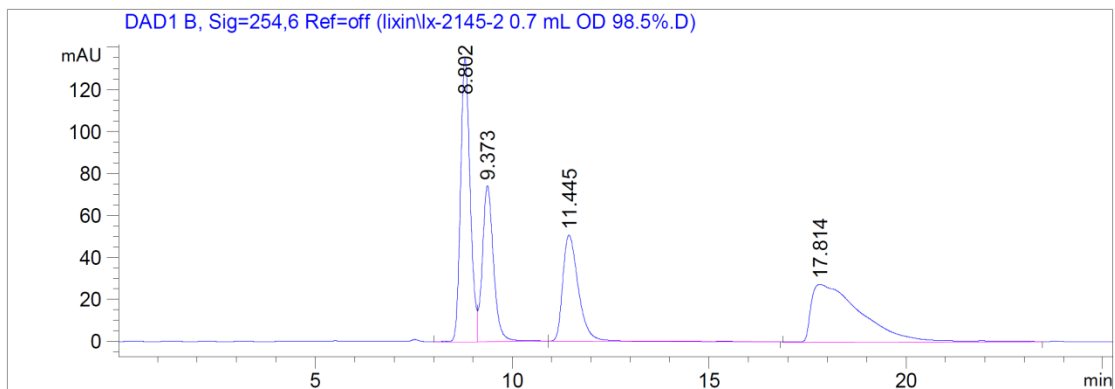
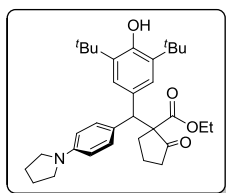


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.446	BB	0.2498	2372.83838	147.38861	26.6774
2	14.322	BV	0.2414	2046.57544	130.17674	23.0093
3	14.909	VV	0.2744	2150.11865	118.07677	24.1734
4	15.756	VB	0.4990	2325.02661	68.66835	26.1399

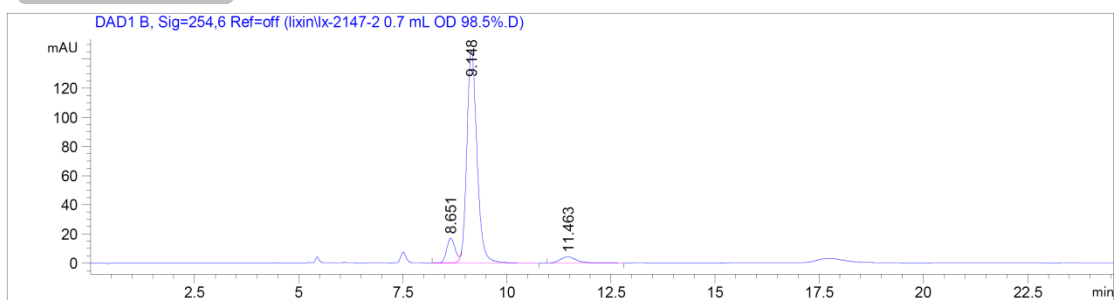
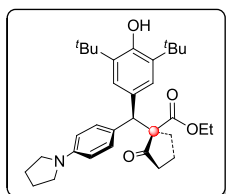


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.521	BV	0.2189	9176.25586	633.76440	90.5038
2	15.764	VV	0.1965	383.78079	29.36015	3.7852
3	16.006	VB	0.2373	533.85358	32.90141	5.2653
4	17.687	BB	0.2783	45.19367	2.50748	0.4457

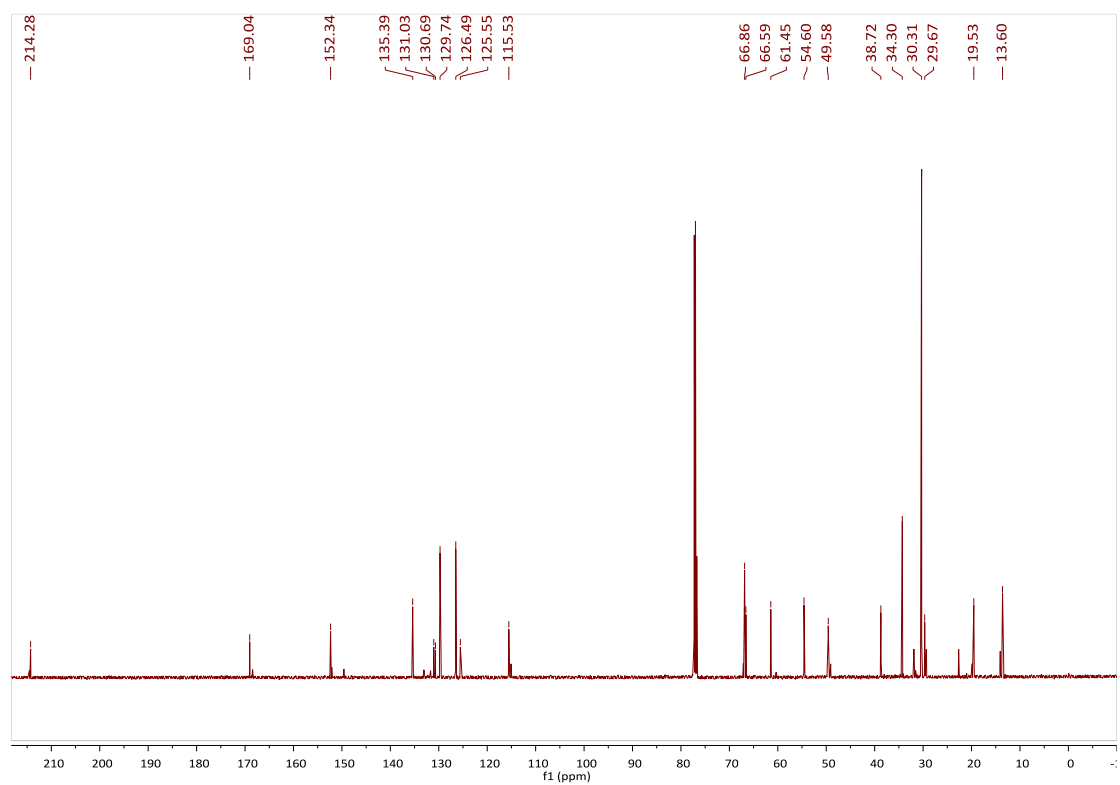
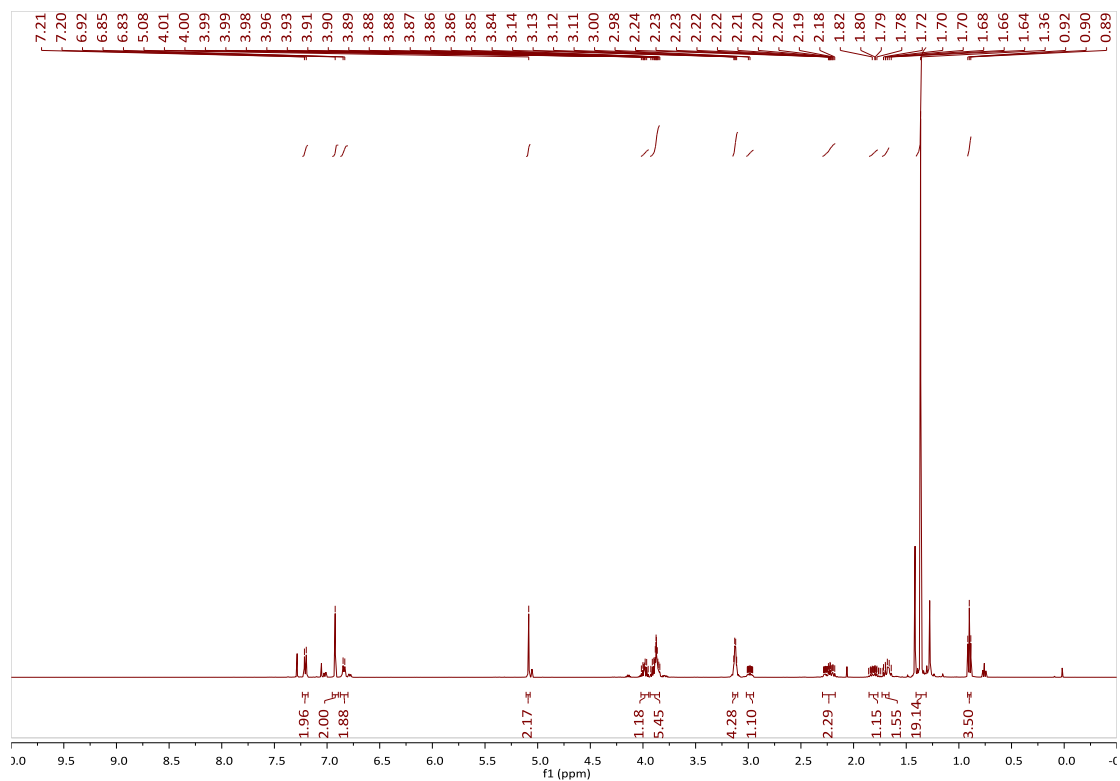
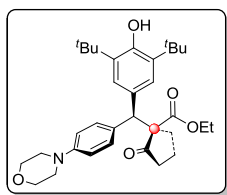


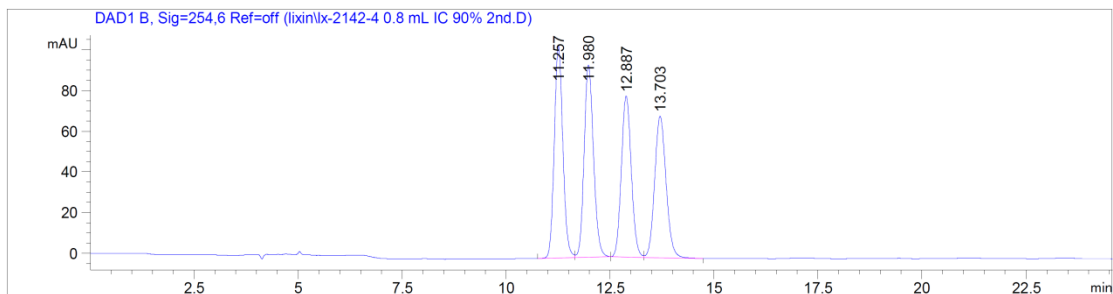
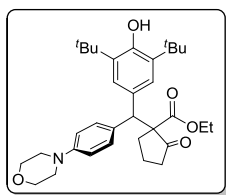


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.802	BV	0.2625	2286.06860	134.33971	30.3488
2	9.373	VV R	0.2997	1447.70581	73.99107	19.2191
3	11.445	BV R	0.4239	1405.67859	50.38414	18.6612
4	17.814	VV R	1.1299	2393.18555	27.47340	31.7709

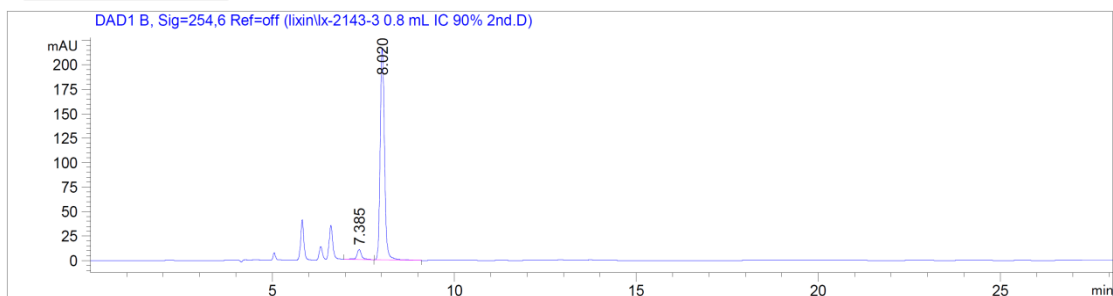
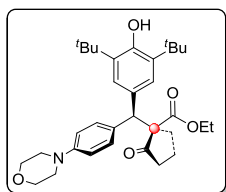


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.651	BV E	0.2164	237.36667	17.05150	8.3178
2	9.148	VB R	0.2609	2495.06372	146.36200	87.4320
3	11.463	BB	0.3705	121.28978	4.47070	4.2502

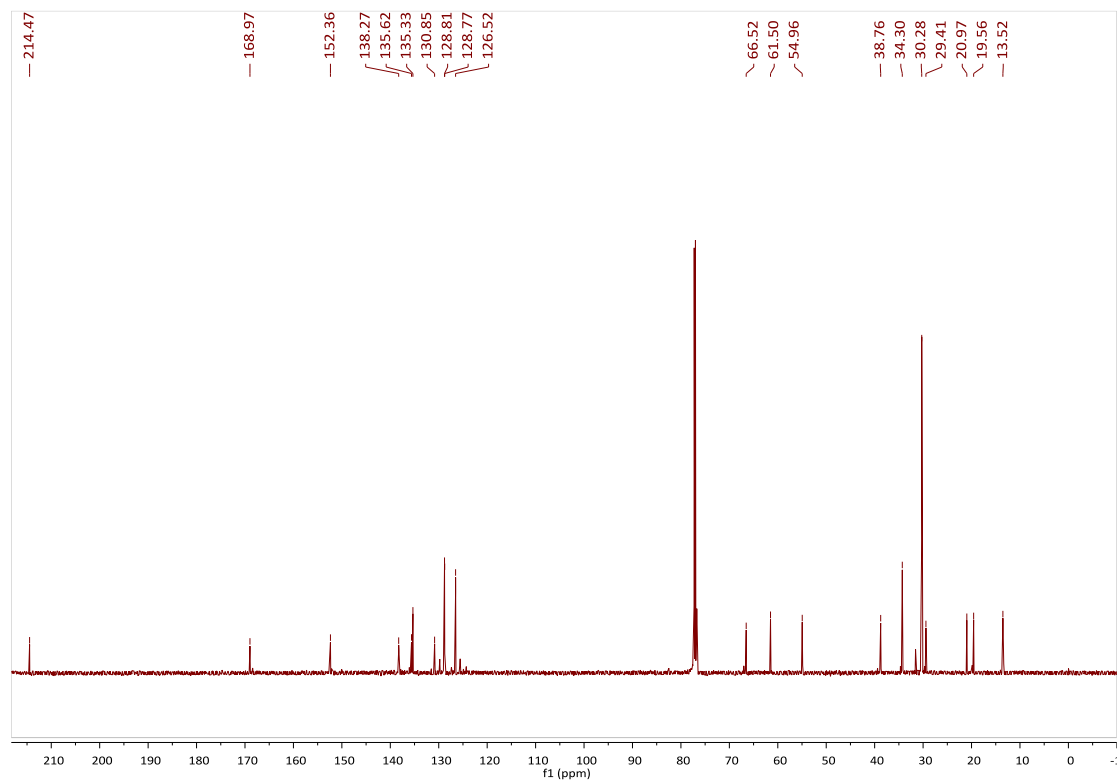
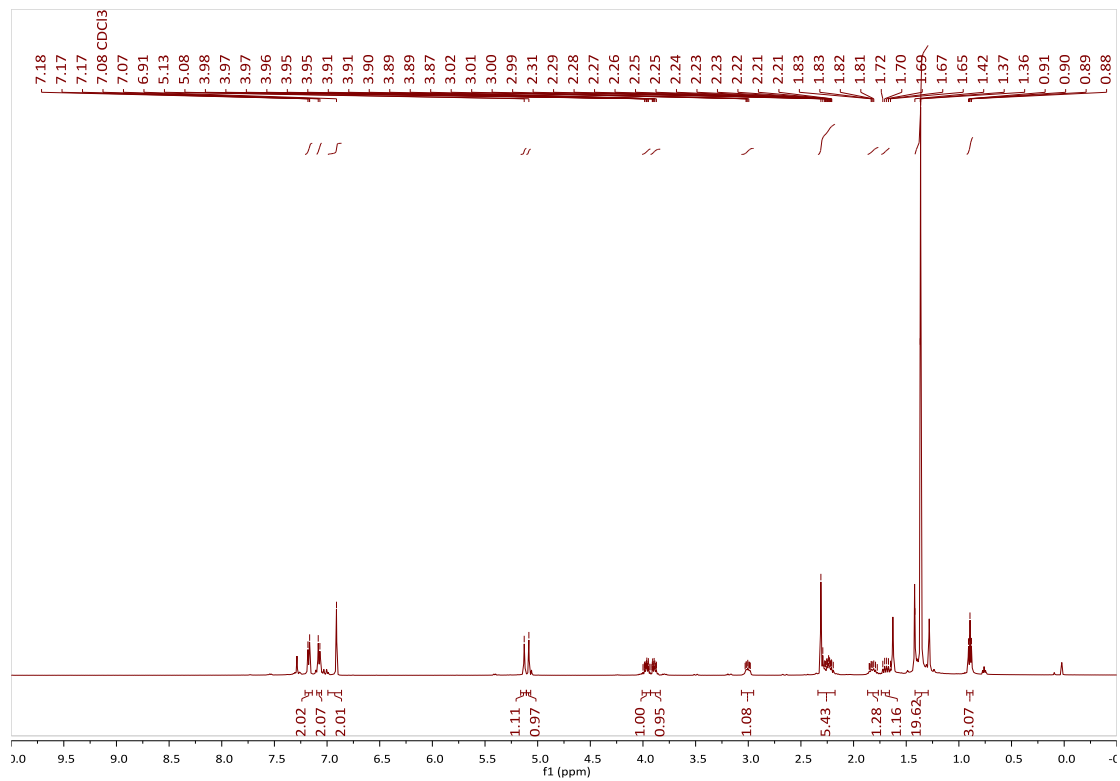
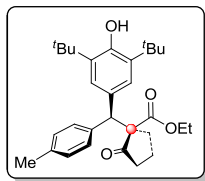


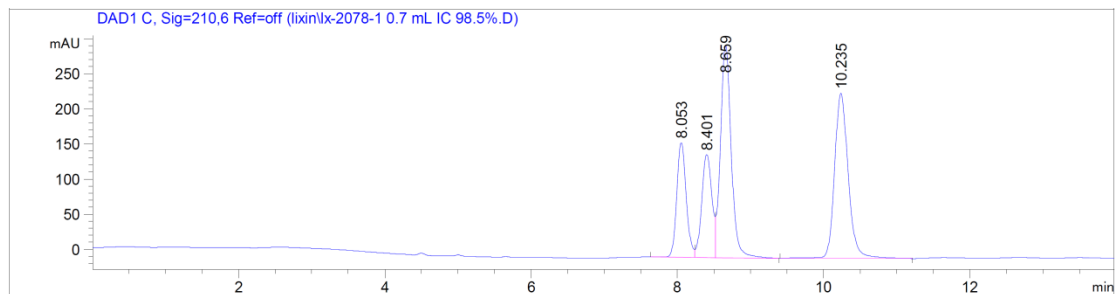
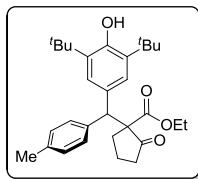


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.257	BV	0.2215	1493.88623	104.07958	26.6167
2	11.980	VB	0.2429	1477.72266	94.27510	26.3287
3	12.887	BV	0.2576	1309.74756	78.93672	23.3359
4	13.703	VB	0.2979	1331.23608	69.37405	23.7187

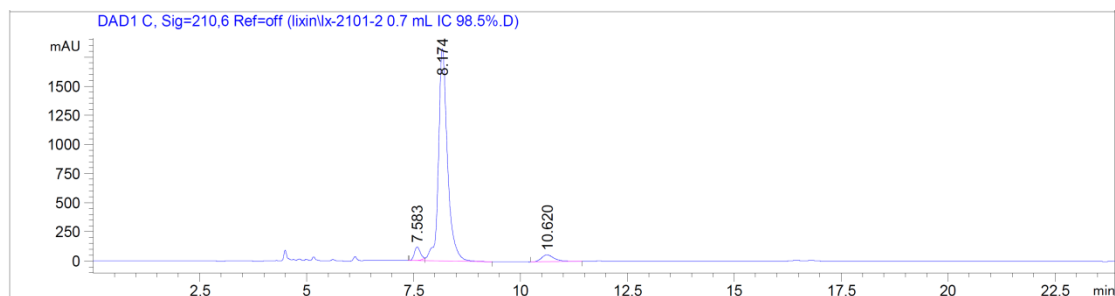
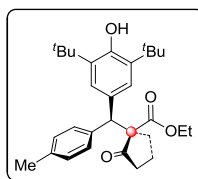


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.385	BB	0.1302	88.48915	10.10199	4.7265
2	8.020	BB	0.1261	1783.70056	216.50288	95.2735

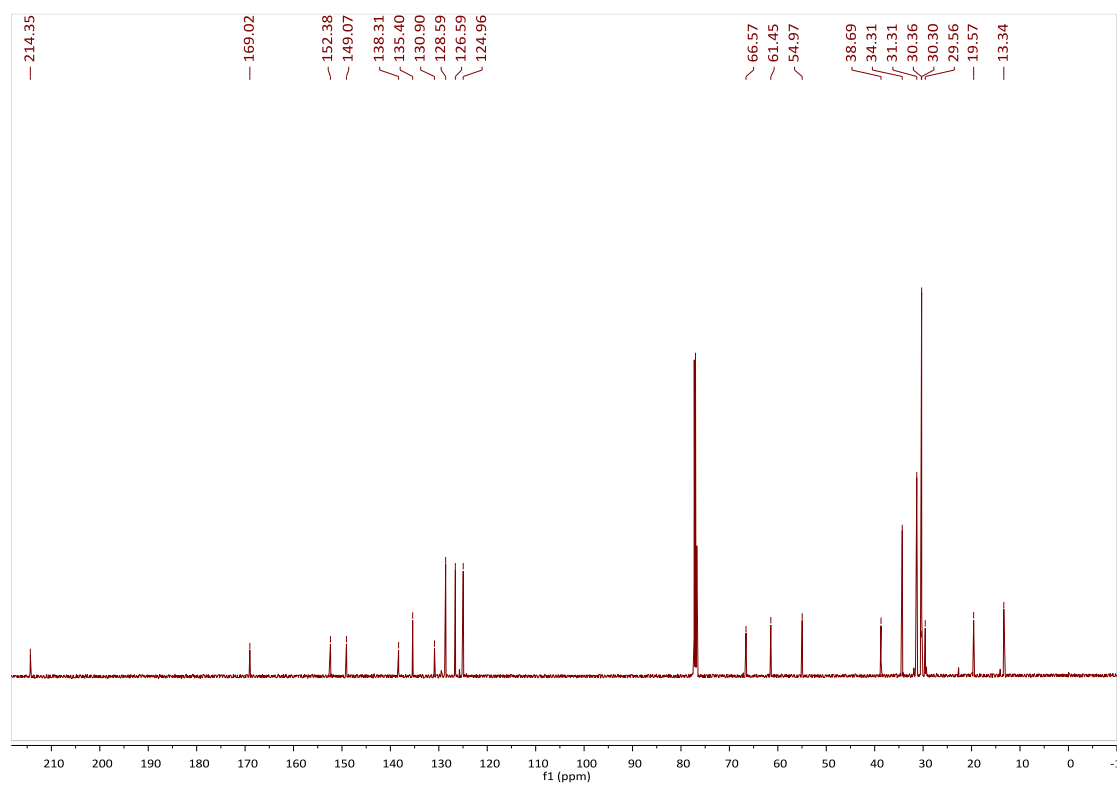
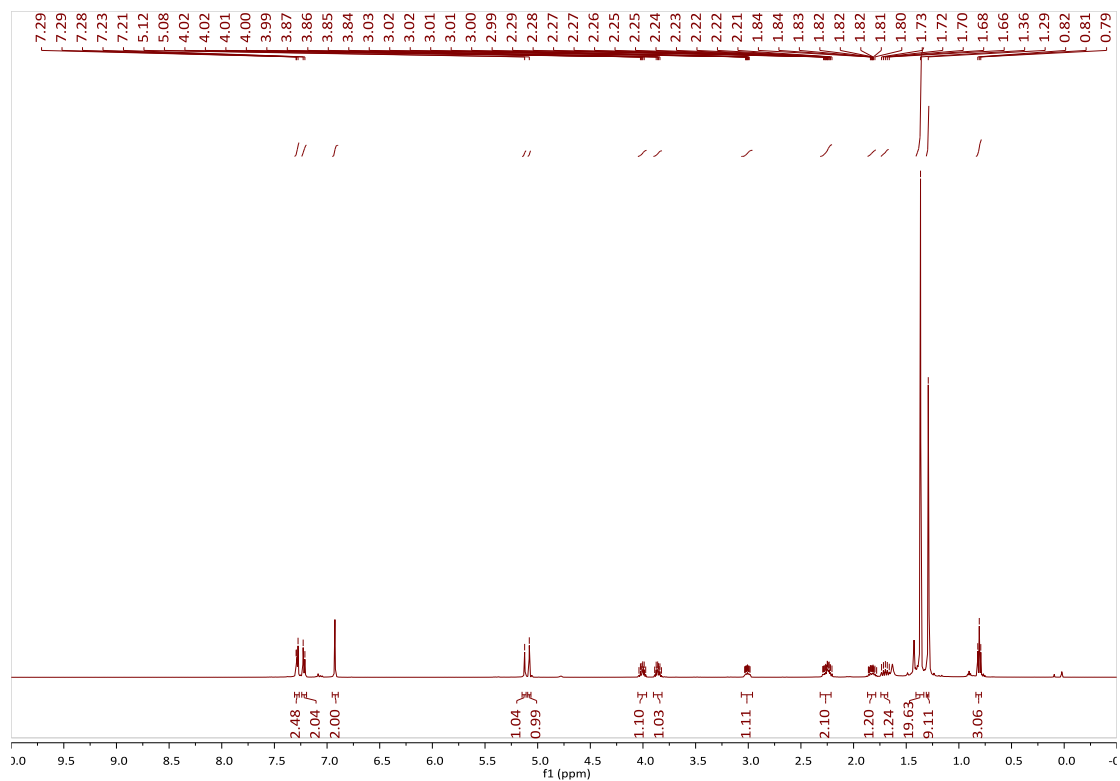
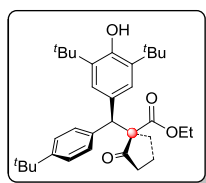


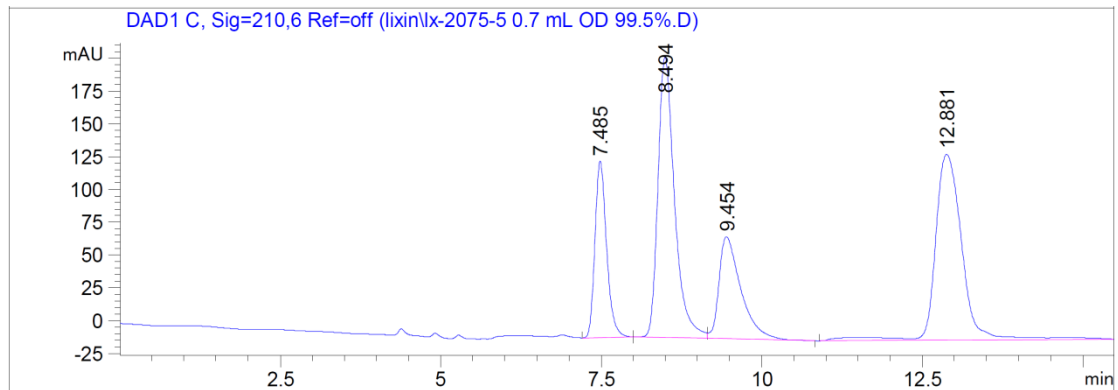
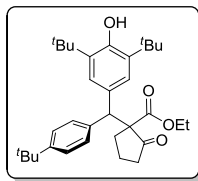


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.053	BV	0.1393	1469.94873	162.84169	16.2736
2	8.401	VV	0.1483	1408.34753	146.34930	15.5916
3	8.659	VB	0.1562	3108.70801	301.64221	34.4160
4	10.235	BB	0.1994	3045.72998	234.64156	33.7188

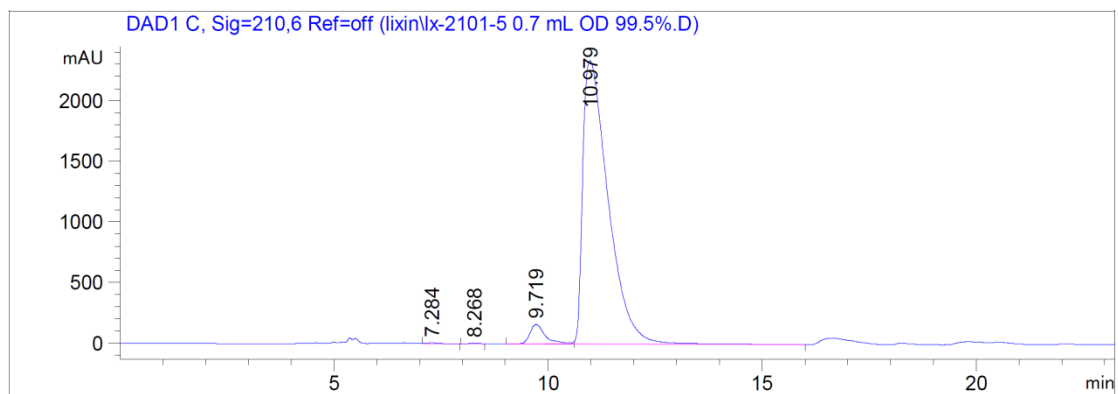
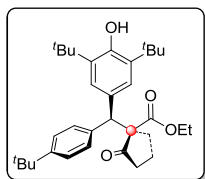


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.583	BV E	0.1473	1089.11060	114.17785	3.7069
2	8.174	VB R	0.2209	2.70492e4	1824.96887	92.0642
3	10.620	BB	0.3199	1242.48865	58.93825	4.2289

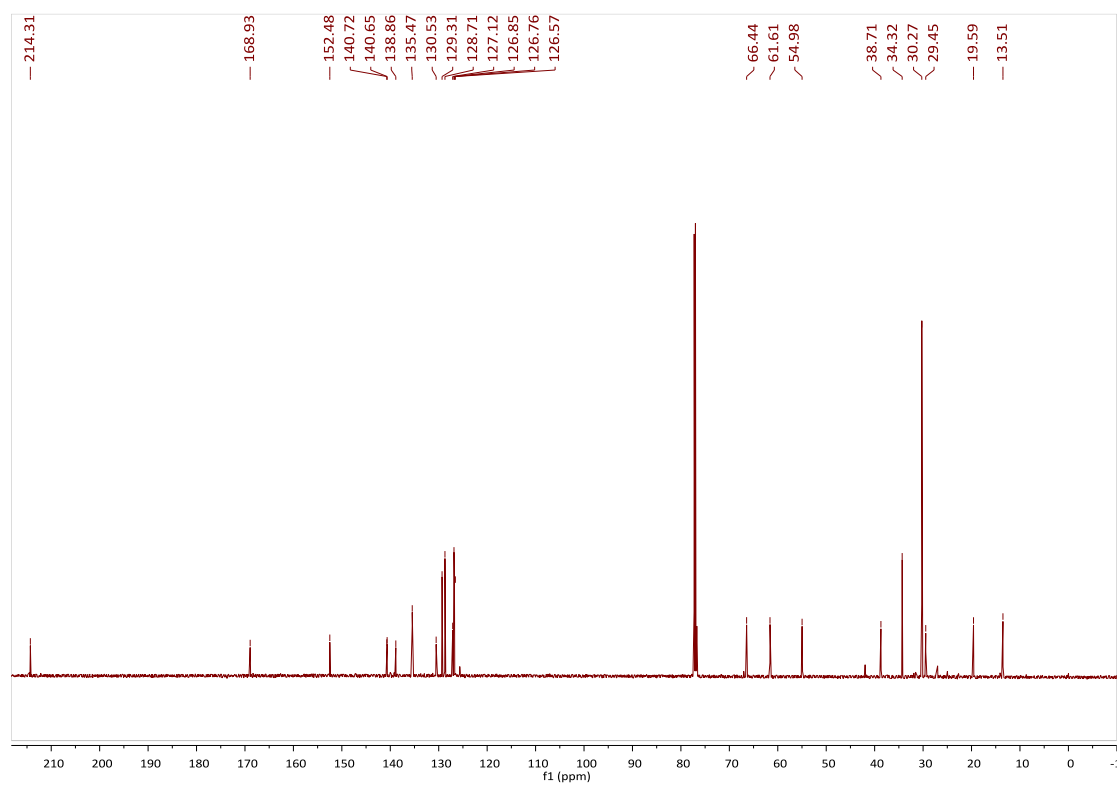
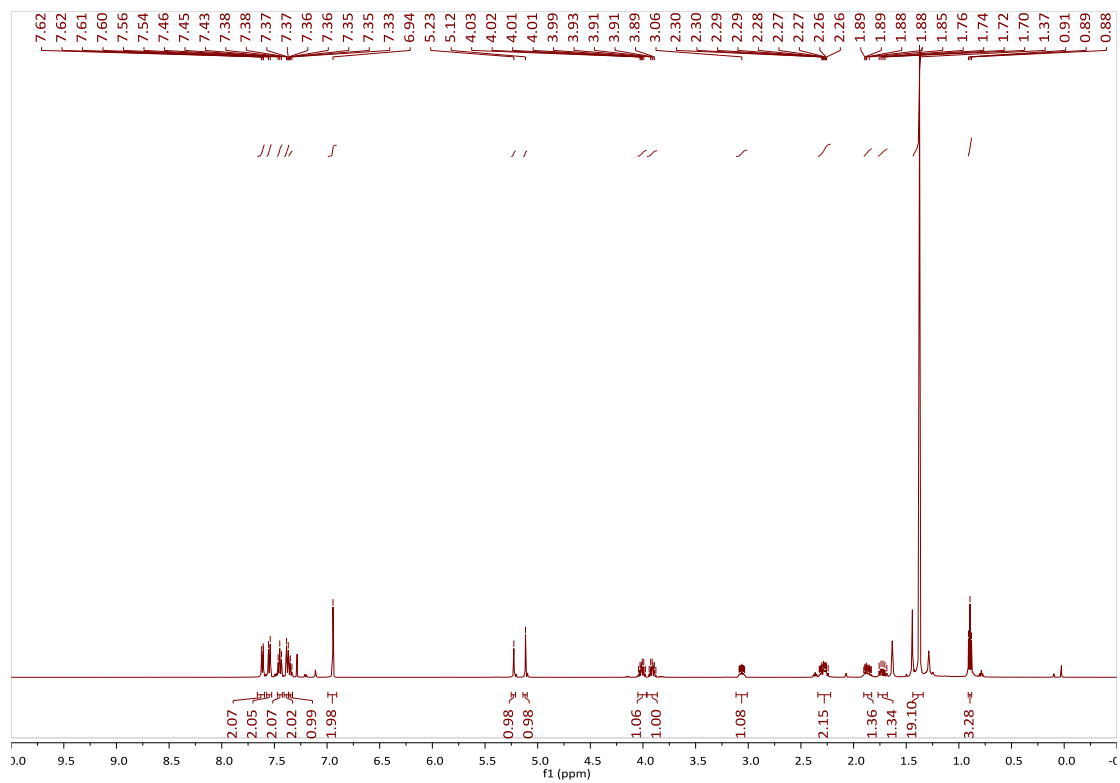
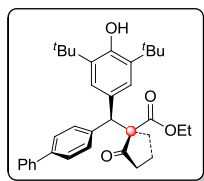


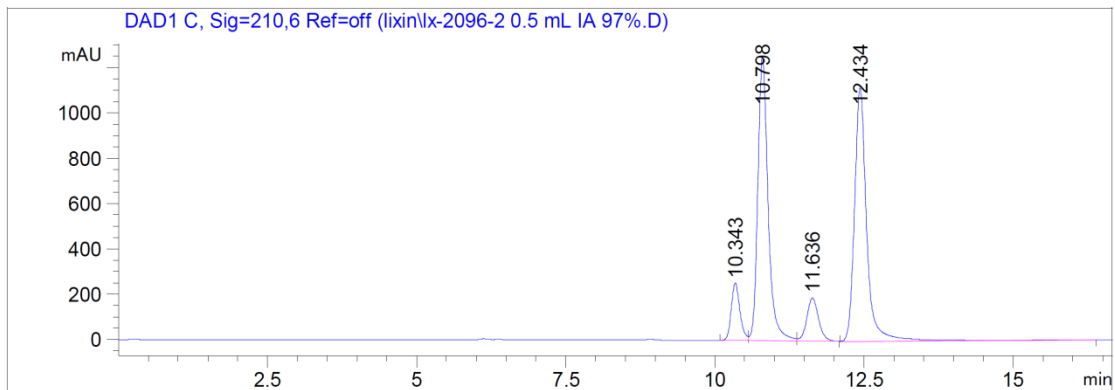
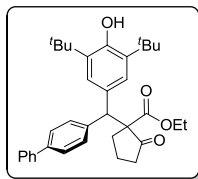


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.485	BB	0.1945	1685.98926	134.21985	14.6415
2	8.494	BV	0.2741	3839.83081	213.21825	33.3459
3	9.454	VB	0.3506	1855.95483	77.71581	16.1175
4	12.881	VV R	0.4553	4133.36426	141.59445	35.8950

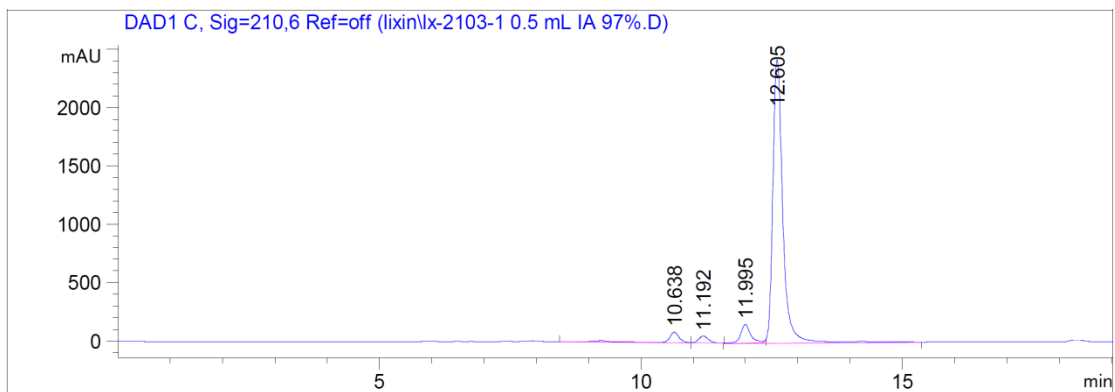
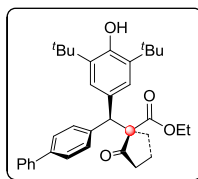


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.284	VB	0.3122	154.31569	7.25509	0.1529
2	8.268	BV	0.3044	80.89815	4.20634	0.0801
3	9.719	BV E	0.3839	4106.14502	161.89053	4.0682
4	10.979	VB R	0.6259	9.65923e4	2338.31738	95.6988

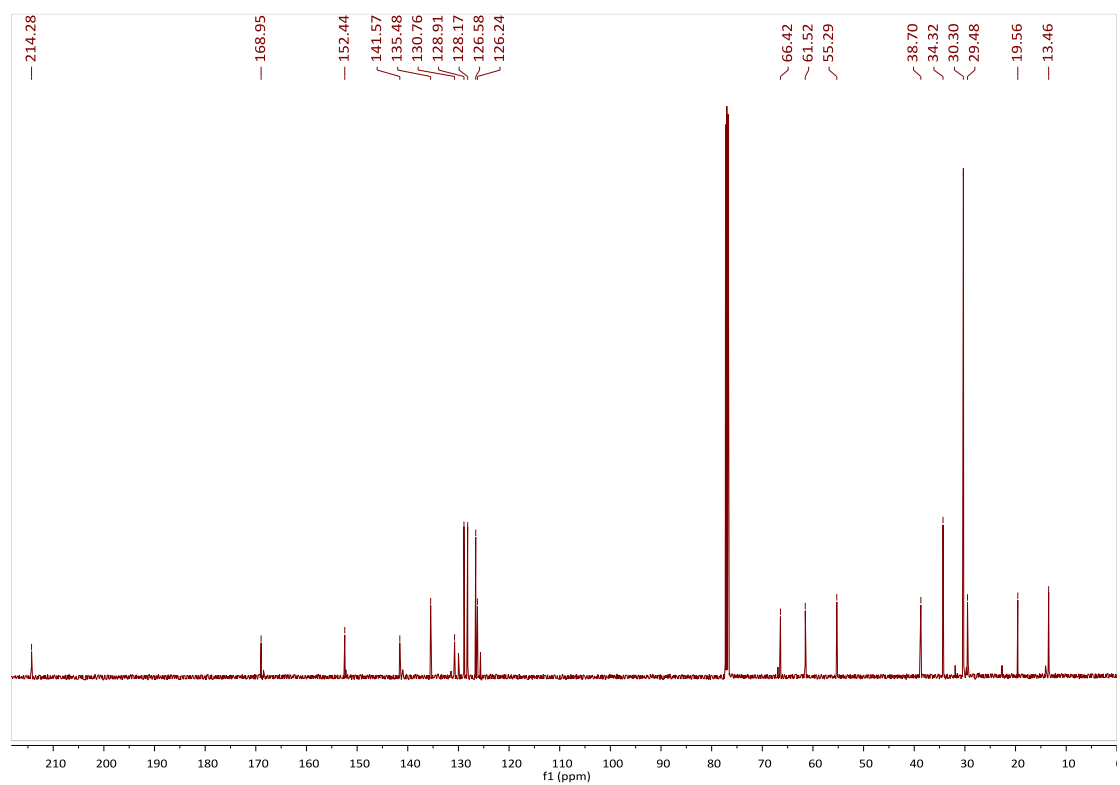
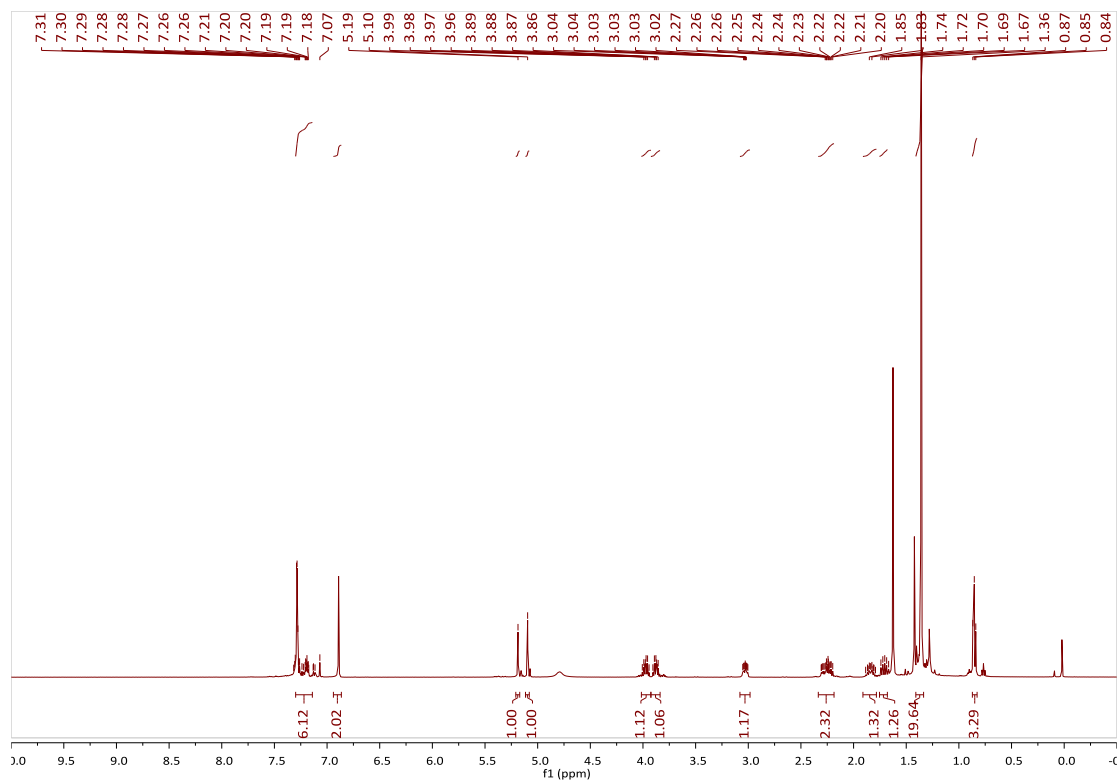
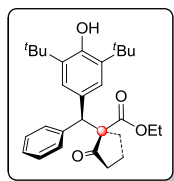


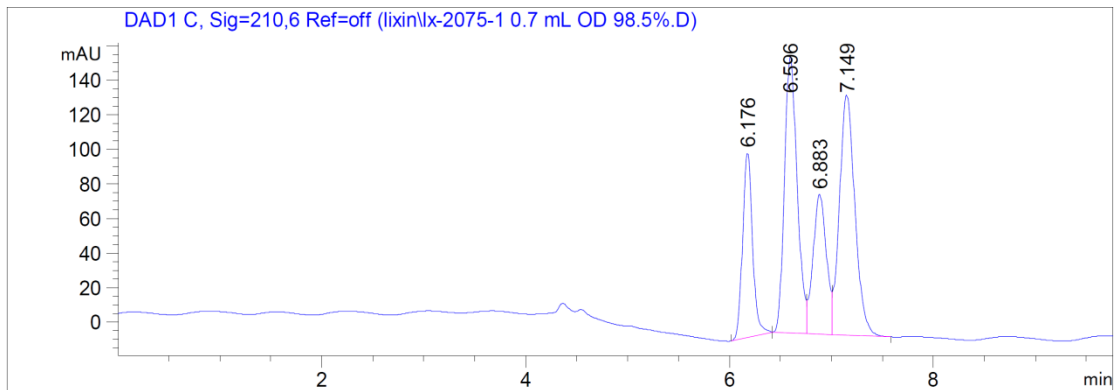
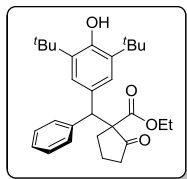


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.343	BV	0.1582	2545.32349	251.29065	7.0564
2	10.798	VV	0.1886	1.49702e4	1242.49036	41.5019
3	11.636	VB	0.2154	2597.66016	190.15742	7.2015
4	12.434	BV R	0.2153	1.59579e4	1113.09985	44.2402

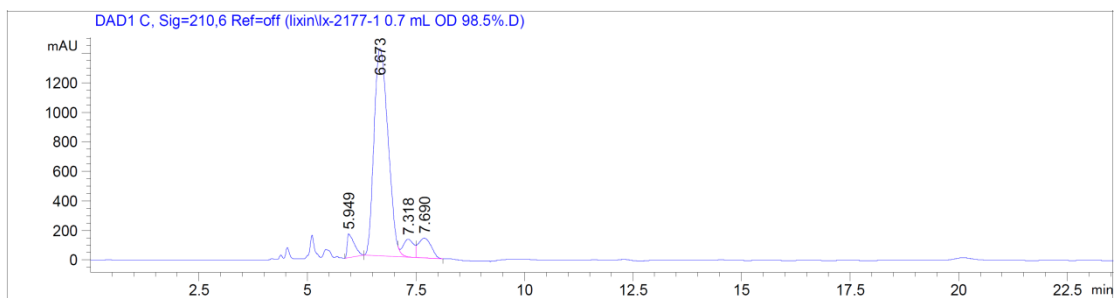
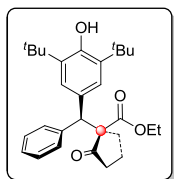


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.638	VV R	0.1962	1749.04431	91.86221	4.7290
2	11.192	VB	0.2039	811.98242	60.77063	2.1954
3	11.995	BV E	0.1958	2137.88135	160.11205	5.7803
4	12.605	VV R	0.2024	3.22869e4	2424.33447	87.2954

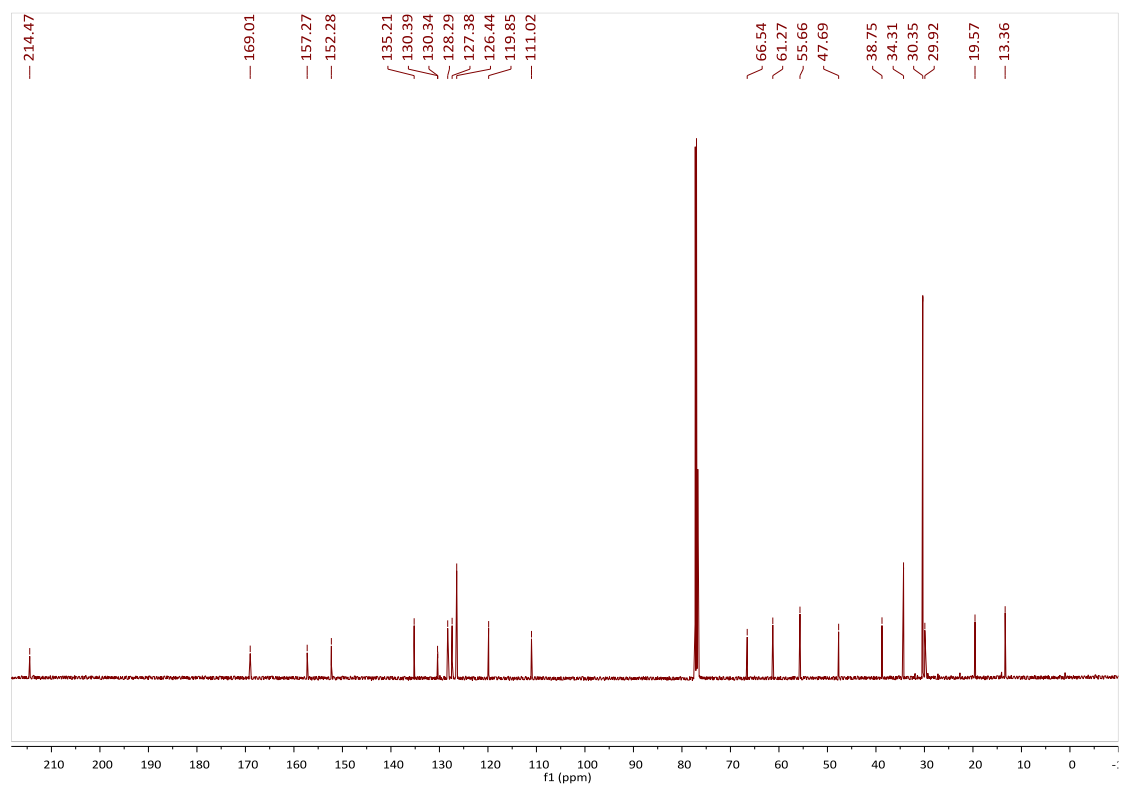
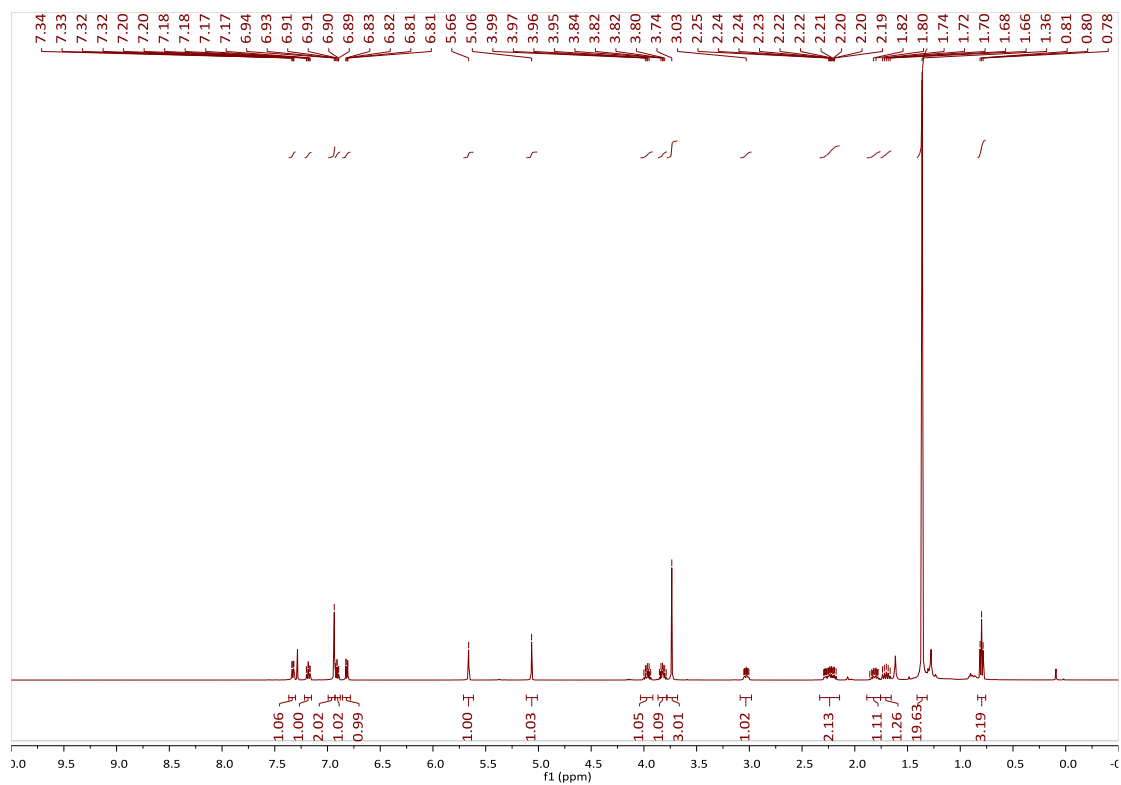
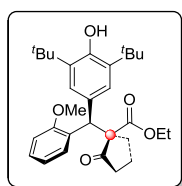


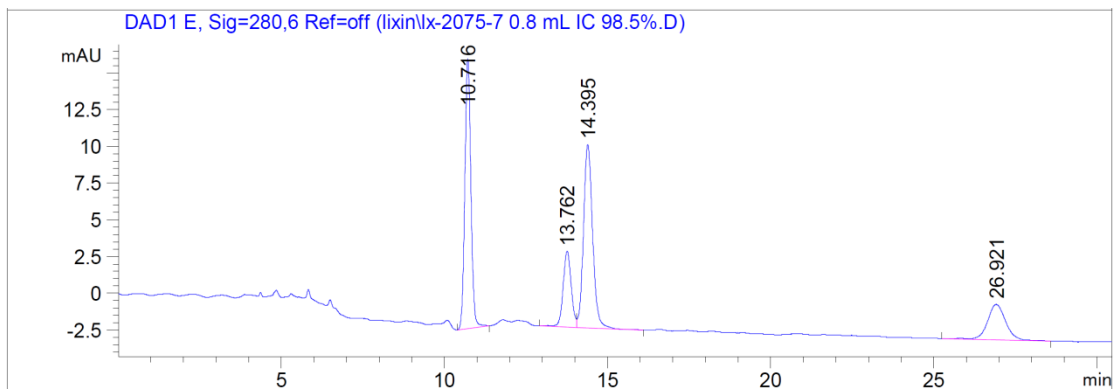
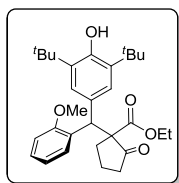


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.176	BB	0.1052	725.00977	106.77317	16.7564
2	6.596	BV	0.1333	1388.50879	159.85616	32.0911
3	6.883	VV	0.1386	739.15875	80.86410	17.0834
4	7.149	VB	0.1617	1474.09473	138.98164	34.0692

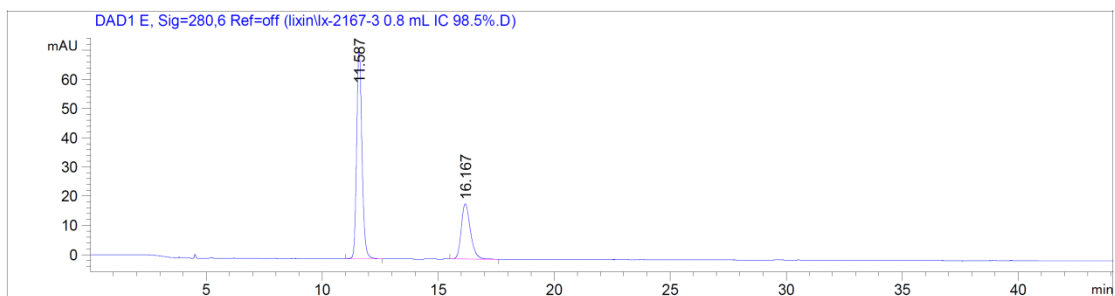
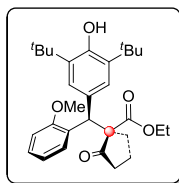


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.949	BB	0.1470	1819.43652	162.08327	4.7688
2	6.673	BV R	0.3605	3.16453e4	1406.62390	82.9430
3	7.318	VV E	0.2454	1929.78821	118.86016	5.0580
4	7.690	VB E	0.3269	2758.56665	133.58318	7.2303

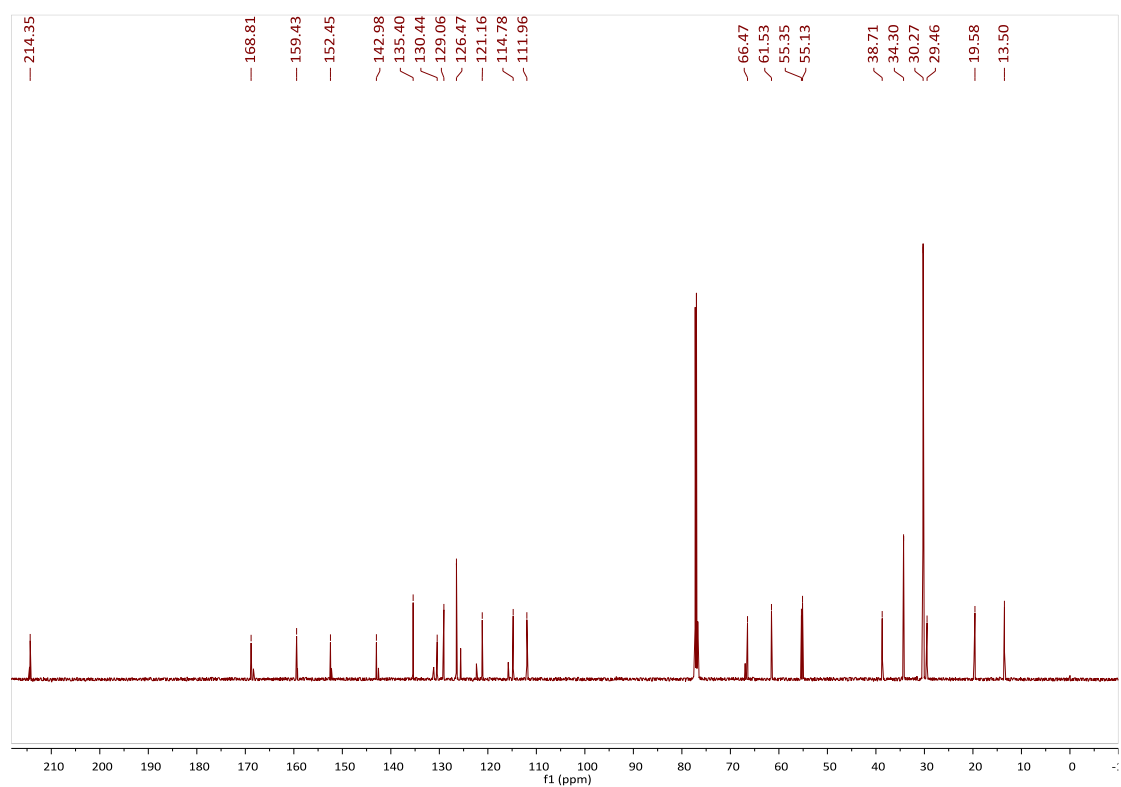
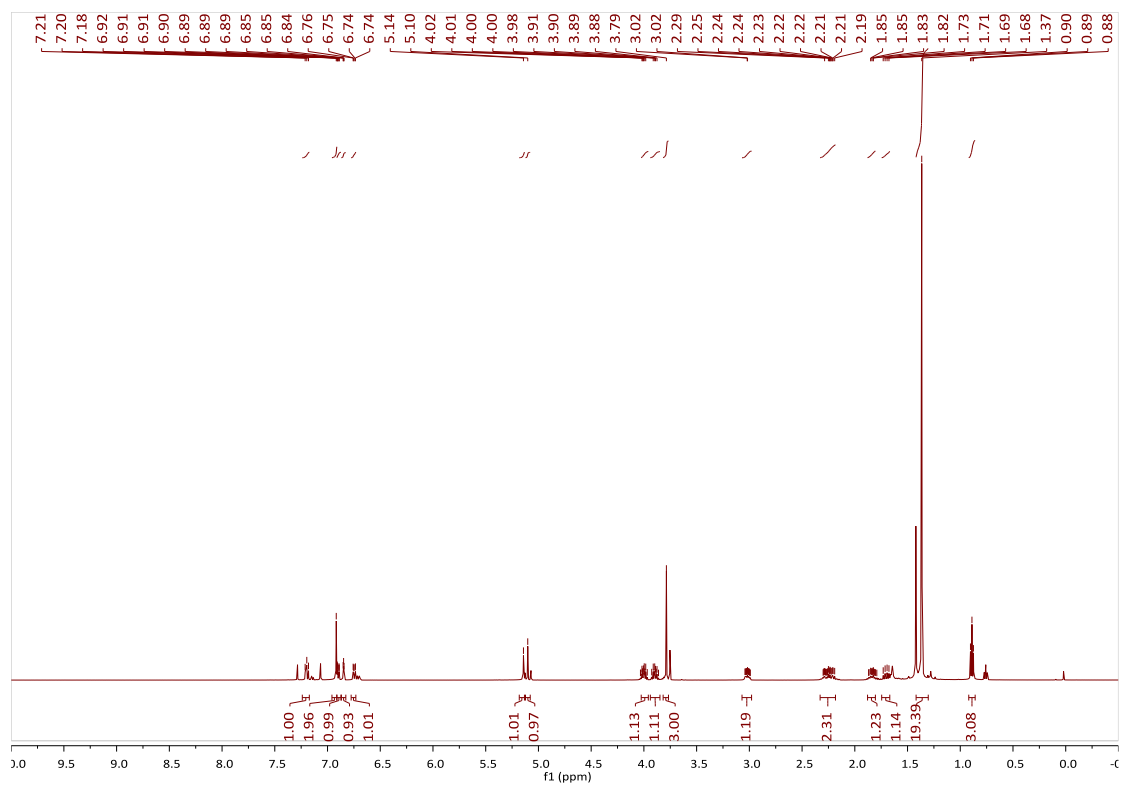
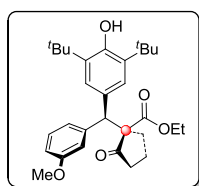


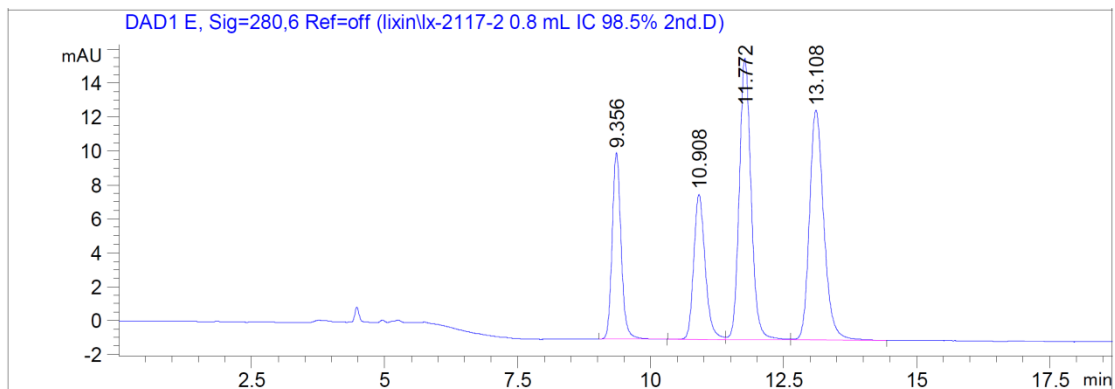
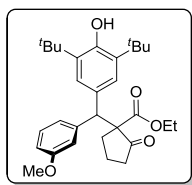


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.716	BB	0.1988	236.21201	18.27972	35.4655
2	13.762	BV	0.2671	89.55058	5.14507	13.4454
3	14.395	VB	0.3006	244.51947	12.47864	36.7128
4	26.921	VB R	0.5977	95.75100	2.42066	14.3763

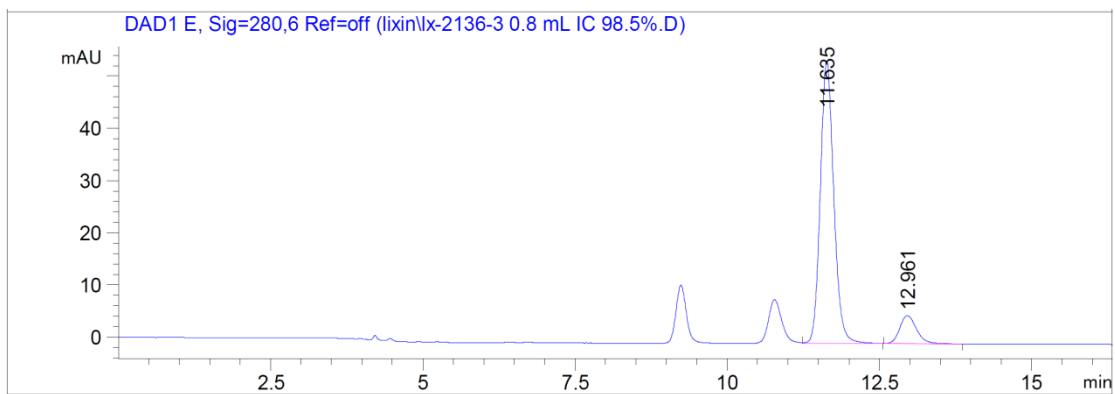
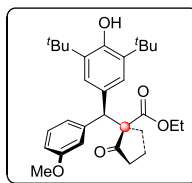


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.587	BB	0.2445	1153.12500	72.13361	68.8897
2	16.167	BB	0.4199	520.74725	18.99386	31.1103

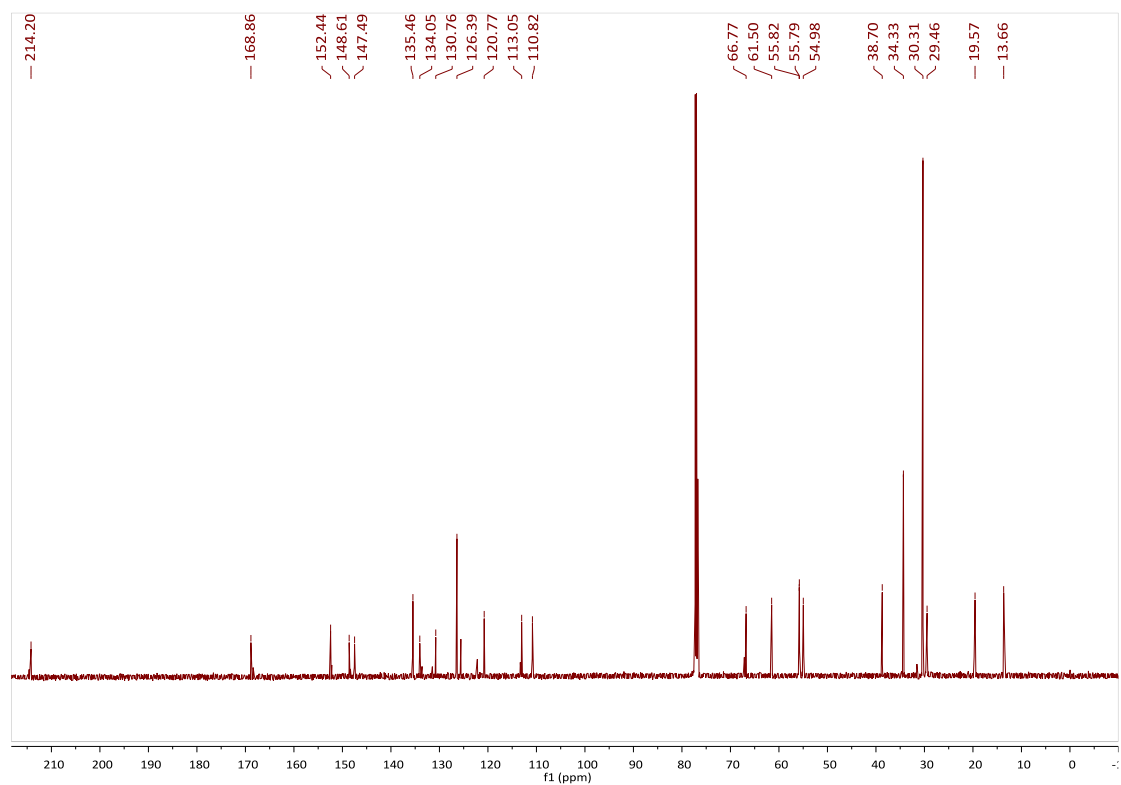
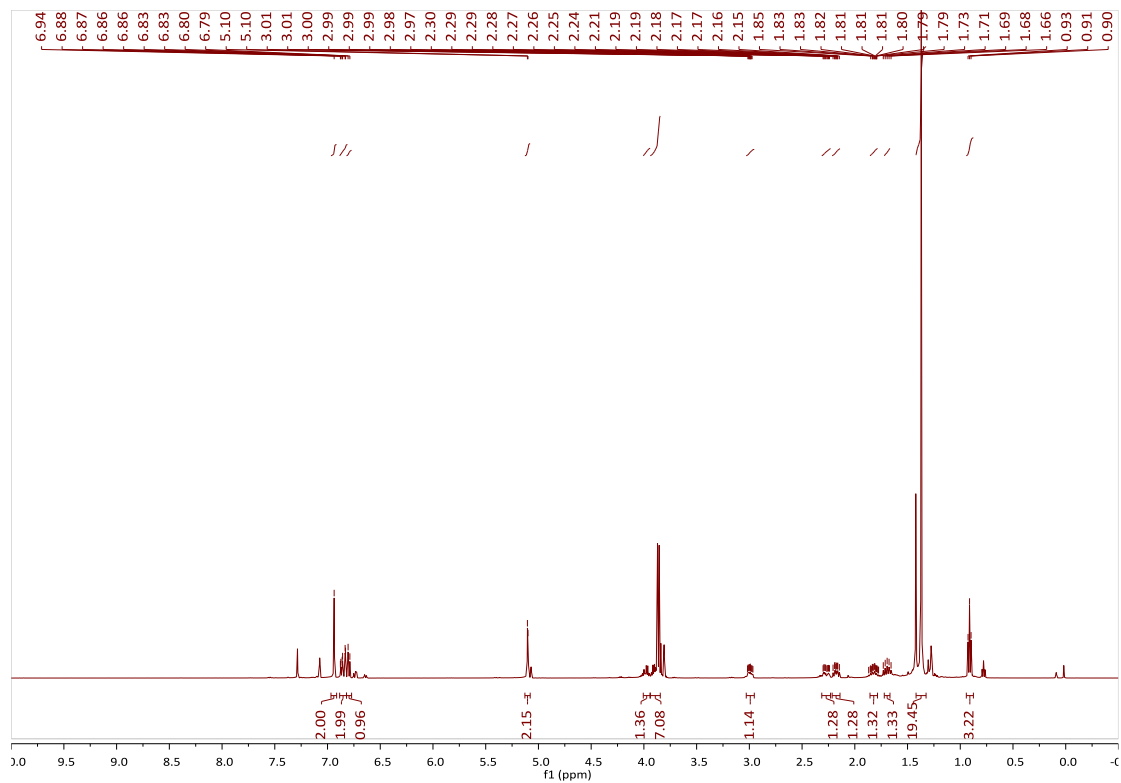
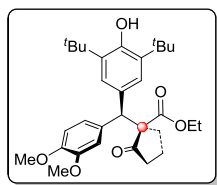


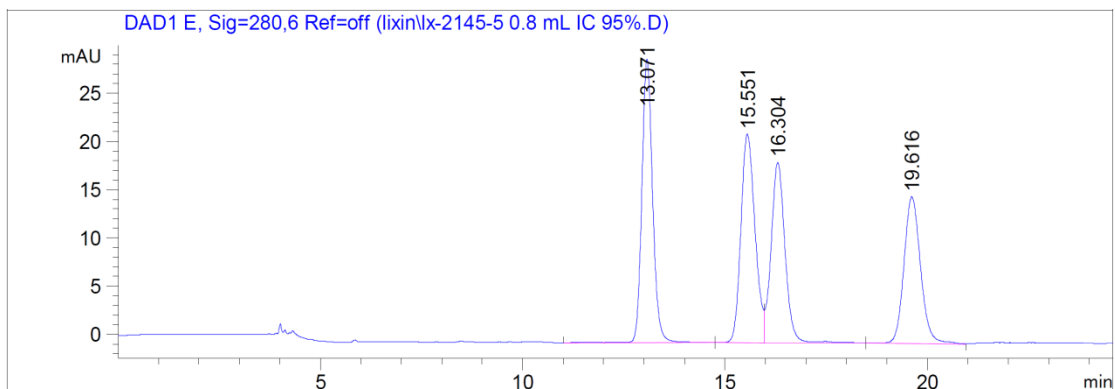
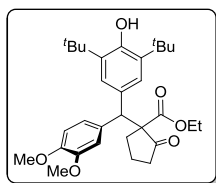


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.356	BB	0.1847	128.20503	10.94332	16.7026
2	10.908	BV	0.2319	128.39276	8.51333	16.7271
3	11.772	VV	0.2371	256.56372	16.52964	33.4253
4	13.108	VB	0.2913	254.41156	13.53224	33.1449

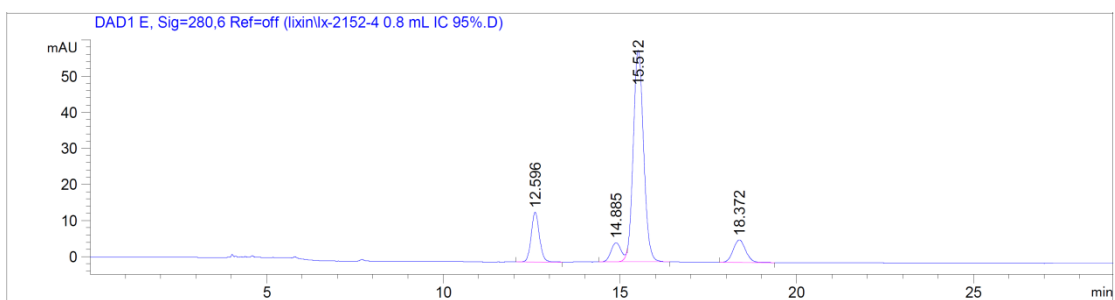
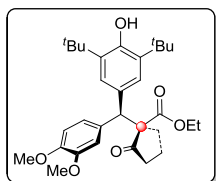


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.635	VB	0.2361	833.05762	53.95769	89.0880
2	12.961	BB	0.2949	102.03762	5.34180	10.9120

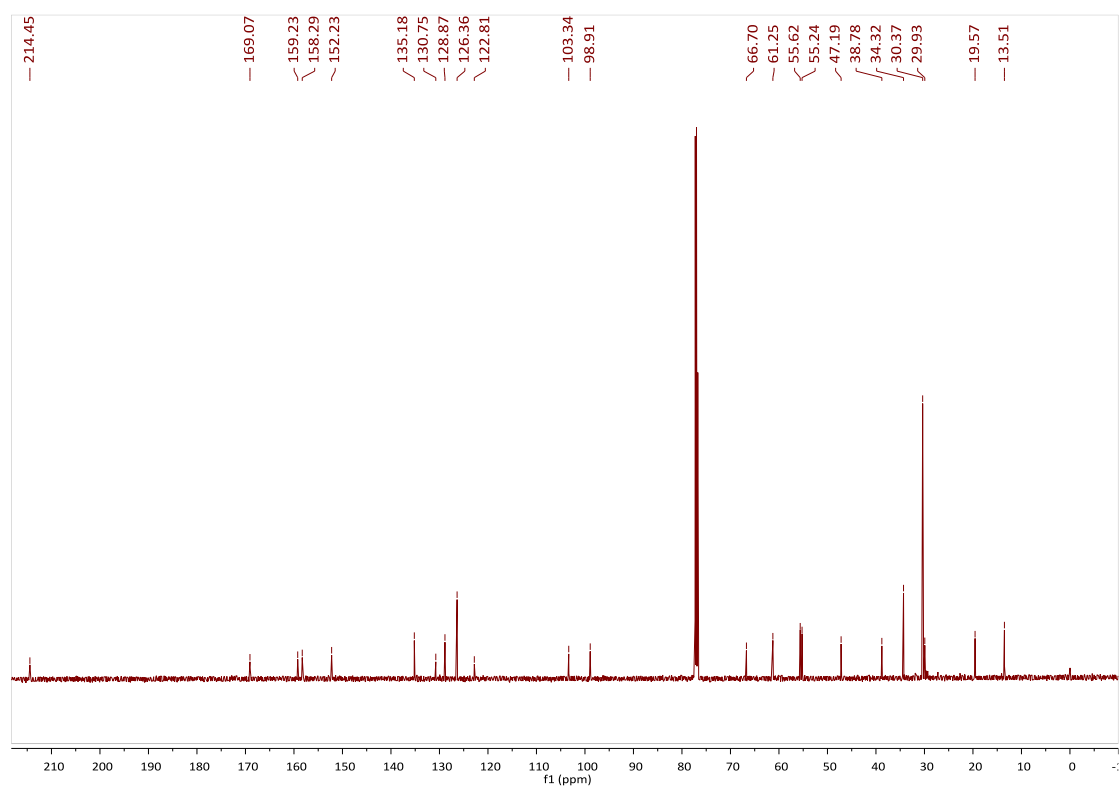
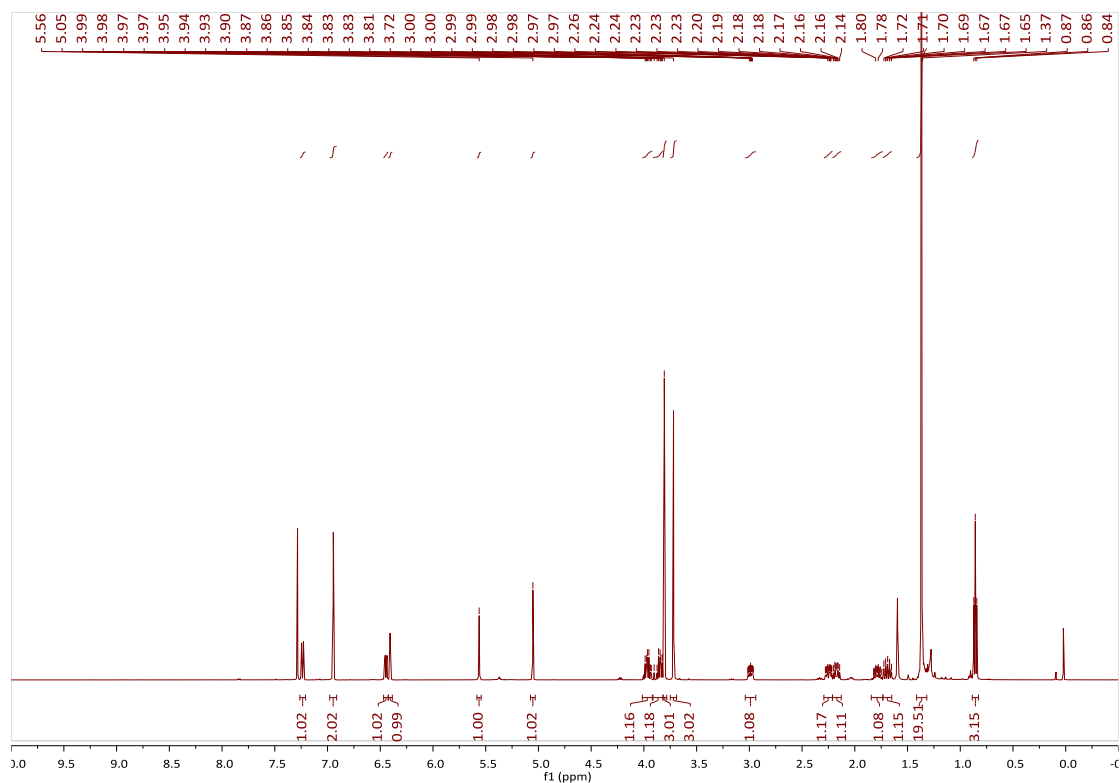
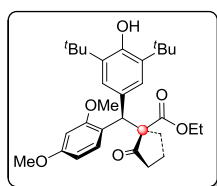


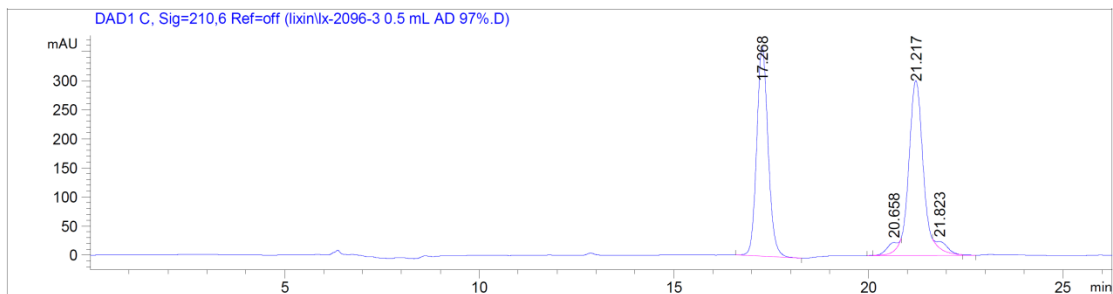
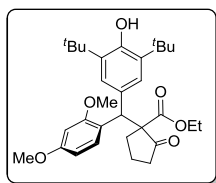


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.071	VB R	0.2810	547.38855	29.29502	28.0284
2	15.551	BV	0.3786	522.79639	21.58084	26.7692
3	16.304	VV R	0.3655	449.12469	18.66358	22.9969
4	19.616	BB	0.4368	433.66684	15.20045	22.2054

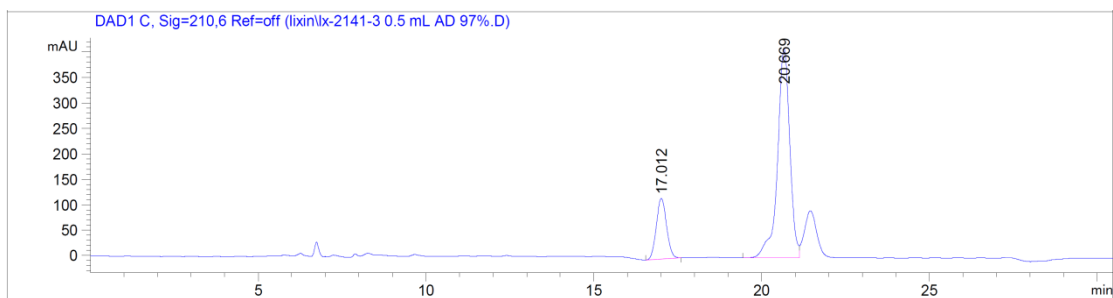
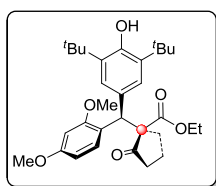


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.596	BB	0.2507	223.46402	13.81766	13.2947
2	14.885	BV E	0.3046	104.52560	5.33441	6.2186
3	15.512	VB R	0.3163	1199.94775	58.73967	71.3896
4	18.372	BB	0.3792	152.90733	6.25530	9.0971

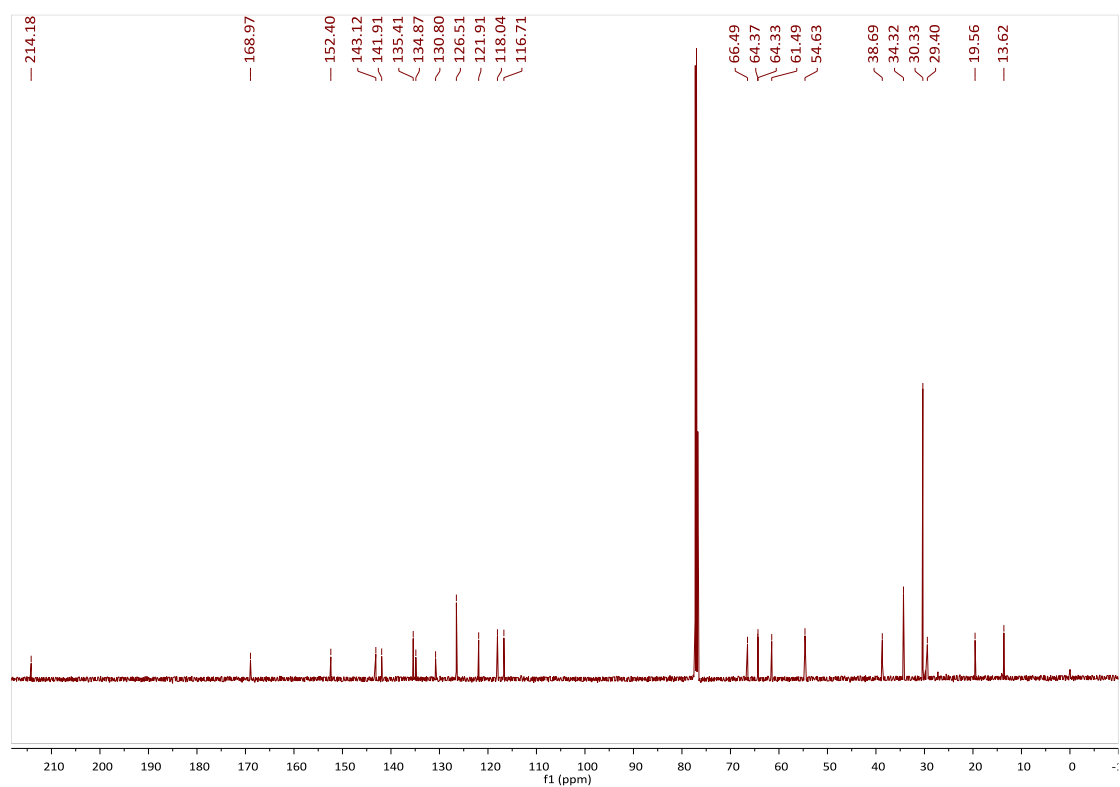
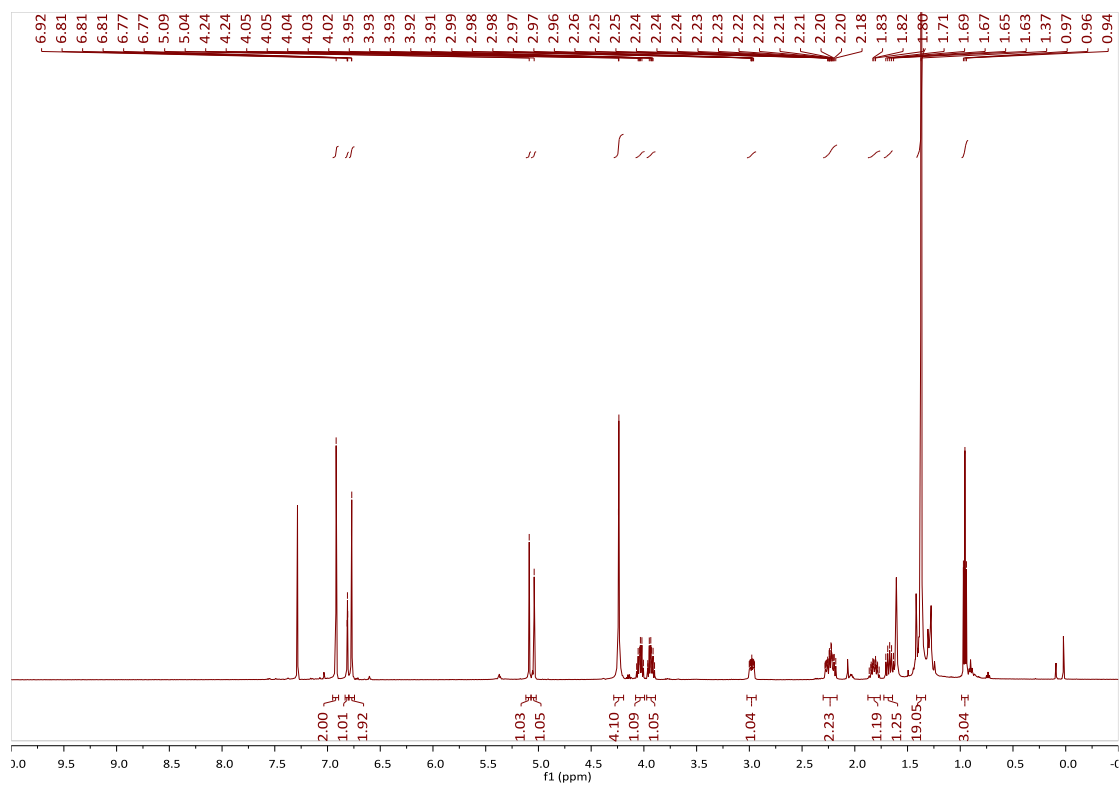
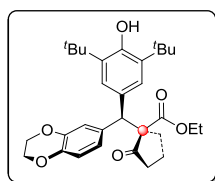


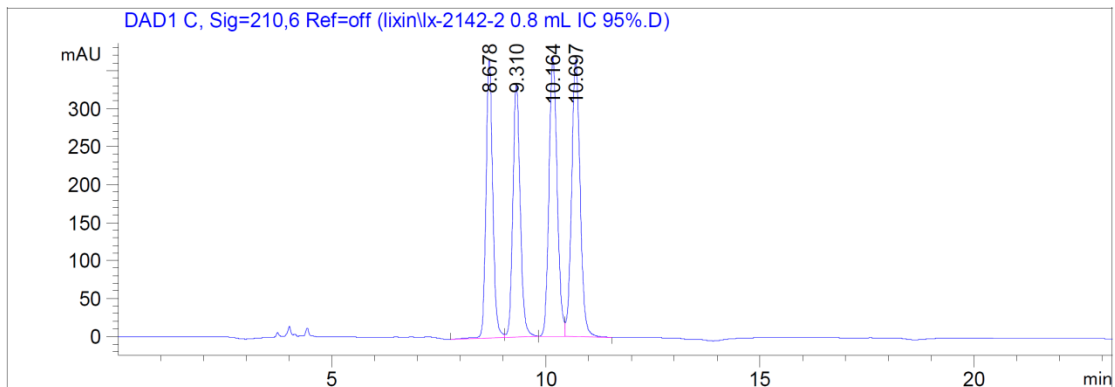
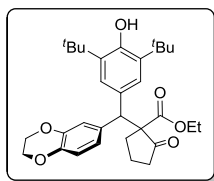


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.268	BB	0.3125	7324.68848	361.27548	46.1718
2	20.658	BV E	0.3022	290.96011	14.24978	1.8341
3	21.217	VV R	0.4022	7995.40674	300.68402	50.3997
4	21.823	VB E	0.3429	252.94128	10.81427	1.5944

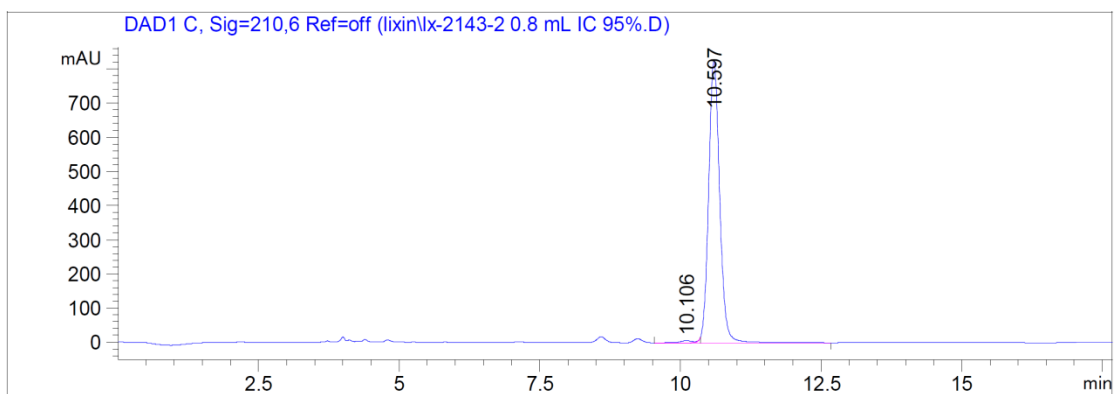
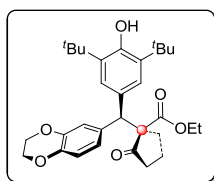


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.012	BB	0.3288	2523.56616	119.29267	19.4076
2	20.669	BV	0.3872	1.04794e4	411.35666	80.5924

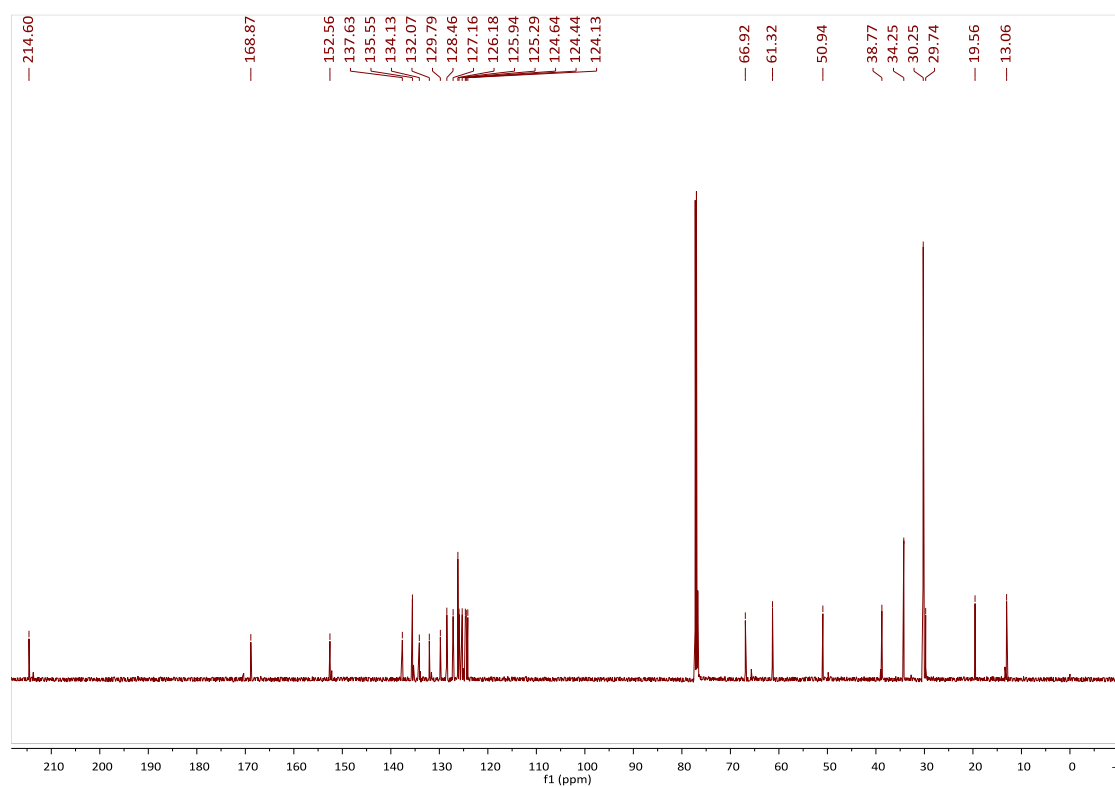
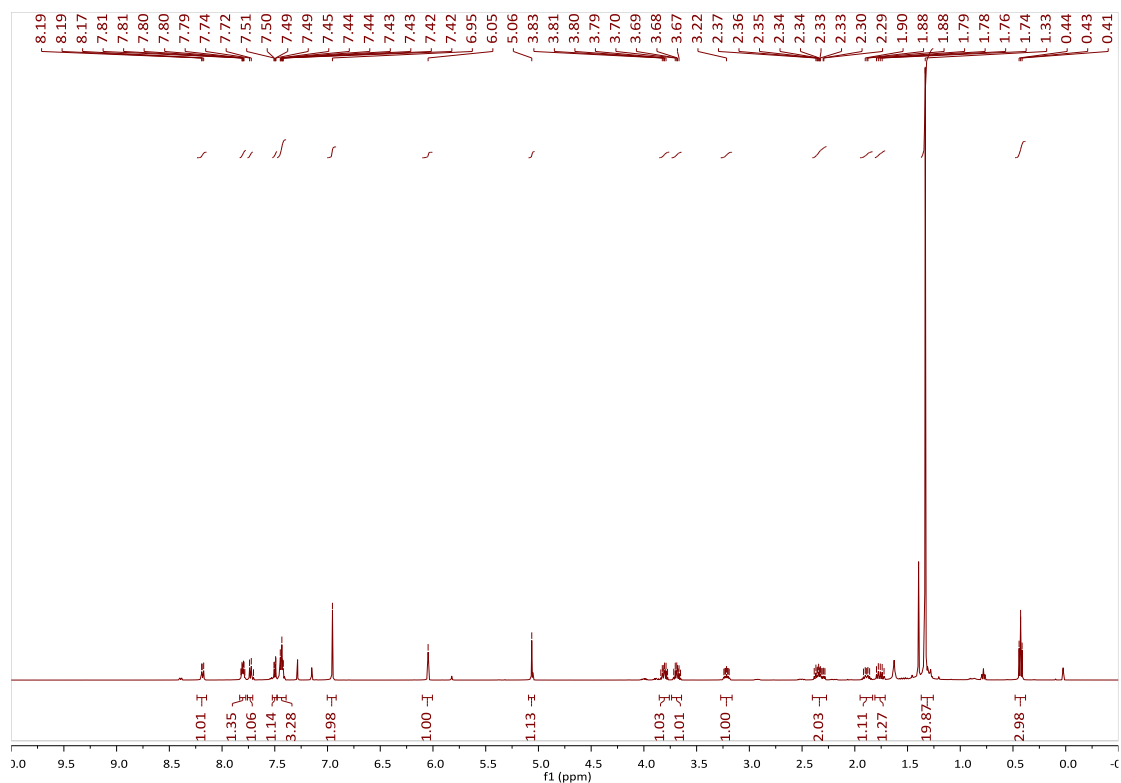
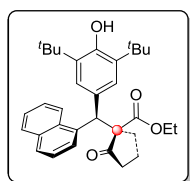


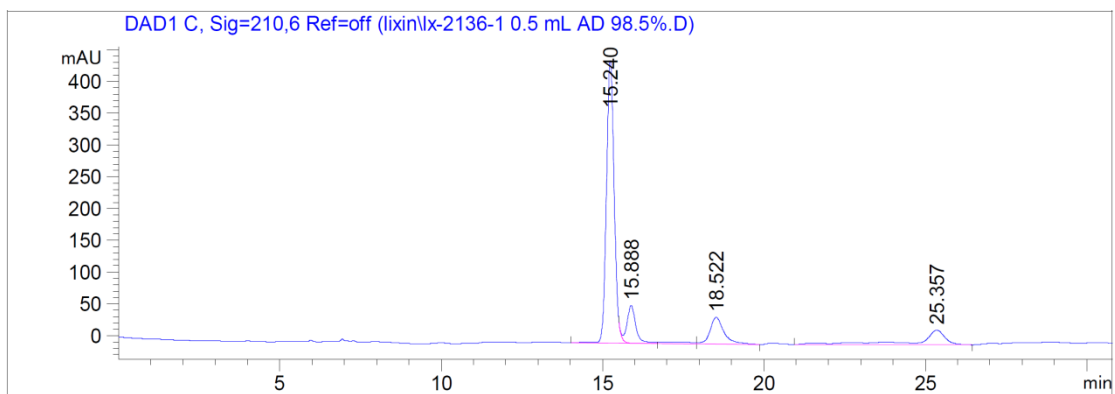
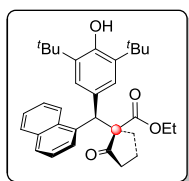
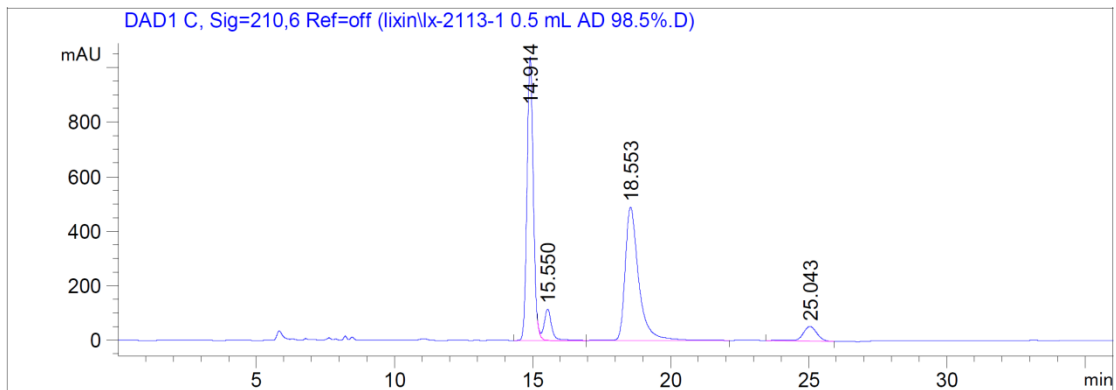
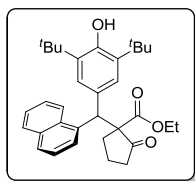


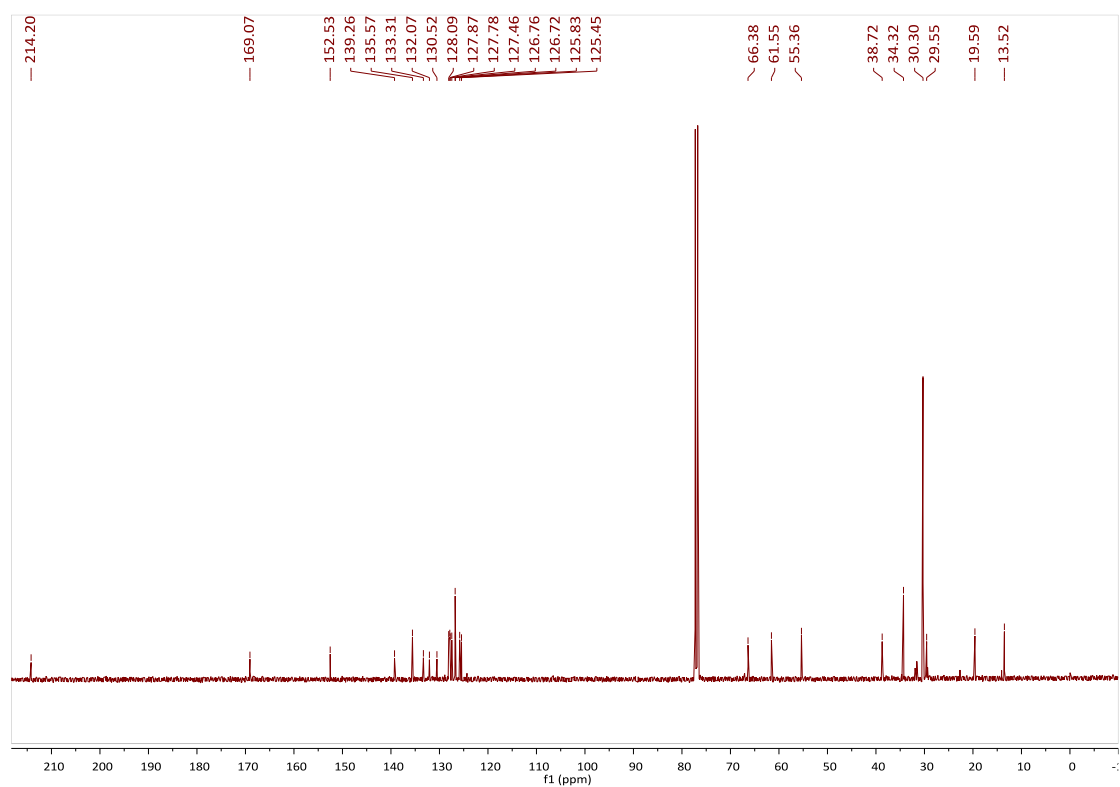
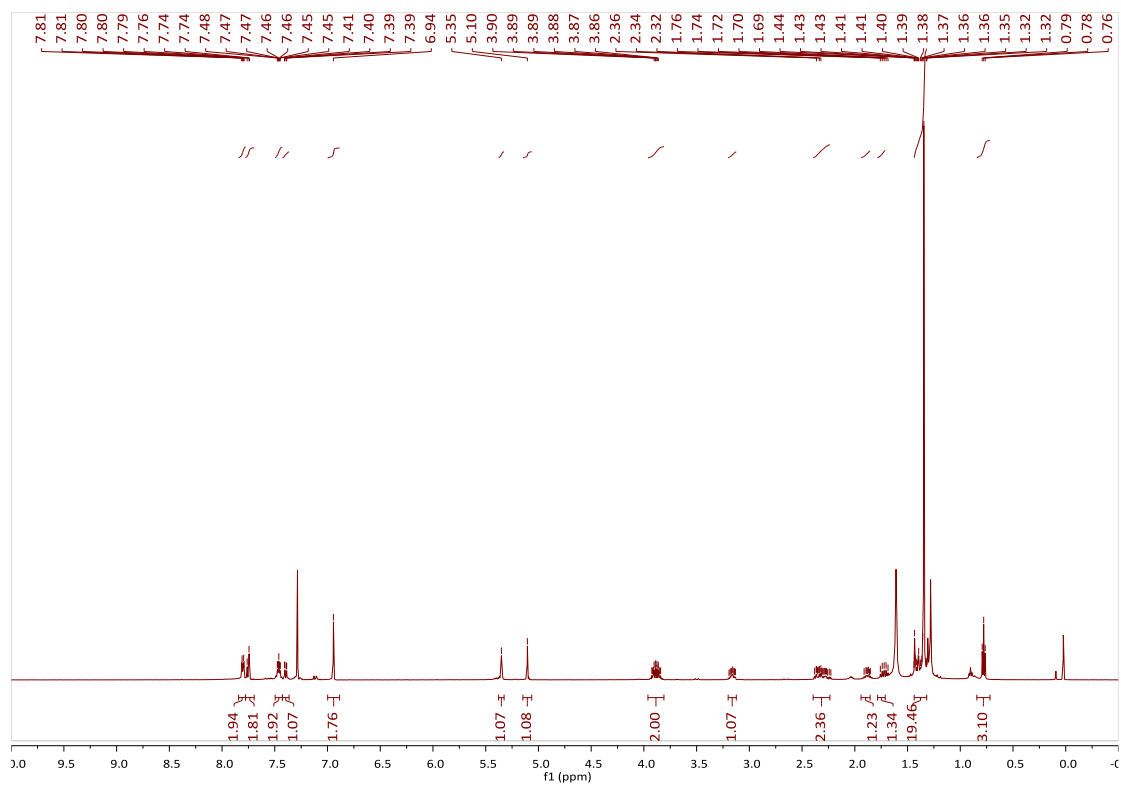
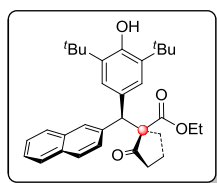
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.678	BV	0.1685	4002.18481	363.40536	22.3619
2	9.310	VB	0.1880	3957.82764	329.86627	22.1140
3	10.164	BV	0.2040	4882.44043	365.05630	27.2802
4	10.697	VB	0.2110	5054.92432	361.91153	28.2439

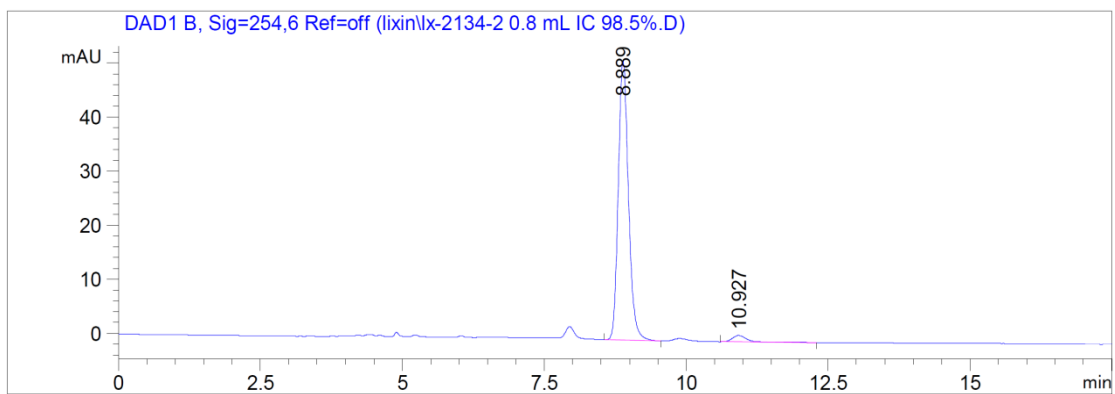
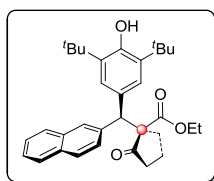
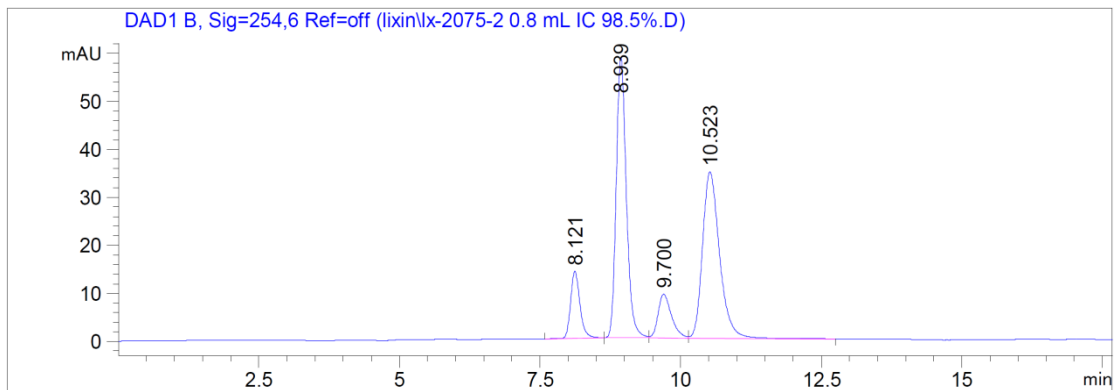
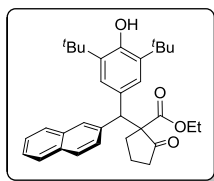


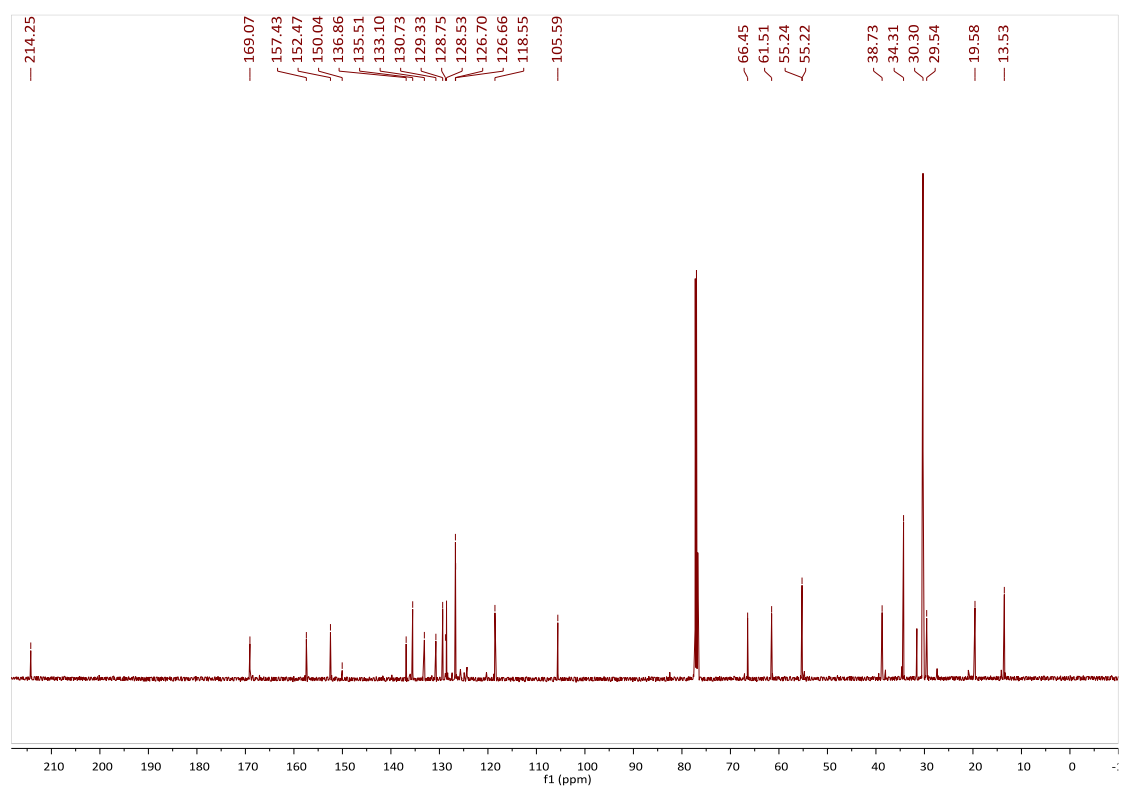
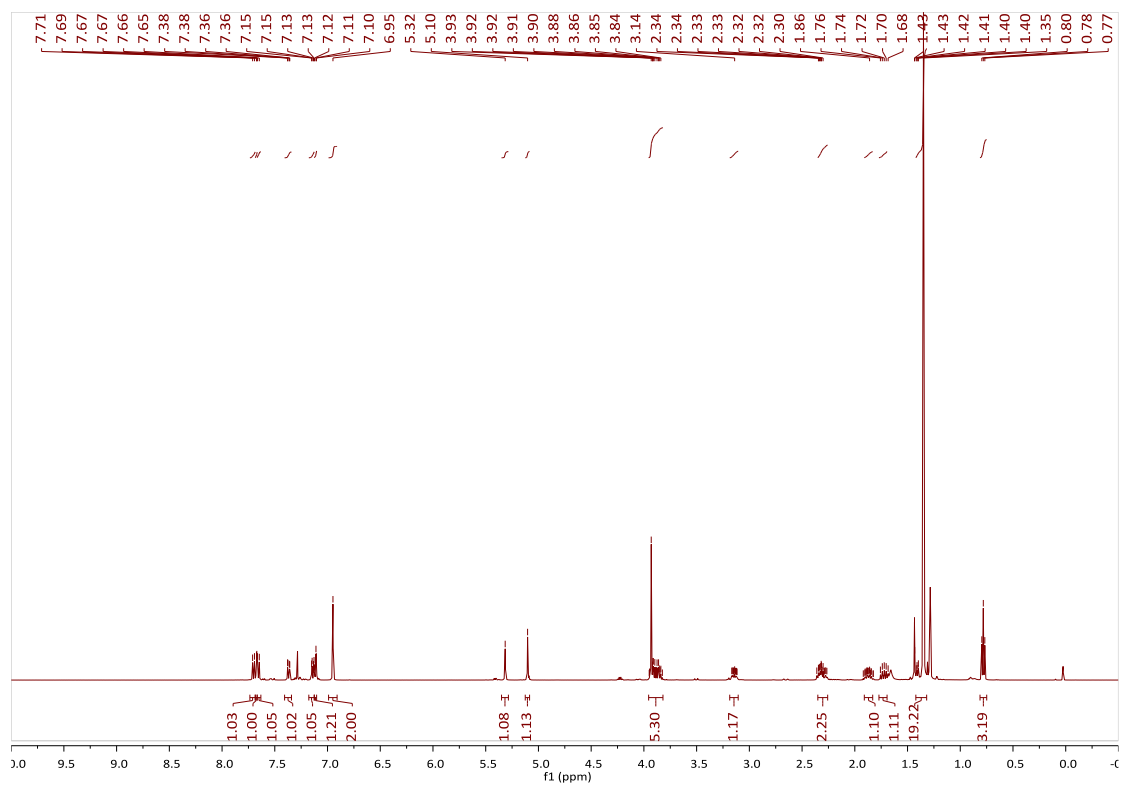
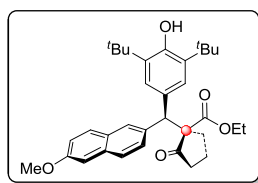
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.106	BV E	0.2402	101.62663	6.43828	0.8869
2	10.597	VB R	0.2173	1.13569e4	821.18353	99.1131

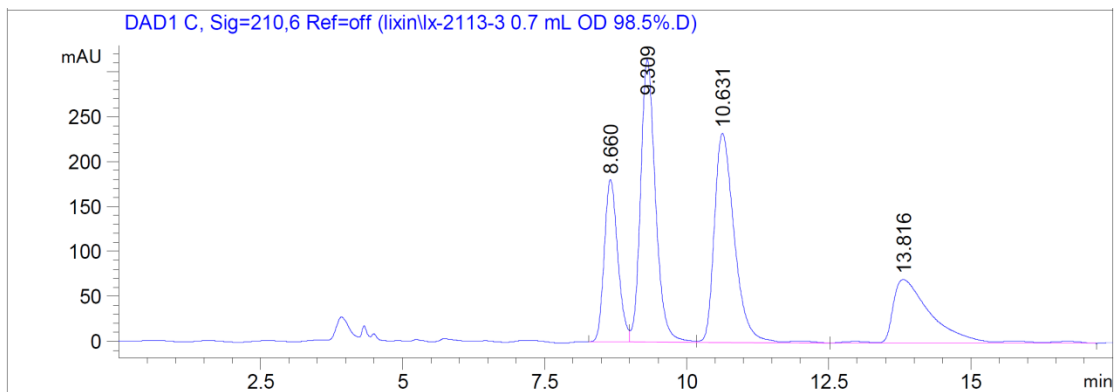
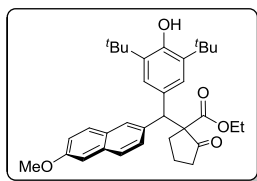




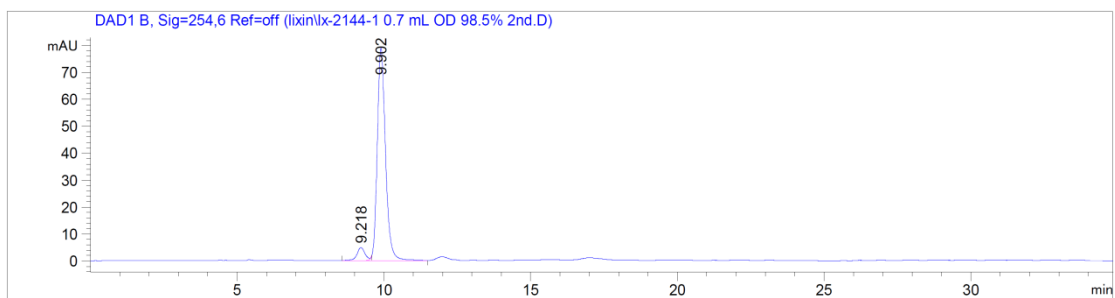
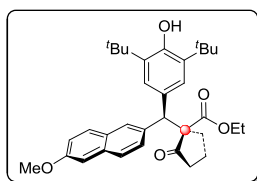




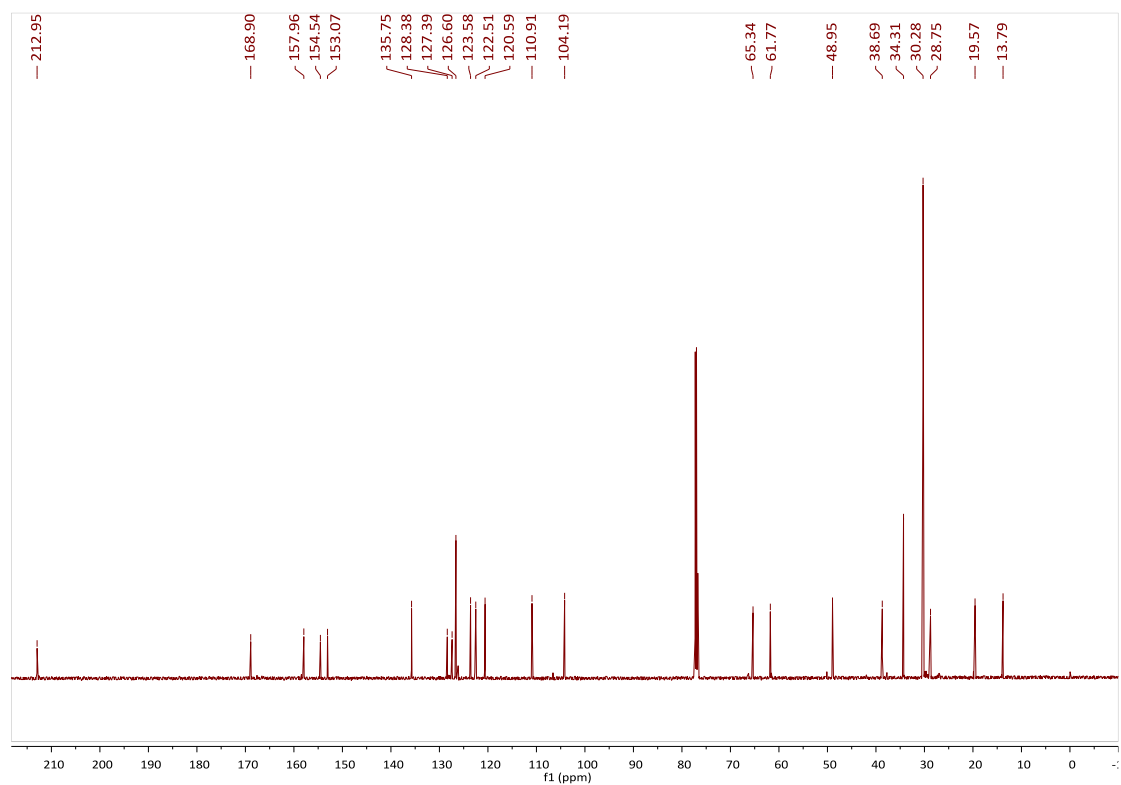
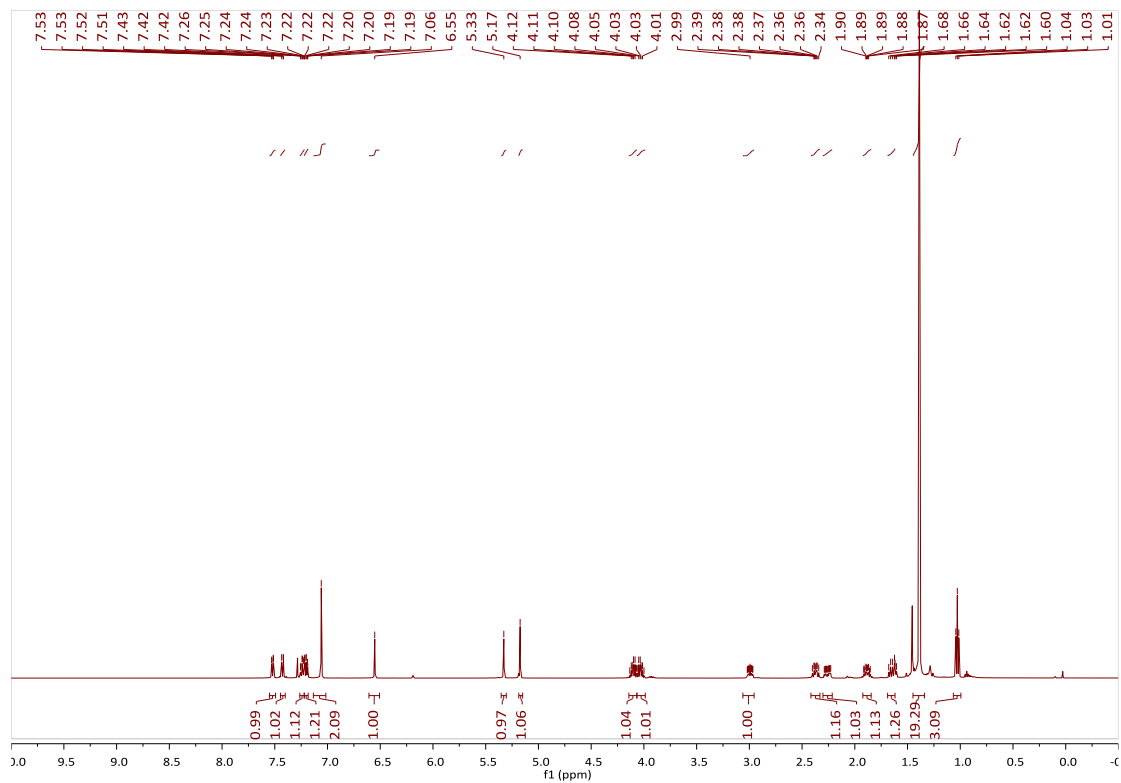
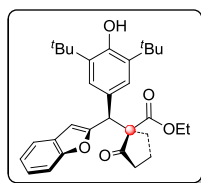


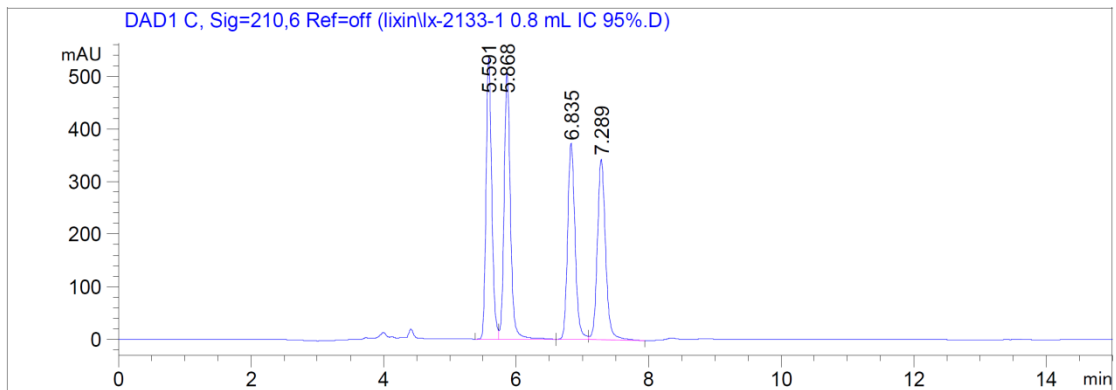
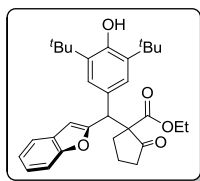


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.660	BV	0.2574	2988.45410	180.30756	16.7856
2	9.309	VV	0.2773	5732.22217	313.51987	32.1968
3	10.631	VV R	0.3798	5712.43652	232.61742	32.0856
4	13.816	VV R	0.6577	3370.60596	70.75017	18.9320

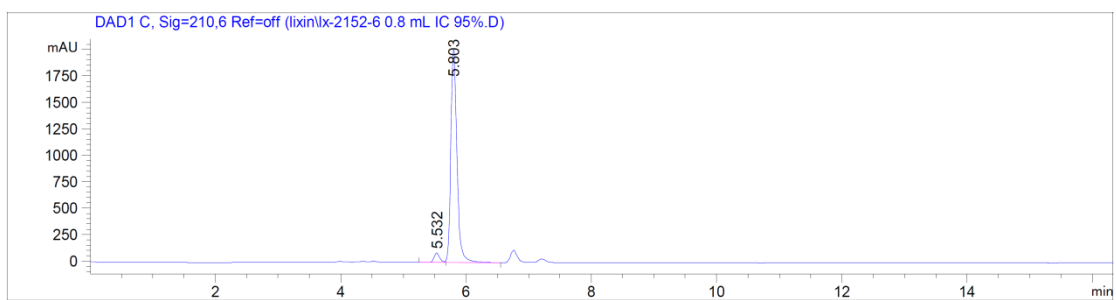
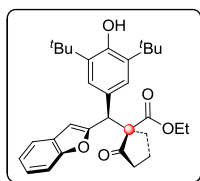


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.218	BV E	0.2823	89.31616	4.77399	5.4920
2	9.902	VB R	0.2975	1536.98804	78.81986	94.5080

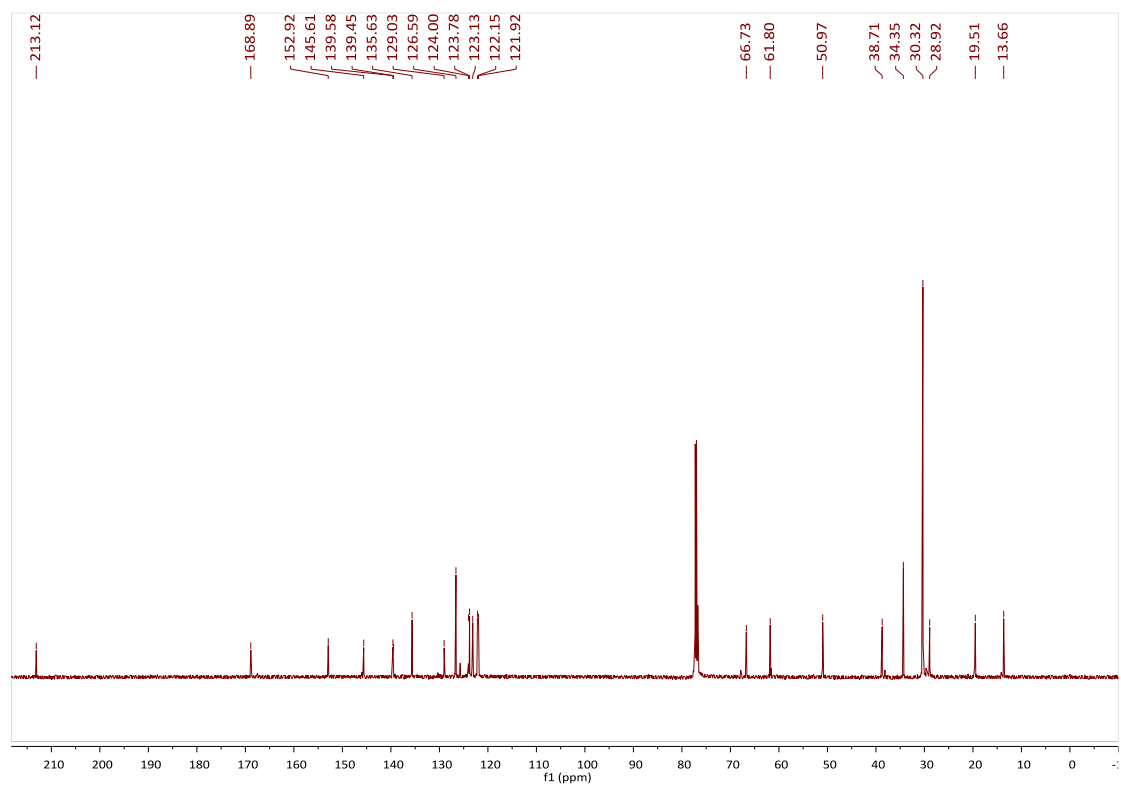
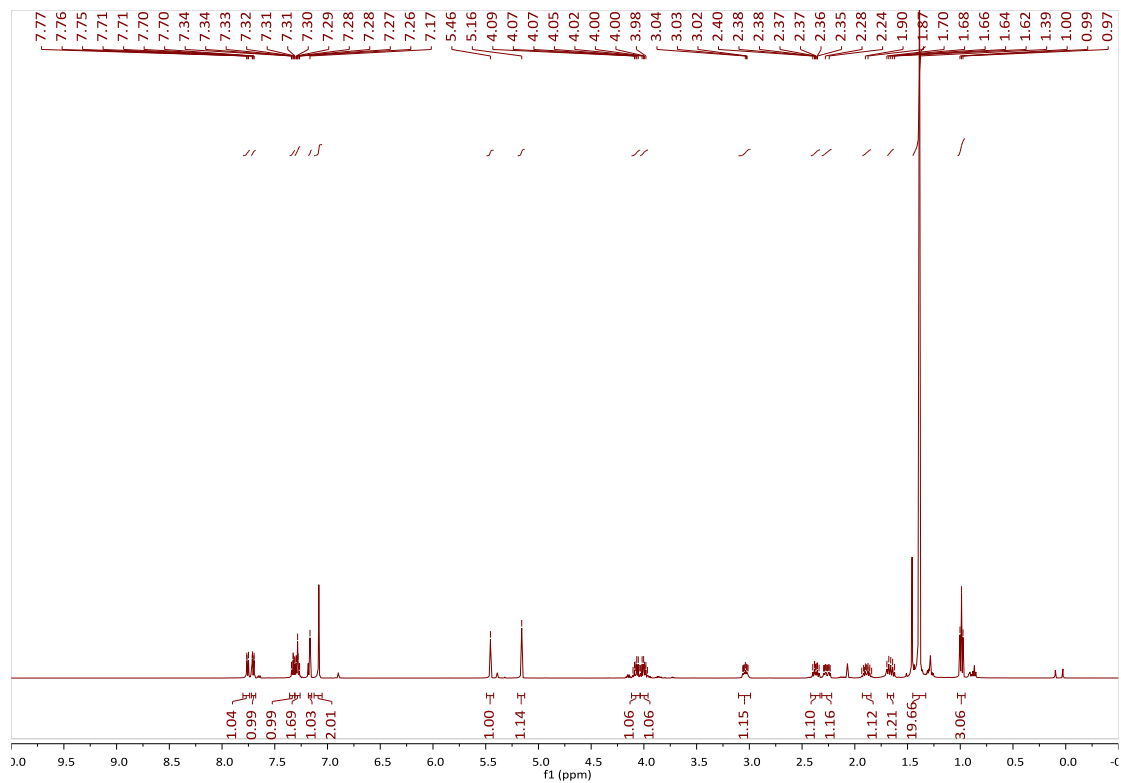
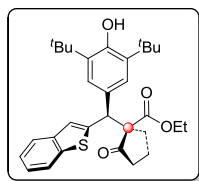


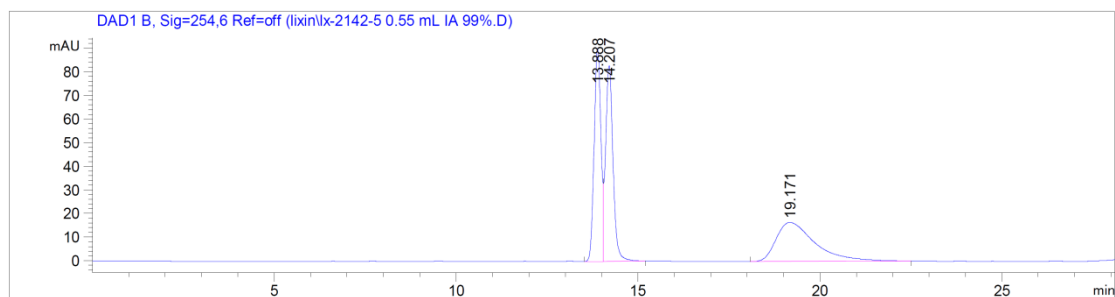
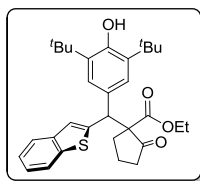


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.591	BV	0.0946	3180.60132	525.37842	25.6457
2	5.868	VB	0.1115	3357.73999	492.80194	27.0740
3	6.835	BV	0.1234	2882.17505	367.99380	23.2394
4	7.289	VB	0.1424	2981.57715	339.80167	24.0409

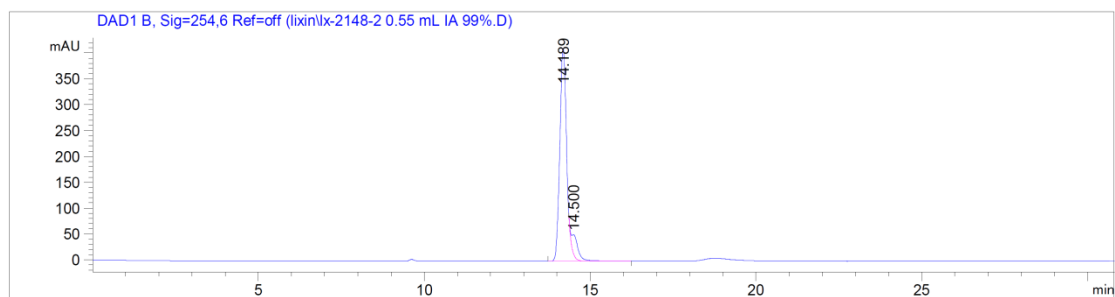
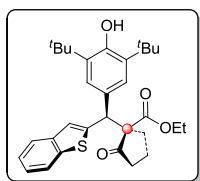


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.532	BV E	0.0943	557.17432	89.93005	3.8855
2	5.803	VB R	0.1037	1.37827e4	2016.53650	96.1145

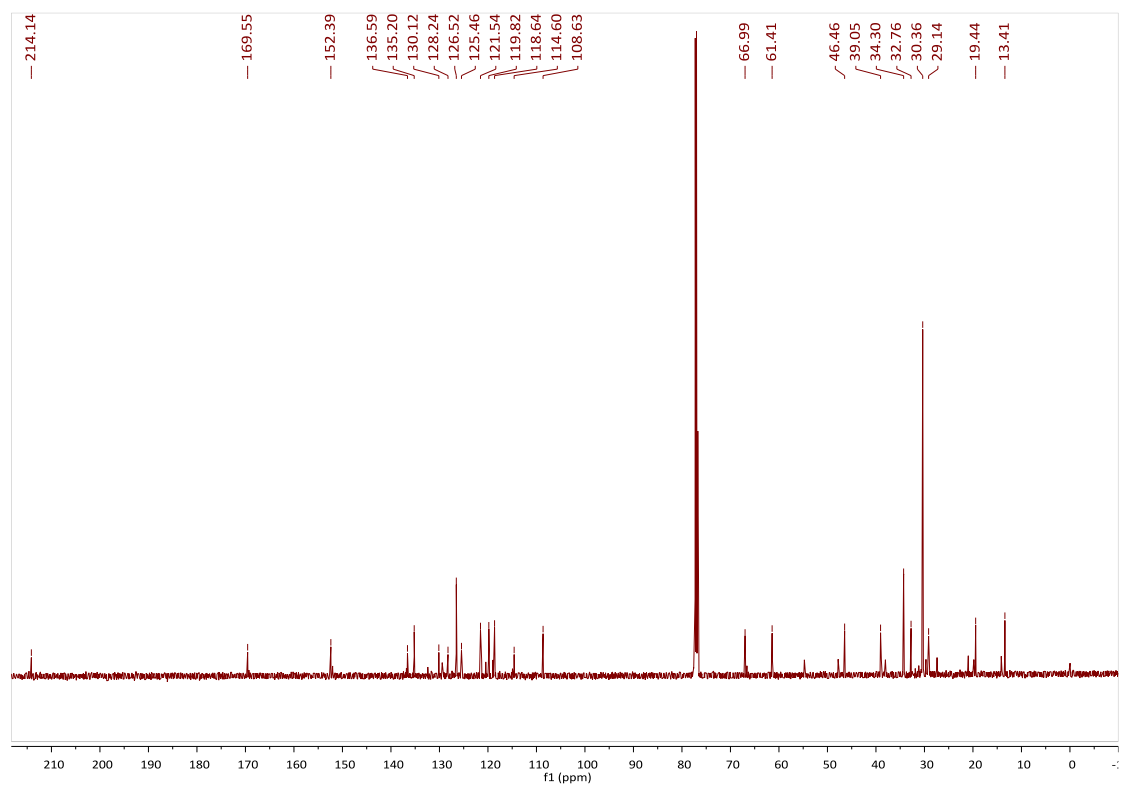


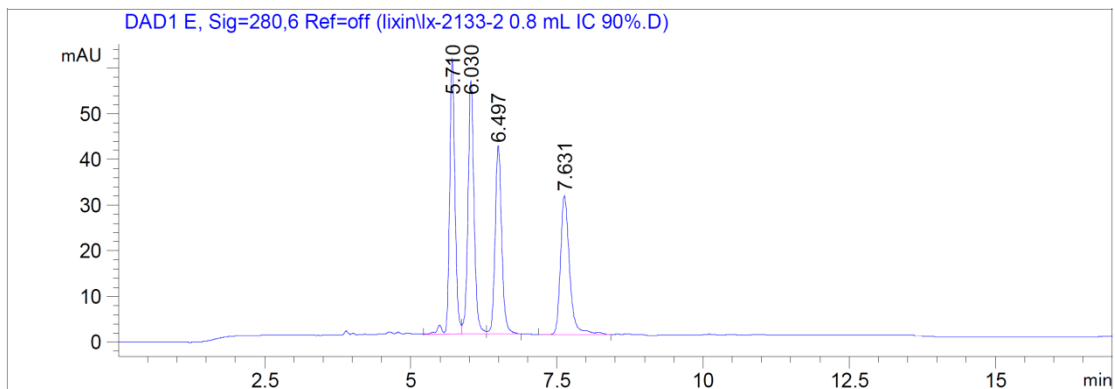
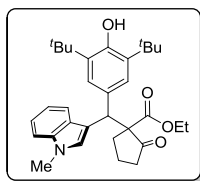


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.888	BV	0.2016	1173.12183	90.27656	32.8581
2	14.207	VB	0.2131	1173.07434	82.90812	32.8567
3	19.171	BB	1.0287	1224.07397	16.55349	34.2852

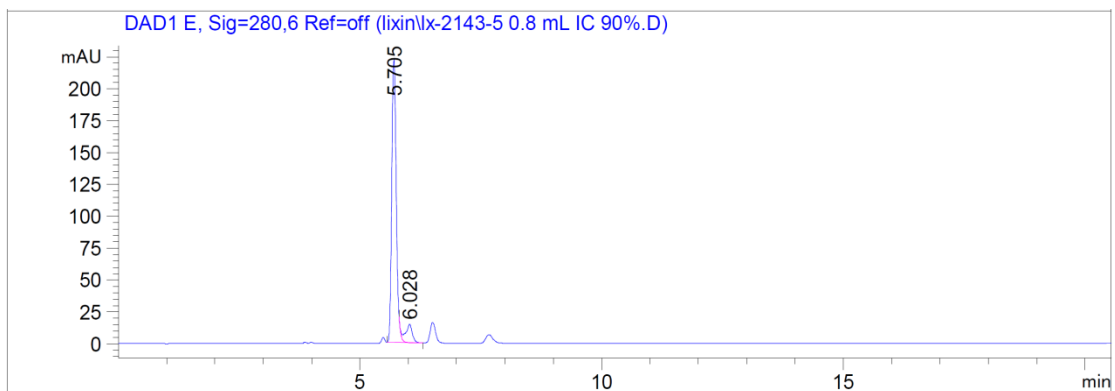
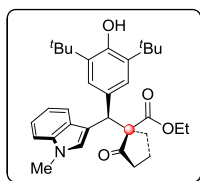


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.189	BV R	0.2224	5941.44482	411.58832	91.0960
2	14.500	VB E	0.2231	580.73248	36.99688	8.9040

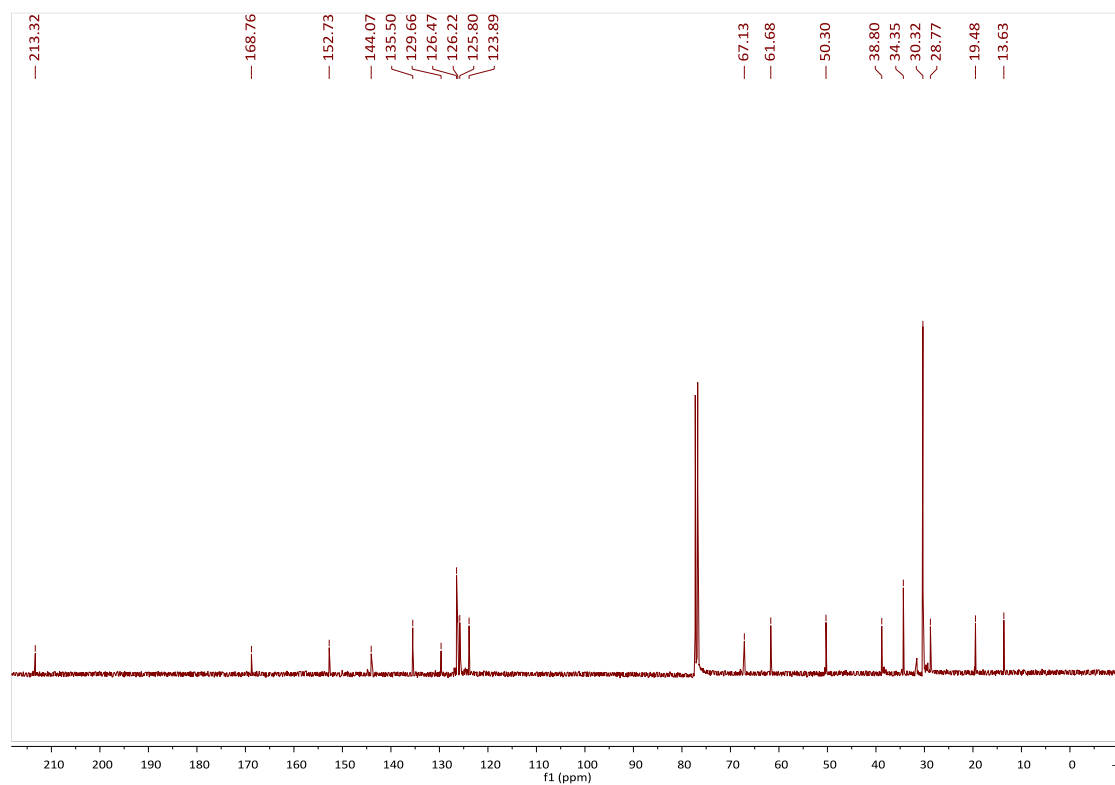
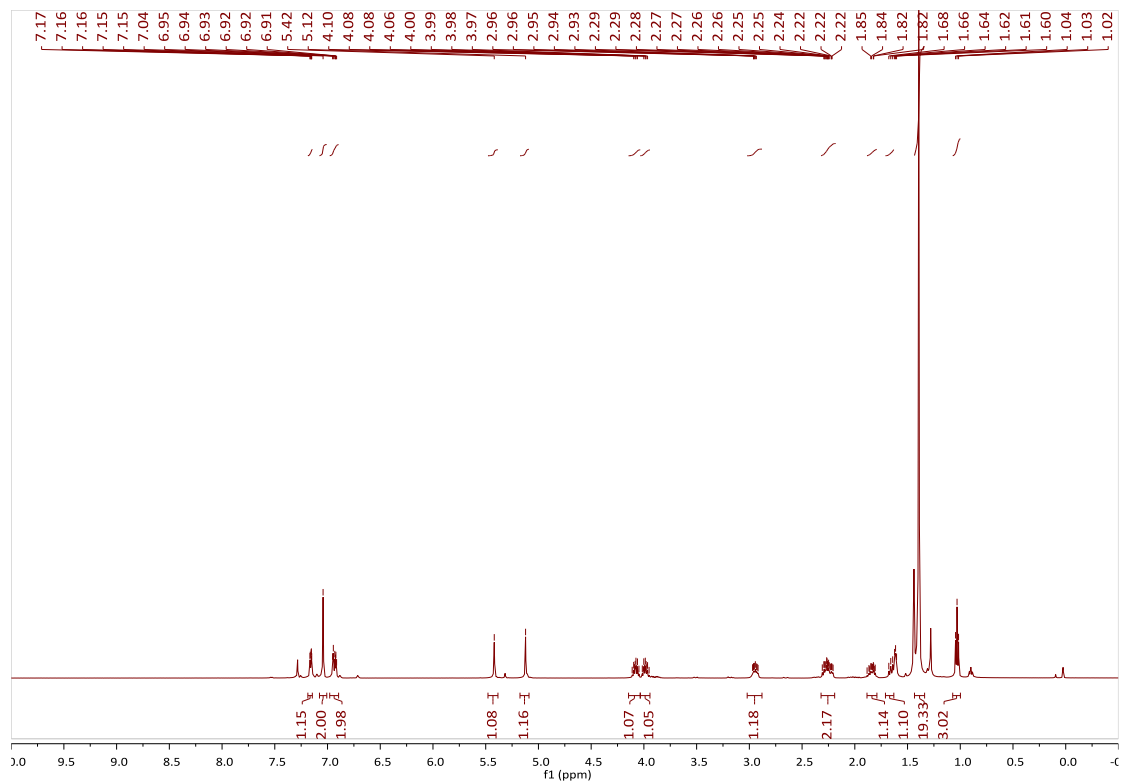
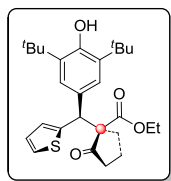


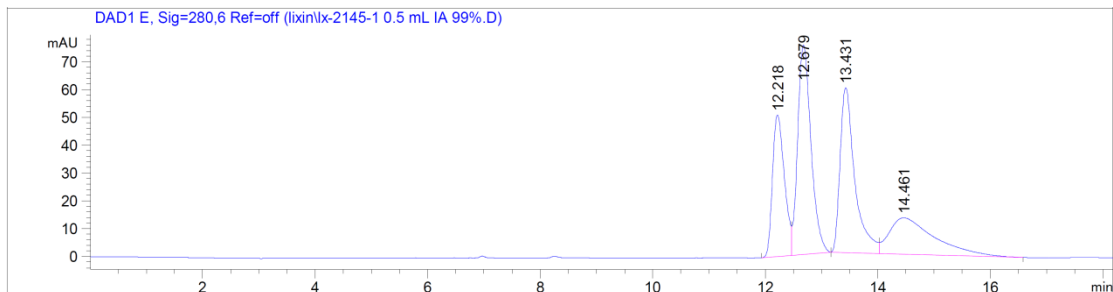
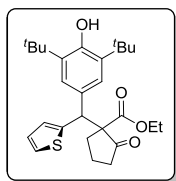


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.710	BV	0.1103	392.70038	58.50858	27.0667
2	6.030	VV	0.1181	401.38361	54.36011	27.6652
3	6.497	VB	0.1247	323.41547	40.68876	22.2912
4	7.631	BB	0.1692	333.36362	30.09654	22.9769

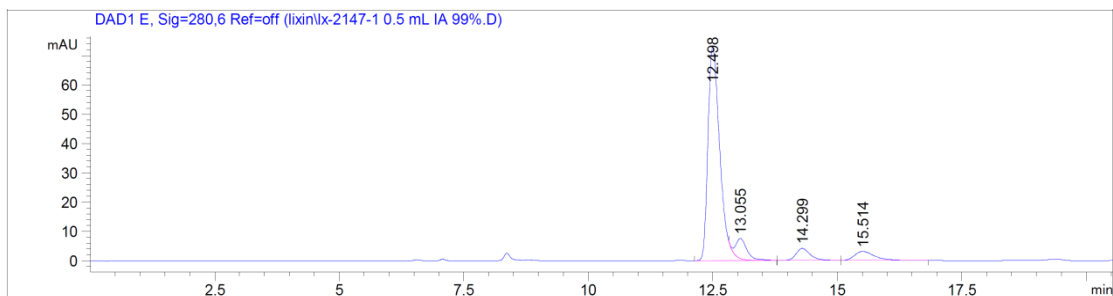
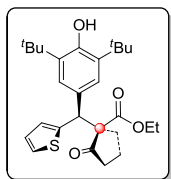


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.705	BV R	0.1086	1423.55835	216.93916	91.0470
2	6.028	VB E	0.1482	139.98412	14.05317	8.9530

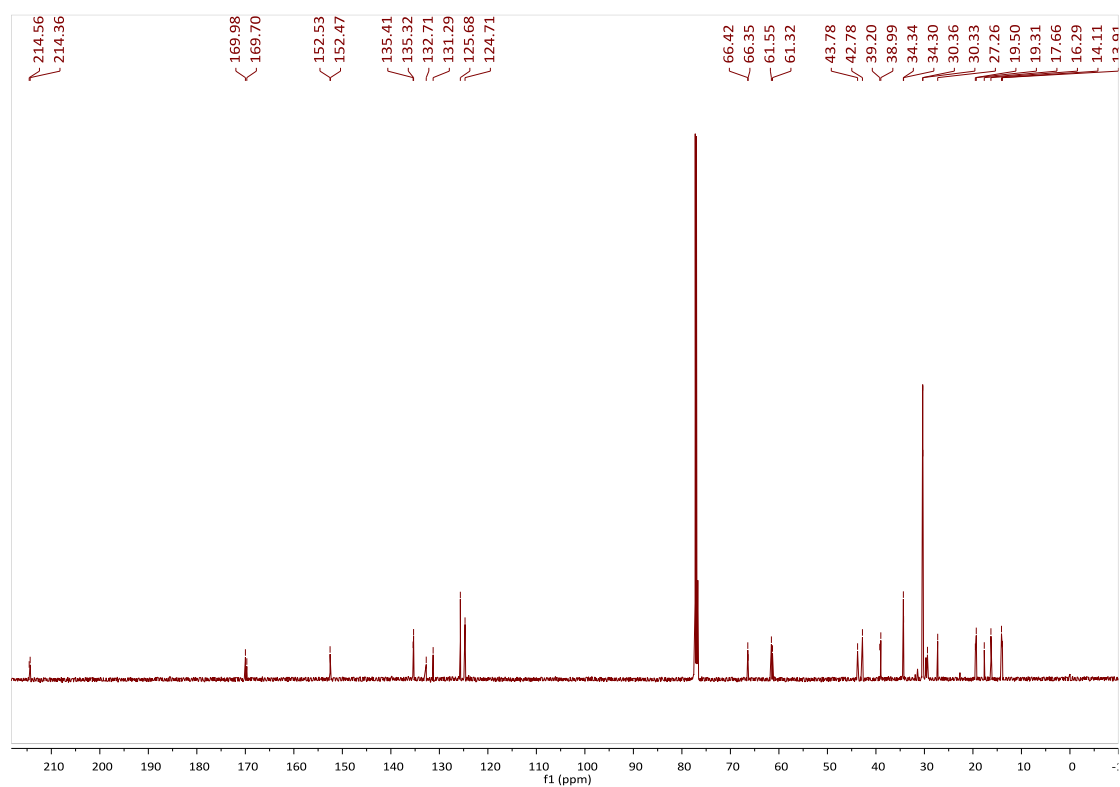
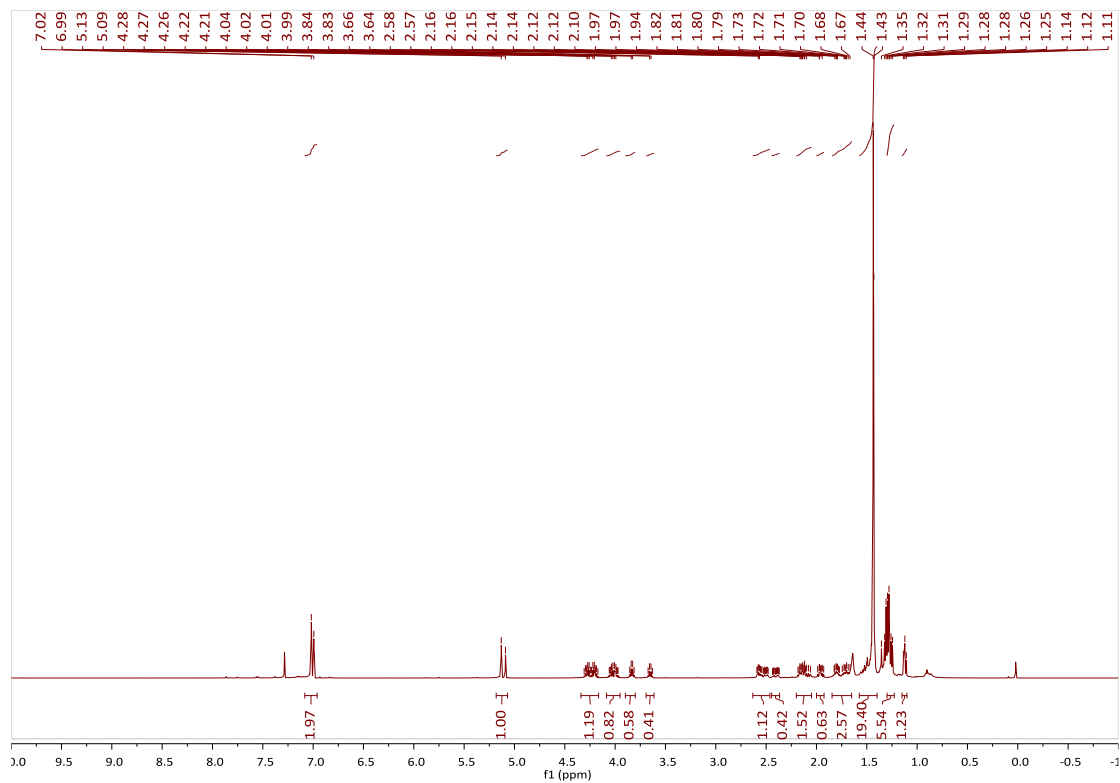
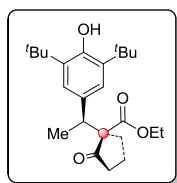


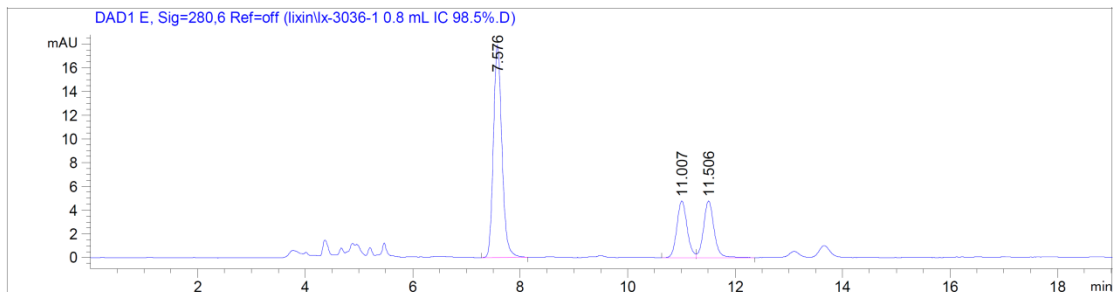
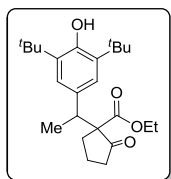


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.218	BV	0.2275	747.78461	50.85527	19.6821
2	12.679	VB	0.2547	1240.13037	75.08587	32.6409
3	13.431	BV	0.2721	1077.95630	59.28917	28.3724
4	14.461	VB	0.7913	733.44080	13.05751	19.3046

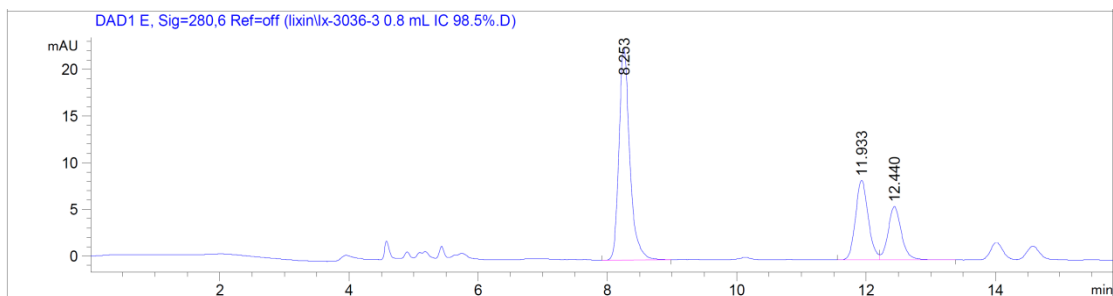
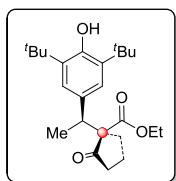


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.498	BV R	0.2553	1207.21985	72.86346	81.6090
2	13.055	VB E	0.2330	107.17213	6.83175	7.2449
3	14.299	BB	0.2966	80.37186	4.06591	5.4332
4	15.514	BB	0.4058	84.50947	3.06412	5.7129

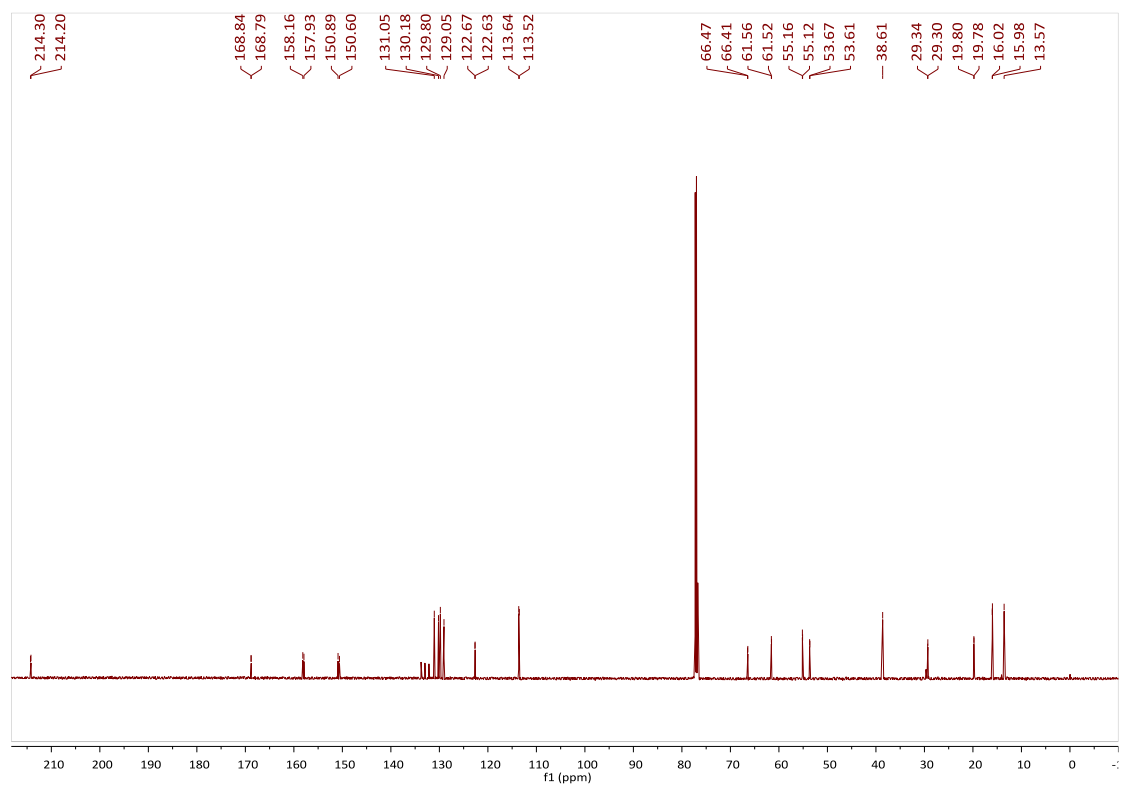
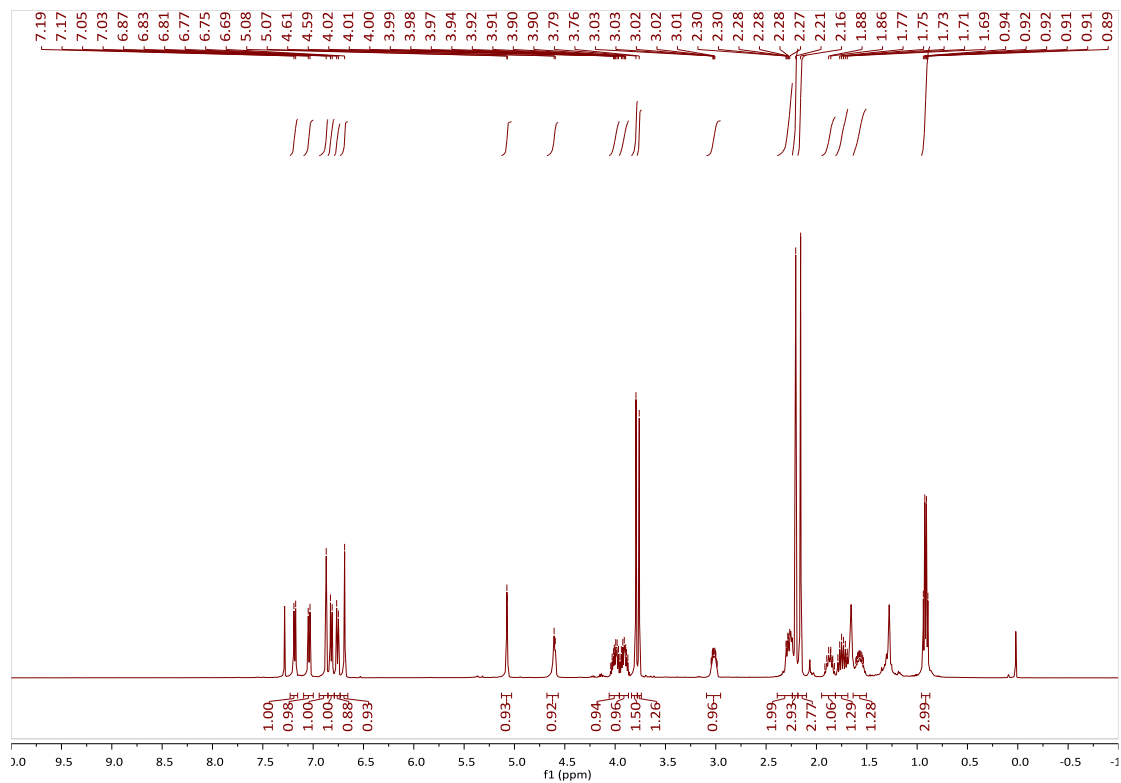
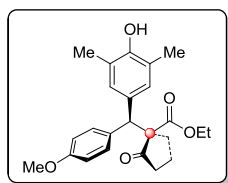


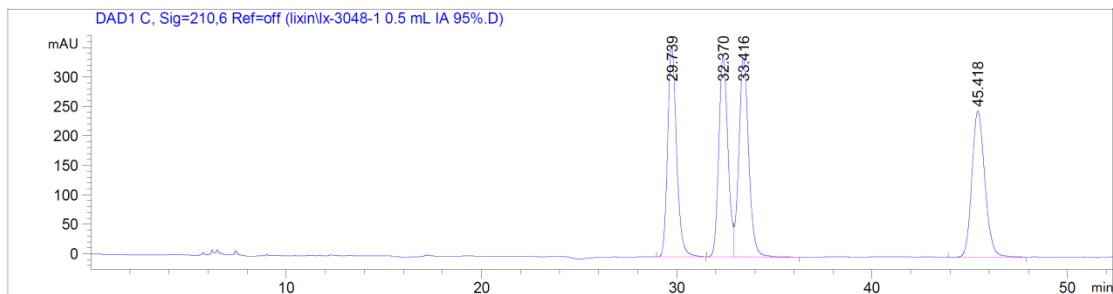
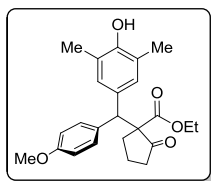


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.576	BB	0.1708	197.76097	17.90735	60.7900
2	11.007	BV	0.2019	62.95538	4.77298	19.3519
3	11.506	VB	0.2080	64.60209	4.77146	19.8581

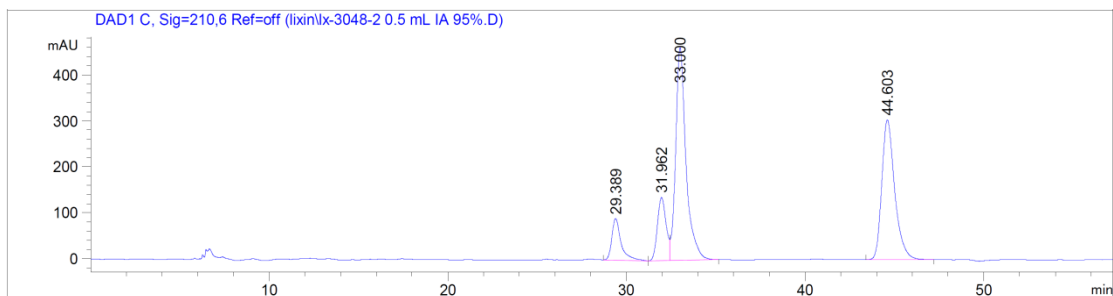
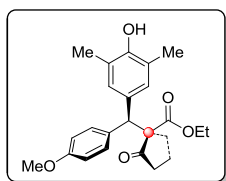


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.253	BB	0.1762	265.48730	22.73929	57.1869
2	11.933	BV	0.2119	116.79064	8.52051	25.1571
3	12.440	VB	0.2171	81.96734	5.72184	17.6560

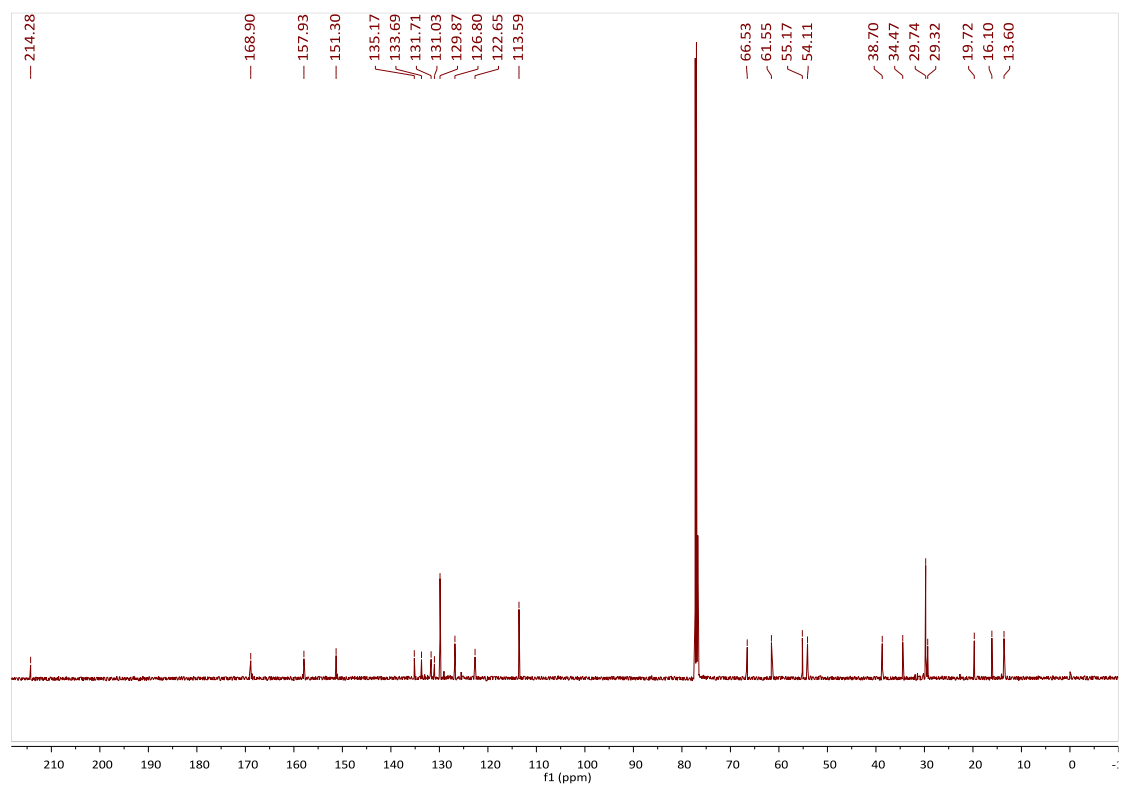
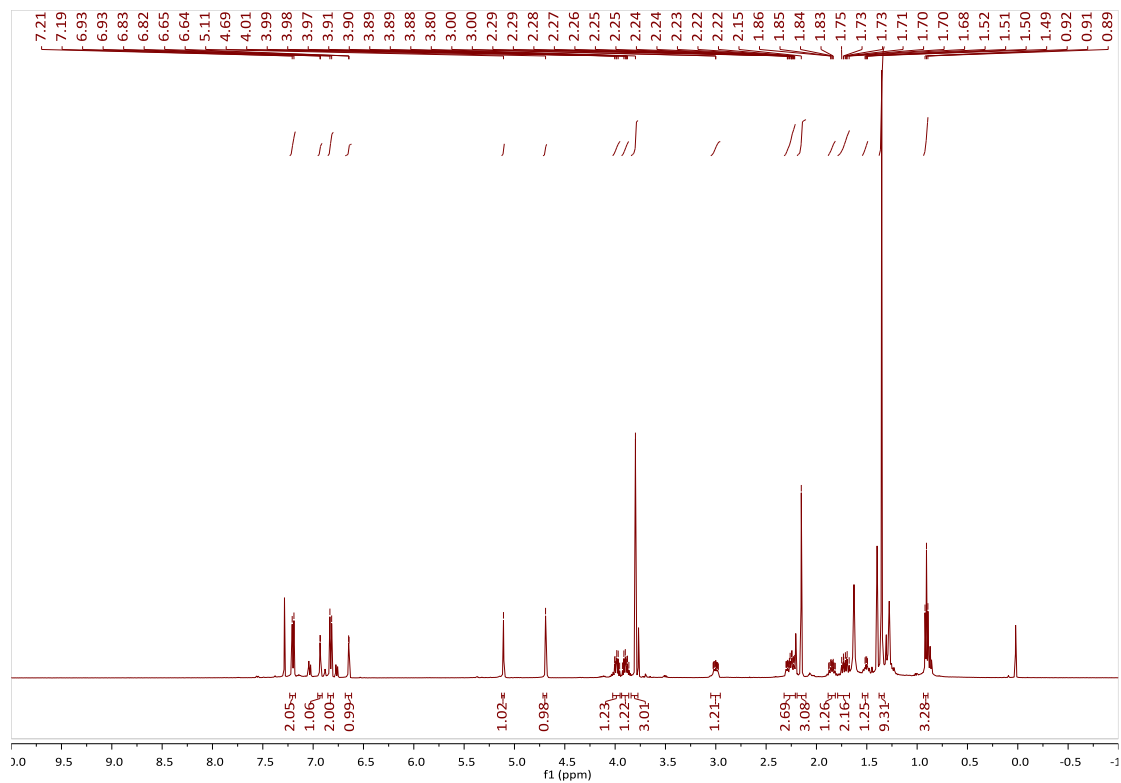
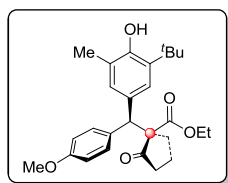


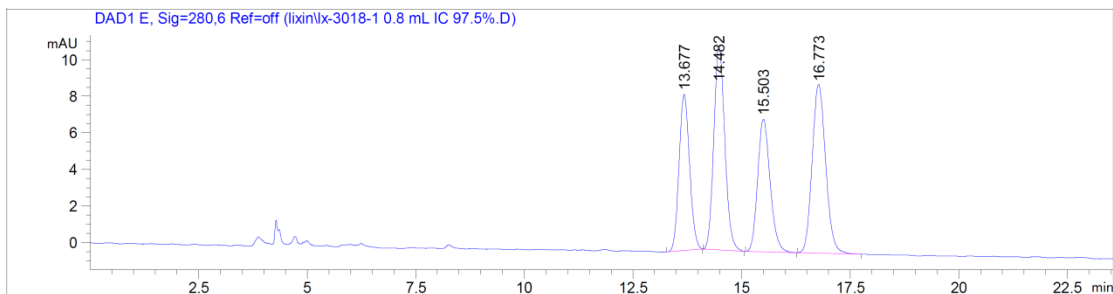
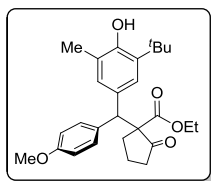


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	29.739	BB	0.4814	1.13295e4	357.84882	24.7865
2	32.370	BV	0.5017	1.10246e4	340.56436	24.1195
3	33.416	VB	0.5304	1.18184e4	337.59784	25.8560
4	45.418	BB	0.7161	1.15359e4	248.28638	25.2380

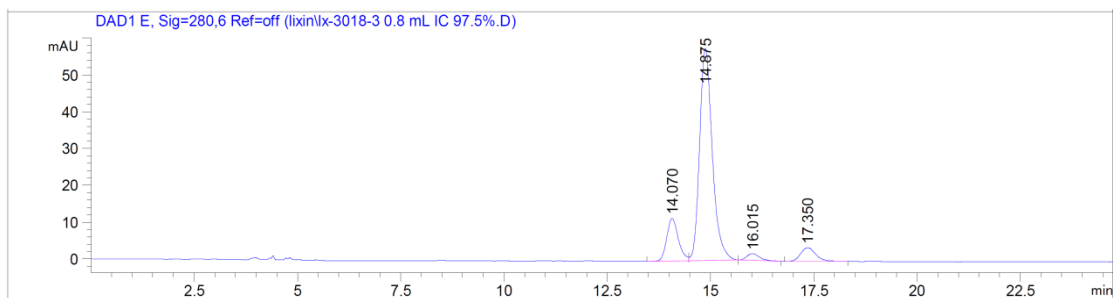
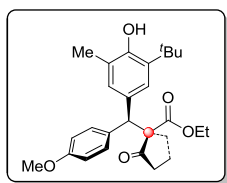


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	29.389	BB	0.5295	3244.38379	90.66420	7.7638
2	31.962	BV	0.5200	4661.09570	137.30804	11.1540
3	33.000	VB	0.5985	1.85899e4	462.97427	44.4857
4	44.603	BB	0.7610	1.52931e4	303.95435	36.5965

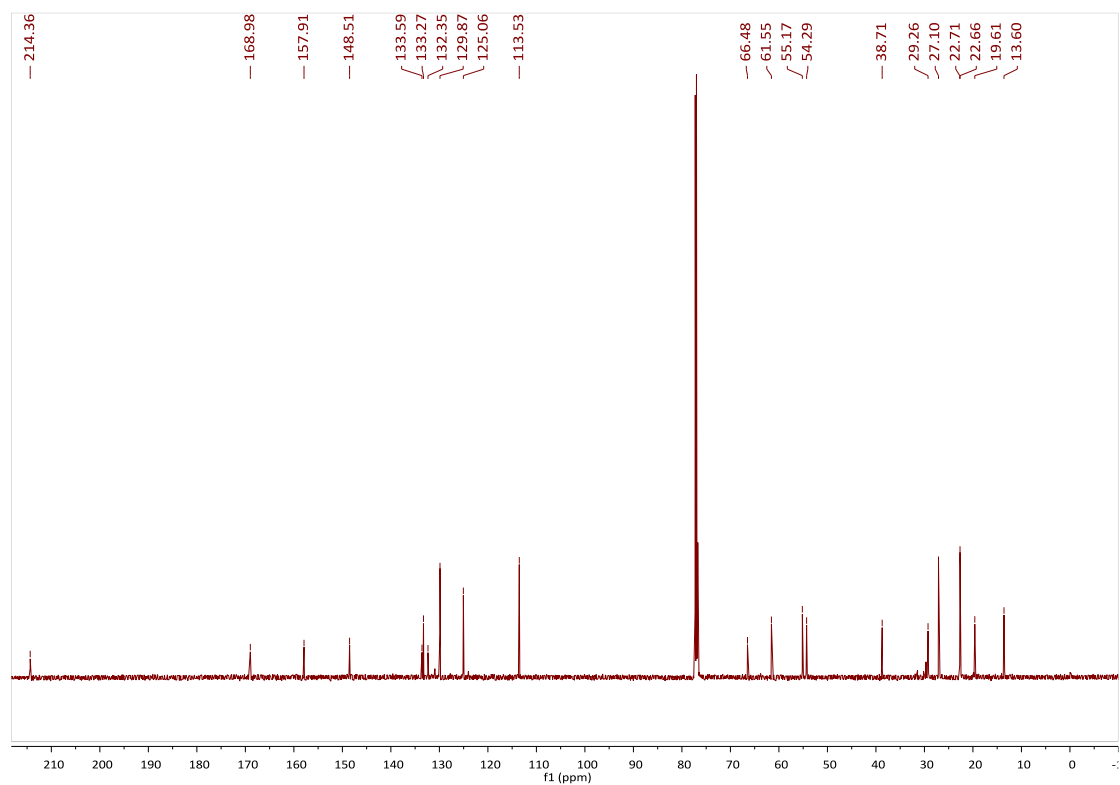
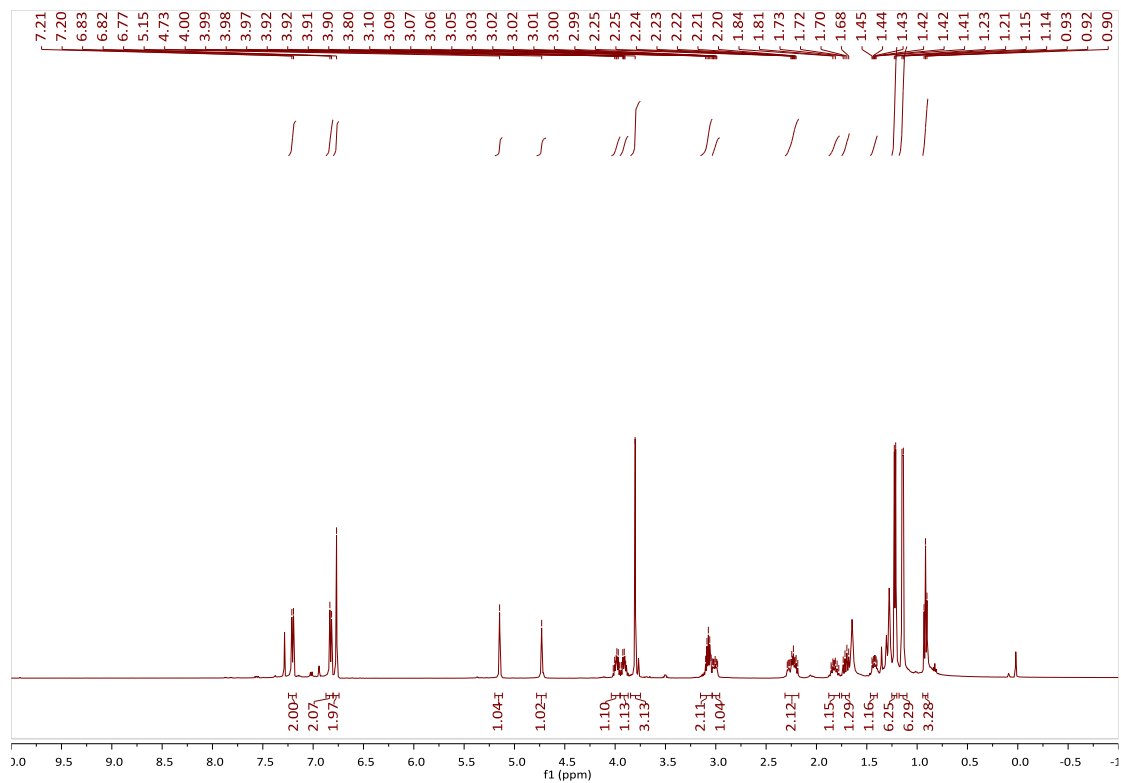
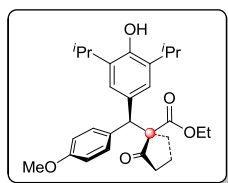


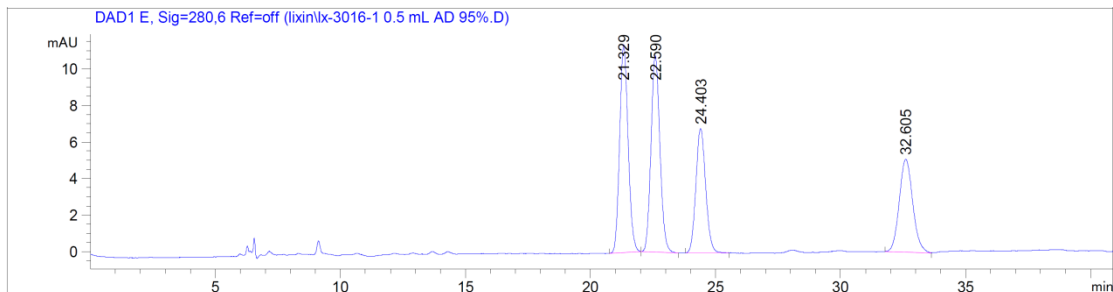
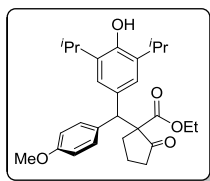


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.677	BB	0.2604	143.78377	8.54199	20.9614
2	14.482	BB	0.2733	196.58699	11.17237	28.6592
3	15.503	BB	0.3055	145.49522	7.26863	21.2109
4	16.773	BB	0.3388	200.08087	9.23551	29.1686

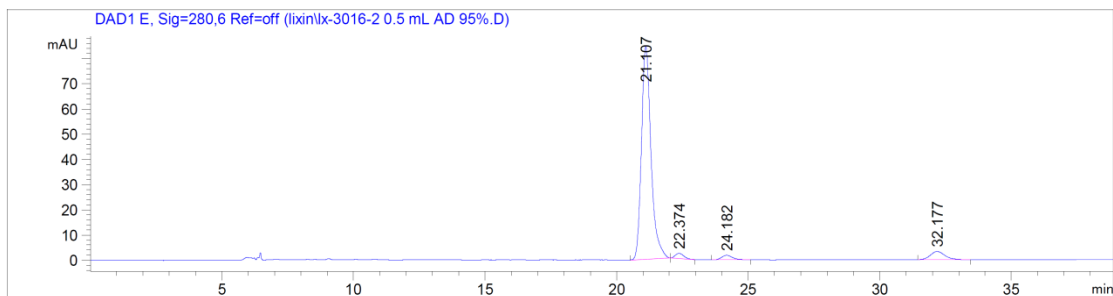
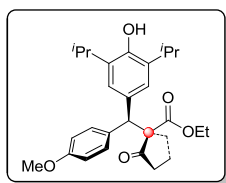


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.070	BV	0.3024	226.61327	11.57590	14.1997
2	14.875	VB	0.3300	1234.47620	57.61588	77.3528
3	16.015	BB	0.3242	39.75277	1.85338	2.4909
4	17.350	BB	0.3809	95.06054	3.73602	5.9565

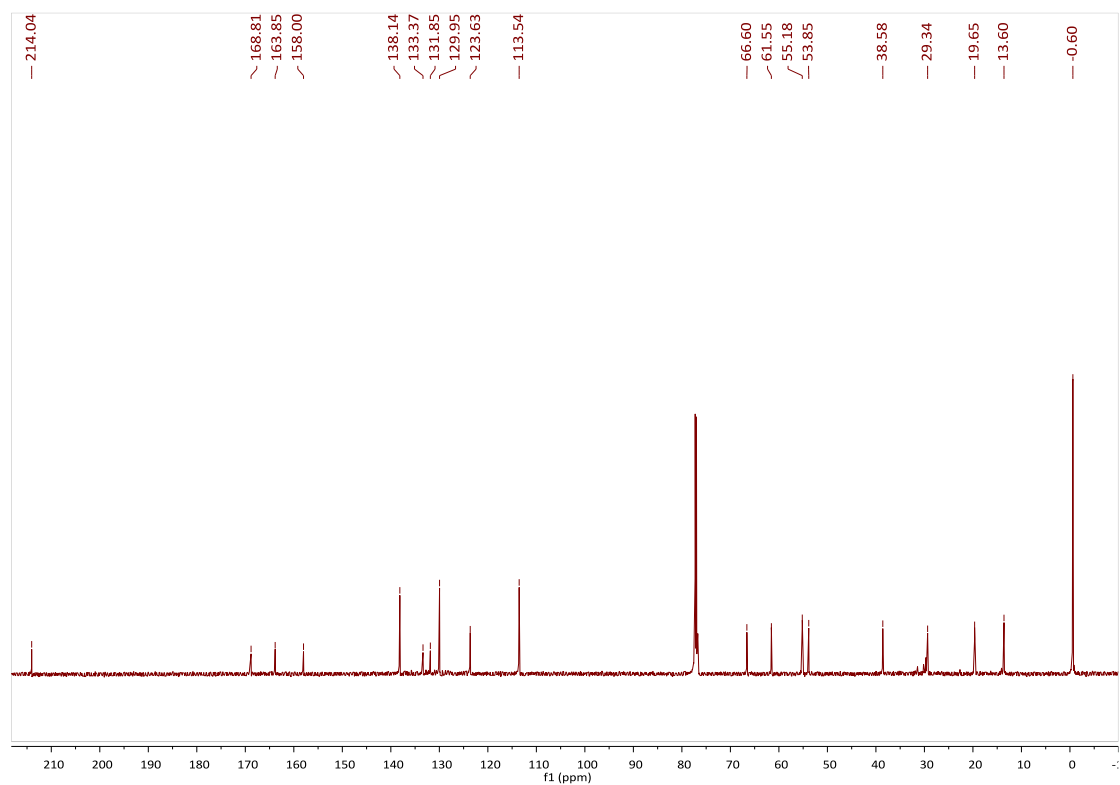
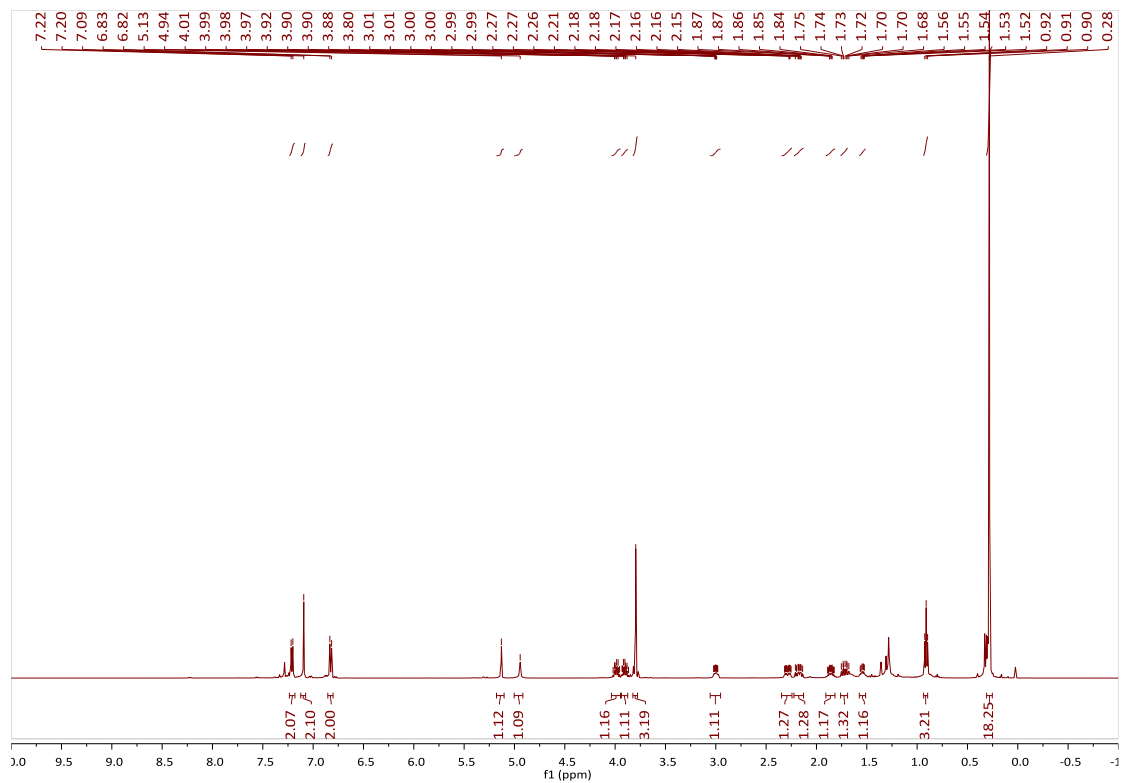
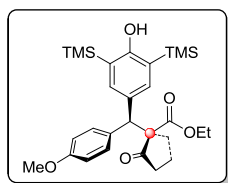


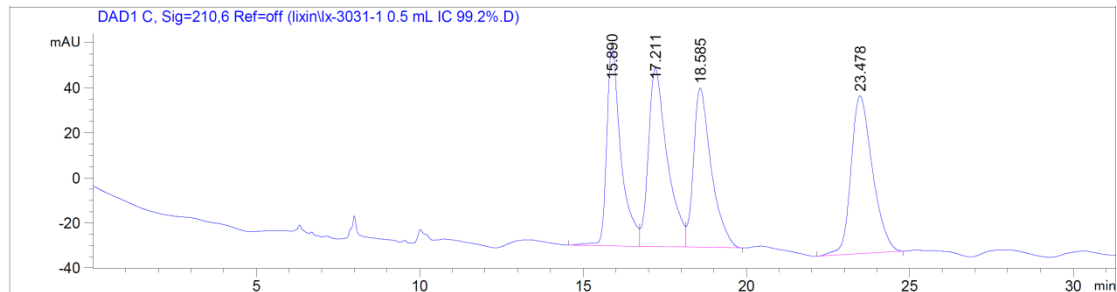
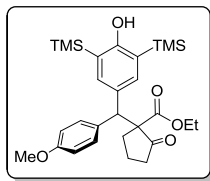


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.329	BB	0.3597	266.70422	11.36937	29.3375
2	22.590	BB	0.3861	267.35431	10.75305	29.4090
3	24.403	BB	0.4161	185.83469	6.81547	20.4418
4	32.605	BB	0.5546	189.19640	5.07868	20.8116

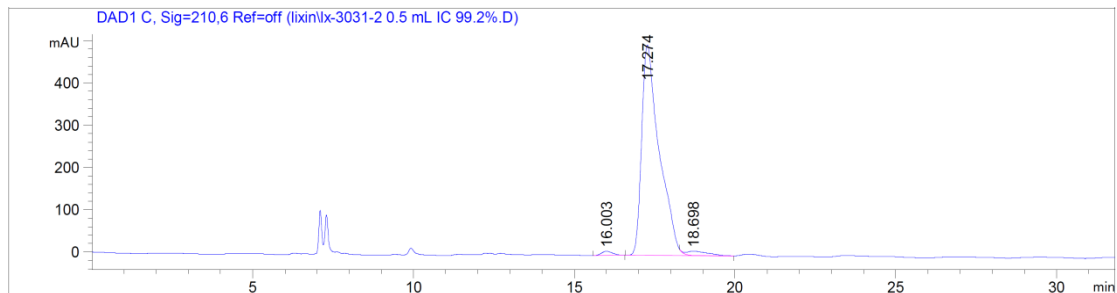
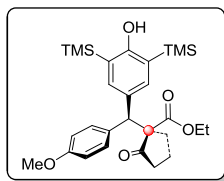


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.107	BB	0.3848	2131.23779	84.33810	90.5878
2	22.374	BB	0.3396	45.72258	2.08730	1.9434
3	24.182	BB	0.3960	52.60191	1.82620	2.2358
4	32.177	BB	0.5402	123.11397	3.21926	5.2329

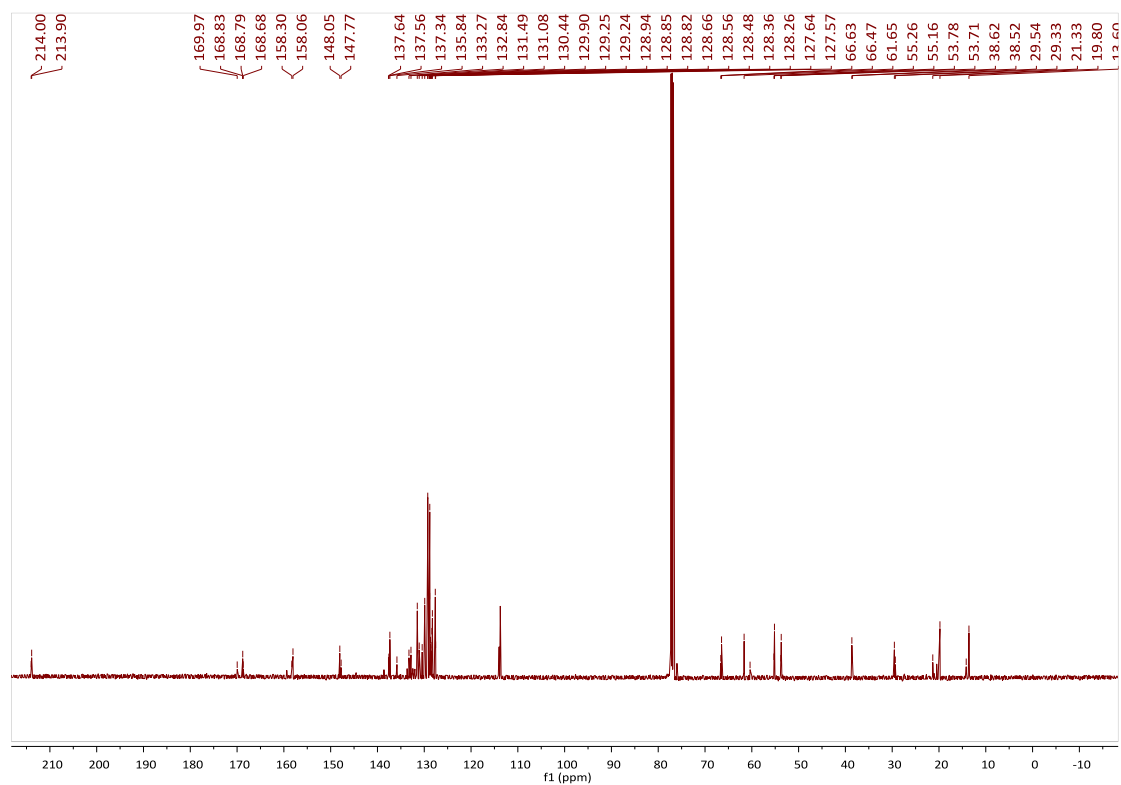
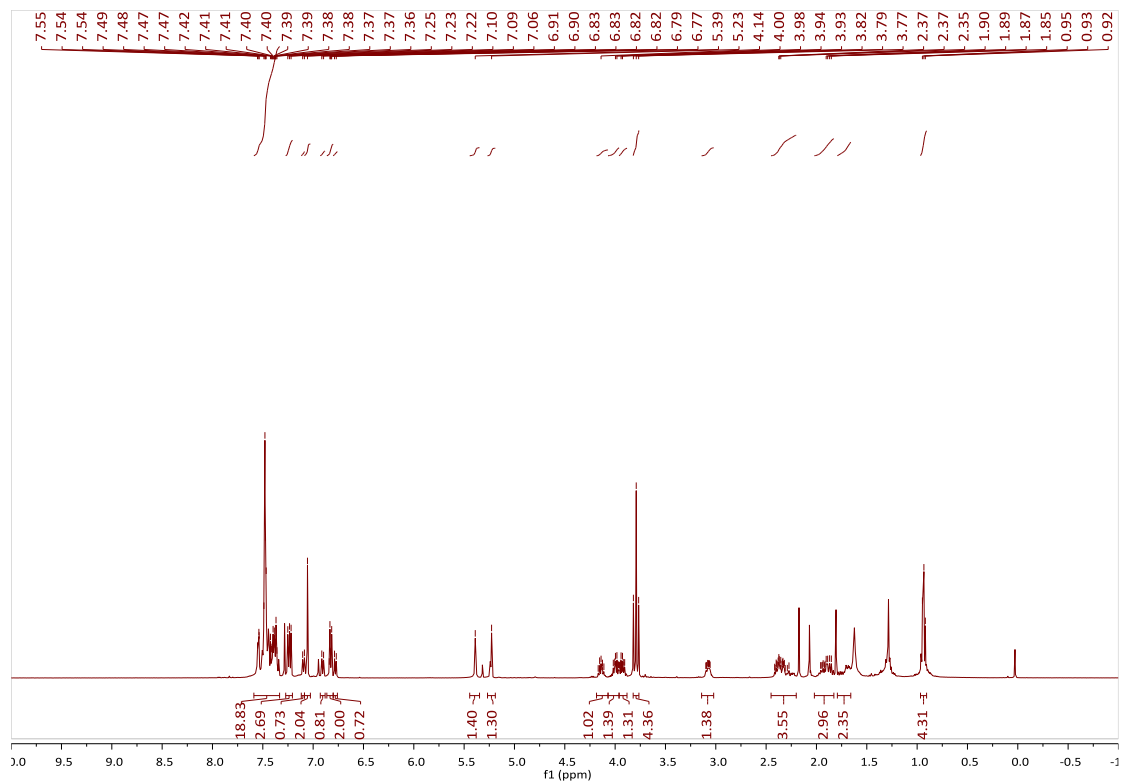
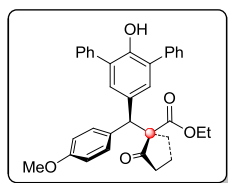


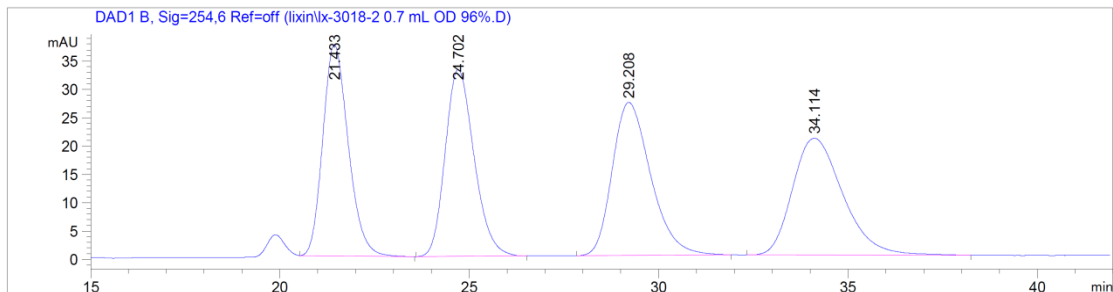
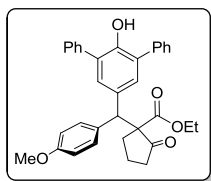


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.890	BV	0.4355	2681.47925	89.51240	22.7982
2	17.211	VV	0.5831	3185.41650	79.21661	27.0827
3	18.585	VB	0.5609	2683.53516	70.68896	22.8156
4	23.478	BB	0.6946	3211.39624	70.08749	27.3035

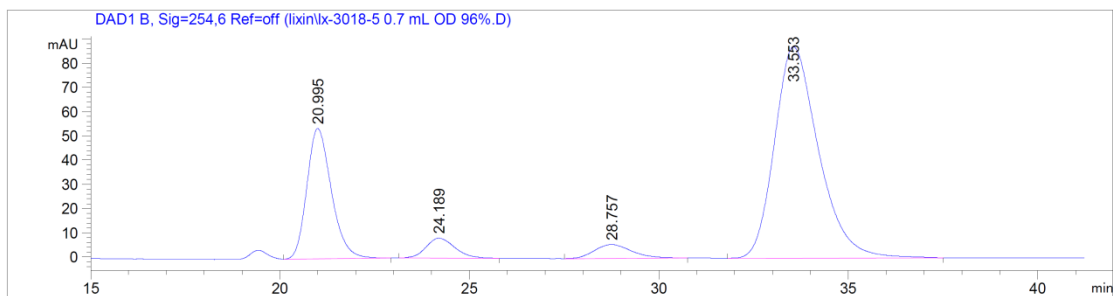
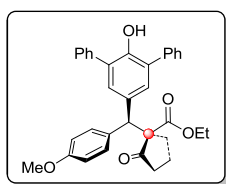


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.003	BB	0.3792	239.49644	9.79727	1.2189
2	17.274	BV R	0.5380	1.89455e4	497.77588	96.4254
3	18.698	VB E	0.6199	462.83081	9.92772	2.3556

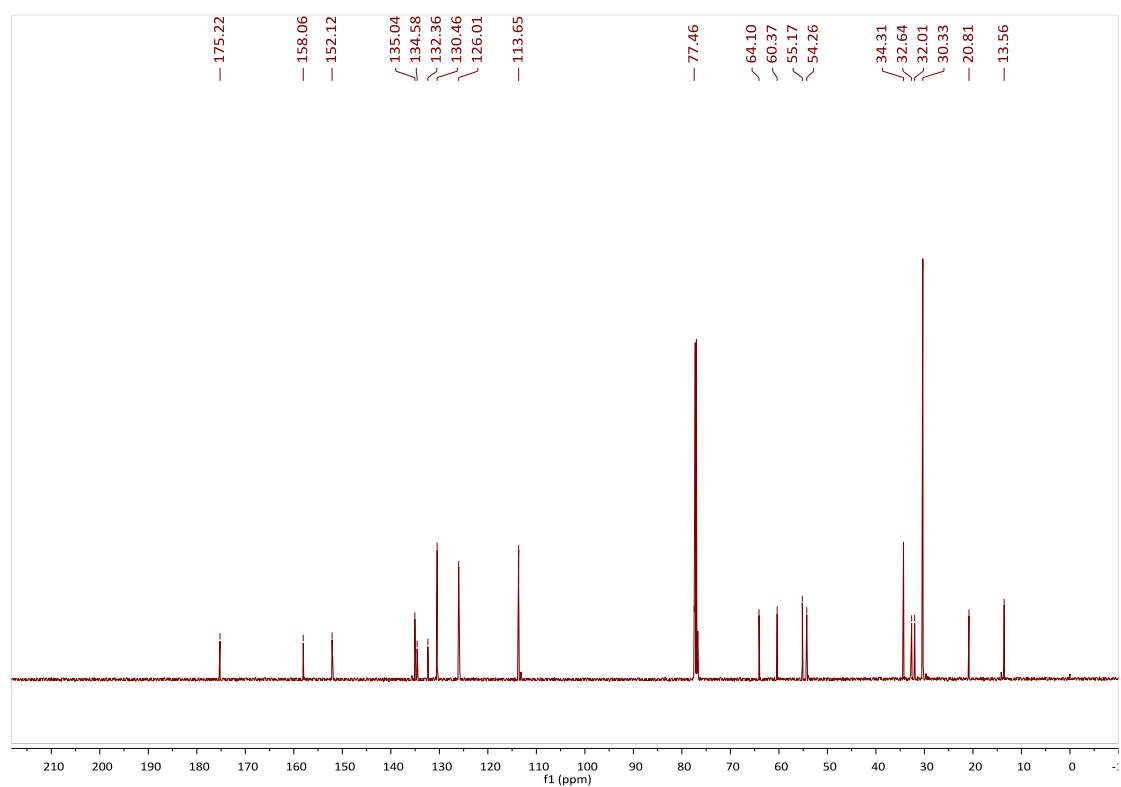
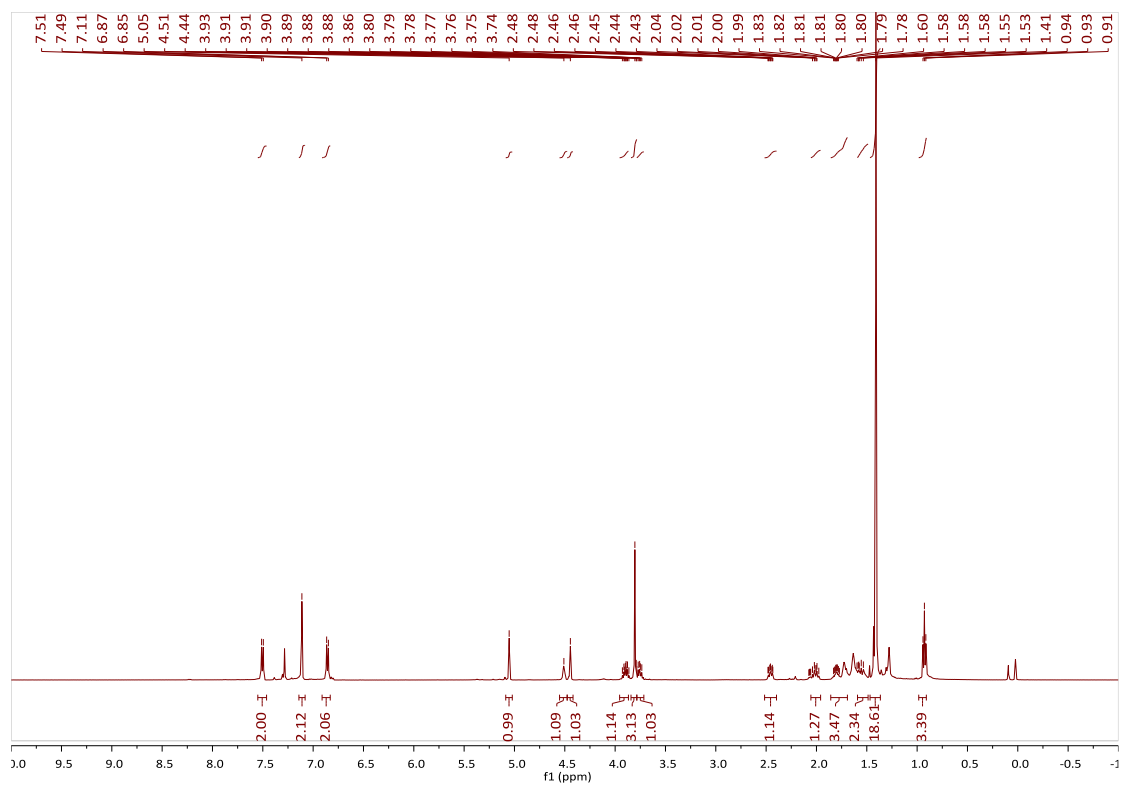
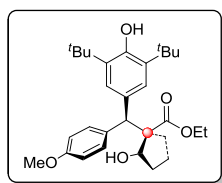


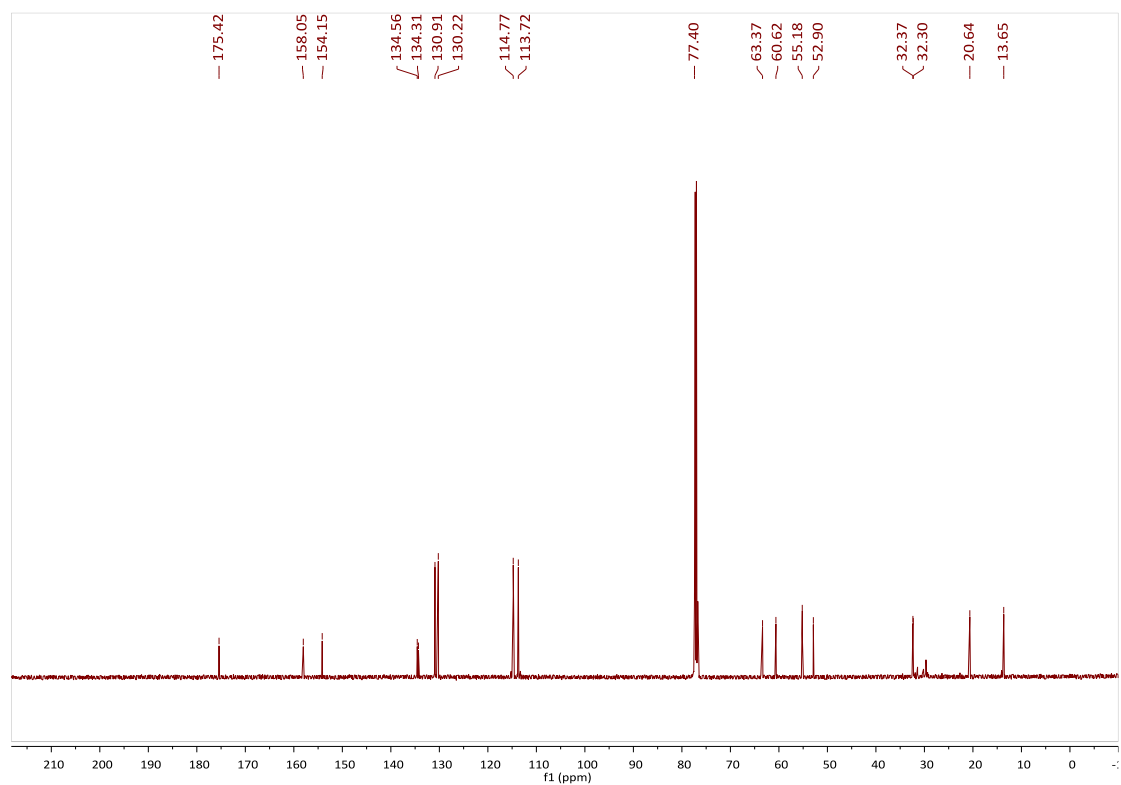
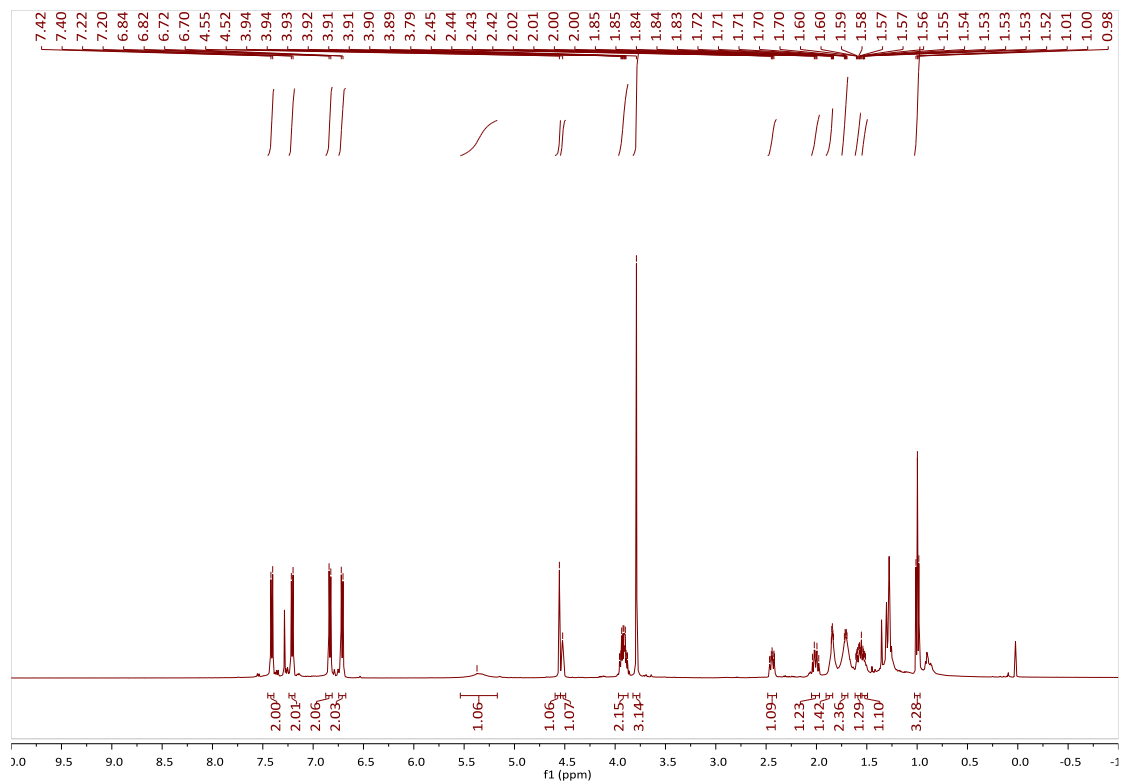
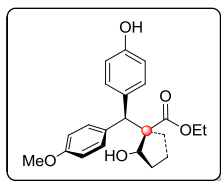


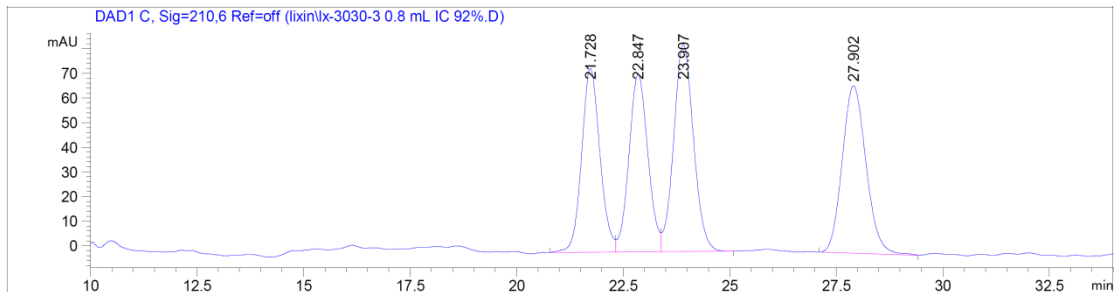
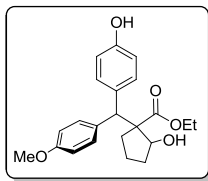
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.433	BB	0.7215	1744.09412	37.30320	23.8384
2	24.702	BB	0.8057	1751.29395	32.97206	23.9369
3	29.208	BB	1.0680	1910.73108	27.05408	26.1161
4	34.114	BB	1.2411	1910.18787	20.65232	26.1086



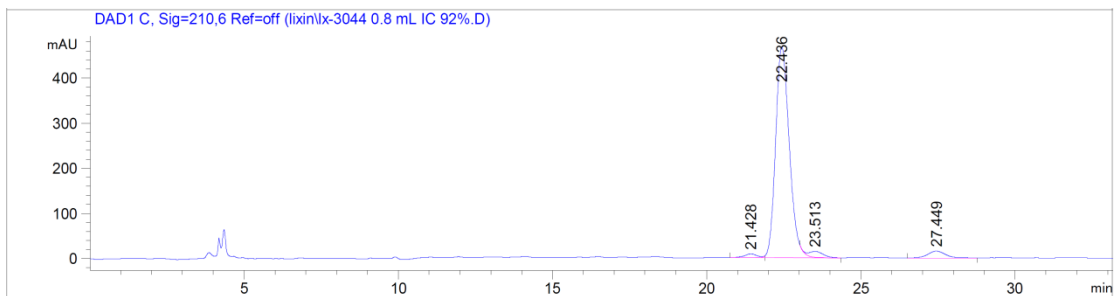
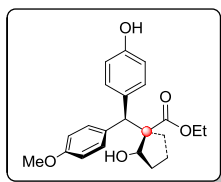
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.995	BB	0.6908	2420.13159	53.80505	23.5019
2	24.189	BB	0.7666	434.43671	8.22039	4.2188
3	28.757	BB	0.8613	395.33597	5.75625	3.8391
4	33.553	BB	1.2093	7047.69971	87.16129	68.4402



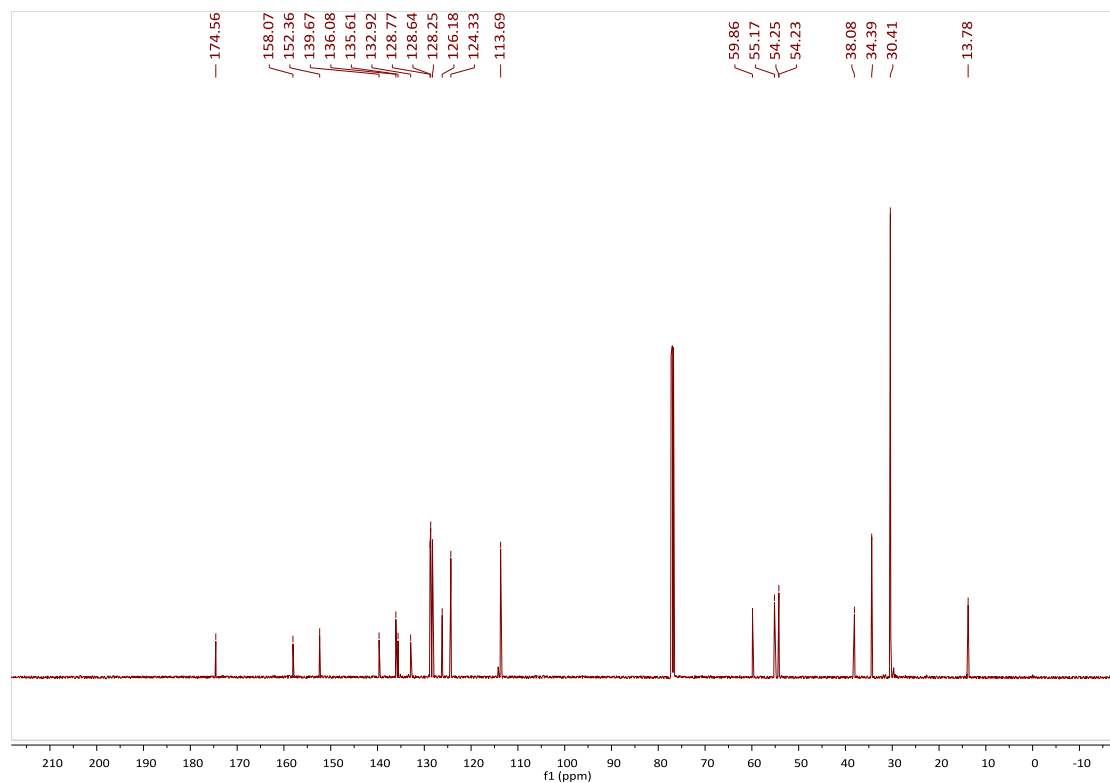
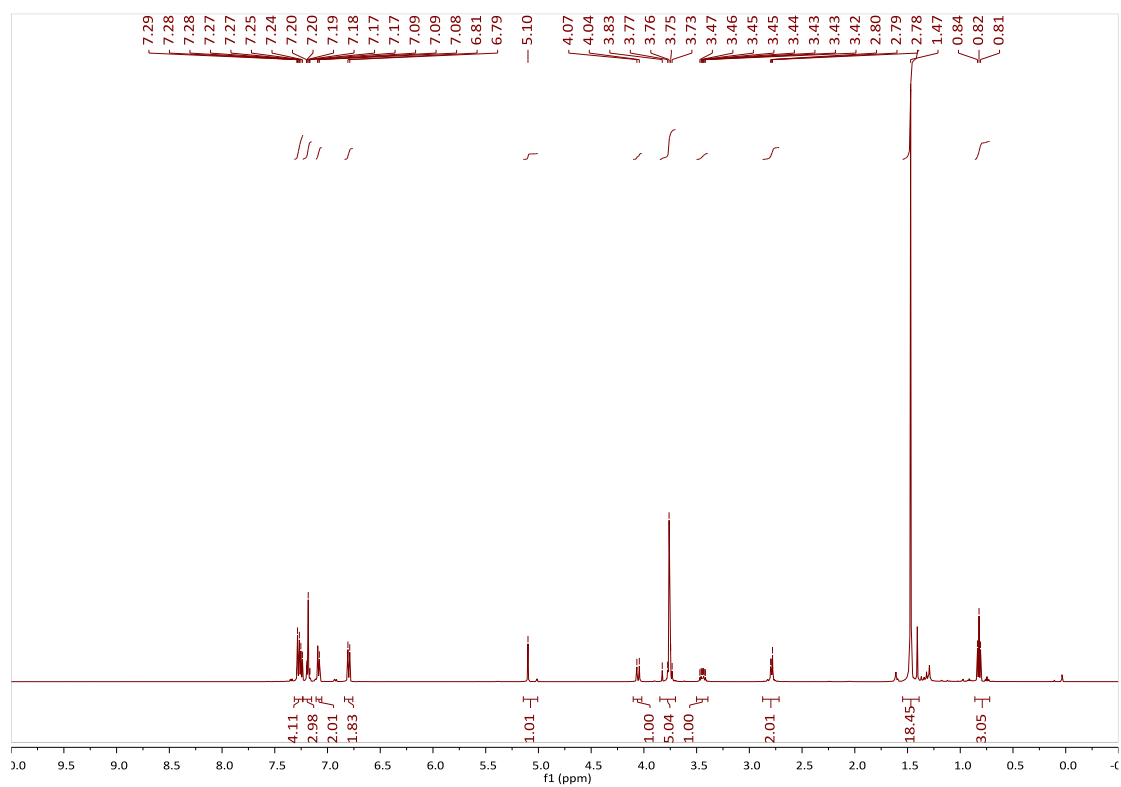
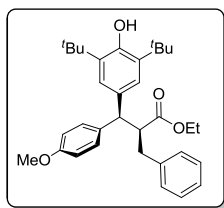


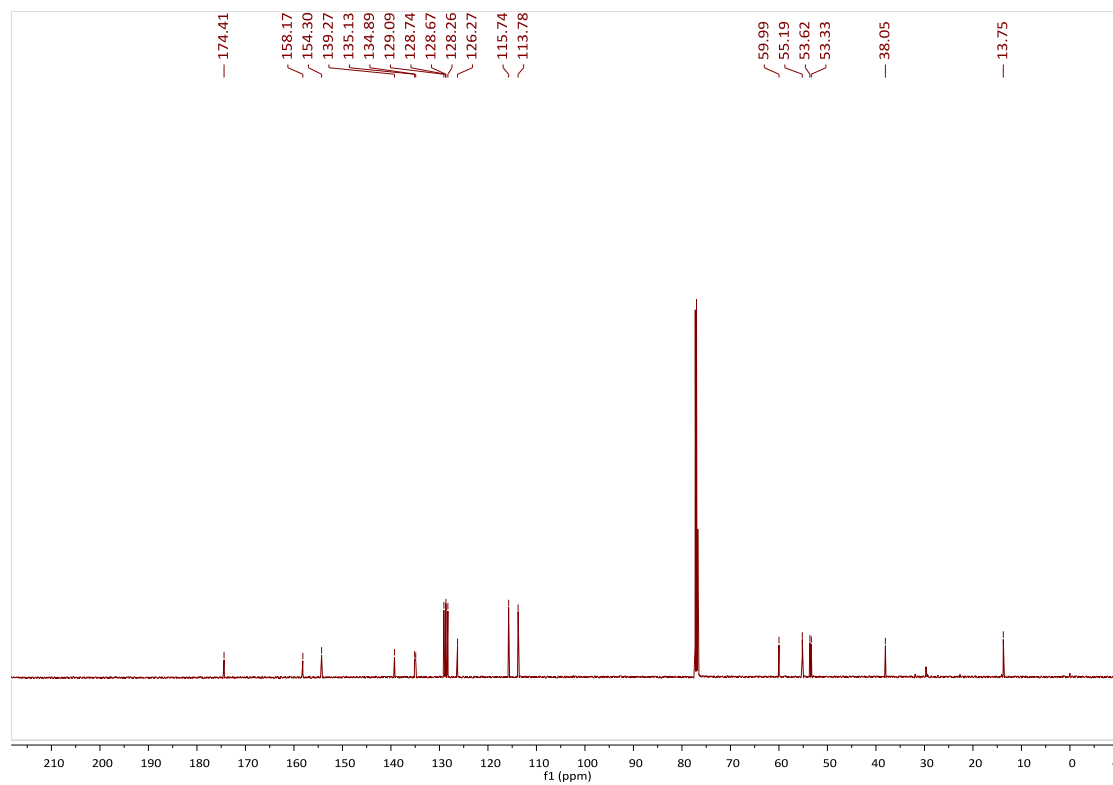
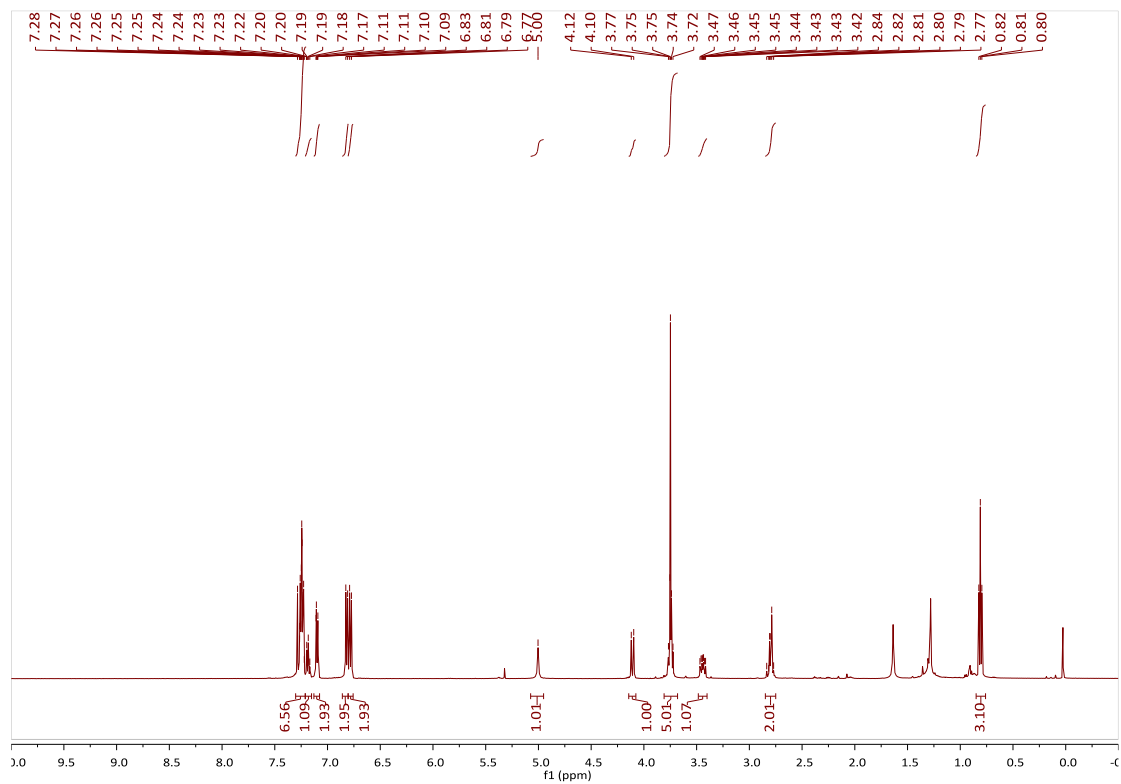
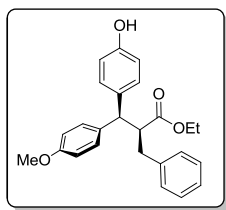


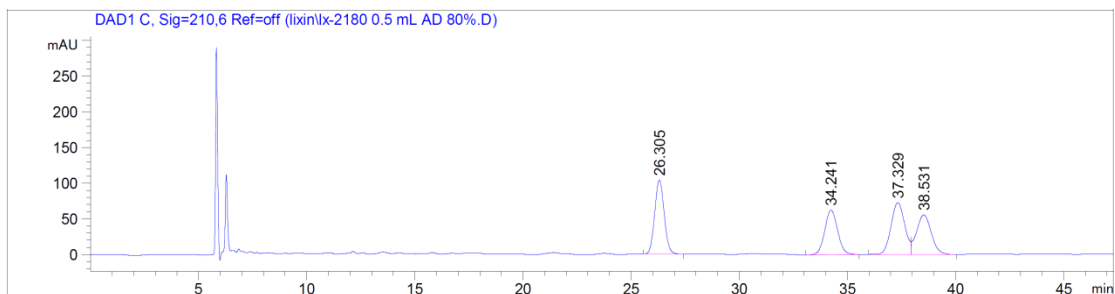
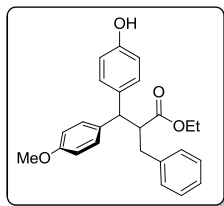
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.728	BV	0.4567	2229.91870	74.59883	22.7006
2	22.847	VV	0.4795	2232.86426	72.06480	22.7306
3	23.907	VB	0.4992	2724.71289	84.27470	27.7376
4	27.902	BB	0.6047	2635.66919	67.91964	26.8312



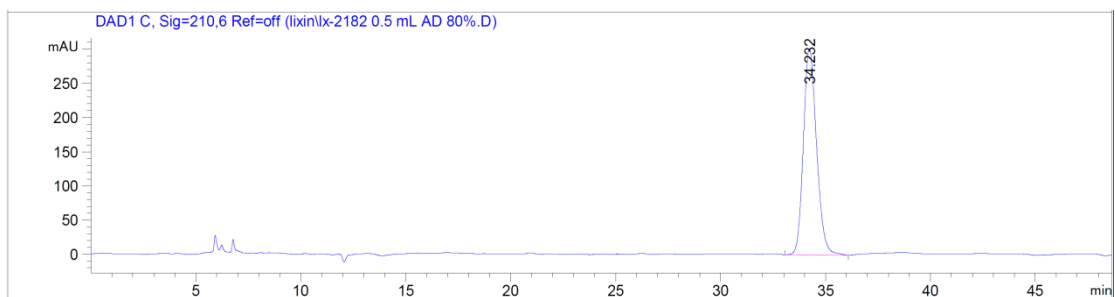
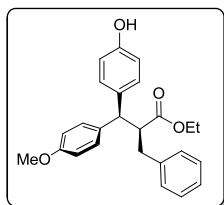
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.428	BV E	0.4091	232.92355	8.40991	1.4785
2	22.436	VV R	0.4794	1.44816e4	467.43732	91.9246
3	23.513	VB E	0.4751	418.72577	13.16331	2.6579
4	27.449	BB	0.6079	620.52545	15.27567	3.9389







Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	26.305	BB	0.4749	3180.76172	103.98998	27.3097
2	34.241	BB	0.6380	2606.00732	62.56393	22.3749
3	37.329	BV	0.6819	3215.57788	72.72440	27.6086
4	38.531	VB	0.7099	2644.67651	55.70596	22.7069



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	34.232	BB	0.6766	1.31845e4	301.27390	100.0000