

Copper/Lewis Base Cooperatively Catalyzed Asymmetric Allylic Alkylation of Morita–Baylis–Hillman Carbonates with Azomethine Ylides

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General Information

All reactions were performed under Ar atmospheres in oven-dried glassware with magnetic stirring. Unless otherwise stated, all reagents were purchased from commercial suppliers and used without further purification. All solvents were purified and dried according to standard methods prior to use. Organic solutions were concentrated under reduced pressure on a rotary evaporator or an oil pump. Reactions were monitored through thin layer chromatography (TLC) on silica gel-precoated glass plates. Chromatograms were visualized by fluorescence quenching with UV light at 254 nm. Flash column chromatography was performed using Qingdao Haiyang flash silica gel (200–300 mesh). Infrared spectra were recorded using a Bruker Optics TENSOR 27 instrument. ^1H and ^{13}C NMR spectra were recorded in CDCl_3 using a 500 MHz NMR instrument (referenced internally to Me_4Si). ^1H NMR data are reported as follows: chemical shift, multiplicity (s = singlet; d = doublet; t = triplet; q = quartet; m = multiplet), coupling constant (Hz), and integral. Data for ^{13}C NMR spectra are reported in terms of chemical shift. Optical rotation was obtained on an Anton Paar MCP 100 polarimeter. Accurate mass measurements were performed using an Agilent instrument with the ESI-MS technique. HPLC analysis was performed on Agilent 1220 series, UV detection monitored at 254 nm, using a Chiralpak AD-H column, a Chiralcel OD-H column, with hexane and *i*-PrOH as the eluent. X-ray crystallographic data were collected using a Bruker APEX-II CCD.

Preparation of Substrates 1 and 2

The azomethine ylides **1**^[1] and MBH carbonates **2**^[2] were synthesized using known literature procedures.

General Procedure for Preparation of Racemic Allylation Products

Under argon atmosphere, to a mixture of azomethine ylides **1** (0.12 mmol), MBH carbonates **2** (0.10 mmol) and the catalyst DABCO (20 mol%, 0.02 mmol, 2.3 mg), $\text{Cu}(\text{MeCN})_4\text{PF}_6$ (5 mol%, 0.005 mmol, 1.8 mg), the ligand Dppf (6 mol%, 0.006 mmol, 3.3 mg) in a Schlenk tube, 1 mL of CH_2Cl_2 was added at room temperature. The resulting mixture was stirred until the starting material was completely consumed (monitored by TLC) and then was concentrated to dryness. The residue was purified through flash column chromatography (10% EtOAc / Petroleum) to afford the corresponding racemic allylation products **3**.

General Procedure for Asymmetric Allylation Reactions

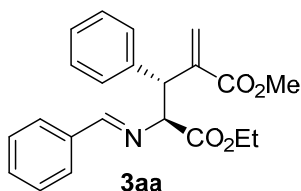
Under argon atmosphere, to a mixture of trisubstituted allenolates **1** (0.10 mmol), MBH carbonates **2** (0.12 mmol), the catalyst DABCO (20 mol%, 0.02 mmol, 2.3 mg), $\text{Cu}(\text{MeCN})_4\text{PF}_6$ (5 mol%, 0.005 mmol, 1.8 mg), the chiral ligand L_2 (6 mol%, 0.006 mmol, 3 mg) in a Schlenk tube, 1 mL of CH_2Cl_2 was added at $-20\text{ }^\circ\text{C}$. The resulting mixture was stirred until the starting material was completely consumed (monitored by TLC) and then was concentrated to dryness. The residue was purified through flash column chromatography (10% EtOAc / Petroleum) to afford the corresponding chiral allylation products **3**.

[1] Xiong, Y.; Du, Z.; Chen, H.; Yang, Z.; Tan, Q.; Zhang, C.; Zhu, L.; Lan, Y.; Zhang, M. *J. Am. Chem. Soc.* **2019**, *141*, 961–971.

[2] Chen, Q.; Bao, Y.; Yang, X.; Dai, Z.; Yang, F.; Zhou, Q. *Org. Lett.* **2018**, *20*, 5380–5383.

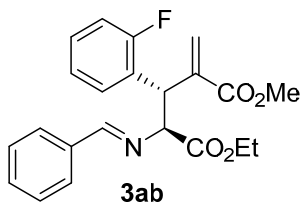
Characterization Data of the Products 3

1-Ethyl-5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-4-methylene-3-phenylpentanedioate (3aa)



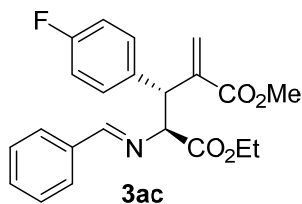
Prepared according to the general procedure (reaction time: 16 h) as described above in 79% yield (28.8 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -311.8$ (c 0.67, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.78 (s, 1H), 7.53 – 7.48 (m, 2H), 7.34 – 7.29 (m, 1H), 7.28 – 7.26 (m, 2H), 7.25 – 7.19 (m, 2H), 7.15 – 7.10 (m, 2H), 7.07 – 7.01 (m, 1H), 6.32 (s, 1H), 5.73 (s, 1H), 4.69 (d, $J = 9.8$ Hz, 1H), 4.41 (d, $J = 9.8$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.63 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.7, 165.6, 163.4, 139.7, 137.5, 134.5, 130.0, 128.3, 127.4, 127.4, 127.1, 125.9, 124.9, 76.2, 60.2, 51.0, 48.0, 13.0; IR (film) ν_{max} 3649, 2985, 1724, 1638, 1581, 1491, 1452, 1275, 1259, 1182, 1148, 1030, 764, 751, 694 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{24}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 366.1700, found 366.1699; HPLC analysis: **3aa**, 90% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 8.2$ min (major), 10.5 min (minor).

1-Ethyl 5-methyl (2S,3S)-2-(((E)-benzylidene)amino)-3-(2-fluorophenyl)-4-methylenepentanedioate (3ab)



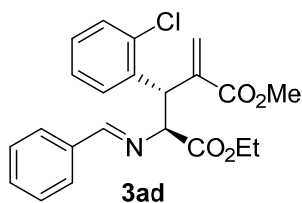
Prepared according to the general procedure (reaction time: 20 h) as described above in 69% yield (27.5 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -297.0$ (c 0.63, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.95 (s, 1H), 7.58 – 7.52 (m, 2H), 7.48 (td, $J = 7.6, 1.8$ Hz, 1H), 7.35 – 7.29 (m, 1H), 7.29 – 7.24 (m, 2H), 7.09 – 7.01 (m, 1H), 6.96 (td, $J = 7.6, 1.3$ Hz, 1H), 6.87 – 6.81 (m, 1H), 6.32 (s, 1H), 5.71 (s, 1H), 5.02 (d, $J = 9.3$ Hz, 1H), 4.60 (d, $J = 9.2$ Hz, 1H), 4.08 (q, $J = 7.1$ Hz, 2H), 3.65 (s, 3H), 1.10 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.5, 165.5, 163.4, 160.0 (d, $J = 247.4$ Hz), 138.3, 134.5, 130.1, 129.8 (d, $J = 3.9$ Hz), 127.6 (d, $J = 8.4$ Hz), 127.5, 127.4, 126.0, 125.0 (d, $J = 13.5$ Hz), 122.8 (d, $J = 3.5$ Hz), 114.3 (d, $J = 22.7$ Hz), 73.9, 60.2, 51.0, 41.7, 13.0; IR (film) ν_{max} 2987, 1727, 1639, 1581, 1491, 1452, 1275, 1260, 1181, 1148, 1097, 1029, 955, 814, 764, 751, 694, 404 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{FNO}_4^+$ $[\text{M}+\text{H}]^+$ 384.1606, found 384.1602; HPLC analysis: **3ab**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 7.4$ min (major), 10.4 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-3-(4-fluorophenyl)-4-methylenepentanedioate (3ac)



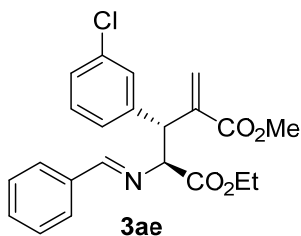
Prepared according to the general procedure (reaction time: 12 h) as described above in 79% yield (31.5 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -237.1$ (c 1.40, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.82 (s, 1H), 7.56 – 7.51 (m, 2H), 7.35 – 7.31 (m, 1H), 7.30 – 7.26 (m, 2H), 7.23 – 7.19 (m, 2H), 6.85 – 6.80 (m, 2H), 6.32 (s, 1H), 5.69 (s, 1H), 4.69 (dd, $J = 9.5, 1.1$ Hz, 1H), 4.38 (d, $J = 9.5$ Hz, 1H), 4.08 (q, $J = 7.1$ Hz, 2H), 3.64 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.5, 165.5, 163.5, 160.7 (d, $J = 245.3$ Hz), 139.6, 134.4, 133.3 (d, $J = 3.2$ Hz), 130.1, 129.9, 129.8, 127.5, 127.4, 125.0, 114.0 (d, $J = 21.1$ Hz), 76.2, 75.5, 60.2, 51.1, 47.4, 13.0; IR (film) ν_{max} 2988, 1725, 1638, 1581, 1508, 1451, 1275, 1259, 1182, 1148, 1029, 764, 750, 694 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{FNO}_4^+$ $[\text{M}+\text{H}]^+$ 384.1606, found 384.1607; HPLC analysis: **3ac**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 9.2$ min (major), 11.9 min (minor).

1-Ethyl 5-methyl (2S,3S)-2-(((E)-benzylidene)amino)-3-(2-chlorophenyl)-4-methylenepentanedioate (3ad)



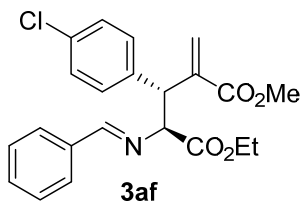
Prepared according to the general procedure (reaction time: 12 h) as described above in 79% yield (31.5 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -237.1$ (c 1.40, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.90 (s, 1H), 7.74 (dd, $J = 7.8, 1.7$ Hz, 1H), 7.62 – 7.57 (m, 2H), 7.38 – 7.26 (m, 3H), 7.21 (dd, $J = 7.9, 1.4$ Hz, 1H), 7.13 (td, $J = 7.5, 1.4$ Hz, 1H), 7.03 (td, $J = 7.6, 1.7$ Hz, 1H), 6.29 (s, 1H), 5.52 (s, 1H), 5.26 (d, $J = 7.8$ Hz, 1H), 4.58 (d, $J = 8.0$ Hz, 1H), 4.08 – 3.97 (m, 2H), 3.66 (s, 3H), 1.04 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.5, 165.6, 163.4, 138.2, 135.8, 134.6, 134.1, 130.1, 129.1, 128.6, 127.5, 127.4, 127.0, 126.9, 125.6, 73.8, 60.1, 51.0, 44.5, 12.9; IR (film) ν_{max} 2986, 1727, 1640, 1473, 1438, 1275, 1260, 1193, 1148, 1035, 764, 751, 693 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{ClNO}_4^+$ $[\text{M}+\text{H}]^+$ 400.1310, found 400.1306; HPLC analysis: **3ad**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 7.0$ min (major), 10.9 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-3-(3-chlorophenyl)-4-methylenepentanedioate (3ae)



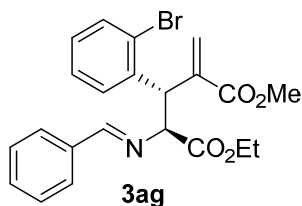
Prepared according to the general procedure (reaction time: 12 h) as described above in 83% yield (34.5 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -281.7$ (c 0.92, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.86 (s, 1H), 7.57 – 7.53 (m, 2H), 7.35 – 7.26 (m, 3H), 7.24 (t, $J = 1.9$ Hz, 1H), 7.15 (dt, $J = 7.2, 1.7$ Hz, 1H), 7.08 – 7.01 (m, 2H), 6.35 (s, 1H), 5.72 (s, 1H), 4.69 (d, $J = 9.6$ Hz, 1H), 4.39 (d, $J = 9.5$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.65 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.3, 165.4, 163.6, 139.8, 139.1, 134.4, 132.9, 130.2, 128.4, 128.1, 127.5, 126.8, 126.1, 125.5, 75.2, 60.3, 51.1, 47.7, 13.0; IR (film) ν_{max} 2962, 1723, 1638, 1595, 1579, 1475, 1437, 1387, 1368, 1291, 1259, 1178, 1147, 1095, 1026, 957, 858, 799, 751 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{ClNO}_4^+$ $[\text{M}+\text{H}]^+$ 400.1310, found 400.1307; HPLC analysis: **3ae**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 7.2$ min (major), 8.5 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-3-(4-chlorophenyl)-4-methylenepentanedioate (3af)



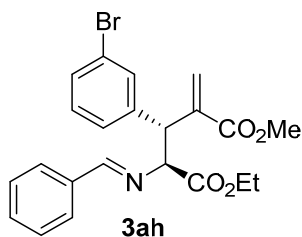
Prepared according to the general procedure (reaction time: 16 h) as described above in 86% yield (35.9 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -287.2$ (c 0.95, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.86 (s, 1H), 7.58 – 7.51 (m, 2H), 7.35 – 7.32 (m, 1H), 7.31 – 7.26 (m, 2H), 7.20 – 7.19 (m, 1H), 7.19 – 7.18 (d, $J = 2.3$ Hz, 1H), 7.13 – 7.10 (m, 2H), 6.32 (s, 1H), 5.69 (s, 1H), 4.69 (d, $J = 9.5$ Hz, 1H), 4.40 (d, $J = 9.4$ Hz, 1H), 4.08 (q, $J = 7.1$ Hz, 2H), 3.64 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.4, 165.5, 163.6, 139.3, 136.2, 134.4, 131.7, 130.2, 129.6, 127.5, 127.4, 127.3, 125.3, 75.2, 60.3, 51.1, 47.5, 13.0; IR (film) ν_{max} 3649, 2987, 1724, 1637, 1491, 1451, 1275, 1260, 1148, 1092, 1015, 819, 764, 750, 693, 423, 410 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{ClNO}_4^+$ $[\text{M}+\text{H}]^+$ 400.1310, found 400.1308; HPLC analysis: **3af**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 9.2$ min (major), 12.8 min (minor).

1-Ethyl 5-methyl (2S,3S)-2-((E)-benzylidene)amino)-3-(2-bromophenyl)-4-methylenepentanedioate (3ag)



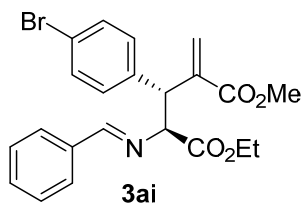
Prepared according to the general procedure (reaction time: 16 h) as described above in 70% yield (32.5 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -159.8$ (c 0.73, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.89 (s, 1H), 7.78 (dd, $J = 7.8, 1.7$ Hz, 1H), 7.62 (dt, $J = 6.8, 1.6$ Hz, 2H), 7.42 (dd, $J = 8.0, 1.3$ Hz, 1H), 7.35 – 7.28 (m, 3H), 7.19 (dd, $J = 15.2, 1.3$ Hz, 1H), 6.95 (td, $J = 7.7, 1.7$ Hz, 1H), 6.29 (s, 1H), 5.49 (s, 1H), 5.25 (d, $J = 7.5$ Hz, 1H), 4.57 (d, $J = 7.8$ Hz, 1H), 4.10 – 3.97 (m, 2H), 3.67 (s, 3H), 1.03 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.5, 165.6, 163.4, 138.3, 137.6, 134.6, 132.0, 130.1, 127.6, 127.4, 127.3, 127.1, 126.2, 73.9, 60.1, 51.0, 47.2, 12.9; IR (film) ν_{max} 3853, 3735, 3649, 2986, 1726, 1637, 1471, 1437, 1275, 1260, 1194, 1148, 1094, 1025, 764, 751, 693 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{BrNO}_4^+$ $[\text{M}+\text{H}]^+$ 444.0805, found 444.0806; HPLC analysis: **3ag**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 7.3$ min (major), 11.5 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-((E)-benzylidene)amino)-3-(3-bromophenyl)-4-methylenepentanedioate (3ah)



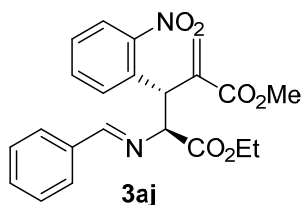
Prepared according to the general procedure (reaction time: 16 h) as described above in 84% yield (38.8 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -199.4$ (c 0.92, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.86 (s, 1H), 7.62 – 7.51 (m, 2H), 7.39 (t, $J = 1.9$ Hz, 1H), 7.34 – 7.31 (m, 1H), 7.31 – 7.26 (m, 2H), 7.22 – 7.16 (m, 2H), 7.00 (t, $J = 7.8$ Hz, 1H), 6.35 (s, 1H), 5.72 (s, 1H), 4.68 (d, $J = 9.5$ Hz, 1H), 4.38 (d, $J = 9.5$ Hz, 1H), 4.08 (q, $J = 7.1$ Hz, 2H), 3.65 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.3, 165.4, 163.7, 140.0, 139.0, 134.4, 131.1, 130.2, 129.0, 128.7, 127.5, 127.4, 127.2, 125.5, 121.2, 75.2, 60.3, 51.1, 47.7, 13.0; IR (film) ν_{max} 3853, 3735, 3675, 3649, 3629, 2985, 1724, 1637, 1569, 1559, 1473, 1437, 1275, 1260, 1149, 1030, 764, 750, 692, 418 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{BrNO}_4^+$ $[\text{M}+\text{H}]^+$ 444.0805, found 444.0807; HPLC analysis: **3ah**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 7.3$ min (major), 9.0 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-3-(4-bromophenyl)-4-methylenepentanedioate (3ai)



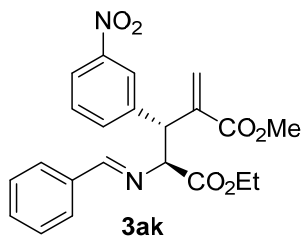
Prepared according to the general procedure (reaction time: 20 h) as described above in 75% yield (34.6 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -245.0$ (c 0.80, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.87 (s, 1H), 7.57 – 7.52 (m, 2H), 7.36 – 7.31 (m, 1H), 7.32 – 7.24 (m, 4H), 7.18 – 7.10 (m, 2H), 6.32 (s, 1H), 5.69 (s, 1H), 4.67 (d, $J = 9.4$ Hz, 1H), 4.40 (d, $J = 9.4$ Hz, 1H), 4.08 (q, $J = 7.1$ Hz, 2H), 3.64 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.4, 165.4, 163.6, 139.3, 136.8, 134.4, 130.3, 130.2, 130.0, 127.5, 127.4, 125.3, 119.9, 75.1, 60.3, 51.1, 47.6, 13.0; IR (film) ν_{max} 3853, 3689, 3629, 3567, 2987, 1733, 1684, 1636, 1559, 1507, 1489, 1473, 1457, 1260, 1148, 819, 764, 693, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{BrNO}_4^+$ $[\text{M}+\text{H}]^+$ 444.0805, found 444.0808; HPLC analysis: **3ai**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 10.1$ min (major), 14.4 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-4-methylene-3-(2-nitrophenyl)pentanedioate (3aj)



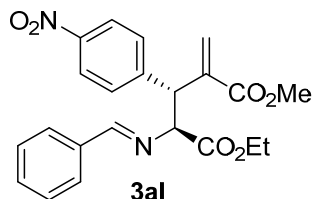
Prepared according to the general procedure (reaction time: 20 h) as described above in 80% yield (34.1 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -23.8$ (c 0.67, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.05 (dd, $J = 8.0, 1.4$ Hz, 1H), 7.99 (s, 1H), 7.69 (dd, $J = 8.1, 1.4$ Hz, 1H), 7.64 – 7.59 (m, 2H), 7.48 (td, $J = 7.7, 1.4$ Hz, 1H), 7.36 – 7.29 (m, 3H), 7.27 (ddd, $J = 8.5, 7.5, 1.4$ Hz, 1H), 6.31 (s, 1H), 5.51 (s, 1H), 5.38 (d, $J = 7.3$ Hz, 1H), 4.61 (d, $J = 7.3$ Hz, 1H), 4.04 – 3.95 (m, 2H), 3.68 (s, 3H), 1.00 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.1, 165.4, 164.1, 149.5, 138.0, 134.4, 132.7, 131.4, 130.3, 130.0, 127.6, 127.5, 127.3, 126.8, 123.5, 73.0, 60.3, 51.2, 42.7, 12.8; IR (film) ν_{max} 3839, 3735, 3675, 3649, 3629, 3567, 2987, 1733, 1684, 1636, 1559, 1540, 1507, 1489, 1473, 1457, 1275, 1260, 819, 750, 693, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{N}_2\text{O}_6^+$ $[\text{M}+\text{H}]^+$ 411.1551, found 411.1552; HPLC analysis: **3aj**, 98% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 11.6$ min (major), 20.2 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-4-methylene-3-(3-nitrophenyl)pentanedioate (3ak)



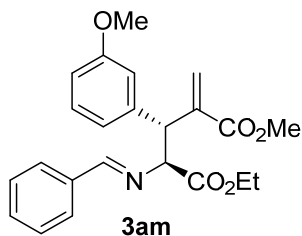
Prepared according to the general procedure (reaction time: 20 h) as described above in 70% yield (29.8 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -261.5$ (c 0.78, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.18 (t, $J = 2.0$ Hz, 1H), 7.94 (d, $J = 4.9$ Hz, 2H), 7.93 – 7.92 (m, 1H), 7.59 – 7.53 (m, 2H), 7.34 – 7.31 (m, 2H), 7.31 – 7.26 (m, 2H), 6.40 (s, 1H), 5.76 (s, 1H), 4.86 (d, $J = 9.1$ Hz, 1H), 4.47 (d, $J = 9.1$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.65 (s, 3H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.0, 165.2, 164.0, 147.1, 140.1, 138.6, 135.1, 130.4, 128.0, 127.6, 127.6, 127.5, 126.1, 123.0, 121.1, 74.5, 60.5, 51.2, 47.7, 13.0; IR (film) ν_{max} 3853, 3675, 3649, 3629, 3567, 2986, 1732, 1684, 1636, 1578, 1527, 1437, 1355, 1275, 1193, 1149, 764, 693, 418 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{N}_2\text{O}_6^+$ $[\text{M}+\text{H}]^+$ 411.1551, found 411.1546; HPLC analysis: **3ak**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 11.8$ min (major), 15.3 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-4-methylene-3-(4-nitrophenyl)pentanedioate (3al)



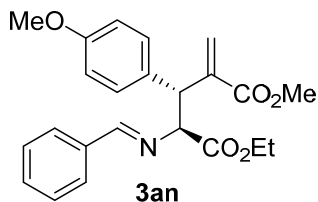
Prepared according to the general procedure (reaction time: 12 h) as described above in 78% yield (33.1 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -258.5$ (c 0.82, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.04 – 7.99 (m, 2H), 7.94 (s, 1H), 7.57 – 7.53 (m, 2H), 7.49 – 7.43 (m, 2H), 7.36 – 7.32 (m, 1H), 7.31 – 7.26 (m, 2H), 6.38 (s, 1H), 5.73 (s, 1H), 4.85 (d, $J = 9.2$ Hz, 1H), 4.47 (d, $J = 9.2$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.65 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 168.9, 165.2, 163.9, 145.9, 145.7, 138.7, 134.1, 130.5, 129.2, 127.6, 127.5, 126.1, 122.3, 74.6, 60.5, 51.2, 47.9, 13.0; IR (film) ν_{max} 3853, 3802, 3649, 3567, 2984, 1733, 1684, 1579, 1528, 1489, 1349, 1275, 1149, 1028, 750, 693, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{N}_2\text{O}_6^+$ $[\text{M}+\text{H}]^+$ 411.1551, found 411.1551; HPLC analysis: **3al**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 23.0$ min (major), 28.8 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-3-(3-methoxyphenyl)-4-methylenepentanedioate (3am)



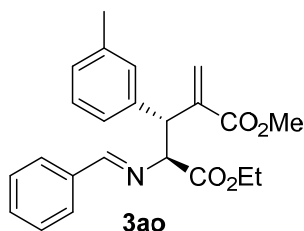
Prepared according to the general procedure (reaction time: 12 h) as described above in 76% yield (31.2 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -354.5$ (c 0.68, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.79 (s, 1H), 7.56 – 7.50 (m, 2H), 7.34 – 7.23 (m, 3H), 7.04 (t, $J = 7.9$ Hz, 1H), 6.83 – 6.76 (m, 2H), 6.59 (ddd, $J = 8.2, 2.6, 0.9$ Hz, 1H), 6.33 (s, 1H), 5.73 (s, 1H), 4.67 (d, $J = 9.8$ Hz, 1H), 4.37 (d, $J = 9.8$ Hz, 1H), 4.09 (qd, $J = 7.2, 1.1$ Hz, 2H), 3.64 (s, 3H), 3.60 (s, 3H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.7, 165.6, 163.3, 158.3, 139.5, 139.1, 134.6, 130.0, 128.0, 127.4, 127.39, 124.9, 120.5, 113.9, 111.6, 75.8, 60.2, 54.0, 51.0, 48.0, 13.0; IR (film) ν_{max} 3853, 2962, 1721, 1637, 1598, 1580, 1519, 1495, 1451, 1387, 1346, 1295, 1259, 1178, 1148, 1095, 1027, 959, 858, 803, 753, 711, 693 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{23}\text{H}_{26}\text{NO}_5^+$ $[\text{M}+\text{H}]^+$ 396.1805, found 396.1802; HPLC analysis: **3am**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 9.6$ min (major), 10.6 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-3-(4-methoxyphenyl)-4-methylenepentanedioate (3an)



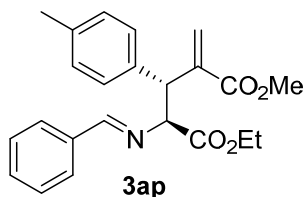
Prepared according to the general procedure (reaction time: 16 h) as described above in 67% yield (27.4 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -333.3$ (c 0.60, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.80 (s, 1H), 7.61 – 7.48 (m, 2H), 7.34 – 7.30 (m, 1H), 7.29 – 7.24 (m, 2H), 7.14 (d, $J = 8.7$ Hz, 2H), 6.67 (d, $J = 8.7$ Hz, 2H), 6.29 (s, 1H), 5.69 (s, 1H), 4.63 (d, $J = 9.6$ Hz, 1H), 4.38 (d, $J = 9.6$ Hz, 1H), 4.14 – 4.04 (m, 2H), 3.63 (d, $J = 2.7$ Hz, 6H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.8, 165.7, 163.3, 157.4, 139.9, 134.6, 123.0, 129.4, 129.3, 127.44, 127.4, 124.6, 112.5, 75.8, 60.1, 54.1, 51.0, 47.3, 13.0; IR (film) ν_{max} 3853, 3750, 3675, 2953, 1733, 1637, 1540, 1521, 1507, 1489, 1456, 1275, 1260, 1147, 1036, 820, 764, 694, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{23}\text{H}_{26}\text{NO}_5^+$ $[\text{M}+\text{H}]^+$ 396.1805, found 396.1804; HPLC analysis: **3an**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 11.5$ min (major), 14.6 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-4-methylene-3-(m-tolyl)pentanedioate (3ao)



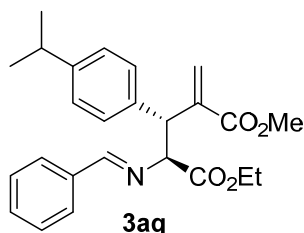
Prepared according to the general procedure (reaction time: 12 h) as described above in 86% yield (33.9 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -358.8$ (c 0.97, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.74 (s, 1H), 7.55 – 7.49 (m, 2H), 7.33 – 7.28 (m, 1H), 7.28 – 7.23 (m, 2H), 7.06 – 6.96 (m, 3H), 6.87 – 6.81 (m, 1H), 6.33 (s, 1H), 5.74 (s, 1H), 4.65 (d, $J = 9.9$ Hz, 1H), 4.36 (d, $J = 9.9$ Hz, 1H), 4.16 – 3.99 (m, 2H), 3.63 (s, 3H), 2.13 (s, 3H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.8, 165.7, 163.3, 139.6, 137.3, 136.5, 134.6, 129.9, 129.2, 127.4, 127.3, 126.9, 126.6, 125.1, 124.8, 75.9, 60.1, 51.0, 47.9, 20.3, 13.0; IR (film) ν_{max} 3853, 3675, 3649, 2984, 1724, 1684, 1559, 1521, 1489, 1457, 1437, 1275, 1260, 1146, 820, 764, 751, 694, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{23}\text{H}_{26}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 380.1856, found 380.1852; HPLC analysis: **3ao**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 6.7$ min (major), 7.6 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-4-methylene-3-(p-tolyl)pentanedioate (3ap)



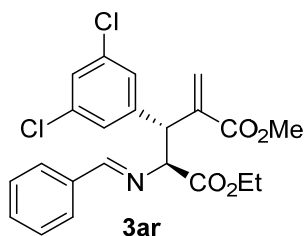
Prepared according to the general procedure (reaction time: 20 h) as described above in 74% yield (29.2 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -347.1$ (c 0.70, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.81 (s, 1H), 7.55 – 7.51 (m, 2H), 7.32 – 7.29 (m, 1H), 7.29 – 7.24 (m, 2H), 7.10 (d, $J = 8.1$ Hz, 2H), 6.93 (d, $J = 7.8$ Hz, 2H), 6.30 (s, 1H), 5.72 (s, 1H), 4.65 (d, $J = 9.8$ Hz, 1H), 4.40 (d, $J = 9.8$ Hz, 1H), 4.08 (qd, $J = 7.1, 1.6$ Hz, 2H), 3.63 (s, 3H), 2.15 (s, 3H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.8, 165.7, 163.3, 139.9, 135.4, 134.6, 134.3, 129.9, 128.1, 127.9, 127.4, 127.4, 124.7, 75.8, 60.1, 51.0, 47.7, 20.0, 13.0; IR (film) ν_{max} 3853, 3802, 3751, 3675, 3649, 3567, 2986, 1724, 1684, 1637, 1559, 1507, 1489, 1473, 1457, 1437, 1275, 1147, 815, 764, 693, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{23}\text{H}_{26}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 380.1856, found 380.1852; HPLC analysis: **3ap**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 7.8$ min (major), 11.6 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-3-(4-isopropylphenyl)-4-methylenepentanedioate (3aq)



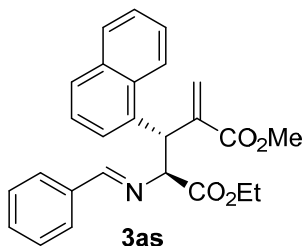
Prepared according to the general procedure (reaction time: 16 h) as described above in 79% yield (33.5 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a white solid. $[\alpha]_D^{25} = -326.9$ (c 0.67, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.71 (s, 1H), 7.52 – 7.46 (m, 2H), 7.34 – 7.28 (m, 1H), 7.28 – 7.23 (m, 2H), 7.14 – 7.08 (m, 2H), 7.01 – 6.93 (m, 2H), 6.31 (s, 1H), 5.73 (s, 1H), 4.64 (d, $J = 9.6$ Hz, 1H), 4.38 (d, $J = 9.6$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.63 (s, 3H), 2.71 (p, $J = 6.9$ Hz, 1H), 1.12 (t, $J = 7.1$ Hz, 3H), 1.08 (d, $J = 2.3$ Hz, 3H), 1.06 (d, $J = 2.3$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.9, 165.7, 163.3, 146.4, 139.7, 134.6, 129.9, 128.2, 127.4, 127.3, 125.2, 124.8, 75.8, 60.1, 51.0, 47.7, 32.6, 22.9, 22.8, 13.0; IR (film) ν_{max} 3853, 3802, 3751, 3675, 2959, 1725, 1653, 1636, 1559, 1507, 1457, 1275, 1260, 1147, 764, 750, 693, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{25}\text{H}_{30}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 408.2169, found 408.2169; HPLC analysis: **3aq**, 99% ee (OD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 5.2$ min (major), 6.0 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-3-(3,5-dichlorophenyl)-4-methylenepentanedioate (3ar)



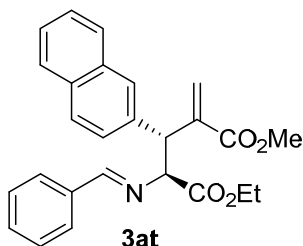
Prepared according to the general procedure (reaction time: 16 h) as described above in 85% yield (38.4 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -227.2$ (c 0.81, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.93 (s, 1H), 7.60 – 7.55 (m, 2H), 7.37 – 7.34 (m, 1H), 7.33 – 7.29 (m, 2H), 7.18 – 7.16 (m, 2H), 7.07 (t, $J = 1.9$ Hz, 1H), 6.38 (s, 1H), 5.71 (s, 1H), 4.68 (d, $J = 9.3$ Hz, 1H), 4.36 (d, $J = 9.3$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.67 (s, 3H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.0, 165.2, 163.9, 141.3, 138.5, 134.2, 133.5, 130.4, 127.6, 127.5, 127.5, 126.9, 126.2, 126.0, 74.6, 60.4, 51.2, 47.5, 13.0; IR (film) ν_{max} 3587, 3567, 2987, 1733, 1684, 1569, 1559, 1540, 1521, 1507, 1489, 1473, 1457, 1395, 1275, 1150, 1029, 859, 798, 764, 692 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{22}\text{Cl}_2\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 434.0920, found 434.0921; HPLC analysis: **3ar**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 5.8$ min (major), 6.9 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-4-methylene-3-(naphthalen-1-yl)pentanedioate (3as)



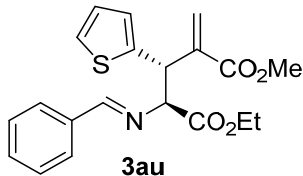
Prepared according to the general procedure (reaction time: 12 h) as described above in 62% yield (26.8 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -163.1$ (c 0.42, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.20 (d, $J = 8.6$ Hz, 1H), 7.77 (d, $J = 9.1$ Hz, 2H), 7.63 (d, $J = 8.1$ Hz, 1H), 7.57 (d, $J = 8.1$ Hz, 1H), 7.43 (t, $J = 7.7$ Hz, 1H), 7.34 (t, $J = 7.6$ Hz, 3H), 7.31 – 7.27 (m, 2H), 7.24 – 7.19 (m, 1H), 7.14 (d, $J = 7.5$ Hz, 1H), 6.31 (s, 1H), 5.66 (d, $J = 8.4$ Hz, 1H), 5.62 (s, 1H), 4.53 (d, $J = 8.4$ Hz, 1H), 4.02 (tq, $J = 7.1, 3.7$ Hz, 2H), 3.60 (s, 3H), 0.97 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.9, 165.9, 162.9, 139.5, 134.4, 132.8, 131.5, 129.8, 127.5, 127.5, 127.4, 127.3, 127.2, 126.6, 126.3, 124.9, 124.2, 124.0, 123.2, 75.5, 60.1, 51.1, 42.4, 12.9; IR (film) ν_{max} 3649, 3587, 2987, 1772, 1733, 1684, 1653, 1647, 1636, 1559, 1507, 1489, 1437, 1396, 1339, 1275, 1260, 764, 693, 458, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{26}\text{H}_{26}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 416.1856, found 416.1854; HPLC analysis: **3as**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 7.3$ min (major), 9.9 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-benzylidene)amino)-4-methylene-3-(naphthalen-2-yl)pentanedioate (3at)



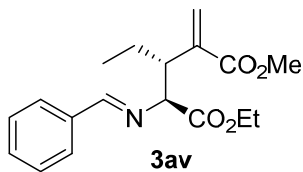
Prepared according to the general procedure (reaction time: 12 h) as described above in 90% yield (38.9 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -163.1$ (c 0.42, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.83 (s, 1H), 7.71 (d, $J = 1.7$ Hz, 1H), 7.65 (td, $J = 8.1, 2.7$ Hz, 2H), 7.61 (d, $J = 8.5$ Hz, 1H), 7.52 – 7.46 (m, 2H), 7.37 (dd, $J = 8.5, 1.8$ Hz, 1H), 7.32 (td, $J = 6.8, 6.1, 3.6$ Hz, 2H), 7.28 – 7.24 (m, 1H), 7.22 (dd, $J = 8.1, 6.4$ Hz, 2H), 6.37 (s, 1H), 5.79 (s, 1H), 4.89 (d, $J = 9.6$ Hz, 1H), 4.53 (d, $J = 9.6$ Hz, 1H), 4.09 (qd, $J = 7.2, 0.9$ Hz, 2H), 3.61 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.7, 165.6, 163.4, 139.6, 135.1, 134.4, 132.2, 131.4, 130.0, 127.4, 127.3, 127.1, 126.8, 126.6, 126.6, 126.4, 125.1, 124.8, 124.6, 75.7, 60.2, 51.0, 48.1, 13.0; IR (film) ν_{max} 3649, 3587, 2987, 1772, 1733, 1684, 1653, 1647, 1636, 1559, 1507, 1489, 1437, 1396, 1339, 1275, 1260, 764, 693, 458, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{26}\text{H}_{26}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 416.1856, found 416.1855; HPLC analysis: **3at**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 11.3$ min (major), 16.3 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-((E)-benzylidene)amino)-4-methylene-3-(thiophen-2-yl)pentanedioate (3au)



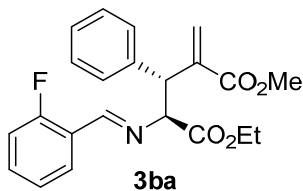
Prepared according to the general procedure (reaction time: 12 h) as described above in 65% yield (25.0 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -194.0$ (c 0.43, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.95 (s, 1H), 7.69 – 7.61 (m, 2H), 7.38 – 7.28 (m, 3H), 7.06 (dd, $J = 5.1, 1.2$ Hz, 1H), 6.91 (dd, $J = 3.7, 1.2$ Hz, 1H), 6.79 (dd, $J = 5.1, 3.5$ Hz, 1H), 6.32 (s, 1H), 5.72 (s, 1H), 5.00 (d, $J = 8.1$ Hz, 1H), 4.41 (d, $J = 8.1$ Hz, 1H), 4.08 (q, $J = 7.1$ Hz, 2H), 3.70 (s, 3H), 1.11 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.2, 165.5, 163.8, 140.4, 139.2, 134.6, 130.1, 127.6, 127.5, 127.5, 126.6, 126.1, 125.4, 124.0, 75.2, 60.2, 51.1, 43.8, 13.0; IR (film) ν_{max} 3587, 2988, 1772, 1684, 1647, 1577, 1540, 1507, 1489, 1457, 1275, 1261, 1150, 764, 750, 694, 477 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{20}\text{H}_{22}\text{NO}_4\text{S}^+$ $[\text{M}+\text{H}]^+$ 372.1264, found 372.1263; HPLC analysis: **3au**, 98% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 7.1$ min (major), 10.6 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-((E)-benzylidene)amino)-3-ethyl-4-methylenepentanedioate (3av)



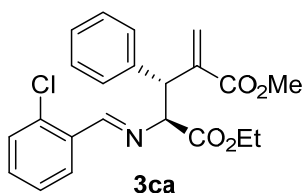
Prepared according to the general procedure (reaction time: 12 h) as described above in 78% yield (25.9 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -190.0$ (c 0.40, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.19 (s, 1H), 7.76 – 7.67 (m, 2H), 7.41 – 7.31 (m, 3H), 6.25 (s, 1H), 5.54 (s, 1H), 4.12 (d, $J = 8.5$ Hz, 2H), 4.07 (qd, $J = 7.1, 2.1$ Hz, 2H), 3.71 (s, 3H), 3.22 (ddd, $J = 10.6, 8.4, 4.1$ Hz, 1H), 1.20 (t, $J = 7.1$ Hz, 2H), 1.16 (t, $J = 7.1$ Hz, 3H), 0.74 (t, $J = 7.4$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 170.1, 166.1, 163.2, 138.5, 134.6, 130.1, 127.6, 127.6, 126.8, 75.7, 59.9, 50.8, 45.6, 21.5, 13.1, 10.4; IR (film) ν_{max} 2965, 1719, 1684, 1637, 1559, 1507, 1457, 1437, 1276, 1260, 1159, 764, 751, 694, 418 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{18}\text{H}_{23}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 318.1700, found 318.1698; HPLC analysis: **3av**, 98% ee (OD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 4.4$ min (major), 5.3 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-2-fluorobenzylidene)amino)-4-methylene-3-phenylpentanedioate (3ba)



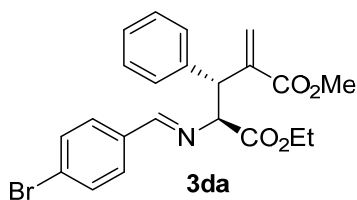
Prepared according to the general procedure (reaction time: 12 h) as described above in 73% yield (29.2 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -338.6$ (c 0.57, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.11 (s, 1H), 7.83 (td, $J = 7.5, 1.8$ Hz, 1H), 7.31 – 7.25 (m, 1H), 7.25 – 7.21 (m, 2H), 7.14 (dd, $J = 8.4, 6.8$ Hz, 2H), 7.09 – 7.02 (m, 2H), 6.91 (ddd, $J = 10.5, 8.3, 1.0$ Hz, 1H), 6.32 (s, 1H), 5.71 (s, 1H), 4.70 (d, $J = 9.7$ Hz, 1H), 4.46 (d, $J = 9.6$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.64 (s, 3H), 1.12 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.5, 165.6, 161.2 (d, $J = 253.2$ Hz), 156.8 (d, $J = 5.1$ Hz), 139.6, 137.4, 131.6 (d, $J = 8.7$ Hz), 128.2, 127.2, 127.0 (d, $J = 2.7$ Hz), 126.0, 124.9, 123.2 (d, $J = 3.6$ Hz), 122.2 (d, $J = 9.4$ Hz), 114.5 (d, $J = 21.0$ Hz), 75.9, 60.2, 51.0, 48.1, 13.0; IR (film) ν_{max} 3567, 2987, 1772, 1684, 1616, 1577, 1540, 1521, 1486, 1457, 1419, 1395, 1276, 1259, 1193, 1149, 1030, 811, 764, 750 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{FNO}_4^+ [\text{M}+\text{H}]^+$ 384.1606, found 384.1601; HPLC analysis: **3ba**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 7.5$ min (major), 9.0 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-2-chlorobenzylidene)amino)-4-methylene-3-phenylpentanedioate (3ca)



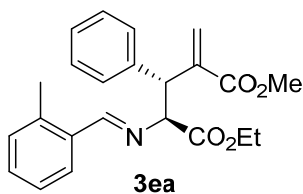
Prepared according to the general procedure (reaction time: 12 h) as described above in 78% yield (32.6 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -375.9$ (c 0.71, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.23 (s, 1H), 7.85 (dd, $J = 7.7, 1.5$ Hz, 1H), 7.25 – 7.18 (m, 5H), 7.17 – 7.16 (m, 1H), 7.14 (d, $J = 7.7$ Hz, 1H), 7.10 – 7.03 (m, 1H), 6.32 (s, 1H), 5.72 (s, 1H), 4.70 (d, $J = 9.8$ Hz, 1H), 4.52 (d, $J = 9.7$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.64 (s, 3H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.5, 165.6, 160.3, 139.6, 137.3, 134.2, 131.6, 130.9, 128.5, 128.2, 127.7, 127.2, 126.0, 125.8, 125.0, 75.6, 60.2, 51.0, 48.2, 13.0; IR (film) ν_{max} 3649, 2984, 1724, 1684, 1634, 1593, 1540, 1507, 1490, 1472, 1456, 1437, 1368, 1275, 1256, 1177, 1148, 1095, 1054, 1030, 954, 818 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{FNO}_4^+ [\text{M}+\text{H}]^+$ 400.1310, found 400.1307; HPLC analysis: **3ca**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 7.3$ min (major), 8.3 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-4-bromobenzylidene)amino)-4-methylene-3-phenylpentanedioate (3da)



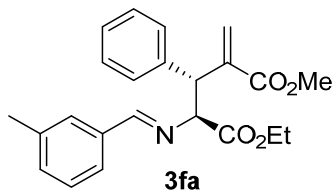
Prepared according to the general procedure (reaction time: 12 h) as described above in 78% yield (35.9 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -181.6$ (c 0.73, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.69 (s, 1H), 7.42 – 7.35 (m, 4H), 7.20 (d, $J = 6.2$ Hz, 2H), 7.13 (t, $J = 7.5$ Hz, 2H), 7.07 – 7.02 (m, 1H), 6.32 (s, 1H), 5.72 (s, 1H), 4.66 (d, $J = 9.8$ Hz, 1H), 4.39 (d, $J = 9.7$ Hz, 1H), 4.09 (q, $J = 7.0$ Hz, 2H), 3.63 (s, 2H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.5, 165.6, 162.1, 139.6, 137.4, 133.4, 130.7, 128.8, 128.2, 127.2, 126.8, 126.0, 124.9, 124.6, 75.7, 60.2, 51.0, 48.1, 13.0; IR (film) ν_{max} 3567, 2986, 1772, 1733, 1684, 1590, 1540, 1521, 1507, 1489, 1473, 1457, 1437, 1419, 1374, 1275, 1193, 1148, 1011, 822 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{BrNO}_4^+$ $[\text{M}+\text{H}]^+$ 444.0805, found 444.0804; HPLC analysis: **3da**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 12.1$ min (major).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-2-methylbenzylidene)amino)-4-methylene-3-phenylpentanedioate (3ea)



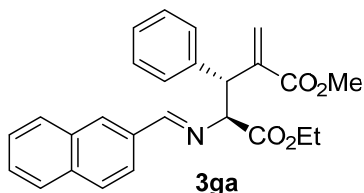
Prepared according to the general procedure (reaction time: 12 h) as described above in 81% yield (32.1 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -221.4$ (c 0.81, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.05 (s, 1H), 7.63 (dd, $J = 7.8, 1.4$ Hz, 1H), 7.25 – 7.21 (m, 2H), 7.18 – 7.12 (m, 4H), 7.11 – 7.04 (m, 3H), 7.00 (d, $J = 7.5$ Hz, 1H), 6.32 (s, 1H), 5.74 (s, 1H), 4.69 (d, $J = 9.9$ Hz, 1H), 4.43 (d, $J = 9.9$ Hz, 1H), 4.10 (qd, $J = 7.1, 2.3$ Hz, 2H), 3.63 (s, 3H), 2.13 (s, 3H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.8, 165.6, 162.4, 139.7, 137.5, 136.8, 132.6, 129.5, 128.3, 127.2, 127.0, 125.9, 125.0, 124.8, 76.4, 60.1, 51.0, 48.1, 18.1, 13.0; IR (film) ν_{max} 3567, 2986, 1772, 1733, 1684, 1653, 1647, 1635, 1602, 1559, 1540, 1521, 1507, 1489, 1473, 1457, 1396, 1275, 1260, 1147, 764 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{23}\text{H}_{26}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 380.1856, found 380.1851; HPLC analysis: **3ea**, 95% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 6.5$ min (major), 8.2 min (minor).

1-Ethyl 5-methyl (2S,3R)-2-(((E)-3-methylbenzylidene)amino)-4-methylene-3-phenylpentanedioate (3fa)



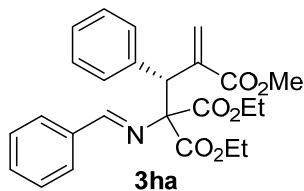
Prepared according to the general procedure (reaction time: 16 h) as described above in 81% yield (32.0 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -331.6$ (c 0.57, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.74 (s, 1H), 7.37 (s, 1H), 7.26 (d, $J = 7.3$ Hz, 1H), 7.23 – 7.20 (m, 2H), 7.16 – 7.10 (m, 5H), 7.05 (t, $J = 7.3$ Hz, 1H), 6.32 (s, 1H), 5.73 (s, 1H), 4.69 (d, $J = 9.8$ Hz, 1H), 4.40 (d, $J = 9.8$ Hz, 1H), 4.09 (q, $J = 7.1$ Hz, 2H), 3.63 (s, 3H), 2.26 (s, 3H), 1.13 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.8, 165.6, 163.6, 139.7, 137.5, 137.1, 134.5, 130.8, 128.2, 127.6, 127.2, 127.1, 125.9, 124.9, 124.8, 75.9, 60.2, 51.1, 48.1, 20.2, 13.0; IR (film) ν_{max} 3567, 3005, 1792, 1734, 1684, 1647, 1636, 1576, 1540, 1521, 1489, 1473, 1457, 1437, 1419, 1396, 1275, 1260, 1147, 764, 750, 705 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{23}\text{H}_{26}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 380.1856, found 380.1852; HPLC analysis: **3fa**, 99% ee (OD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 6.0$ min (minor), 7.9 min (major).

1-Ethyl 5-methyl (2S,3R)-4-methylene-2-(((E)-naphthalen-2-ylmethylene)amino)-3-phenylpentanedioate (3ga)



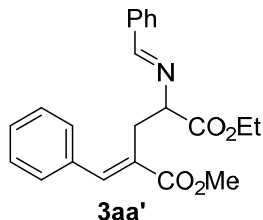
Prepared according to the general procedure (reaction time: 12 h) as described above in 89% yield (38.3 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -266.7$ (c 0.60, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.91 (s, 1H), 7.82 (dd, $J = 8.5, 1.6$ Hz, 1H), 7.79 – 7.69 (m, 4H), 7.41 (pd, $J = 6.9, 1.5$ Hz, 2H), 7.26 – 7.22 (m, 2H), 7.12 (t, $J = 7.6$ Hz, 2H), 7.06 – 7.00 (m, 1H), 6.34 (s, 1H), 5.76 (s, 1H), 4.72 (d, $J = 9.8$ Hz, 1H), 4.46 (d, $J = 9.8$ Hz, 1H), 4.11 (q, $J = 7.1$ Hz, 2H), 3.64 (s, 3H), 1.14 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 169.8, 165.7, 163.4, 139.7, 137.5, 133.8, 132.2, 131.8, 129.4, 128.3, 127.6, 127.3, 127.2, 126.8, 126.3, 125.9, 125.4, 124.9, 122.9, 76.0, 60.2, 51.0, 48.2, 13.0; IR (film) ν_{max} 3567, 2986, 1772, 1684, 1653, 1576, 1559, 1521, 1507, 1490, 1437, 1396, 1275, 1260, 1148, 861, 822, 764, 750, 705, 478 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{26}\text{H}_{26}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 416.1856, found 416.1854; HPLC analysis: **3ga**, 99% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_R = 15.8$ min (major), 22.6 min (minor).

1,1-Diethyl 3-methyl (R,E)-1-(benzylideneamino)-2-phenylbut-3-ene-1,1,3-tricarboxylate (3ha)



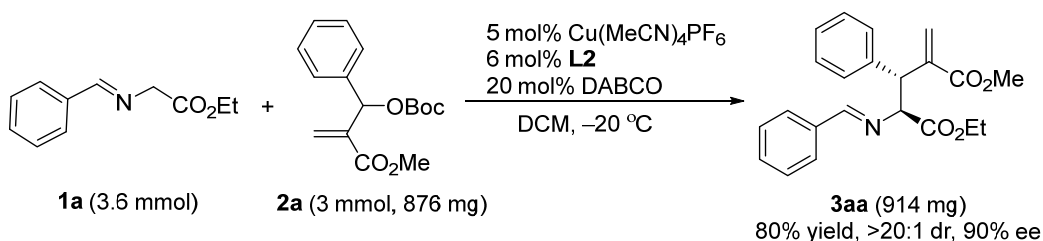
Prepared according to the general procedure (reaction time: 16 h) as described above in 69% yield (31.2 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. $[\alpha]_D^{25} = -59.6$ (c 0.47, CH_2Cl_2); ^1H NMR (500 MHz, CDCl_3) δ 8.06 (s, 1H), 7.77 – 7.71 (m, 2H), 7.49 – 7.43 (m, 2H), 7.42 – 7.36 (m, 3H), 7.15 – 7.05 (m, 3H), 6.35 (s, 1H), 6.32 (s, 1H), 5.24 (s, 1H), 4.21 – 4.11 (m, 2H), 4.01 (q, $J = 7.1$ Hz, 2H), 3.66 (s, 3H), 1.17 (t, $J = 7.1$ Hz, 3H), 1.03 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (126 MHz, CDCl_3) δ 167.2, 166.8, 166.6, 164.7, 139.3, 137.7, 135.2, 130.4, 129.6, 127.7, 127.6, 127.2, 126.7, 125.9, 78.5, 61.1, 60.9, 51.1, 48.5, 12.9, 12.8; IR (film) ν_{max} 2983, 1739, 1684, 1646, 1559, 1507, 1496, 1456, 1388, 1368, 1277, 1235, 1198, 1149, 1096, 1052, 860, 804, 751, 703, 419 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{25}\text{H}_{28}\text{NO}_6^+$ $[\text{M}+\text{H}]^+$ 438.1911, found 438.1906; HPLC analysis: **3ha**, 50% ee (AD-H, isopropanol : hexane = 10:90, 1.0 mL/min, UV: 254 nm), $t_{\text{R}} = 7.1$ min (major), 11.1 min (minor).

5-Ethyl 1-methyl 2-((E)-benzylidene)-4-(((E)-benzylidene)amino)pentanedioate (3aa')



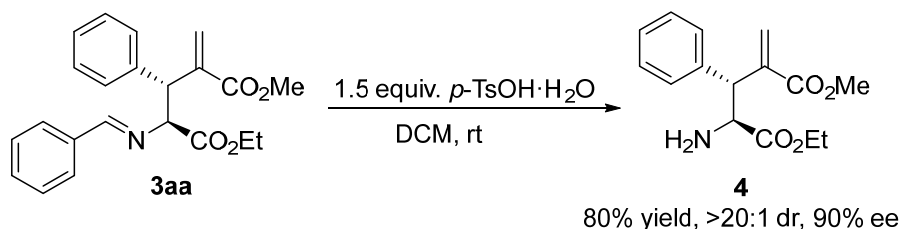
Prepared according to the general procedure (reaction time: 24 h) as described above in 43% yield (15.7 mg). It was purified by flash chromatography (10% EtOAc/PE) to afford a yellow oil. ^1H NMR (500 MHz, CDCl_3) δ 8.15 (s, 1H), 7.76 (s, 1H), 7.72 – 7.64 (m, 2H), 7.61 – 7.54 (m, 2H), 7.43 – 7.31 (m, 6H), 4.37 (dd, $J = 9.7, 4.6$ Hz, 1H), 4.21 – 4.12 (m, 2H), 3.80 (s, 3H), 3.34 (dd, $J = 13.9, 9.6$ Hz, 1H), 3.22 (dd, $J = 13.9, 4.6$ Hz, 1H), 1.25 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (126 MHz, CDCl_3) δ 171.6, 168.4, 165.4, 163.7, 142.6, 135.6, 135.0, 131.0, 129.6, 128.7, 128.6, 128.5, 128.4, 71.8, 61.2, 52.1, 31.3, 14.2; IR (film) ν_{max} 3649, 2985, 1724, 1638, 1581, 1491, 1452, 1275, 1259, 1182, 1148, 1030, 764, 751, 694 cm^{-1} ; HRMS (ESI) calcd for $\text{C}_{22}\text{H}_{23}\text{NO}_4\text{Na}^+$ $[\text{M}+\text{H}]^+$ 388.1519, found 388.1513.

Scale-up Synthesis of the Product 3aa



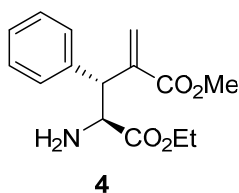
Under argon atmosphere, to a mixture of azomethine ylide **1a** (3.6 mmol), MBH carbonate **2a** (3 mmol, 876 mg), the catalyst DABCO (20 mol%, 0.6 mmol, 69 mg), $\text{Cu}(\text{MeCN})_4\text{PF}_6$ (5 mol%, 0.15 mmol, 54 mg), the chiral ligand **L2** (6 mol%, 0.18 mmol, 90 mg) in a Schlenk tube, 30 mL of CH_2Cl_2 was added at $-20\text{ }^\circ\text{C}$. The resulting mixture was stirred until the starting material was completely consumed (monitored by TLC) and then was concentrated to dryness. The residue was purified through flash column chromatography (10% EtOAc / Petroleum) to afford the corresponding allylation products **3aa** in 80% yield (914 mg) with >20:1 dr and 90% ee.

Transformation of the Product 3aa



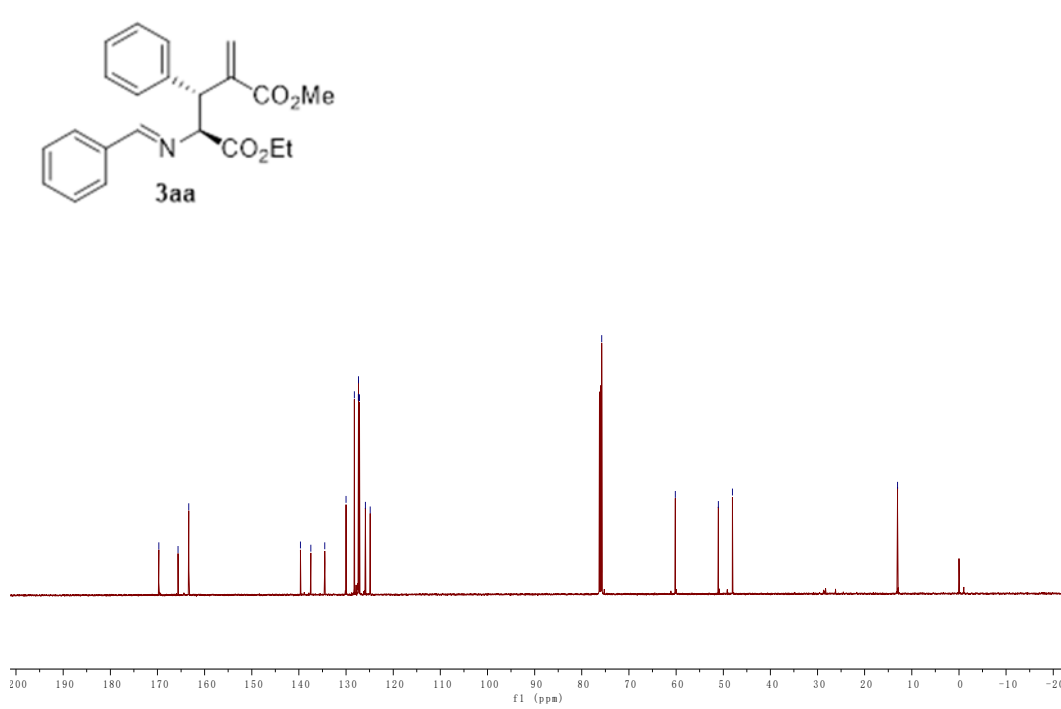
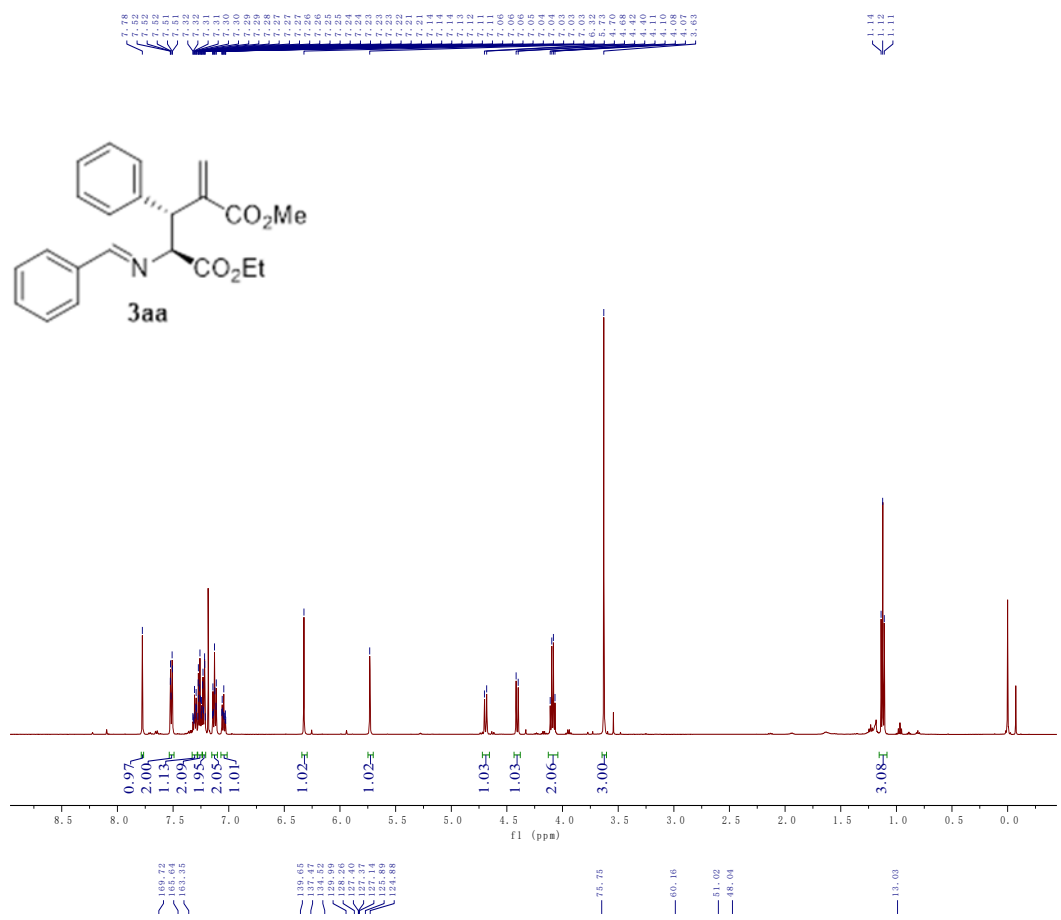
The product **3aa** (0.1 mmol) were dissolved in dichloromethane (1 mL), and then $p\text{-TsOH}\cdot\text{H}_2\text{O}$ (0.15 mmol, 1.5 equiv.) was added. After stirring at room temperature for 4 h, the mixture was purified by flash column chromatography on silica gel (petroleum ether/EtOAc 1:1) to furnish a colorless oil **4** (23.5 mg, 80% yield with >20:1 dr and 90% ee).

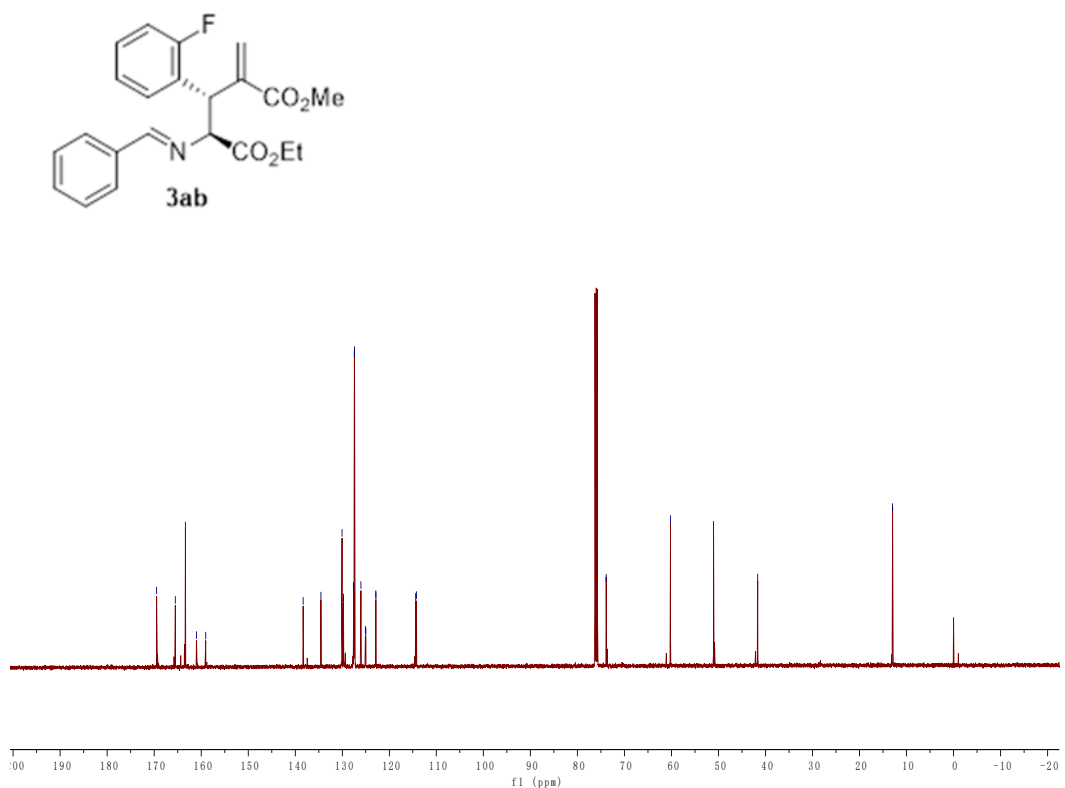
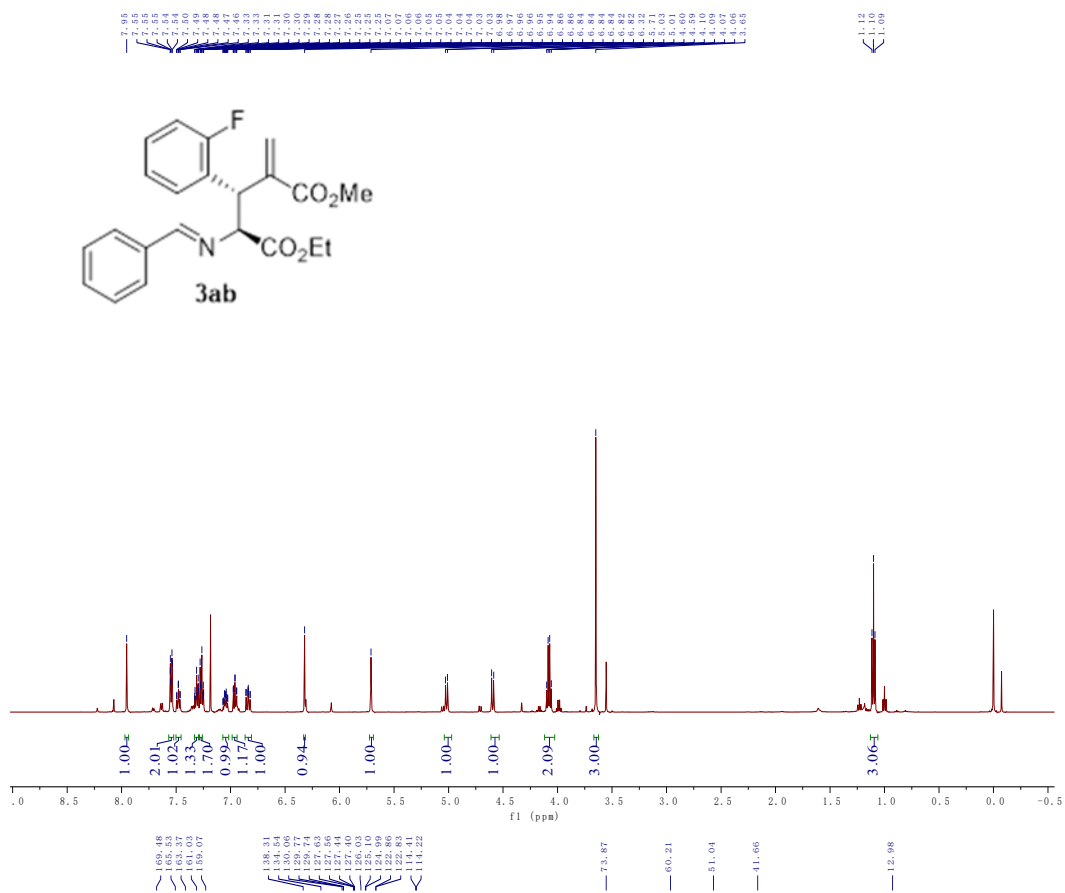
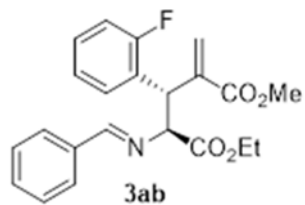
1-Ethyl 5-methyl (2S,3R)-2-amino-4-methylene-3-phenylpentanedioate (**4**)

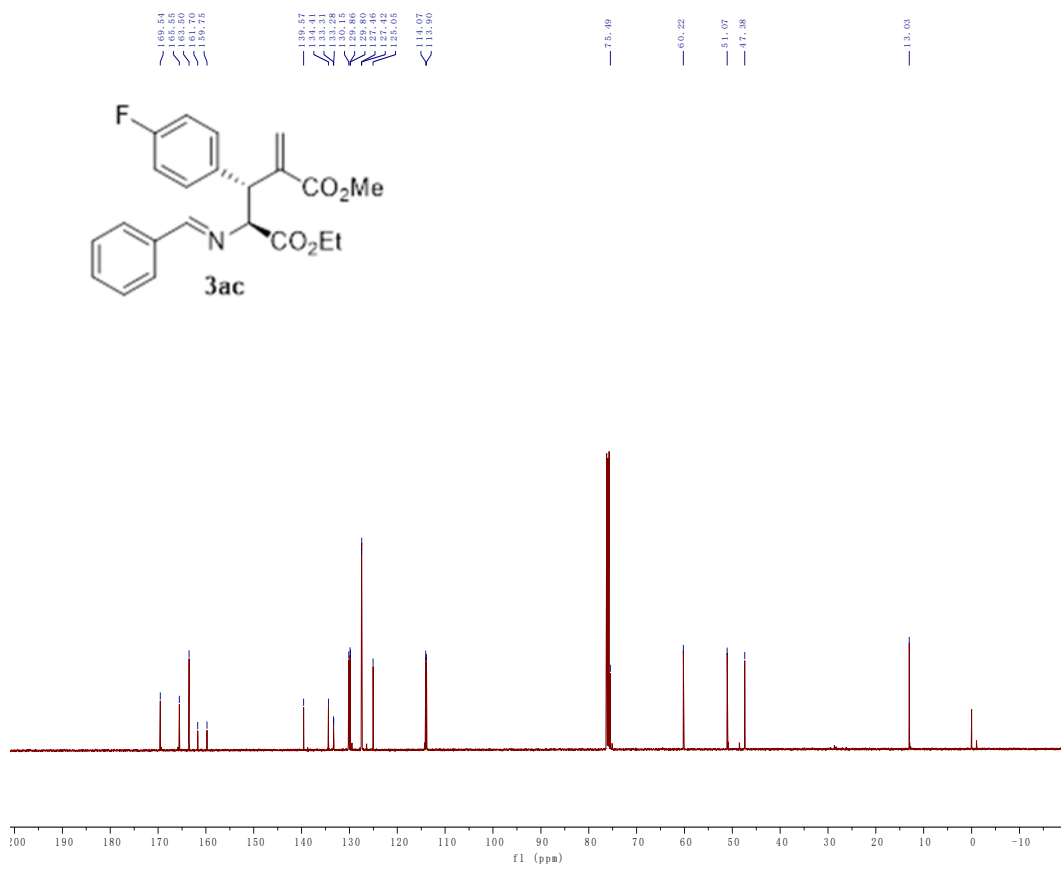
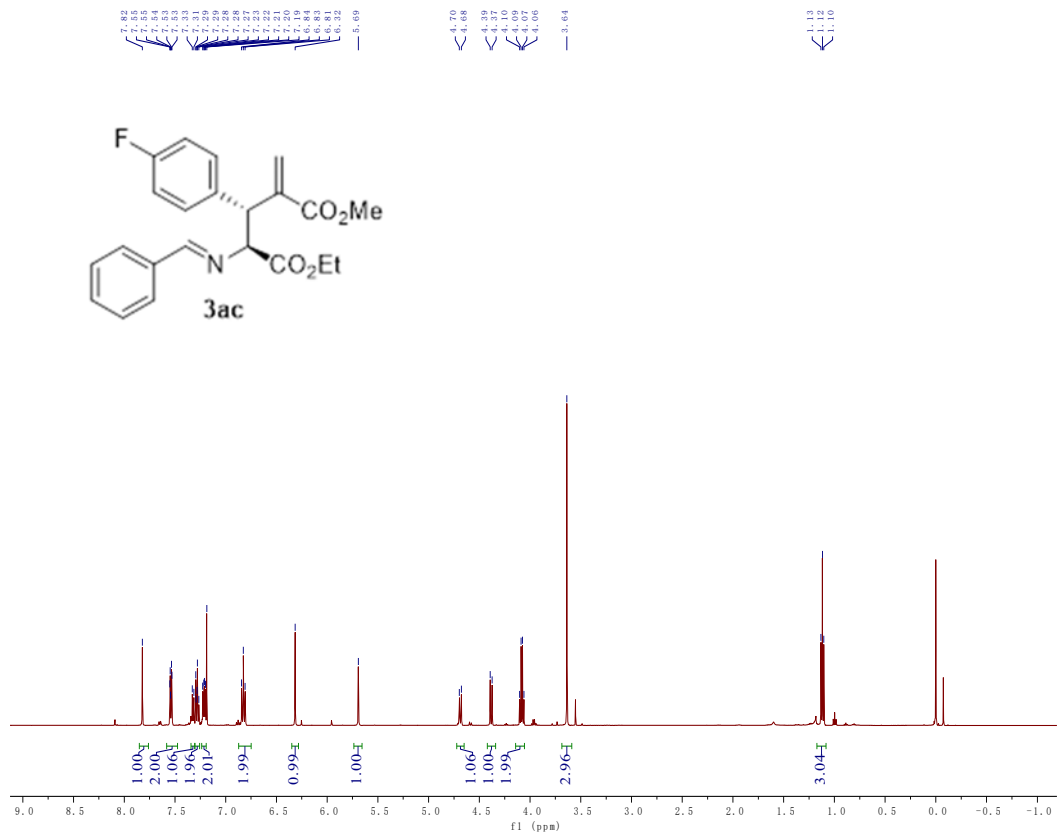


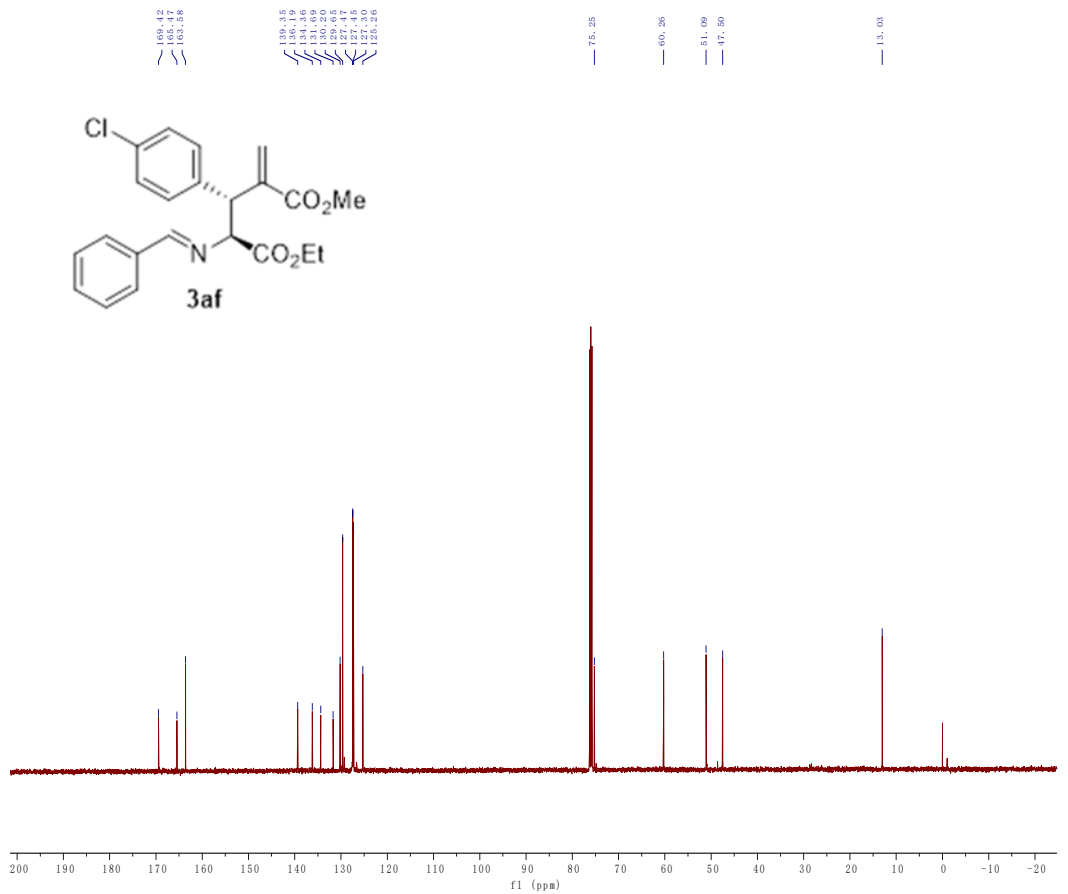
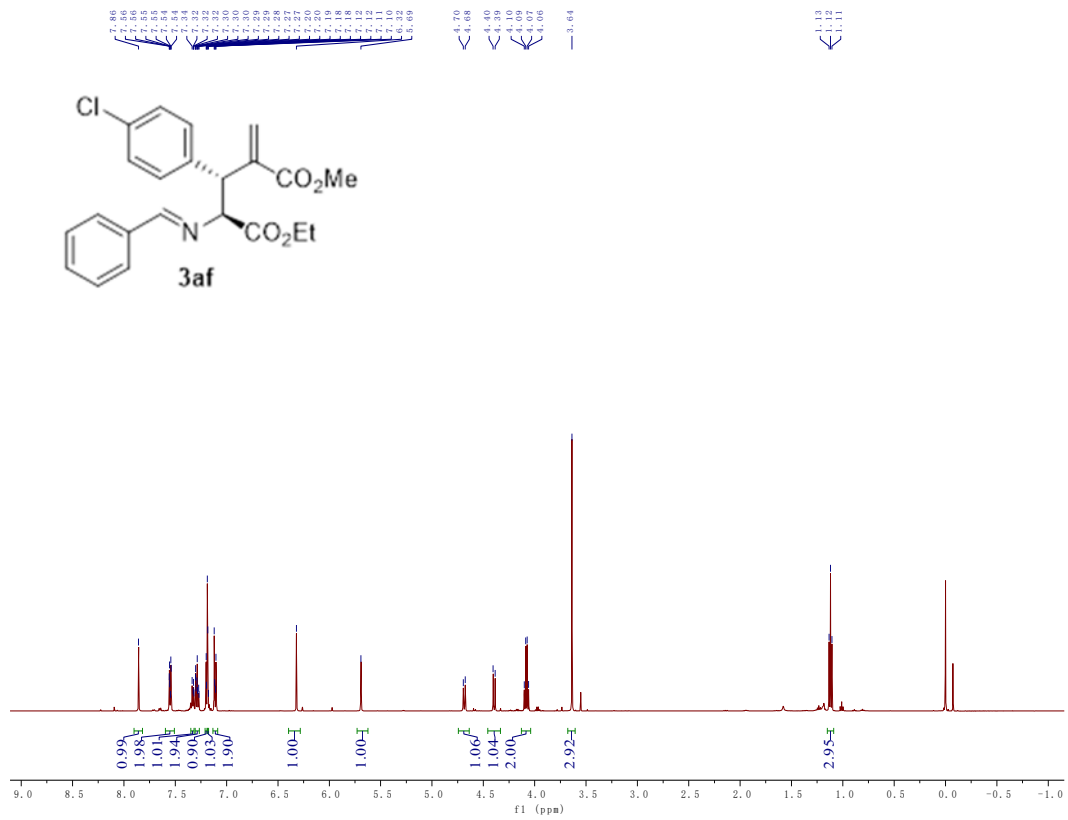
Prepared according to the general procedure (reaction time: 16 h) as described above in 80% yield (23.5 mg). It was purified by flash chromatography (50% EtOAc/PE) to afford colorless oil. $[\alpha]_D^{25} = 11.3$ (c 0.71, CH_2Cl_2); $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.34 – 7.21 (m, 5H), 6.37 (s, 1H), 5.98 (s, 1H), 4.25 (d, $J = 8.0$ Hz, 1H), 4.15 (q, $J = 7.1$ Hz, 2H), 4.06 (d, $J = 8.0$ Hz, 1H), 3.68 (s, 3H), 1.24 (t, $J = 7.1$ Hz, 3H); $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 174.2, 166.7, 140.9, 138.2, 129.0, 128.6, 127.3, 126.1, 61.1, 57.4, 52.0, 50.7, 14.1; HRMS (ESI) calcd for $\text{C}_{15}\text{H}_{20}\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ 278.1387, found 278.1383; HPLC analysis: **4**, 90% ee (AD-H, isopropanol : hexane = 40:60, 1.0 mL/min, UV: 254 nm), $t_R = 5.6$ min (minor), 6.8 min (major).

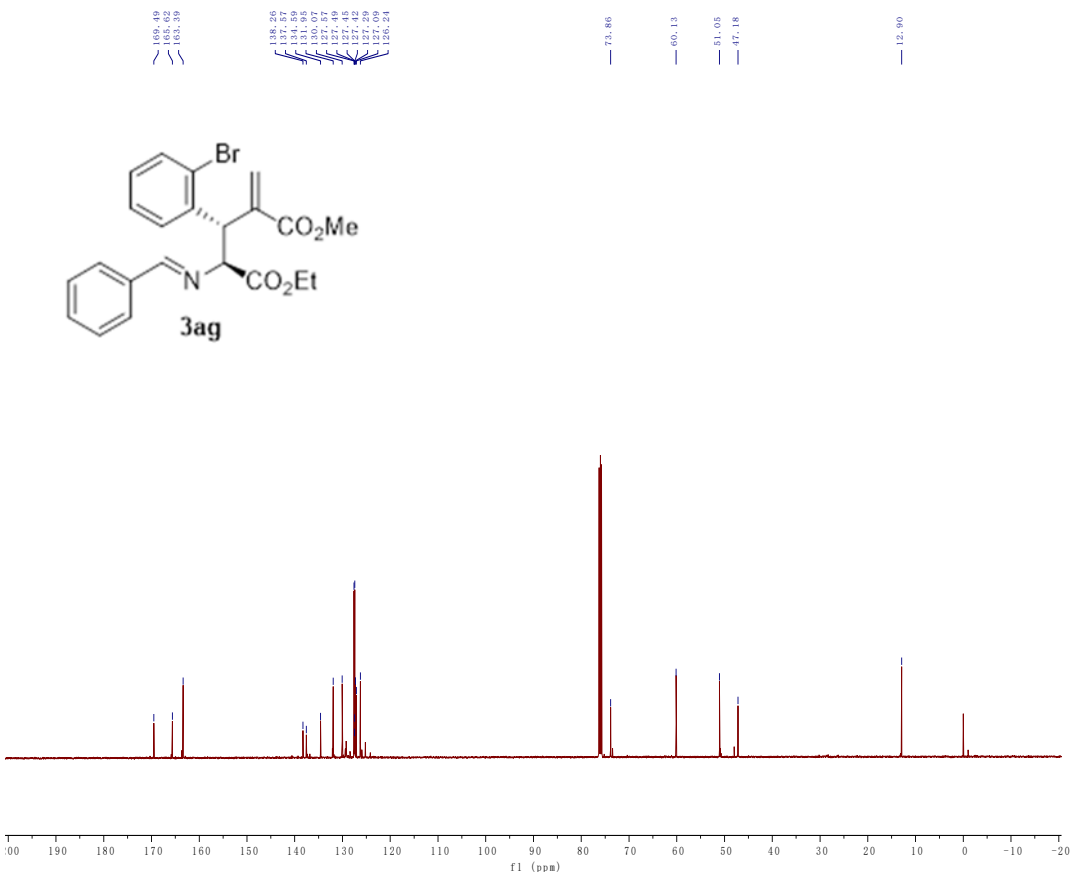
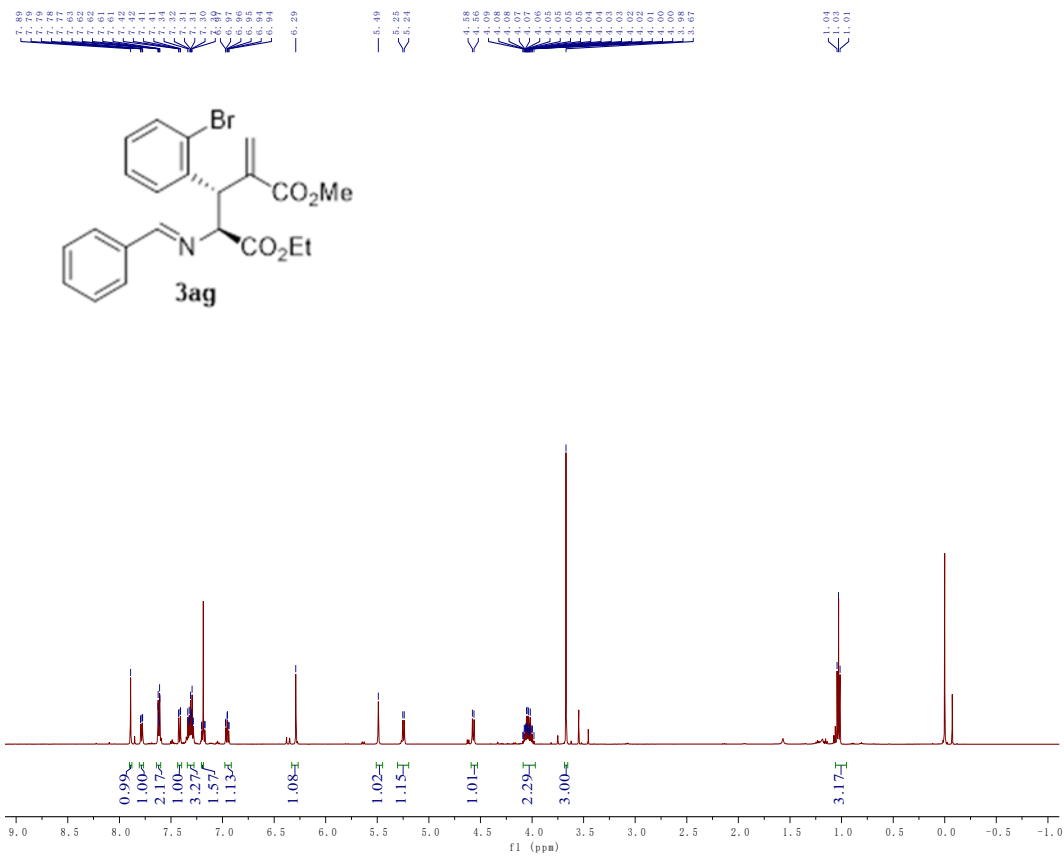
¹H and ¹³C NMR Spectra of All Products

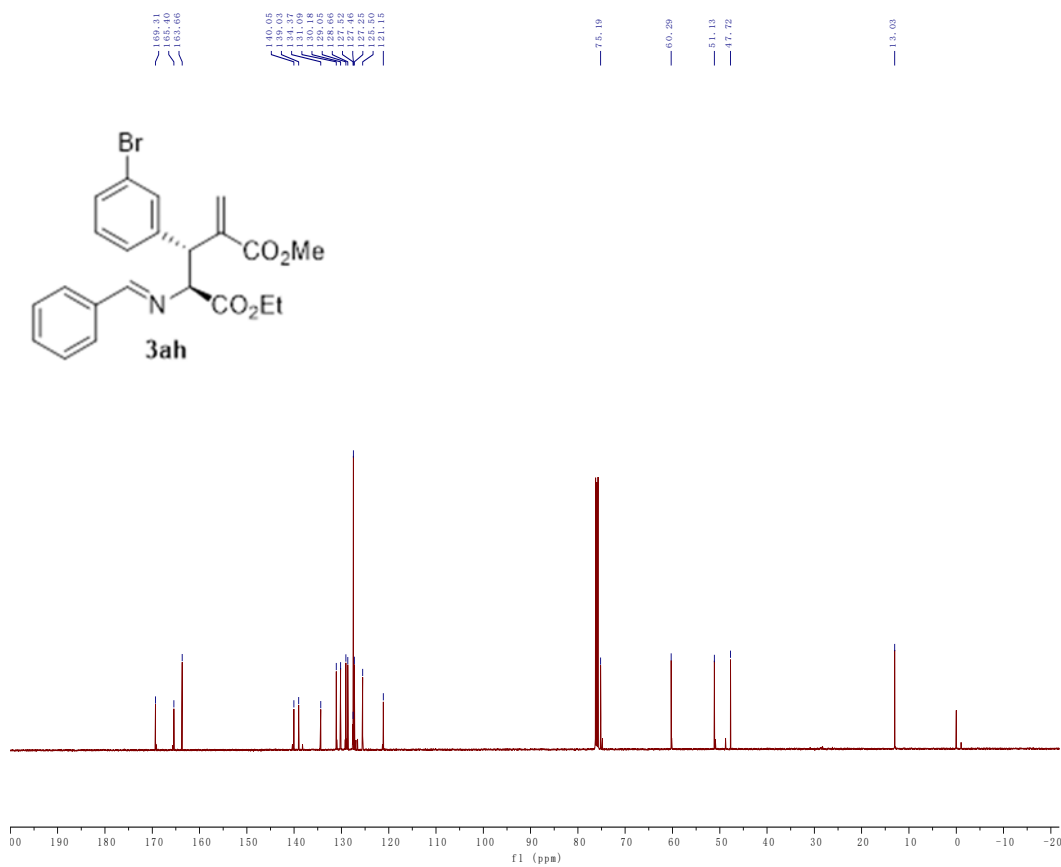
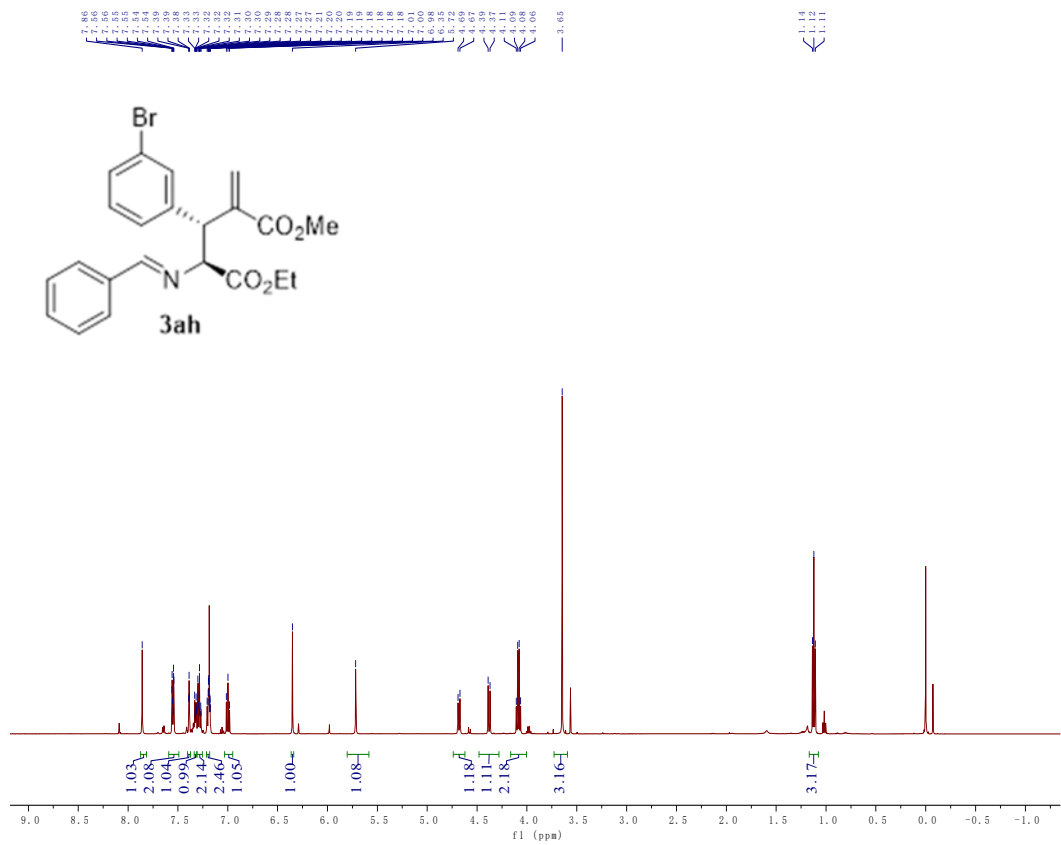


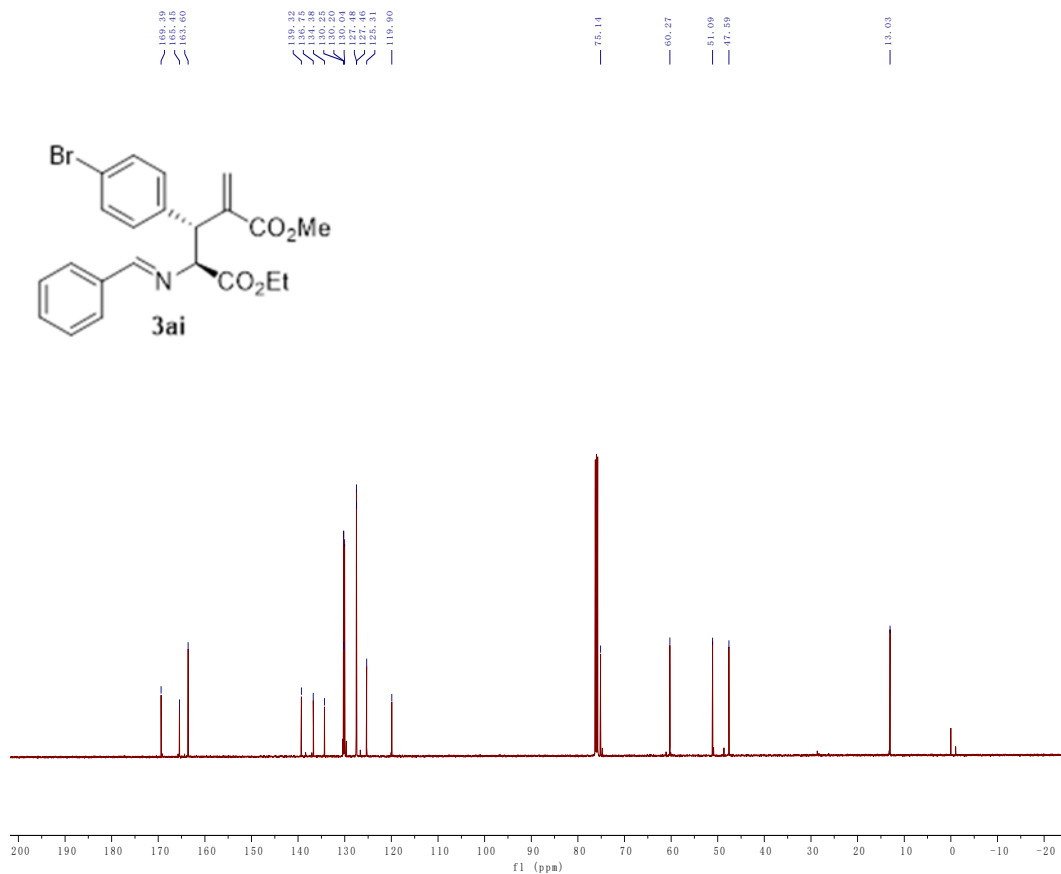
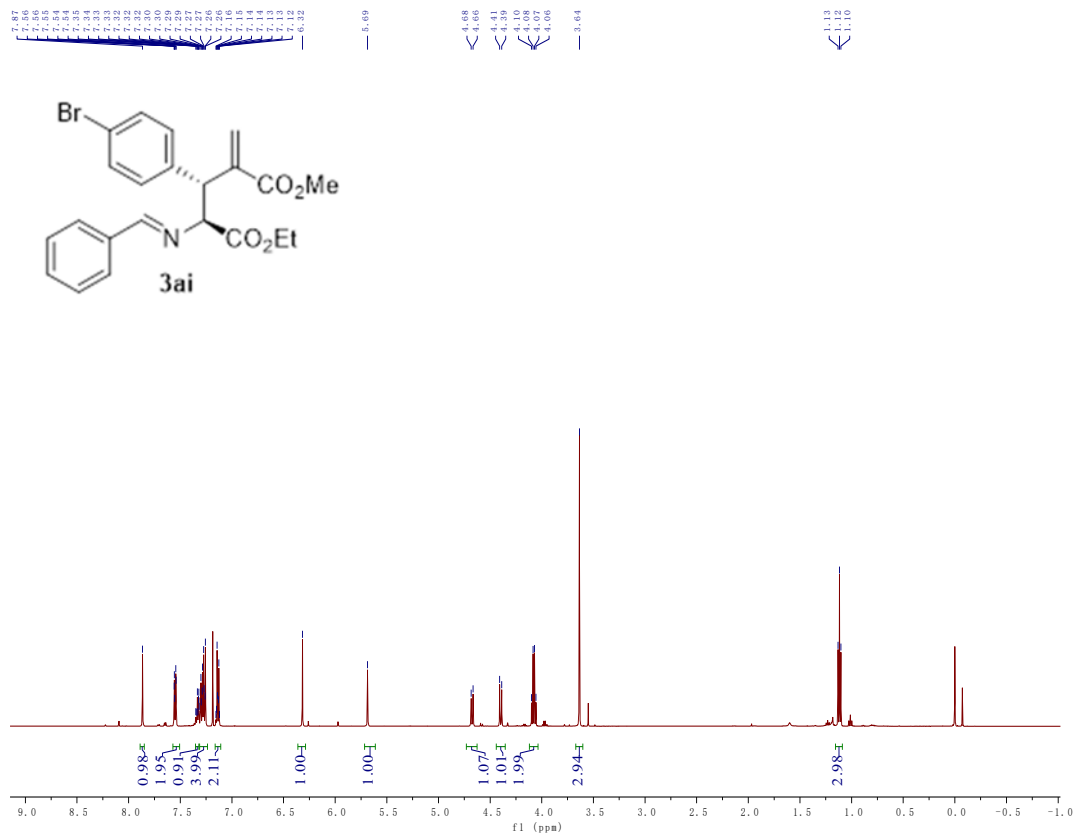


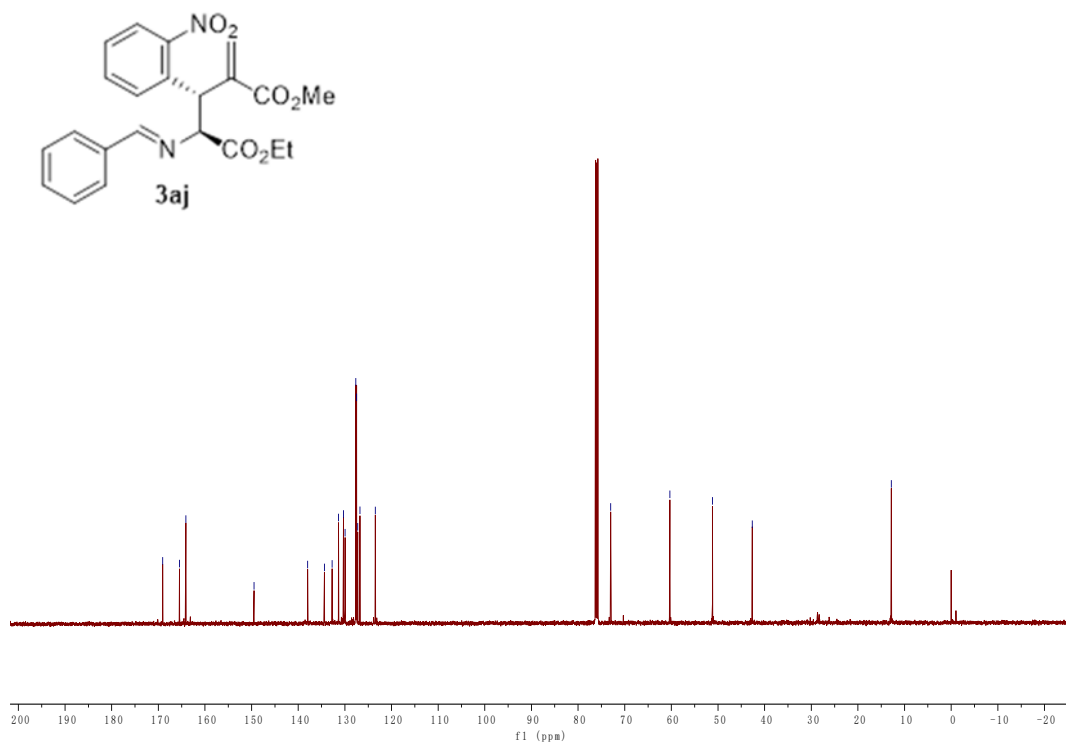
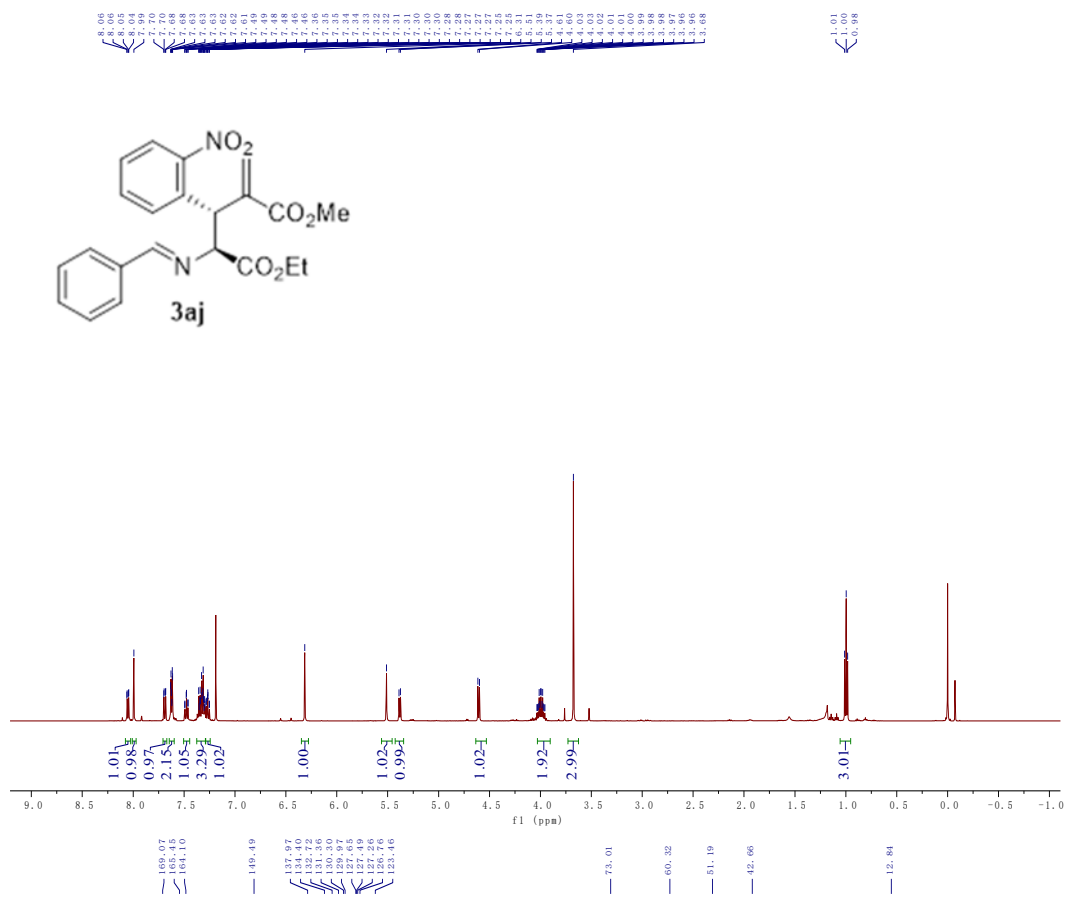


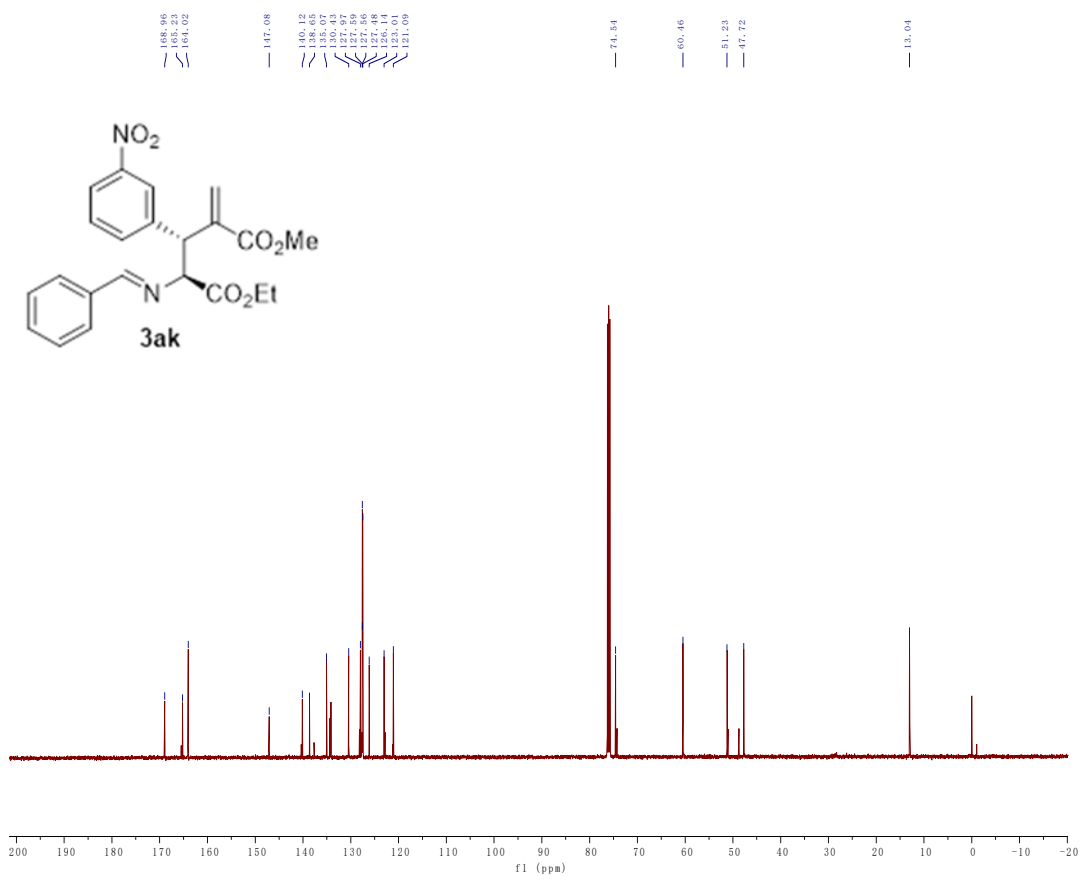
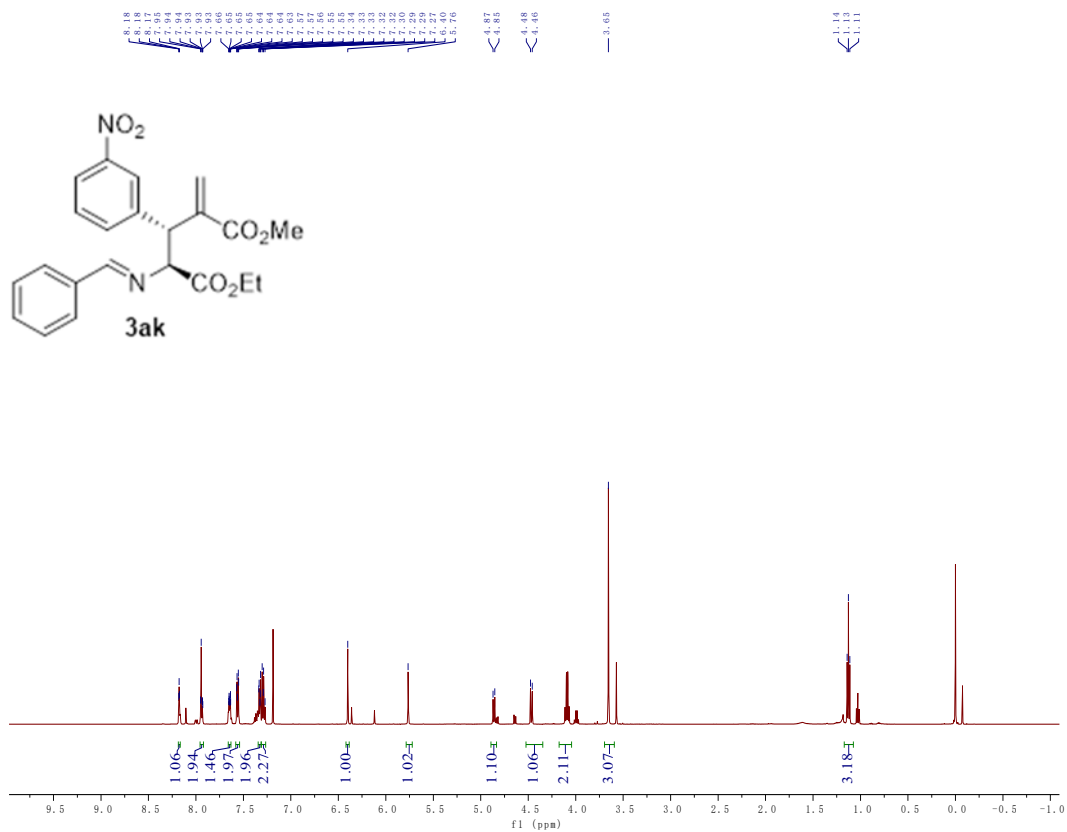


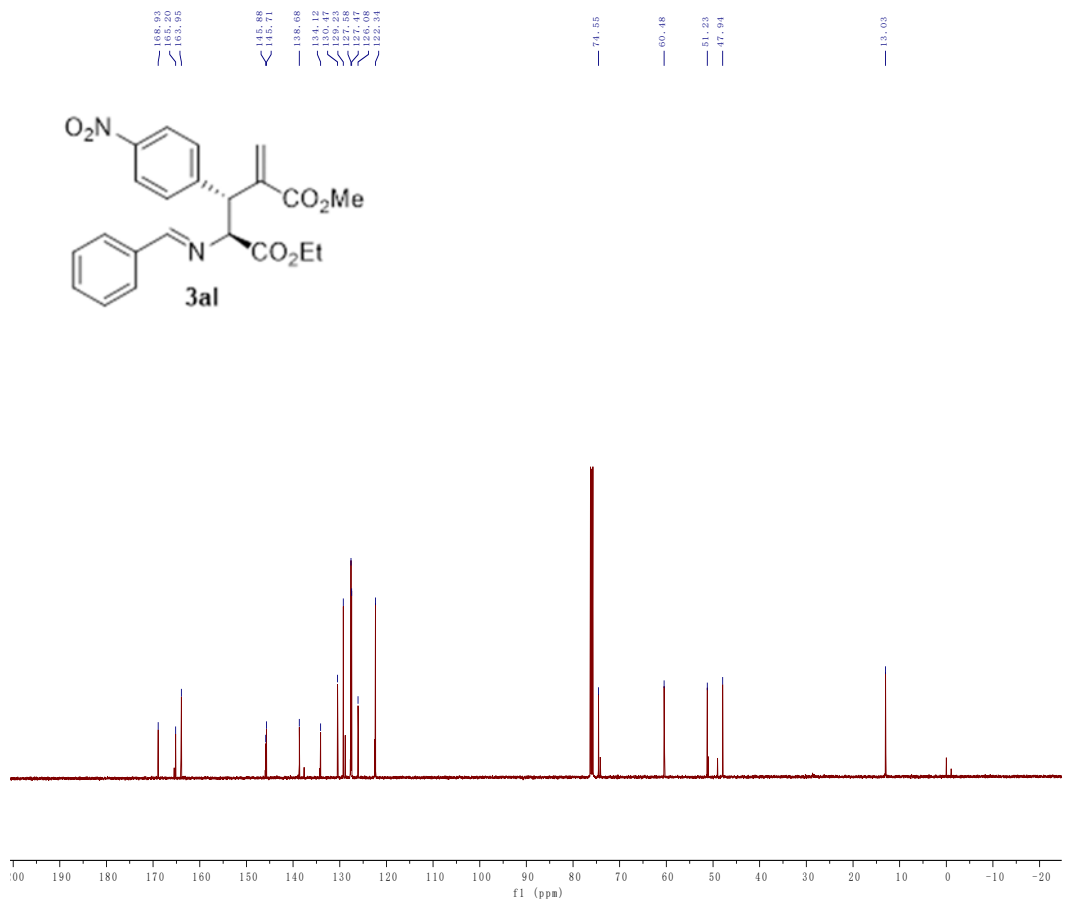
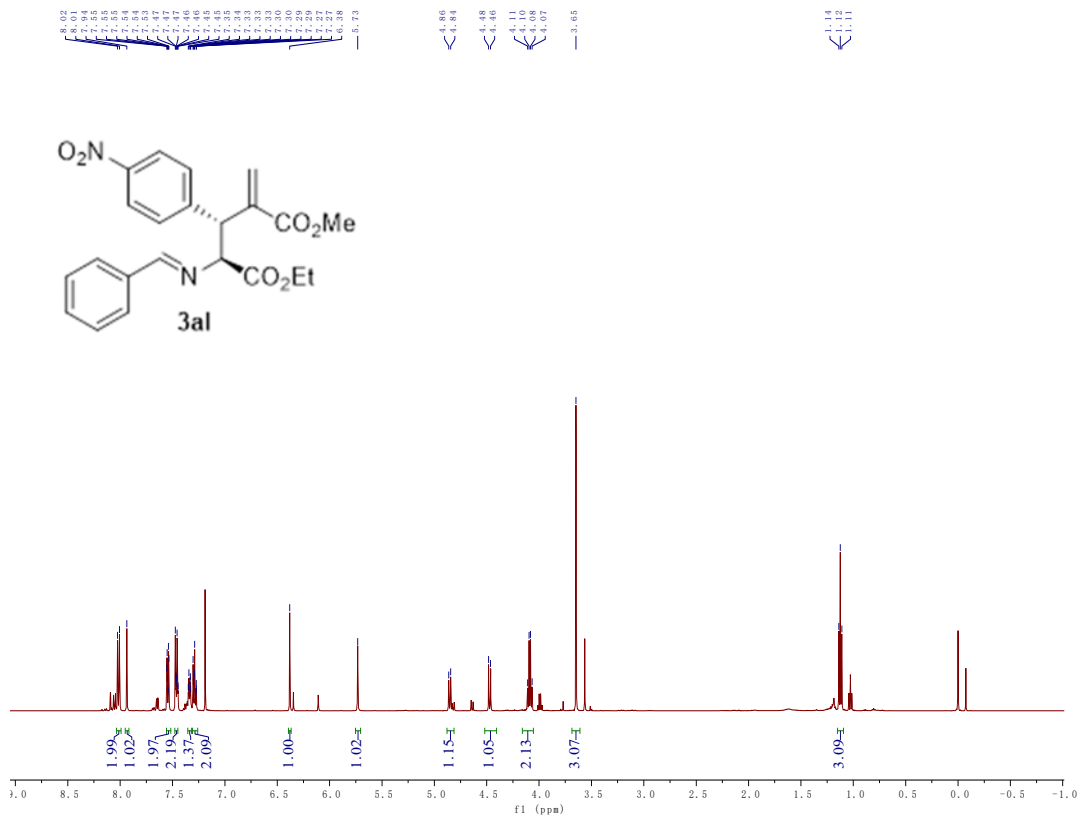


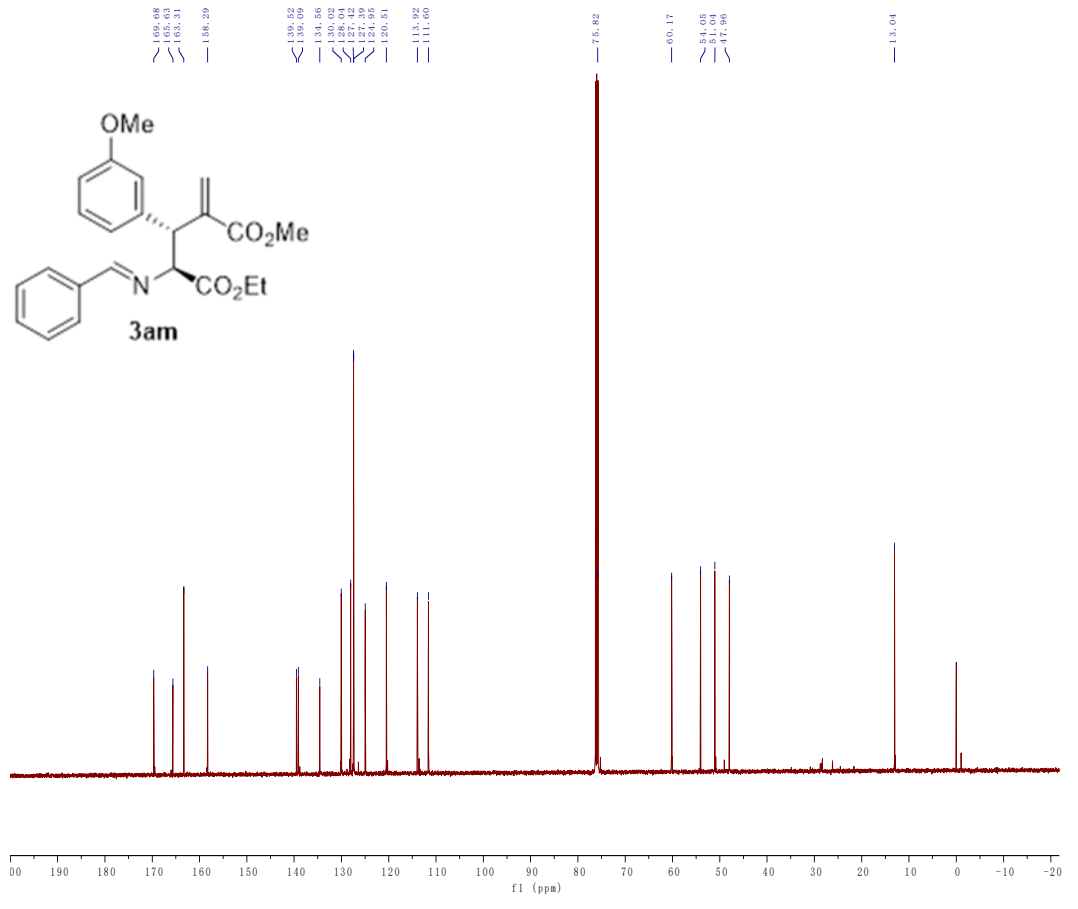
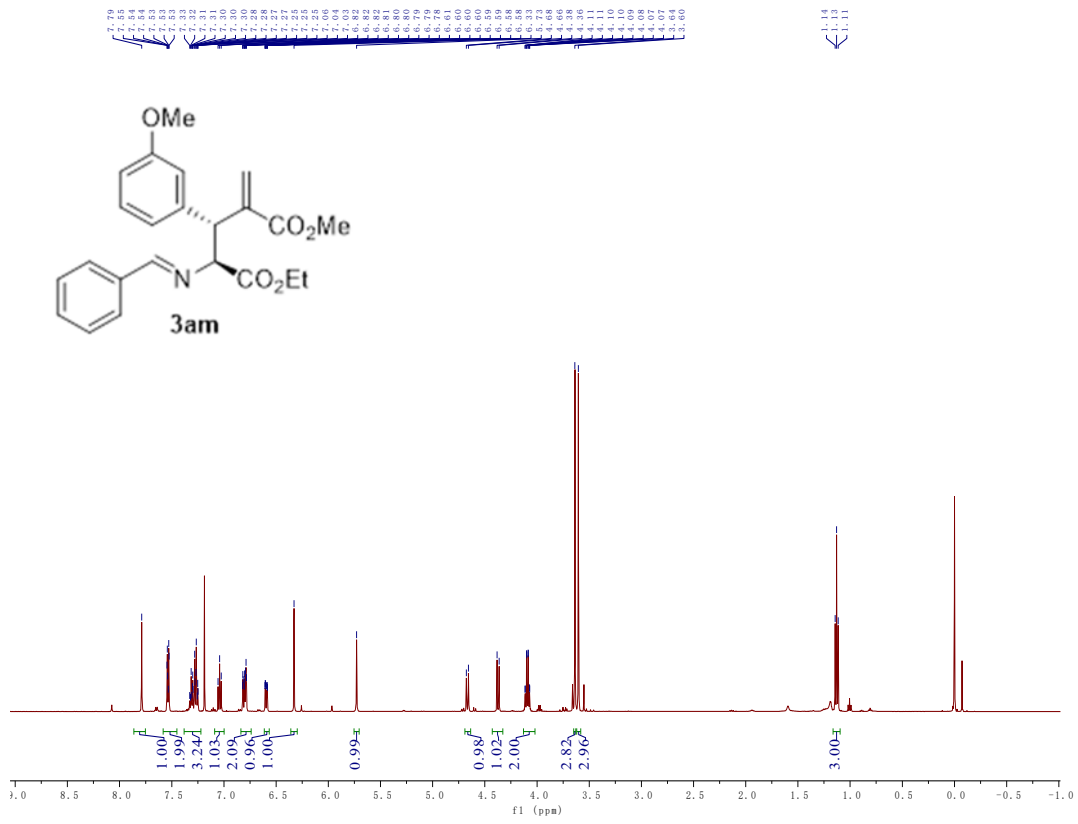


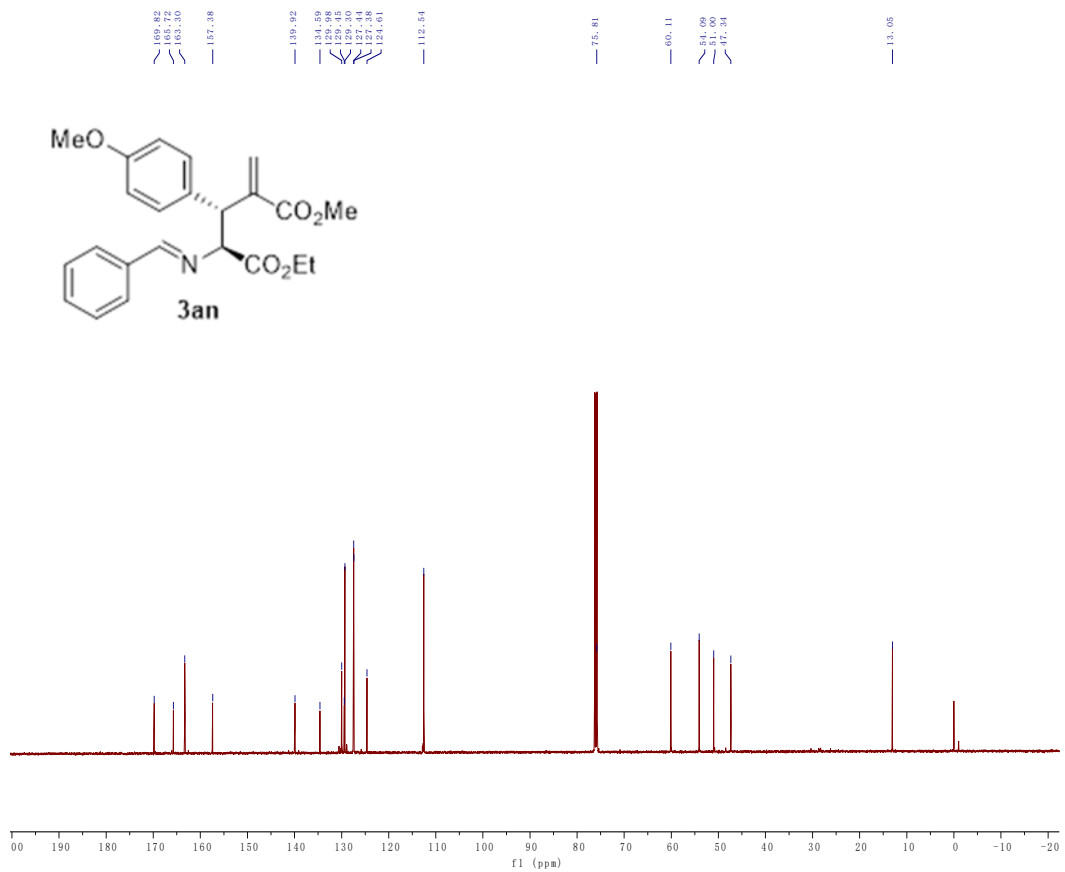
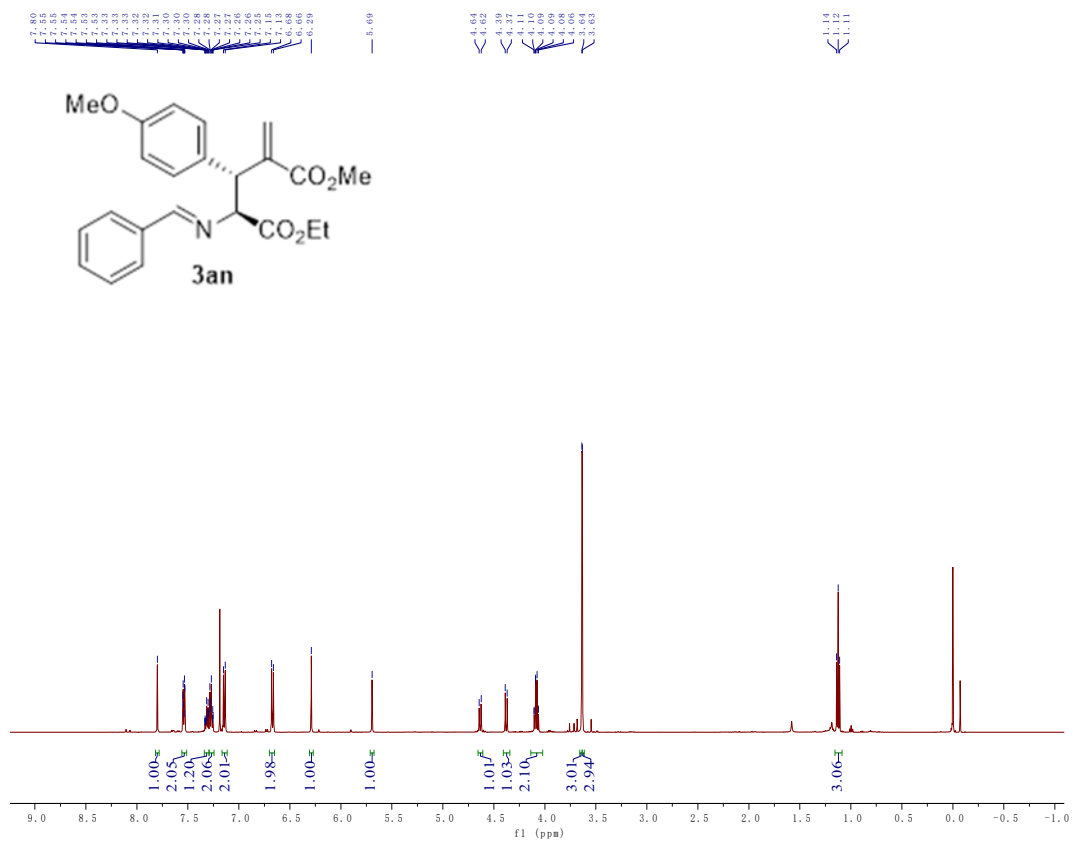


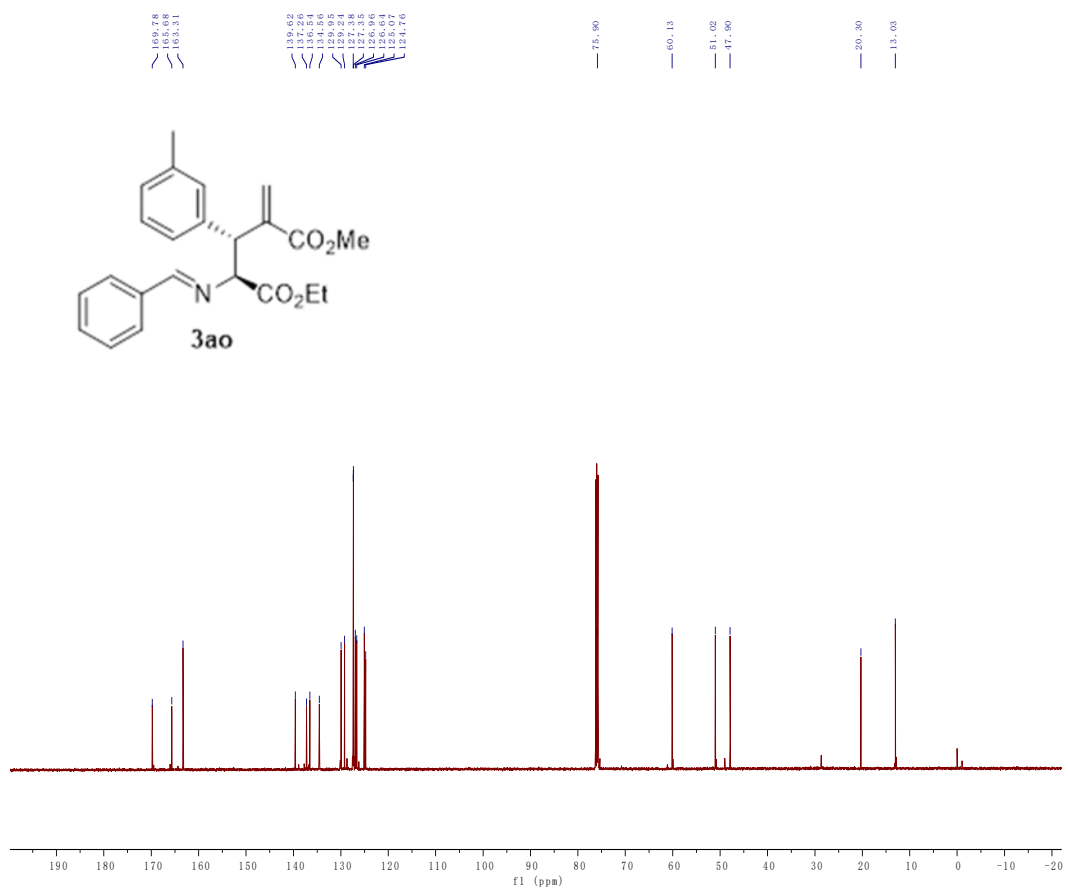
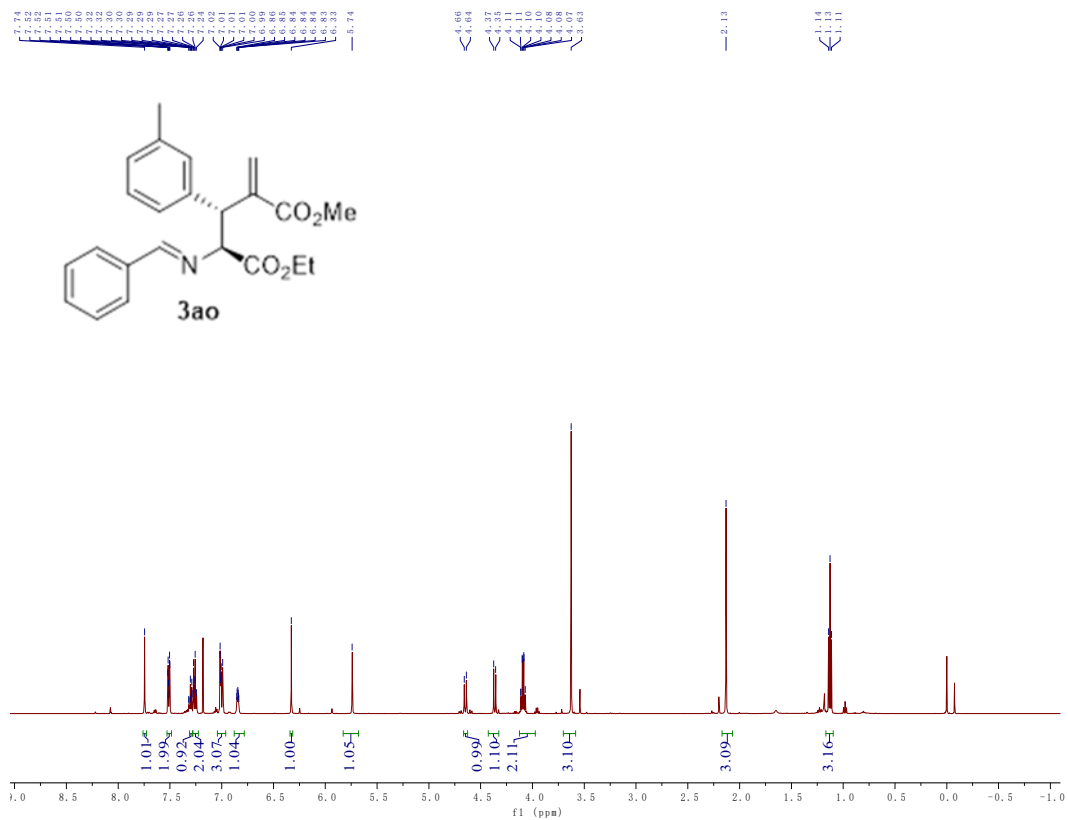


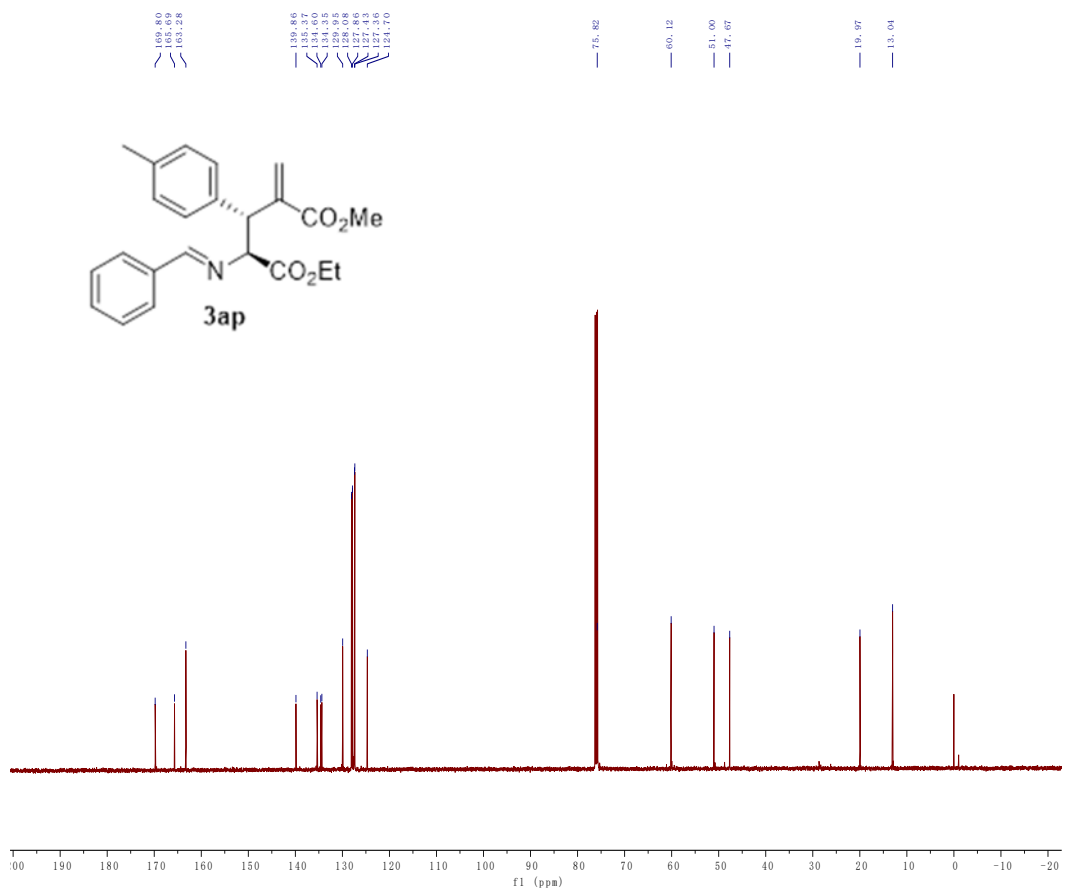
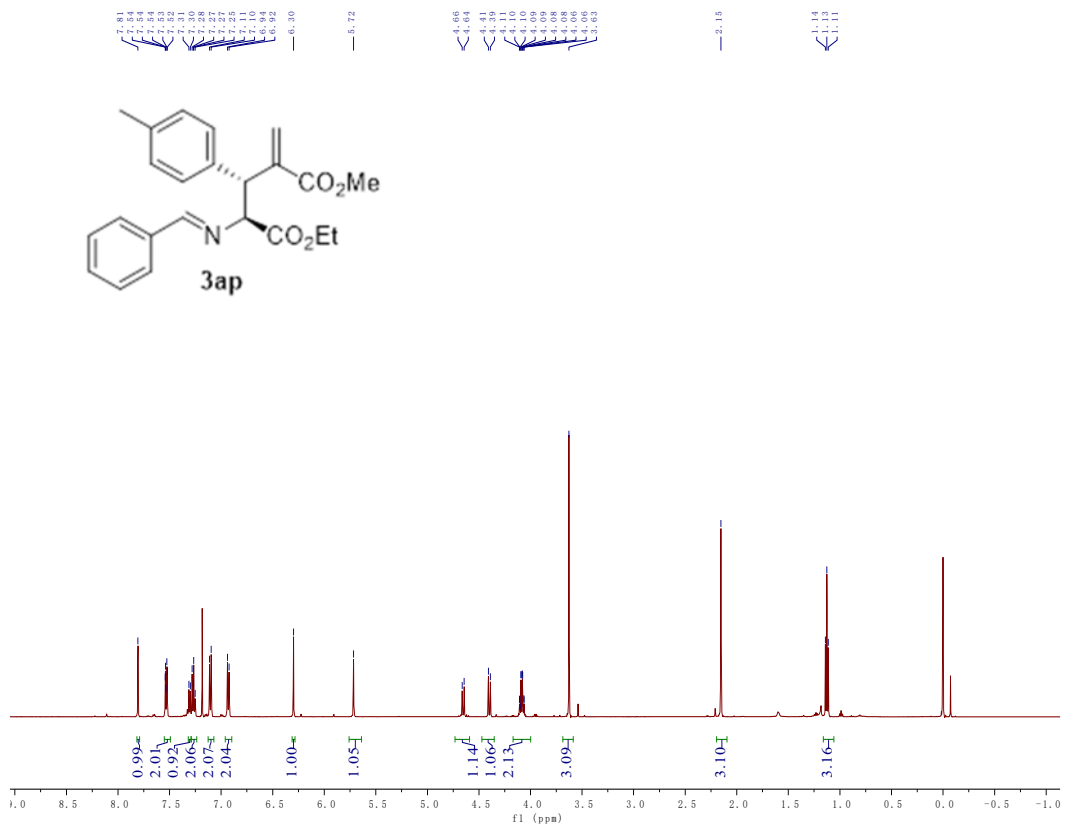


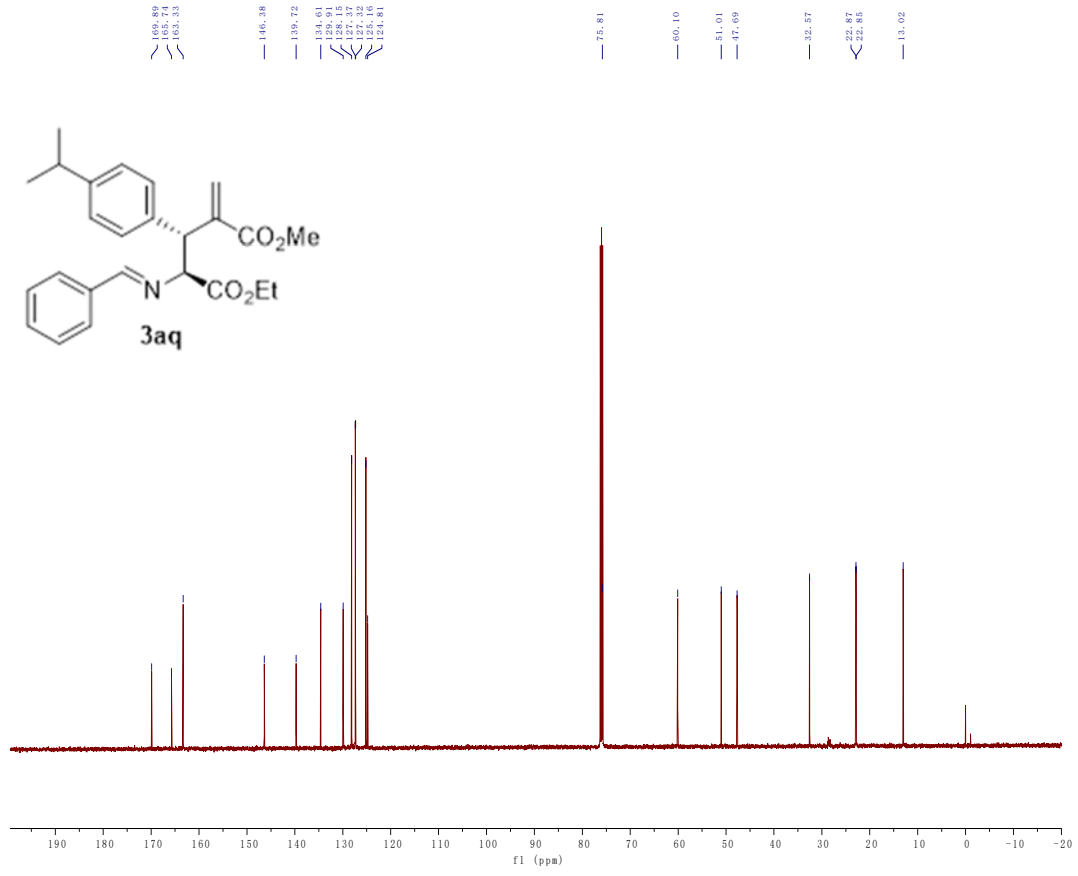
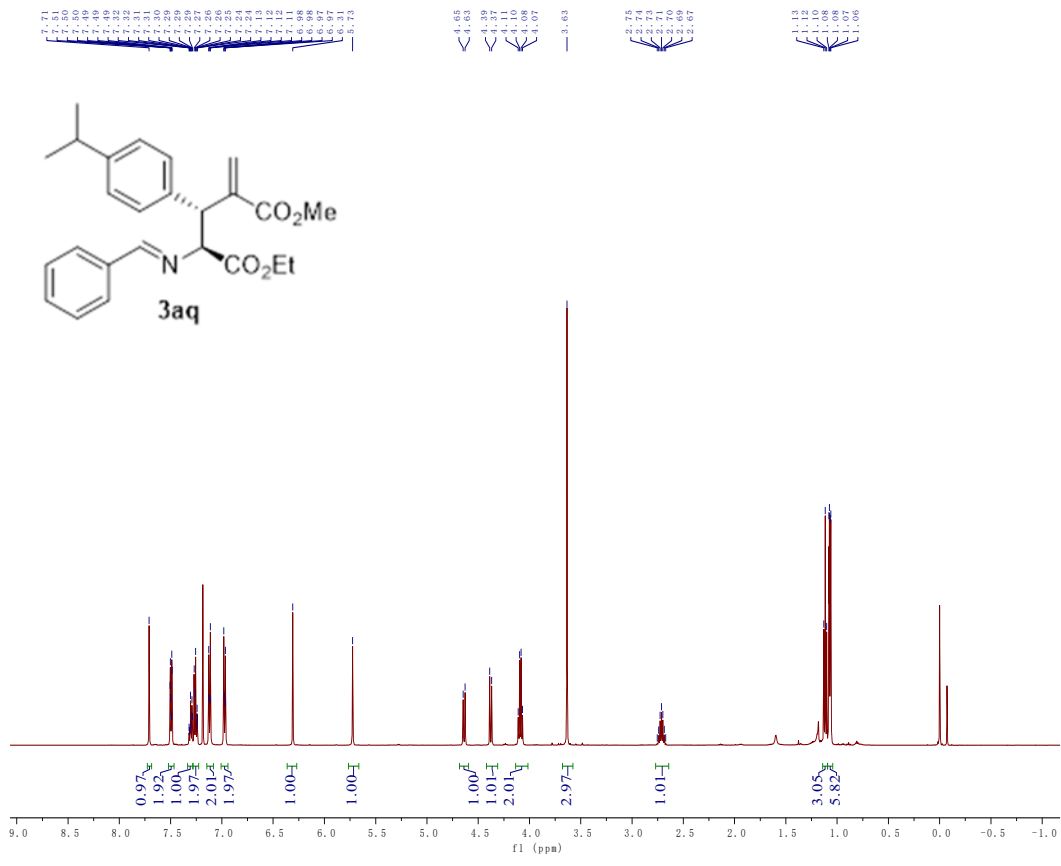


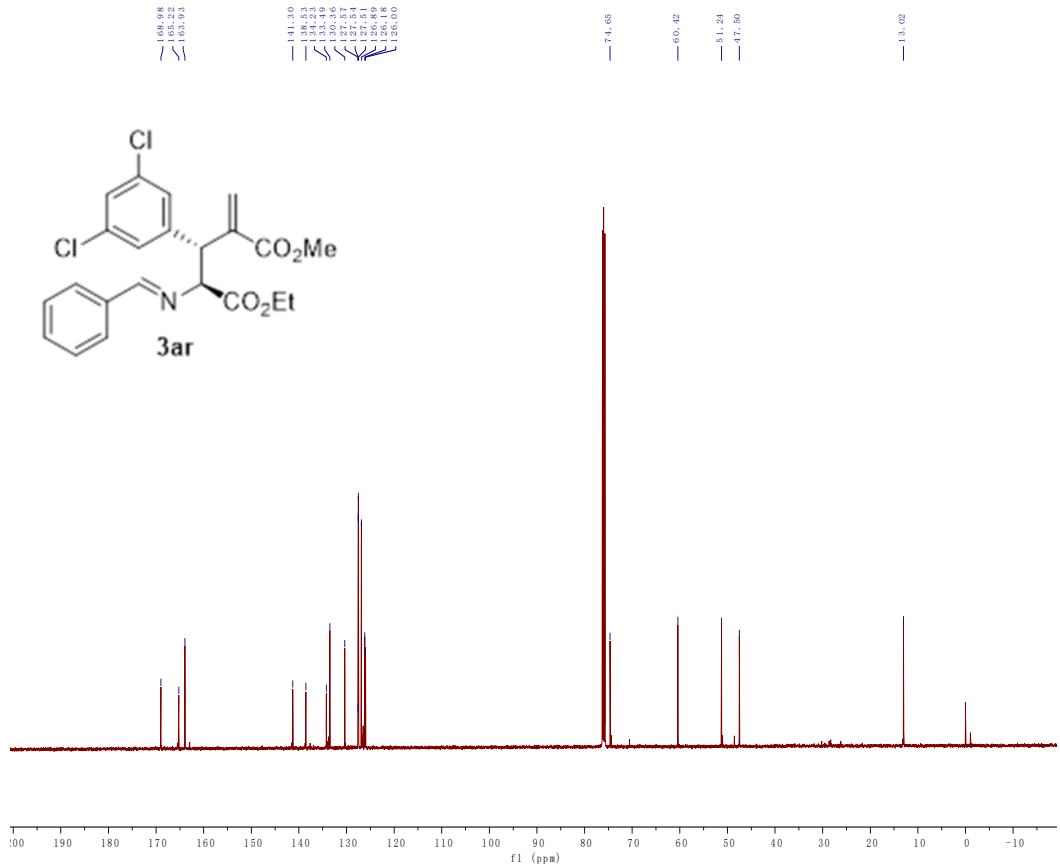
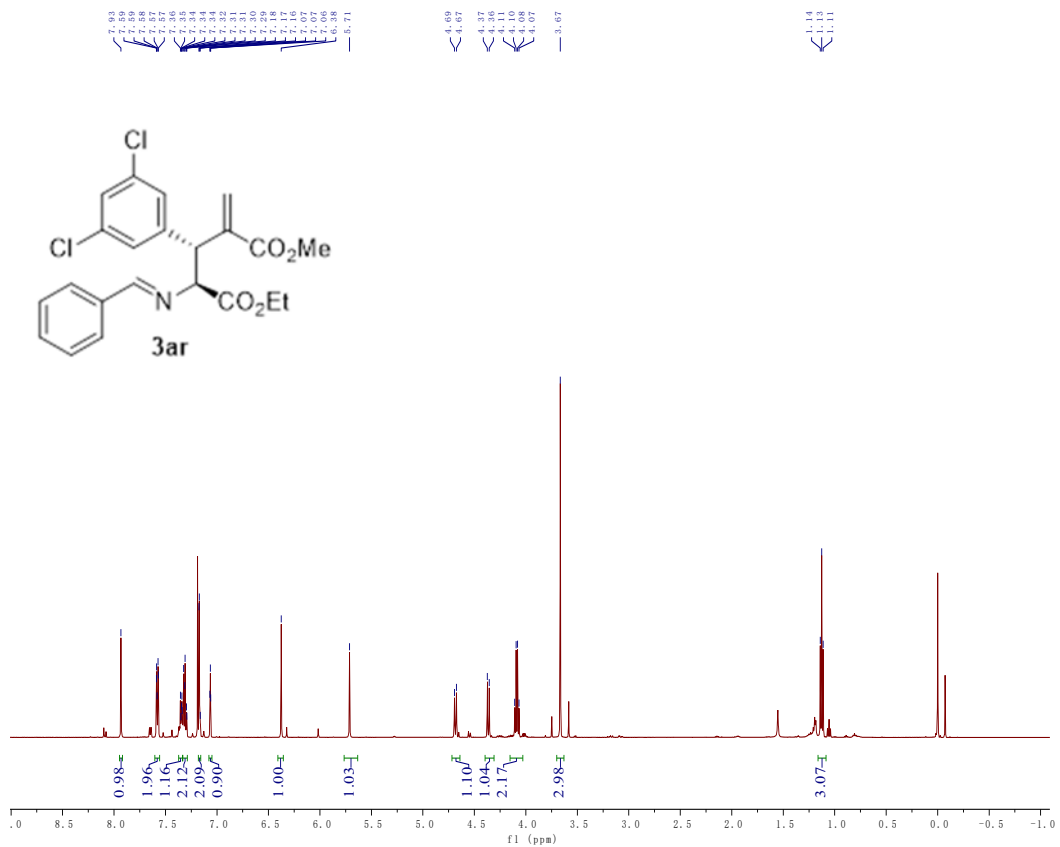


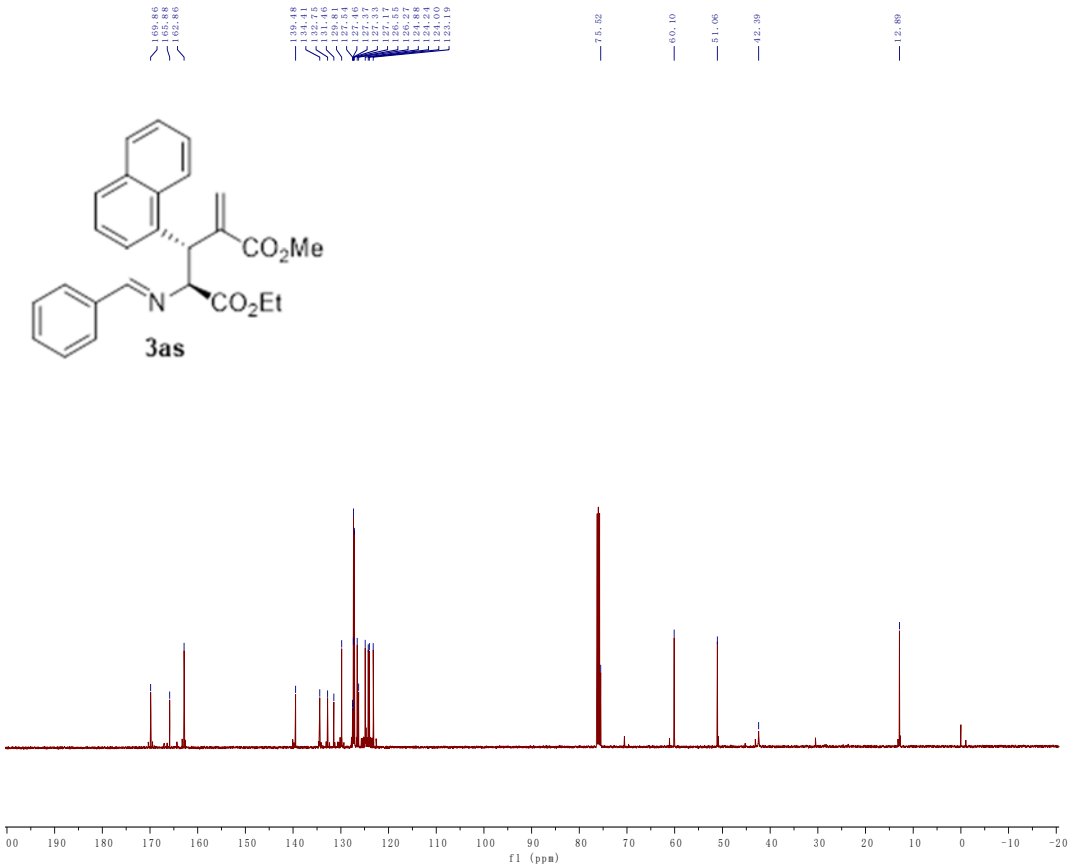
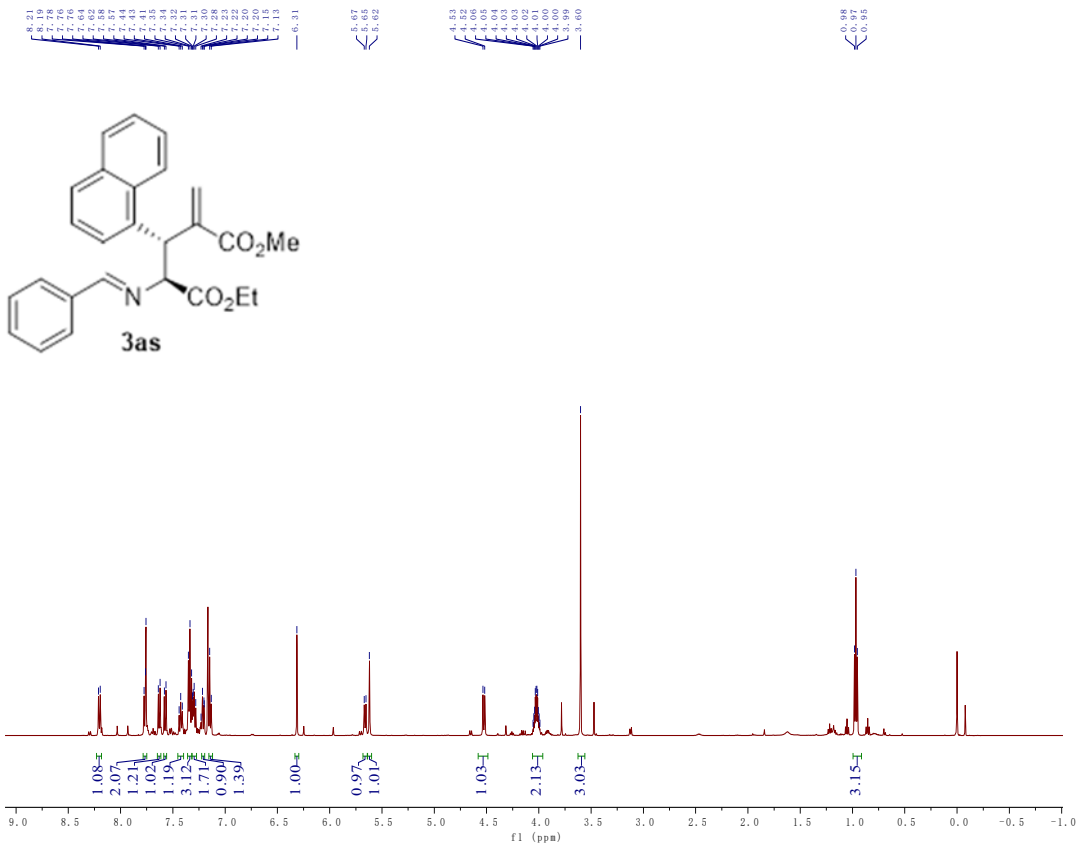


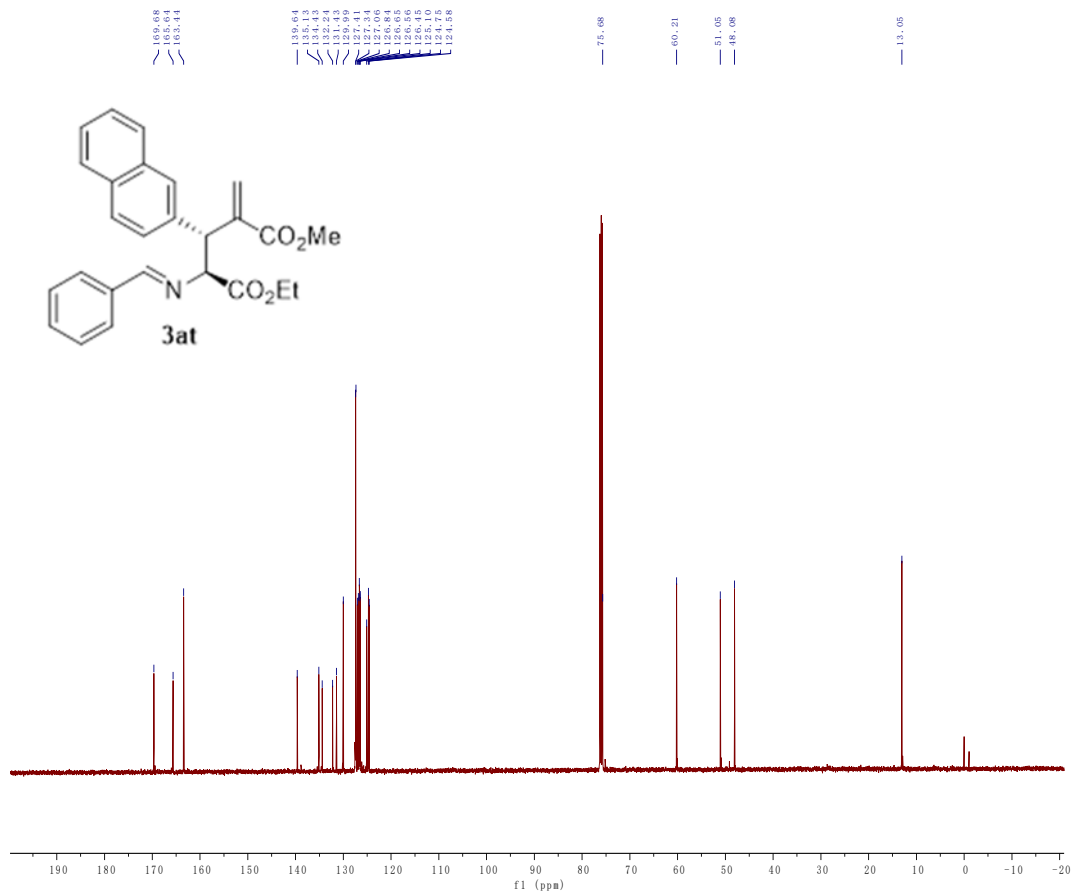
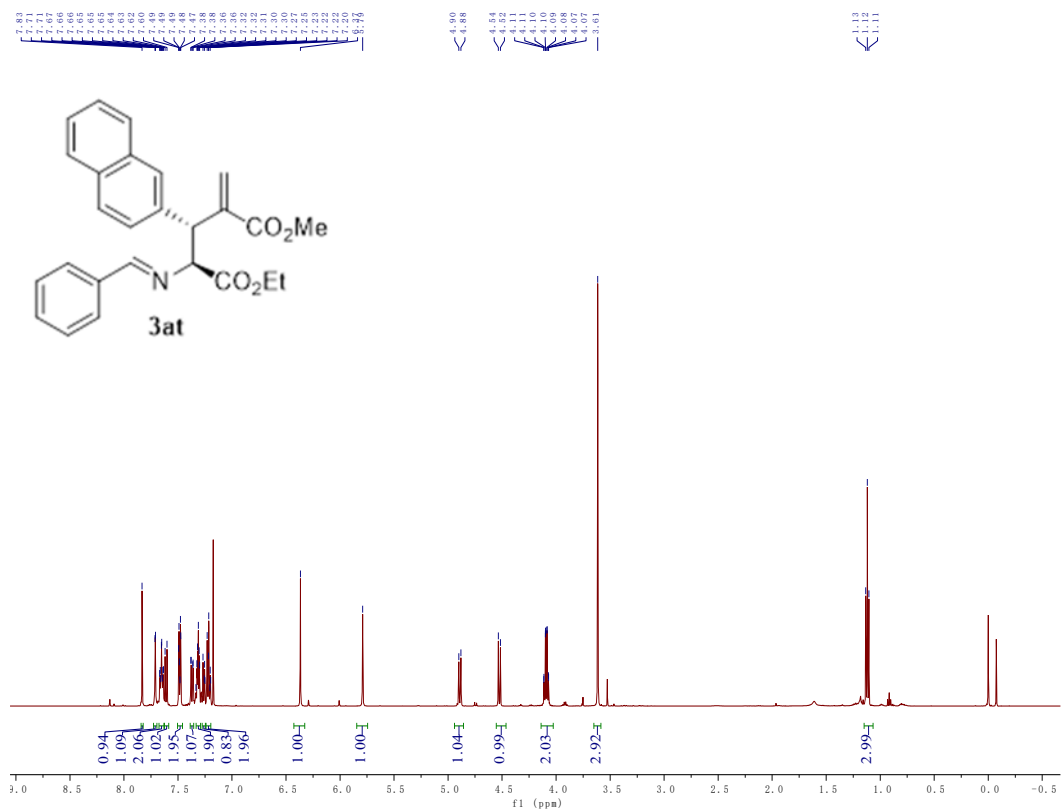


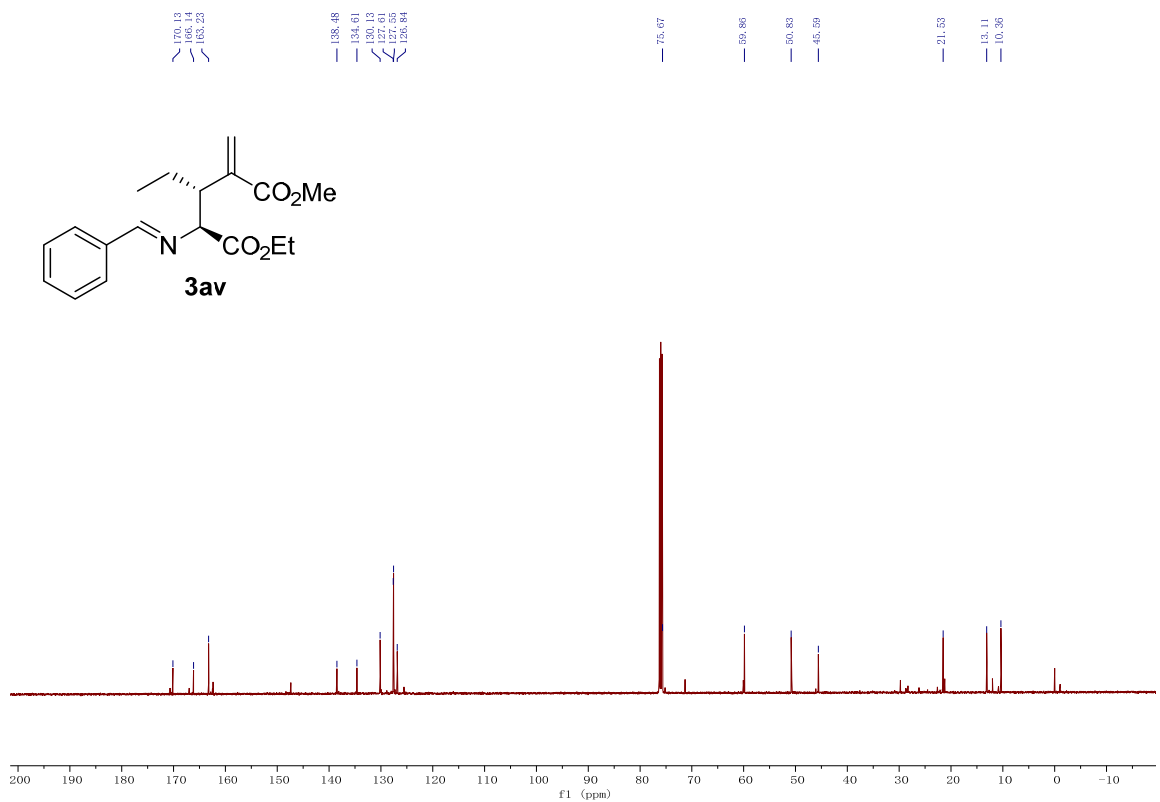
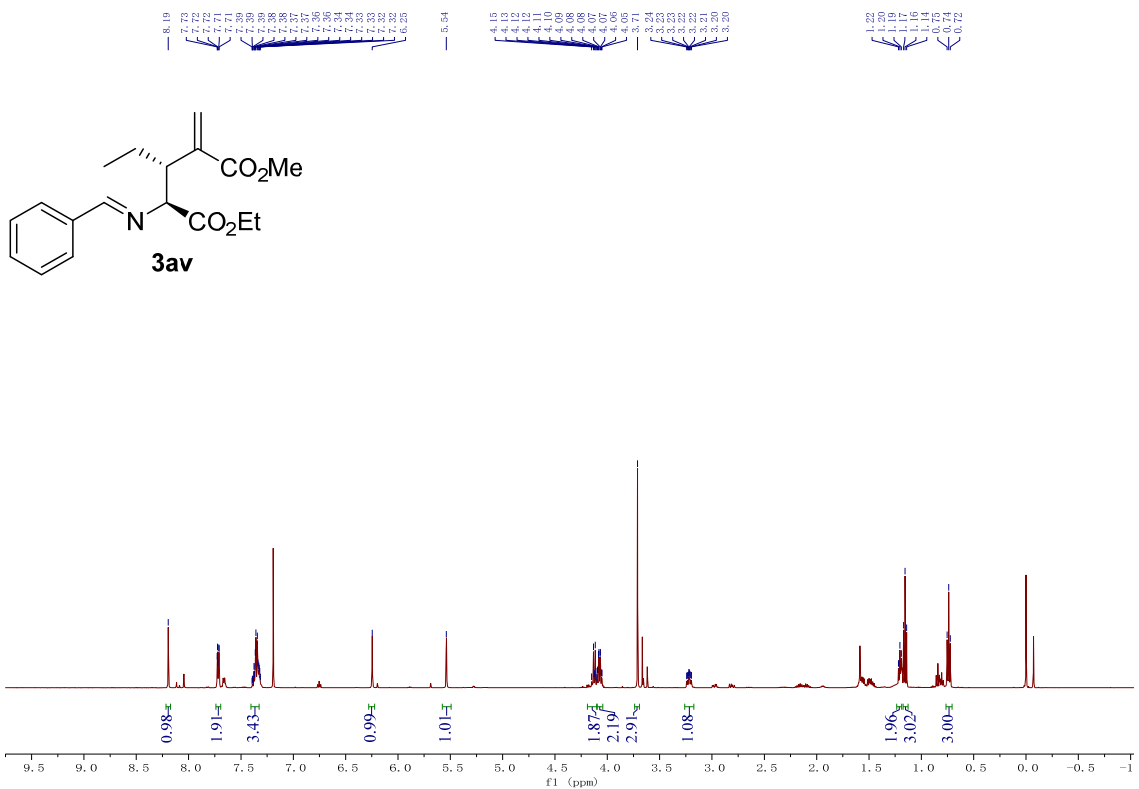


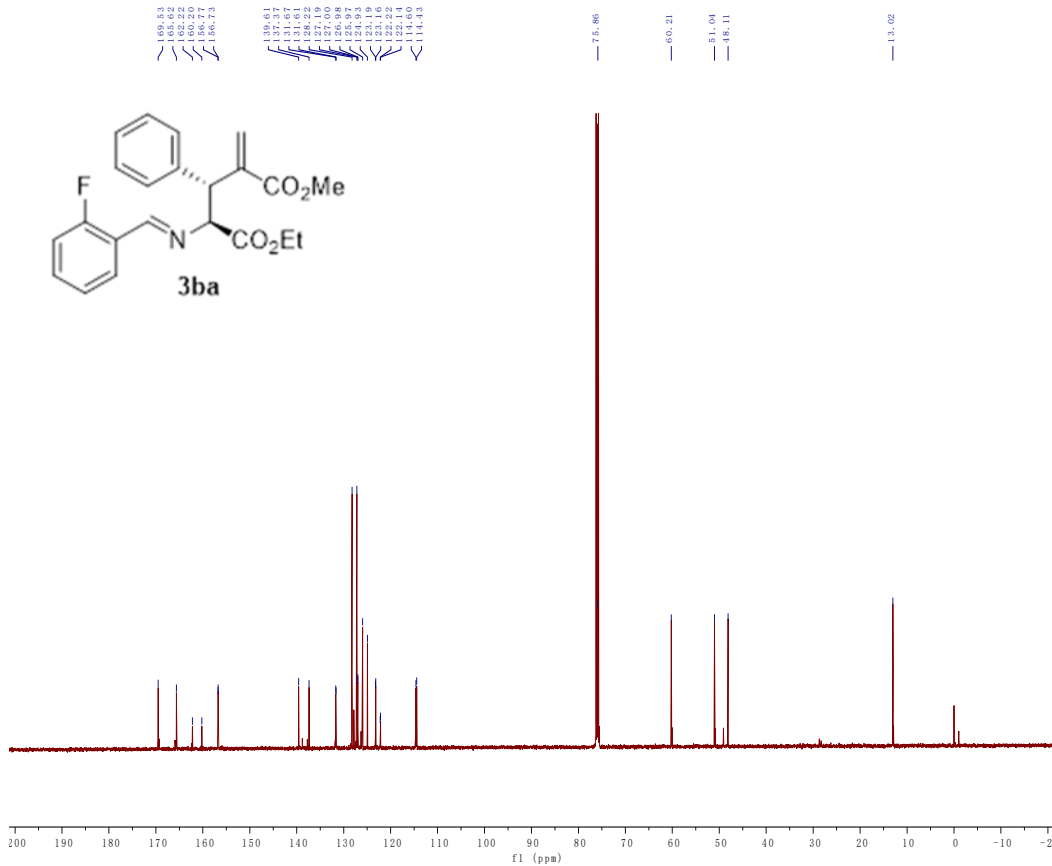
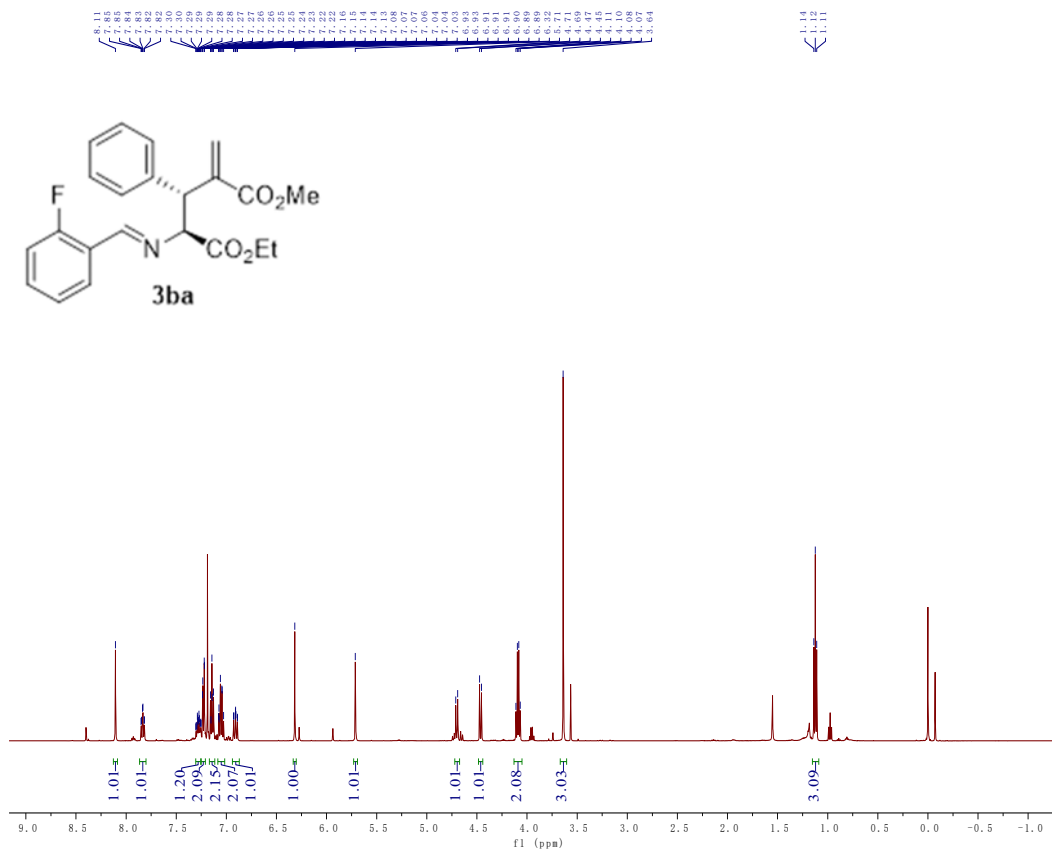


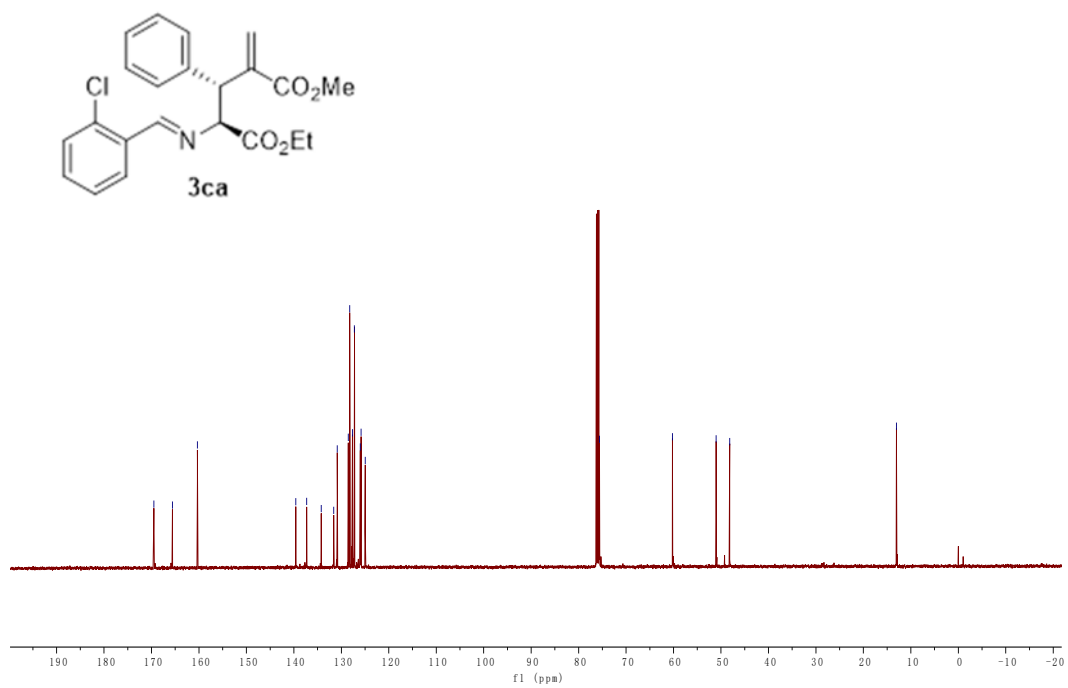
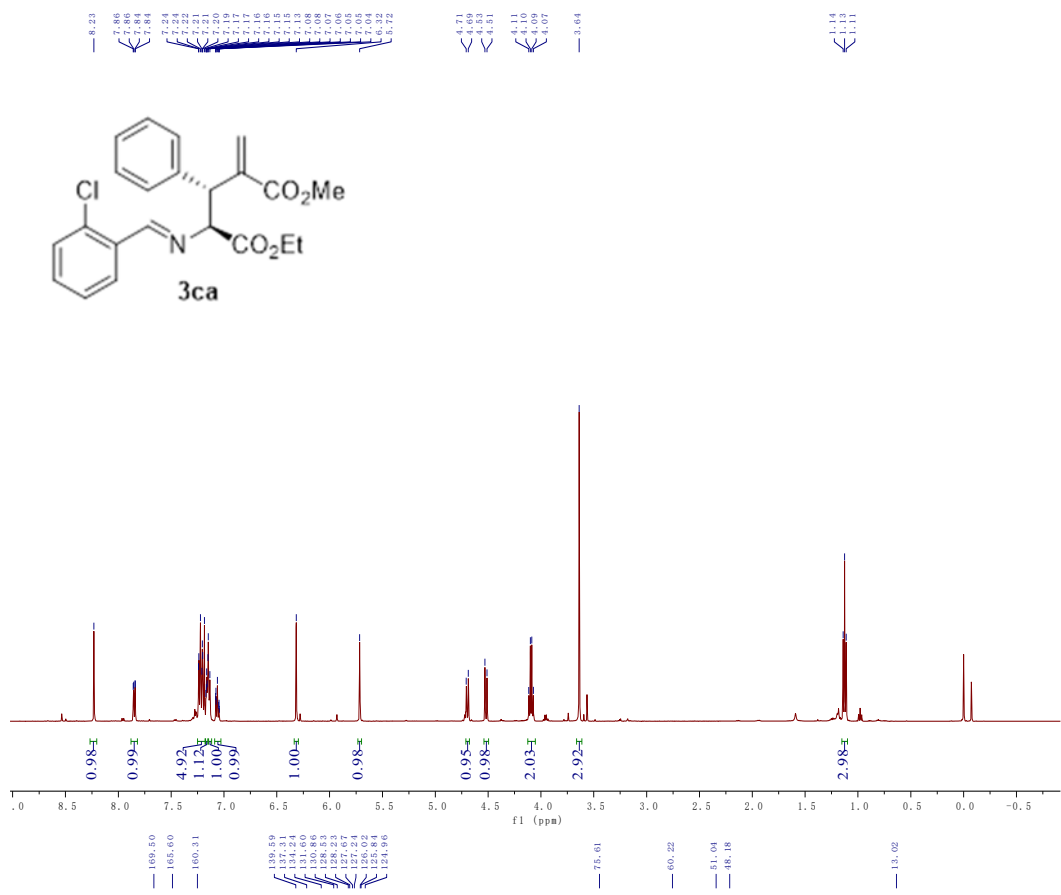


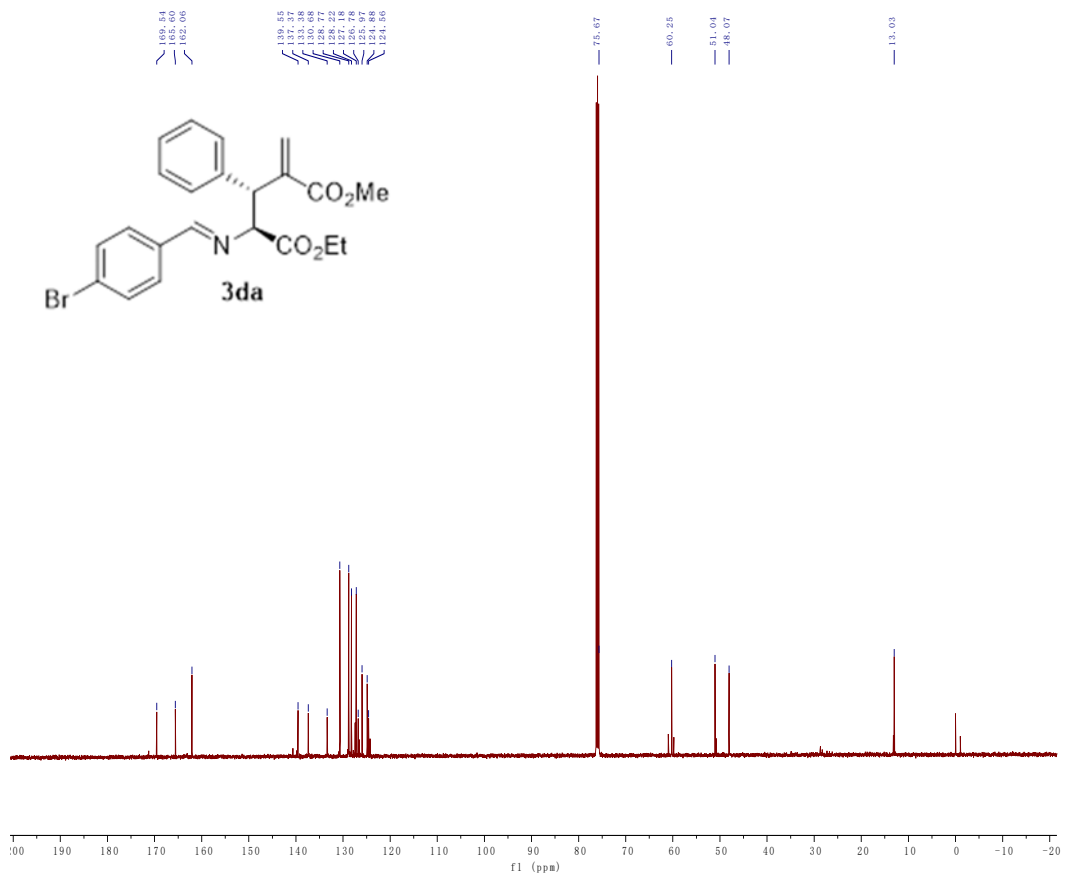
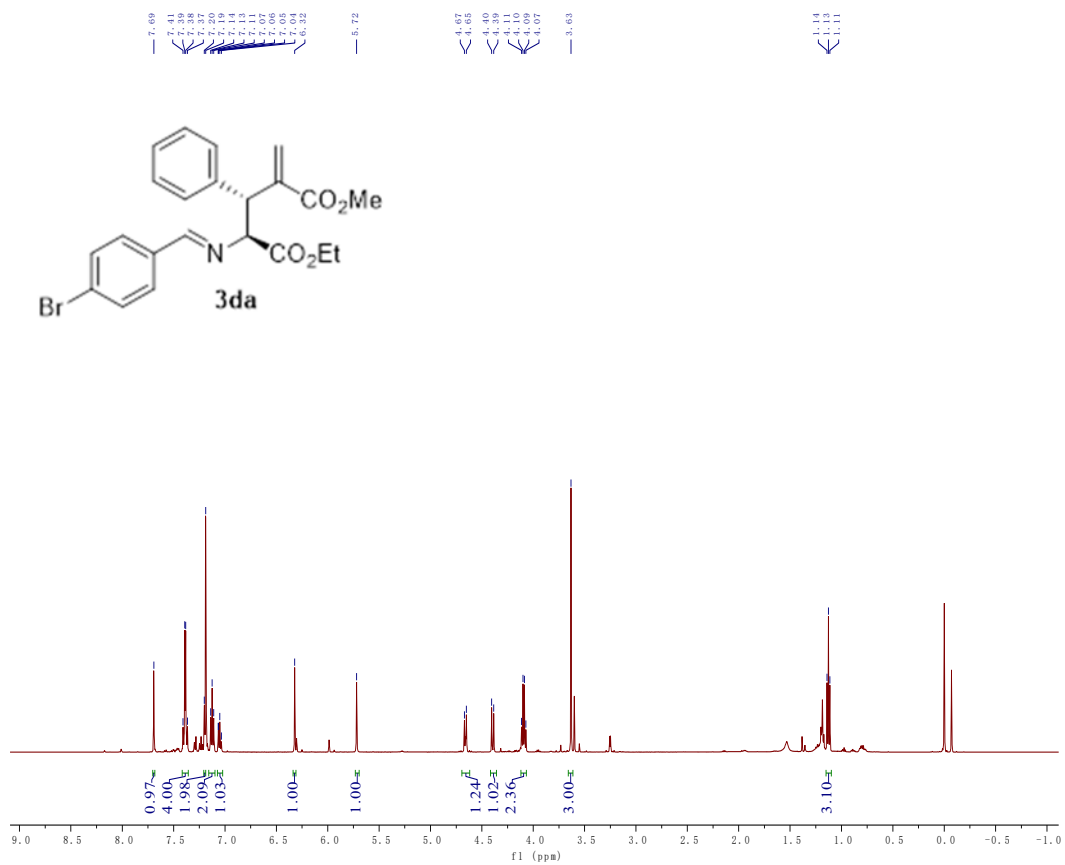


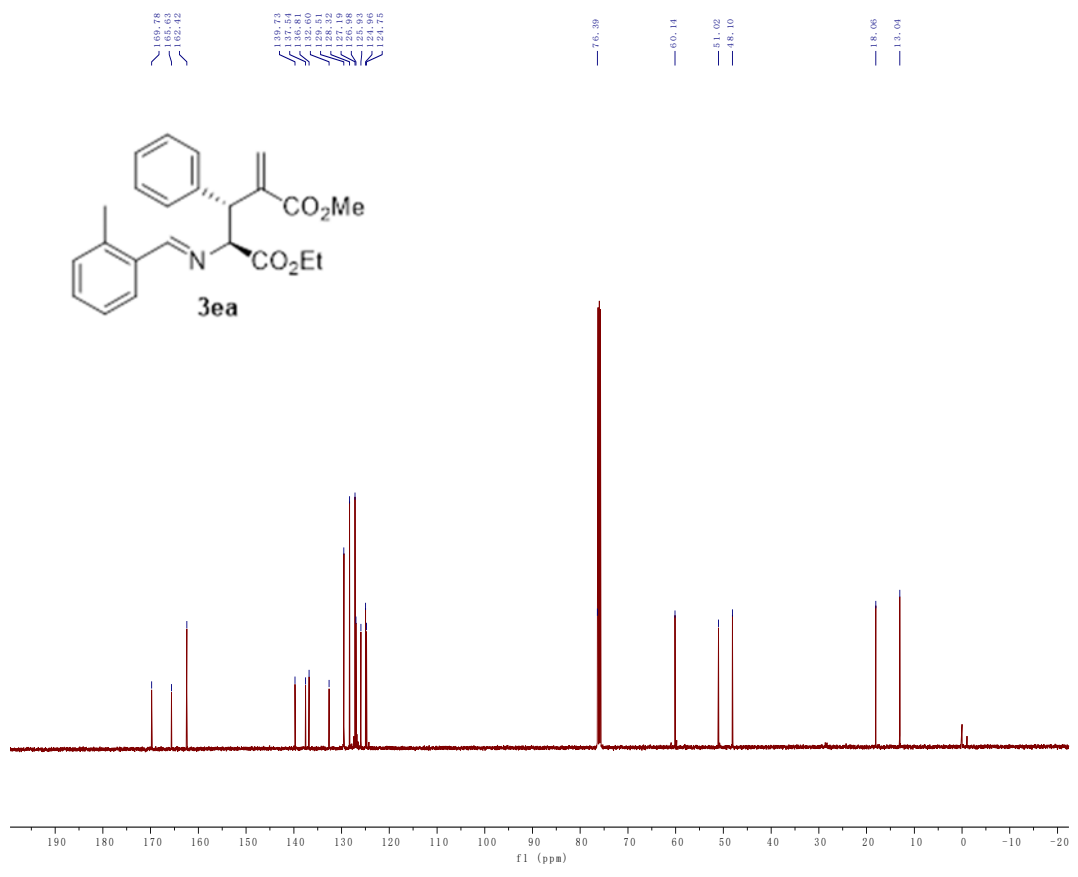
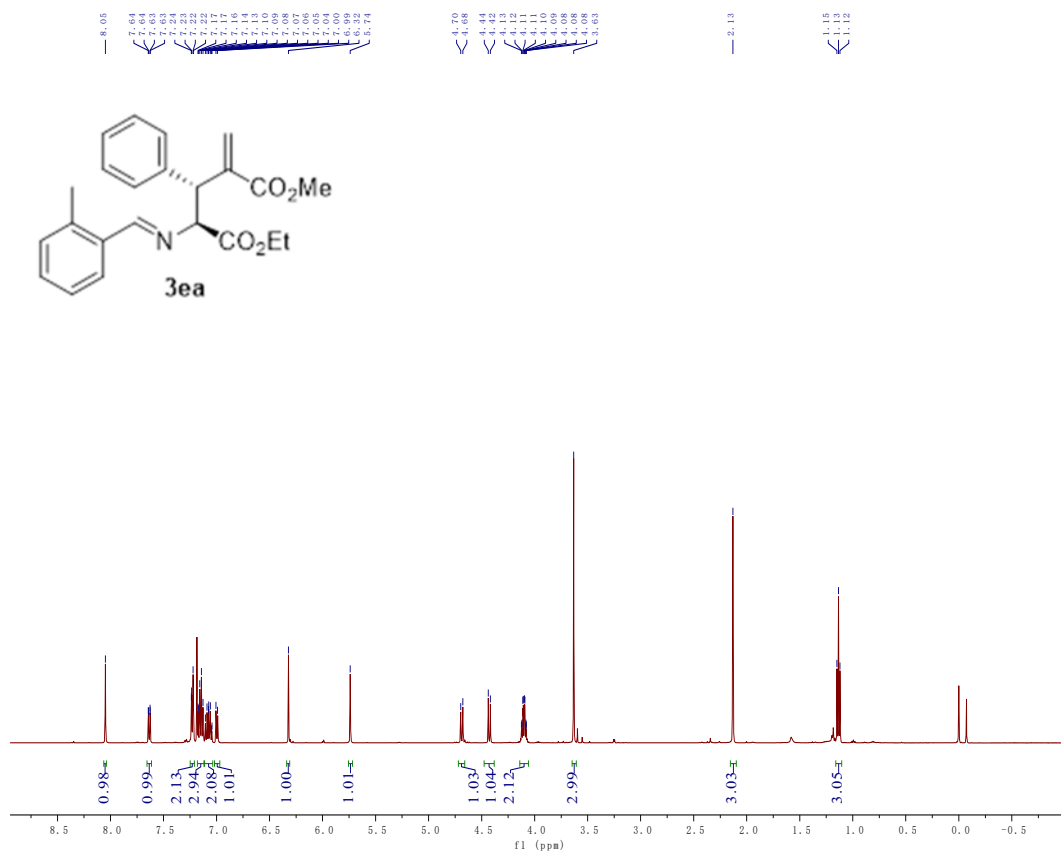


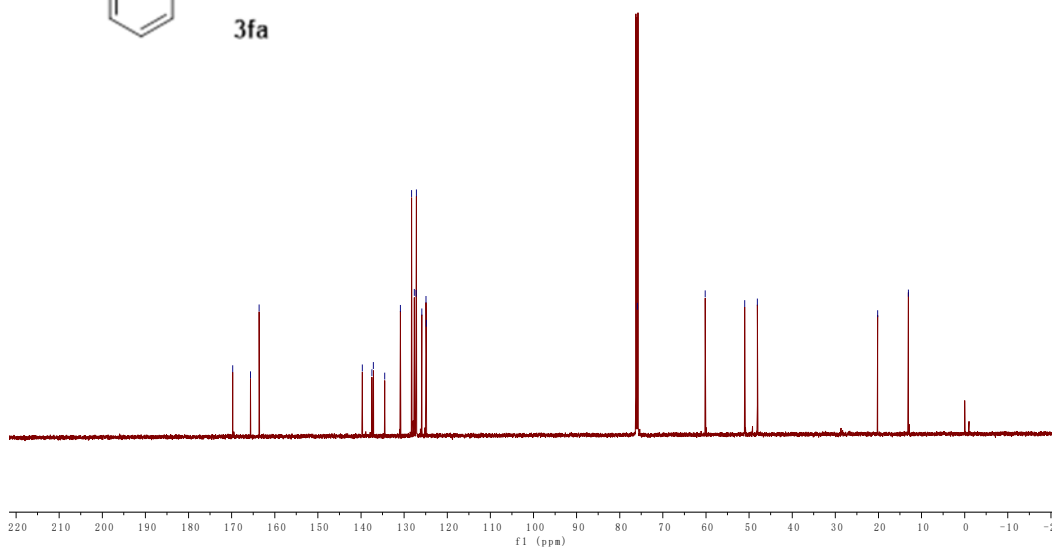
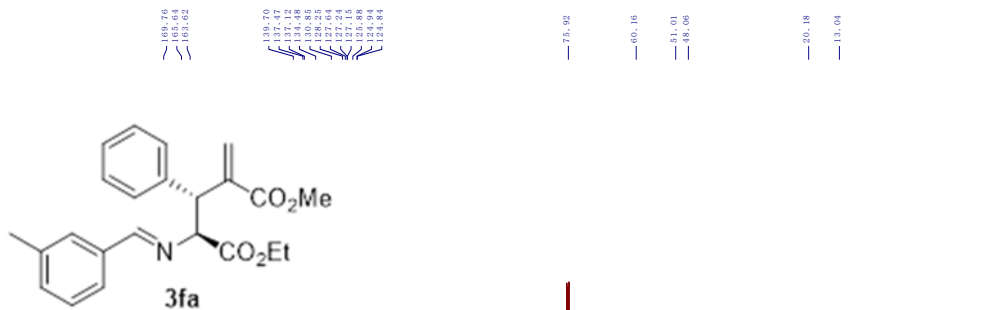
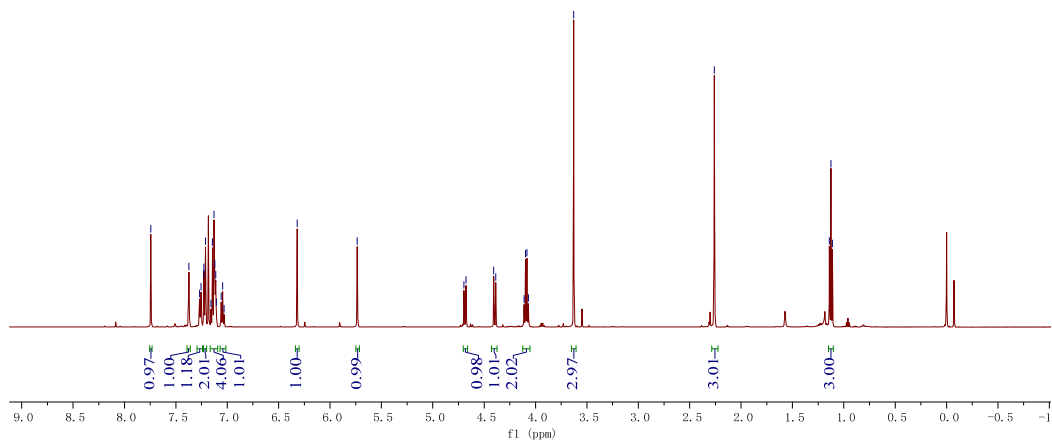
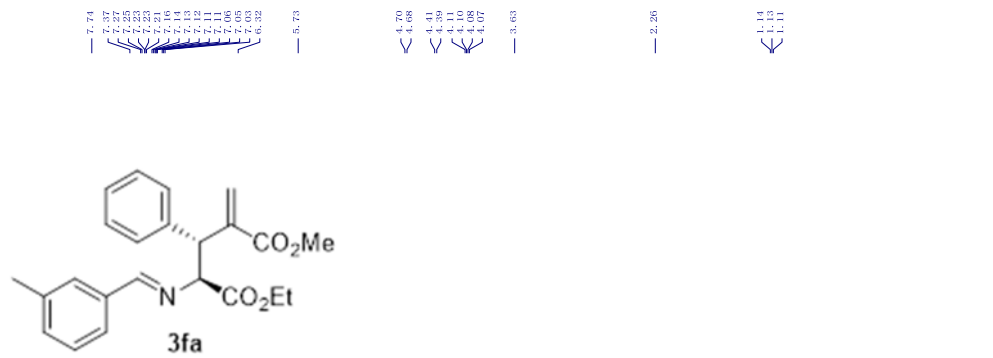


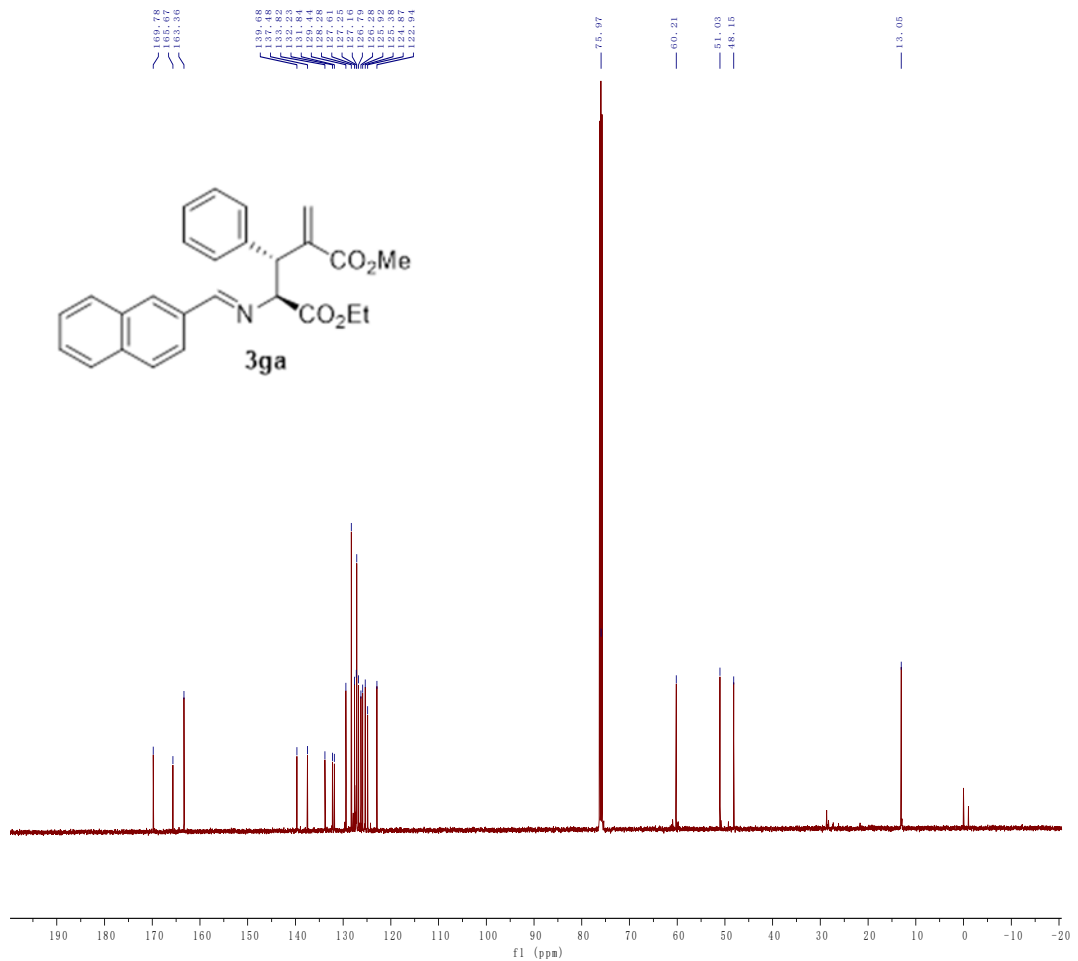
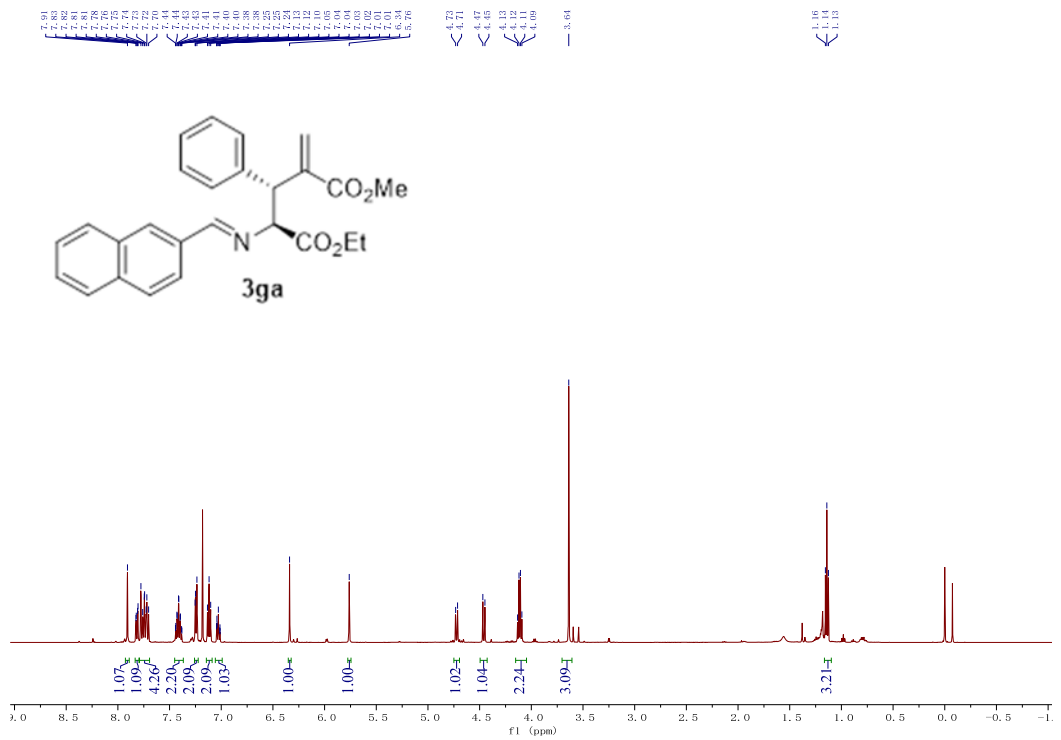


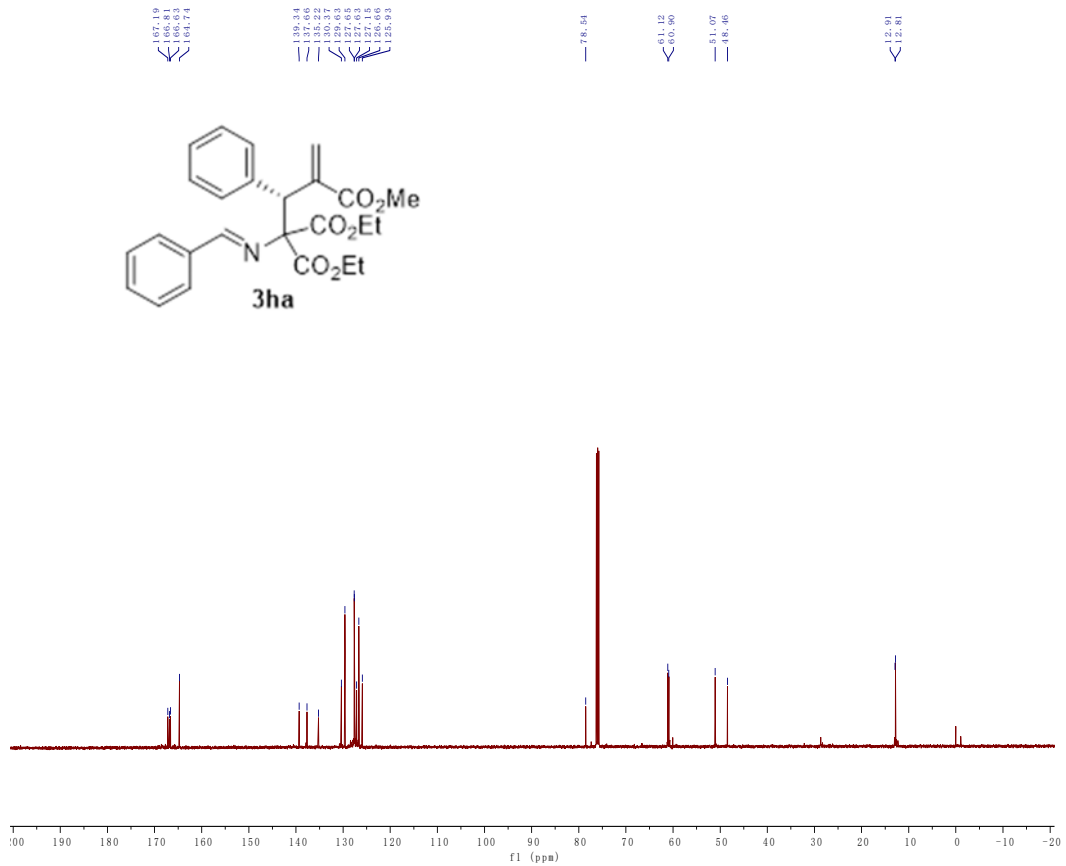
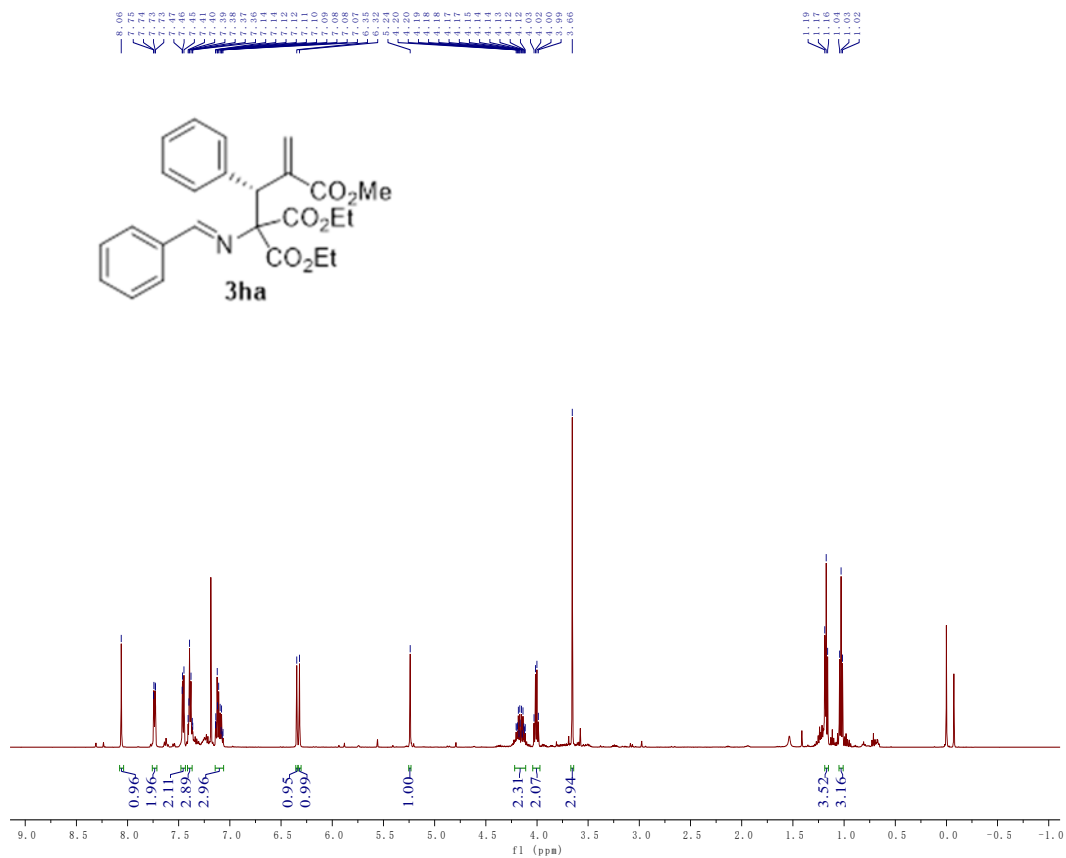


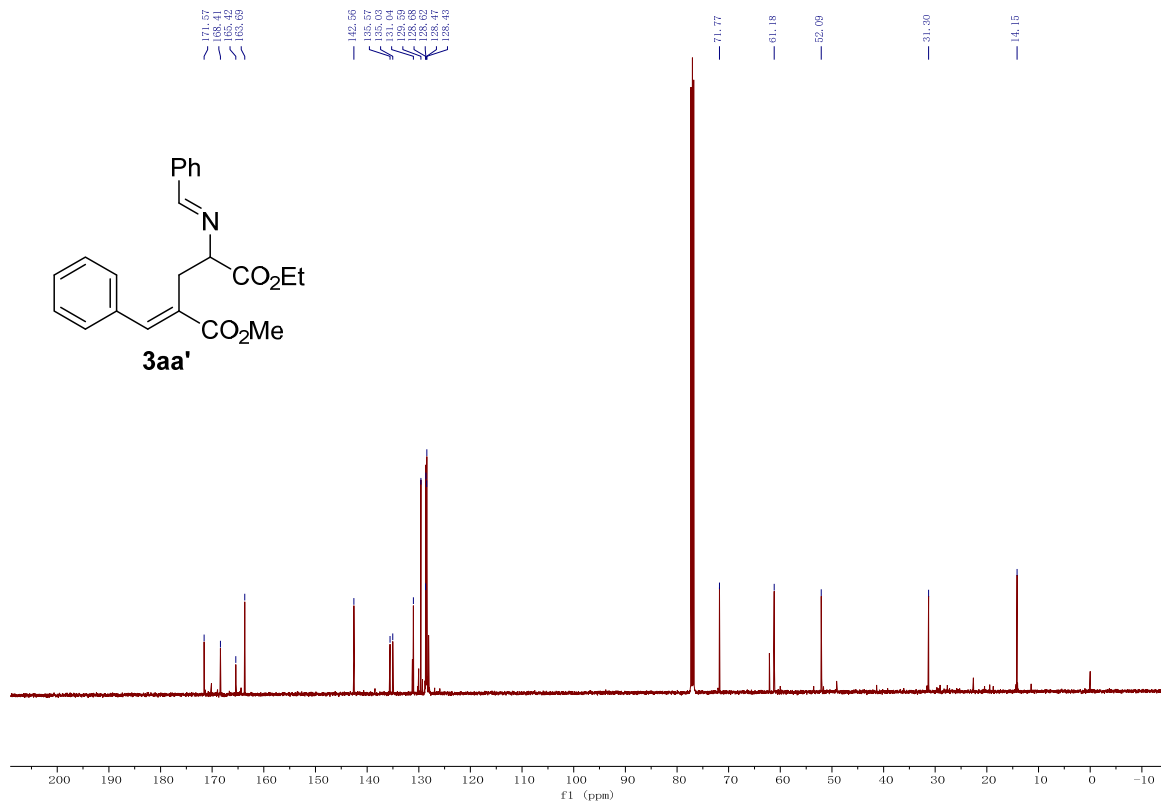
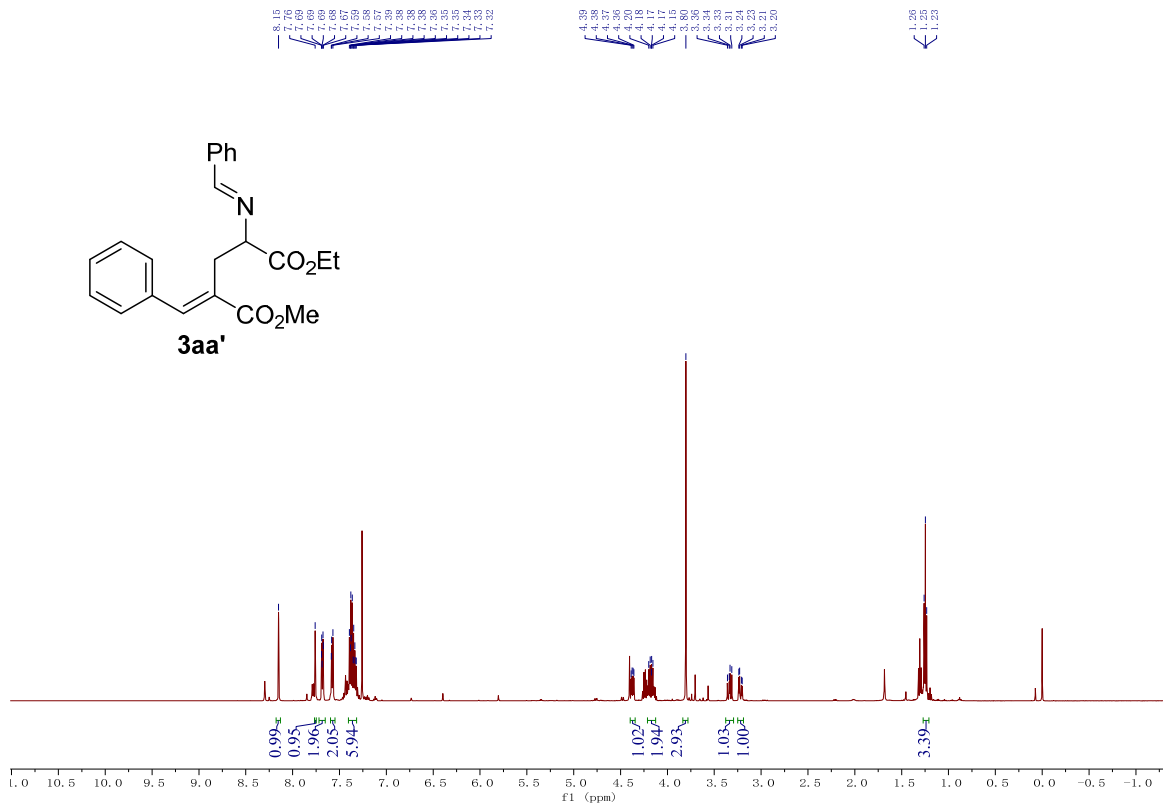






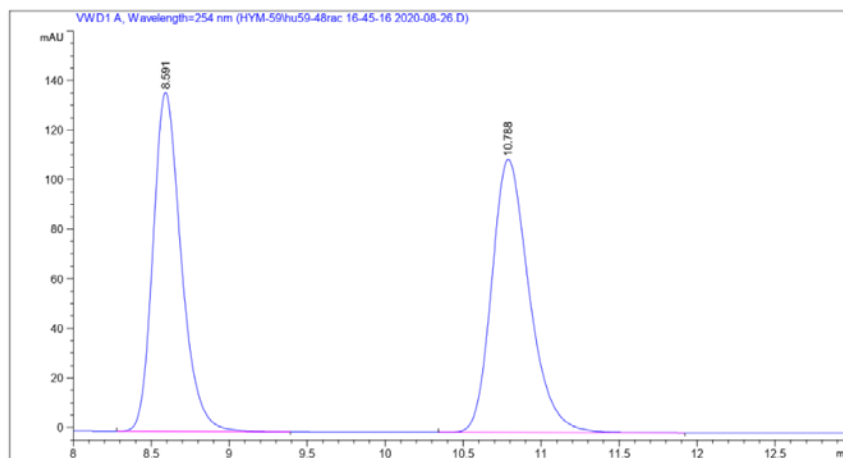






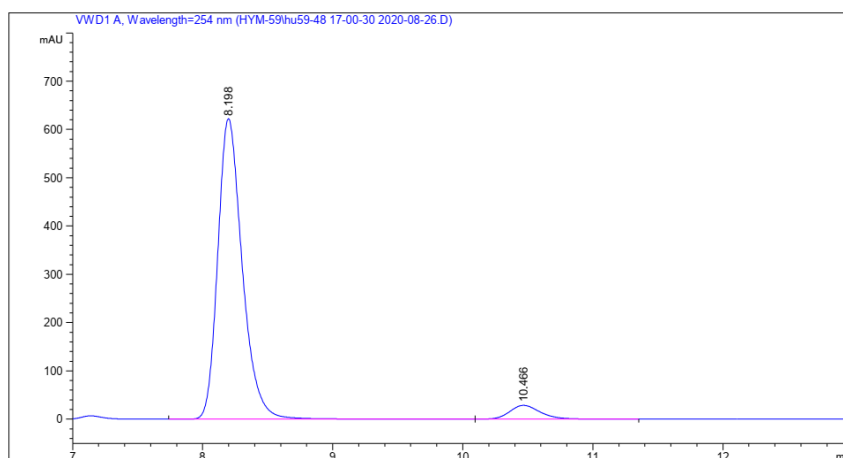
HPLC Chromatograms of All Products

HPLC Chromatograms of racemic 3aa



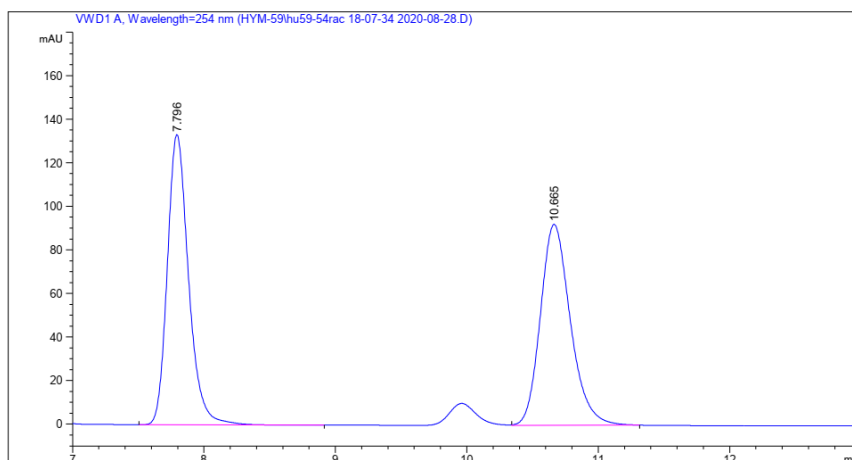
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 8.591 | BB | 0.1912 | 1712.84253 | 136.69846 | 48.3190 |
| 2 | 10.788 | BB | 0.2542 | 1832.02319 | 110.06268 | 51.6810 |

HPLC Chromatograms of chiral 3aa



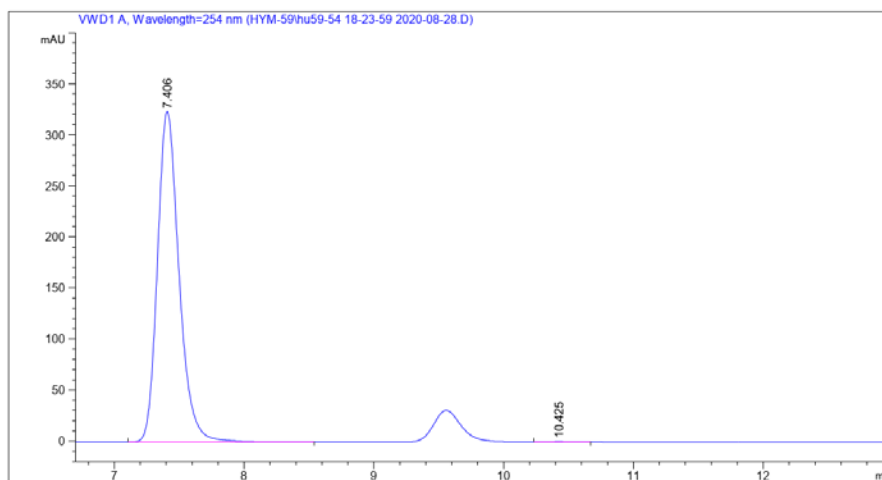
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 8.198 | BB | 0.1984 | 8127.72607 | 622.33002 | 94.6097 |
| 2 | 10.466 | BB | 0.2478 | 463.06863 | 28.46234 | 5.3903 |

HPLC Chromatograms of racemic 3ab



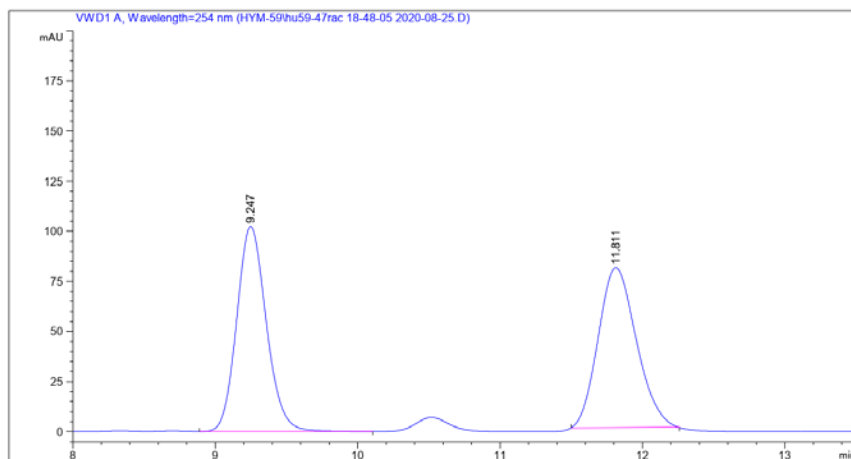
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.796 | BB | 0.1719 | 1494.28882 | 133.21382 | 50.5653 |
| 2 | 10.665 | MM R | 0.2641 | 1460.87671 | 92.20504 | 49.4347 |

HPLC Chromatograms of chiral 3aa



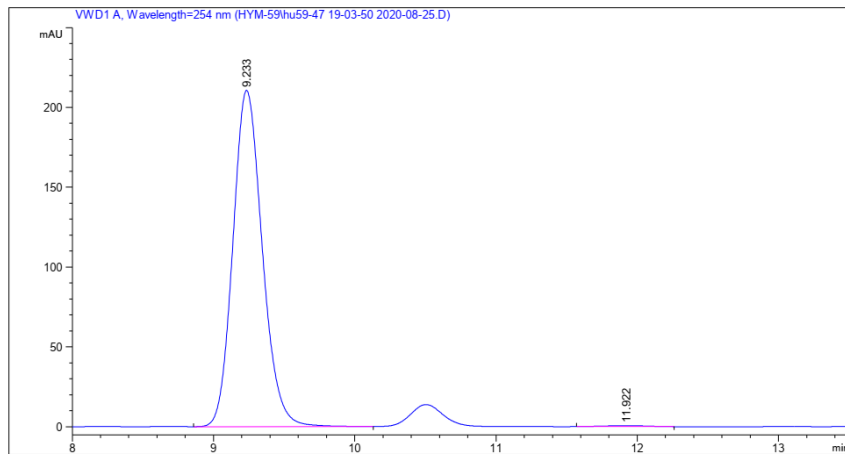
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.406 | BB | 0.1754 | 3725.95532 | 323.36945 | 99.8929 |
| 2 | 10.425 | MM R | 0.2171 | 3.99421 | 3.06626e ⁻¹ | 0.1071 |

HPLC Chromatograms of racemic 3ac



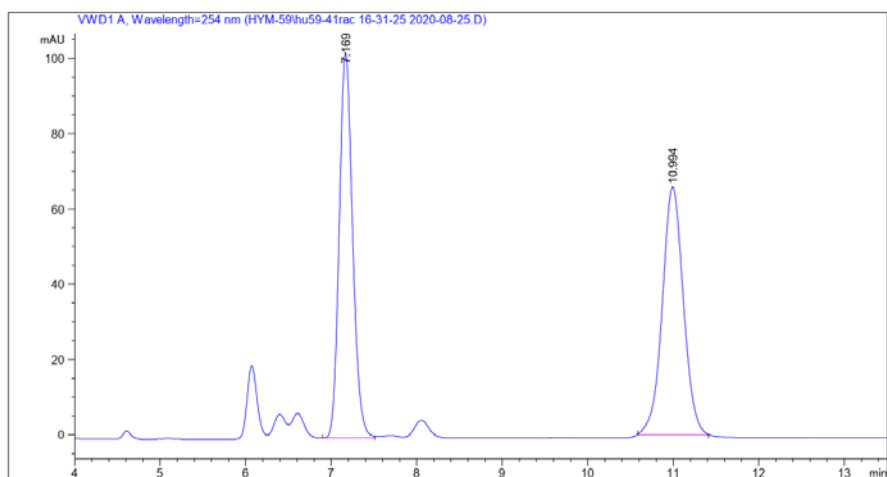
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 9.247 | BB | 0.2225 | 1476.97656 | 102.24300 | 49.8662 |
| 2 | 11.811 | MM R | 0.3105 | 1484.90466 | 79.70834 | 50.1338 |

HPLC Chromatograms of chiral 3ac



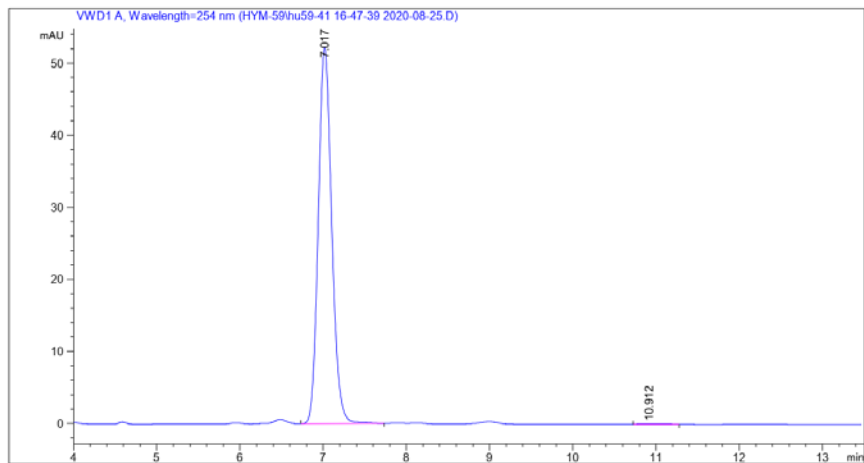
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 9.233 | BB | 0.2224 | 3039.62354 | 210.60506 | 99.5715 |
| 2 | 11.922 | MM R | 0.3557 | 13.08107 | 6.12965e ⁻¹ | 0.4285 |

HPLC Chromatograms of racemic 3ad



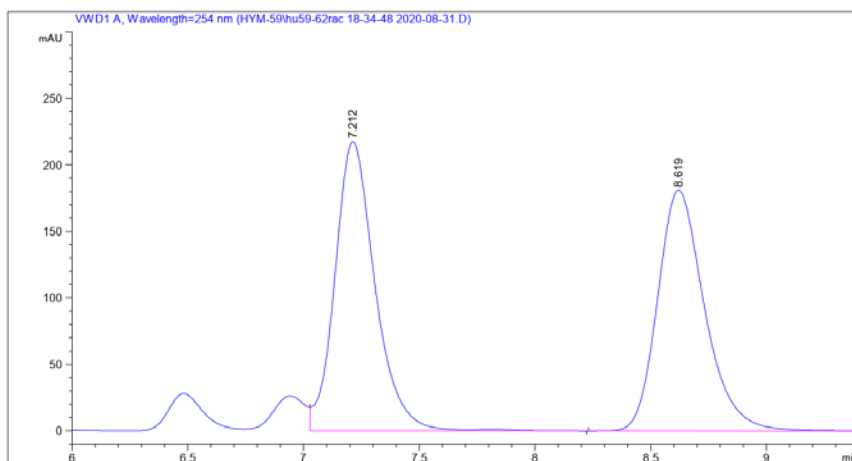
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.169 | MF R | 0.1810 | 1112.44470 | 102.42384 | 49.6782 |
| 2 | 10.994 | MM R | 0.2857 | 1126.85718 | 65.72699 | 50.3218 |

HPLC Chromatograms of chiral 3ad



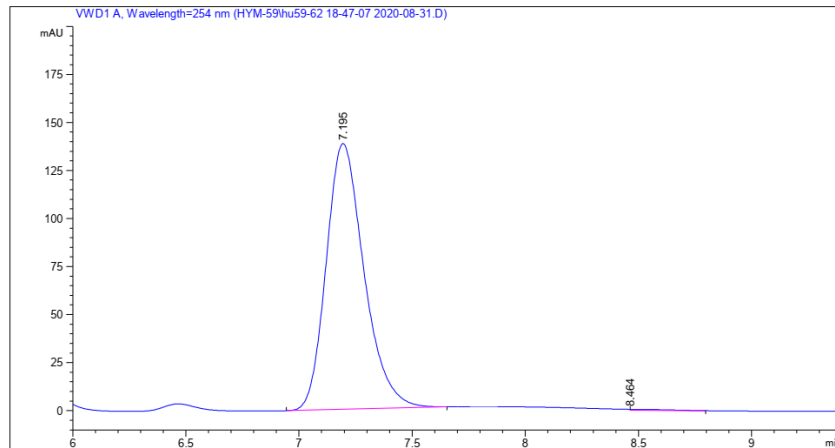
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.017 | BB | 0.1741 | 586.60352 | 52.21996 | 99.8082 |
| 2 | 10.912 | MM R | 0.3774 | 1.12750 | 4.97937e ⁻² | 0.1918 |

HPLC Chromatograms of racemic 3ae



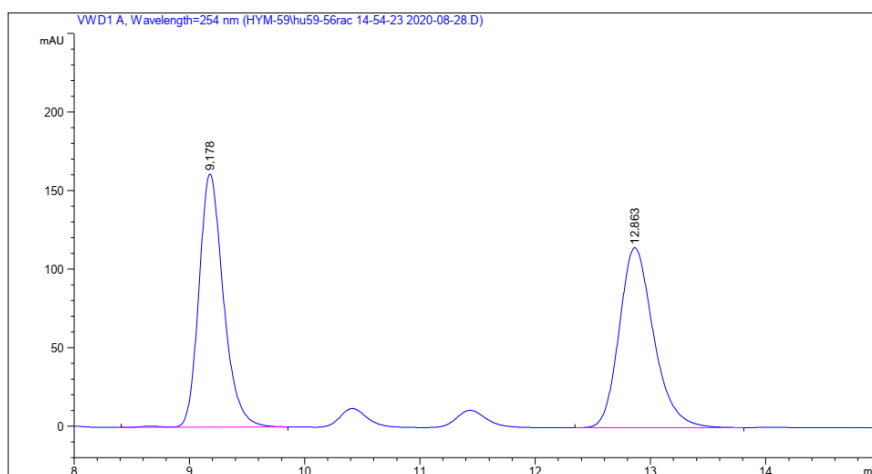
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.212 | FM R | 0.2009 | 2620.86719 | 217.45316 | 50.6397 |
| 2 | 8.619 | BV | 0.2146 | 2554.64673 | 181.06151 | 49.3603 |

HPLC Chromatograms of chiral 3ae



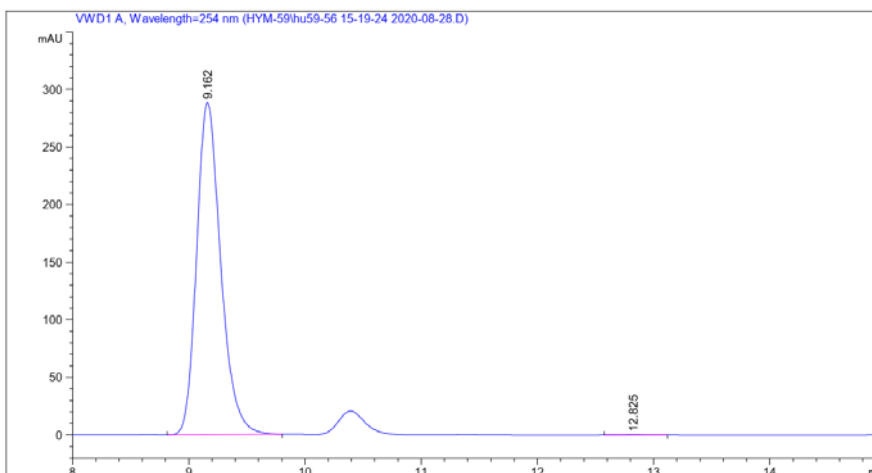
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.195 | BB | 0.1774 | 1605.88464 | 138.34399 | 99.6441 |
| 2 | 8.464 | MM R | 0.1796 | 5.73642 | 4.06650e ⁻¹ | 0.3559 |

HPLC Chromatograms of racemic 3af



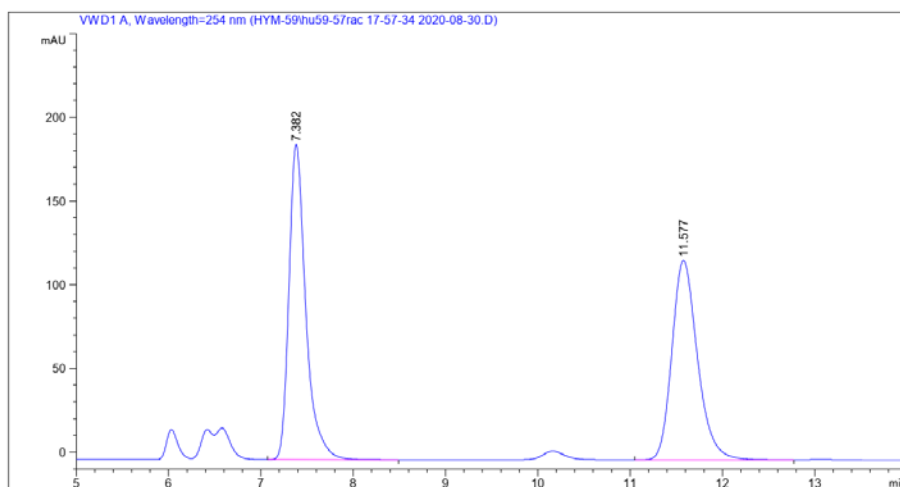
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 9.178 | VB R | 0.2249 | 2374.18945 | 161.12790 | 49.9730 |
| 2 | 12.863 | BB | 0.3169 | 2376.75781 | 114.63092 | 50.0270 |

HPLC Chromatograms of chiral 3af



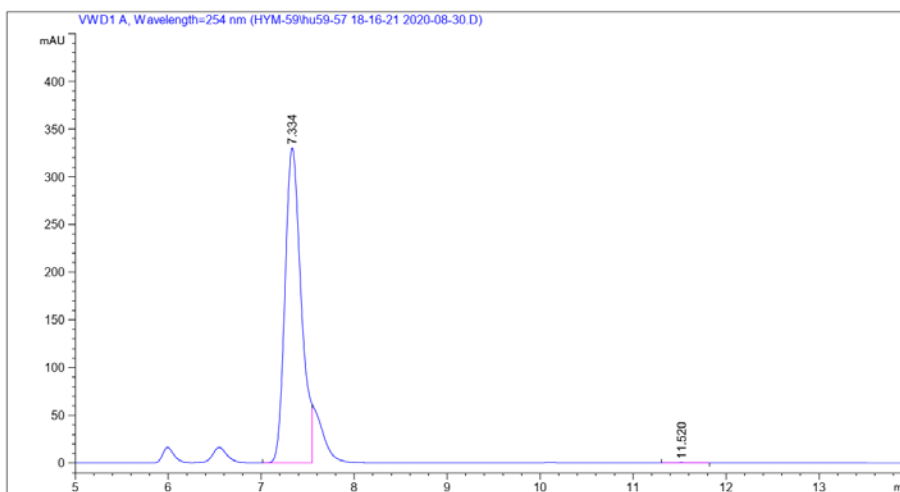
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 9.162 | BB | 0.2209 | 4153.00586 | 288.51843 | 99.8242 |
| 2 | 12.825 | MM R | 0.3236 | 7.31216 | 3.76627e ⁻¹ | 0.1758 |

HPLC Chromatograms of racemic 3ag



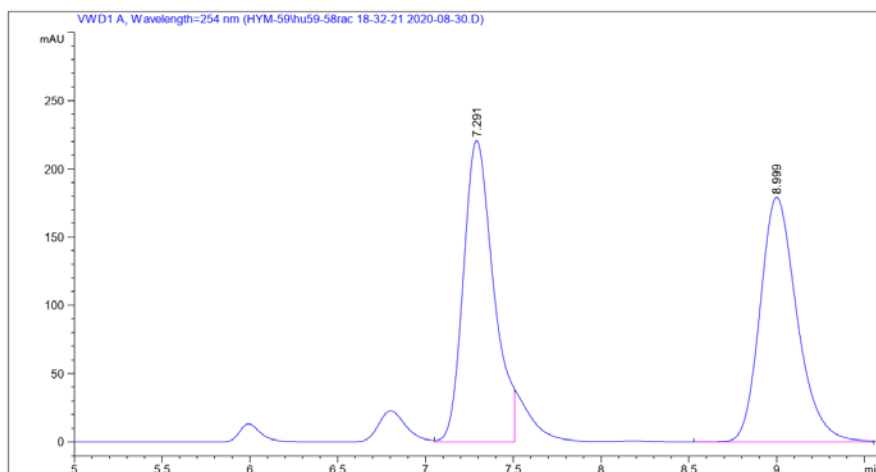
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.382 | BB | 0.1918 | 2383.39331 | 188.11639 | 50.9623 |
| 2 | 11.577 | BB | 0.2945 | 2293.38232 | 119.18517 | 49.0377 |

HPLC Chromatograms of chiral 3ag



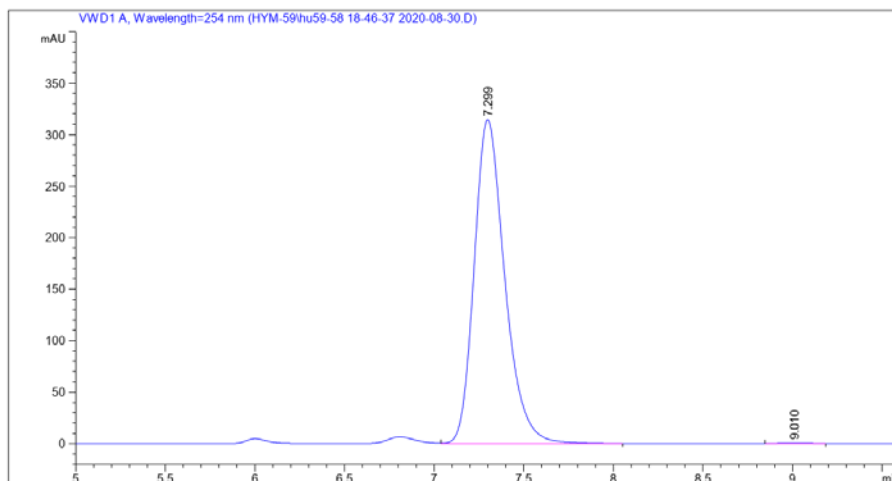
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.334 | MF R | 0.2016 | 3994.07983 | 330.16687 | 99.8577 |
| 2 | 11.520 | MM R | 0.2779 | 5.69105 | 3.41320e ⁻¹ | 0.1423 |

HPLC Chromatograms of racemic 3ah



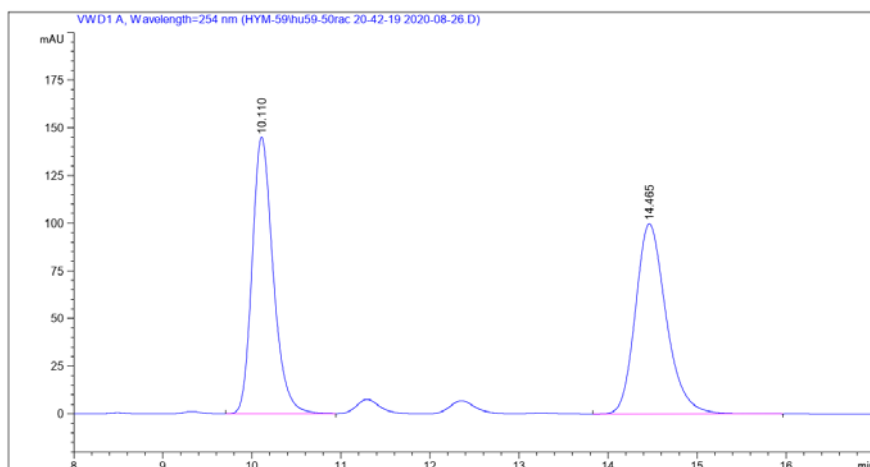
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.291 | MF R | 0.1991 | 2639.03223 | 220.87839 | 50.1450 |
| 2 | 8.999 | BV | 0.2236 | 2623.76904 | 179.37888 | 49.8550 |

HPLC Chromatograms of chiral 3ah



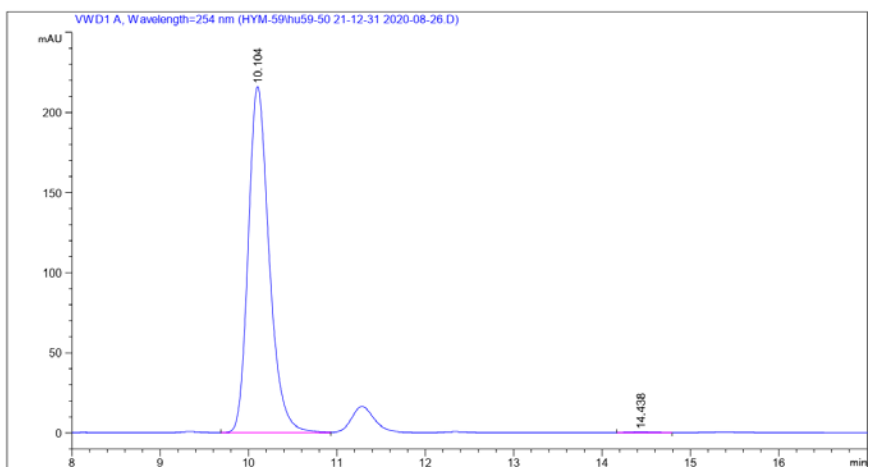
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.299 | FM R | 0.1977 | 3728.96094 | 314.41290 | 99.8339 |
| 2 | 9.010 | MM R | 0.2057 | 6.20463 | 5.02812e ⁻¹ | 0.166 |

HPLC Chromatograms of racemic 3ai



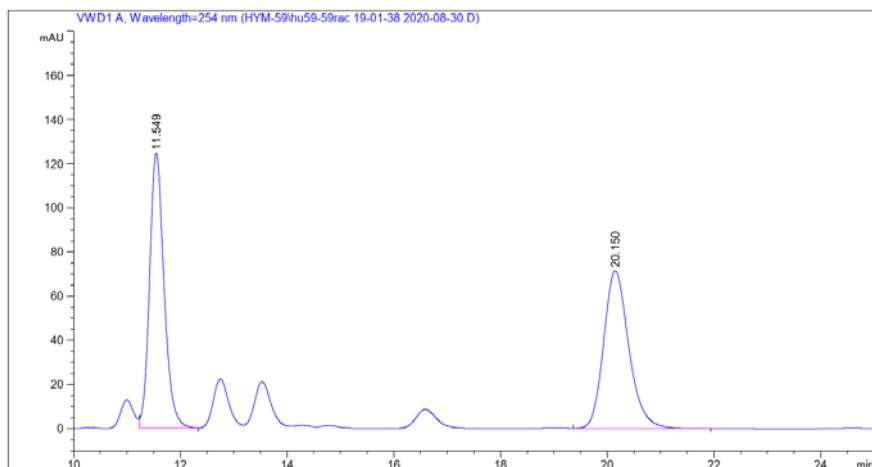
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 10.110 | BB | 0.2504 | 2379.46826 | 145.04608 | 49.9006 |
| 2 | 14.465 | BB | 0.3666 | 2388.95142 | 99.68684 | 50.0994 |

HPLC Chromatograms of chiral 3ai



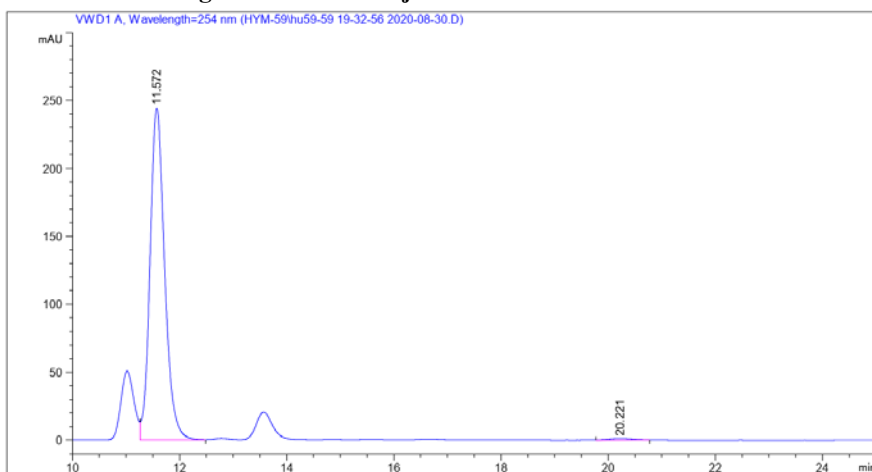
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 10.104 | BV | 0.2511 | 3553.41455 | 215.81415 | 99.7120 |
| 2 | 14.438 | MM R | 0.3720 | 10.26190 | 4.59823e ⁻¹ | 0.2880 |

HPLC Chromatograms of racemic 3aj



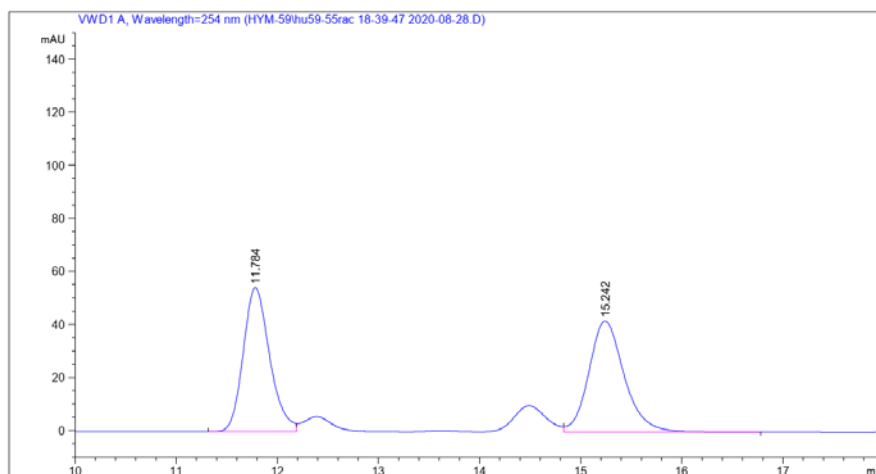
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 11.549 | FM R | 0.3142 | 2346.92480 | 124.48588 | 50.0798 |
| 2 | 20.150 | BB | 0.5012 | 2339.44482 | 71.41546 | 49.9202 |

HPLC Chromatograms of chiral 3aj



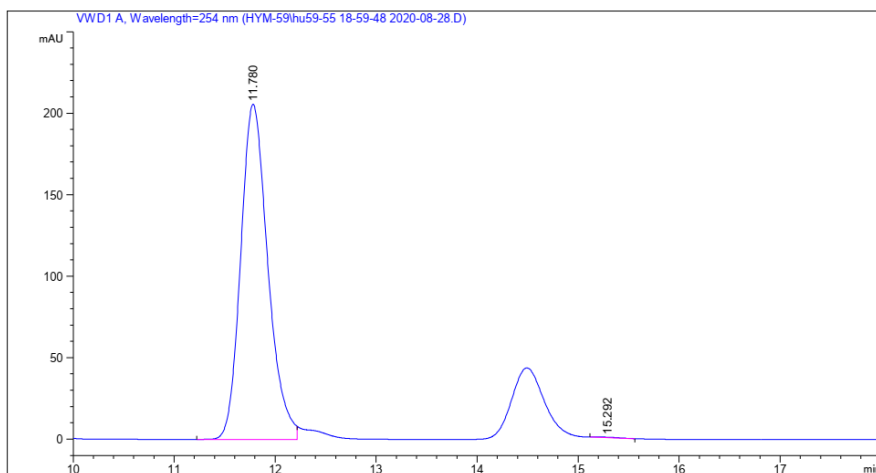
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 11.572 | VB | 0.2893 | 4632.67334 | 244.25403 | 99.1283 |
| 2 | 20.221 | MM R | 0.5268 | 40.73787 | 1.28892 | 0.8717 |

HPLC Chromatograms of racemic 3ak



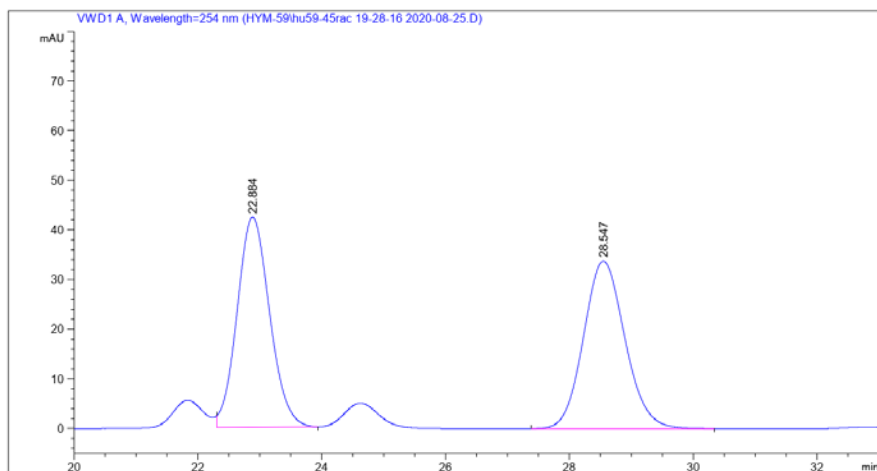
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 11.784 | MF R | 0.3032 | 987.23230 | 54.26437 | 49.2864 |
| 2 | 15.242 | VB | 0.3701 | 1015.82043 | 41.85960 | 50.7136 |

HPLC Chromatograms of chiral 3ak



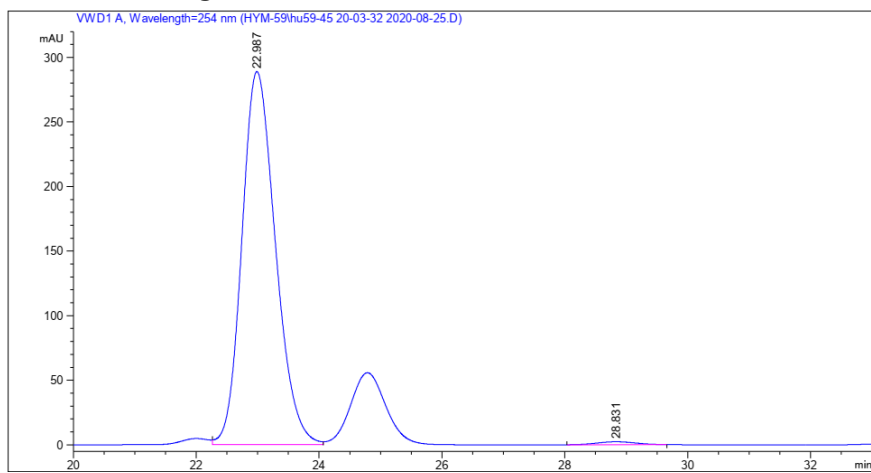
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 11.780 | MF R | 0.3109 | 3835.11230 | 205.58322 | 99.8924 |
| 2 | 15.292 | MM R | 0.2389 | 4.12980 | 2.88150e ⁻¹ | 0.1076 |

HPLC Chromatograms of racemic 3a



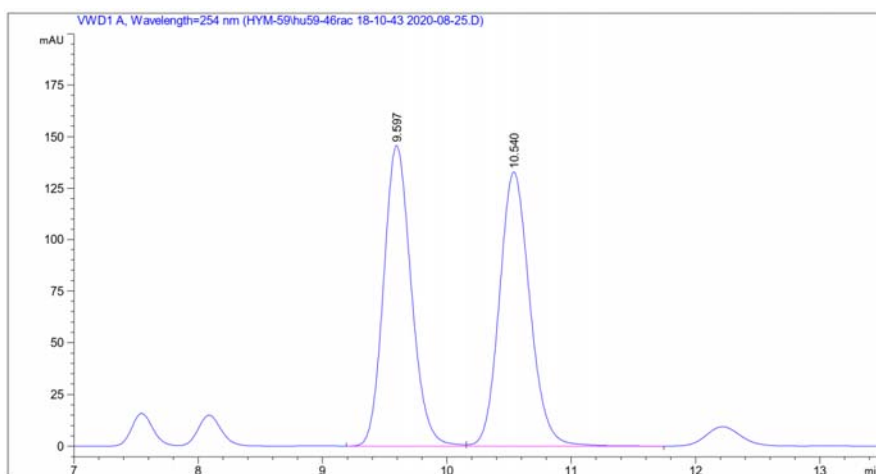
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 22.884 | FM R | 0.6082 | 1546.19812 | 42.36943 | 49.6972 |
| 2 | 28.547 | BB | 0.7150 | 1565.03821 | 33.74928 | 50.3028 |

HPLC Chromatograms of chiral 3a



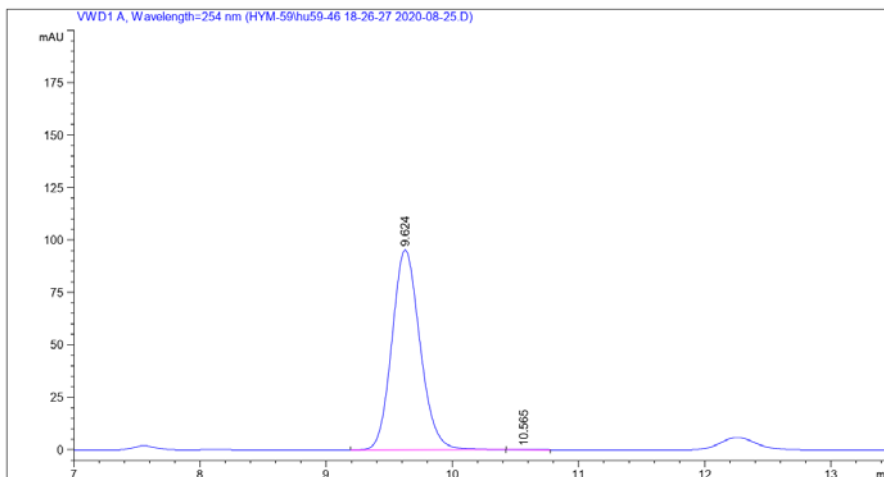
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 22.987 | FM R | 0.6319 | 1.09553e4 | 288.93787 | 99.1013 |
| 2 | 28.831 | MM R | 0.7235 | 99.35131 | 2.28862 | 0.8987 |

HPLC Chromatograms of racemic 3am



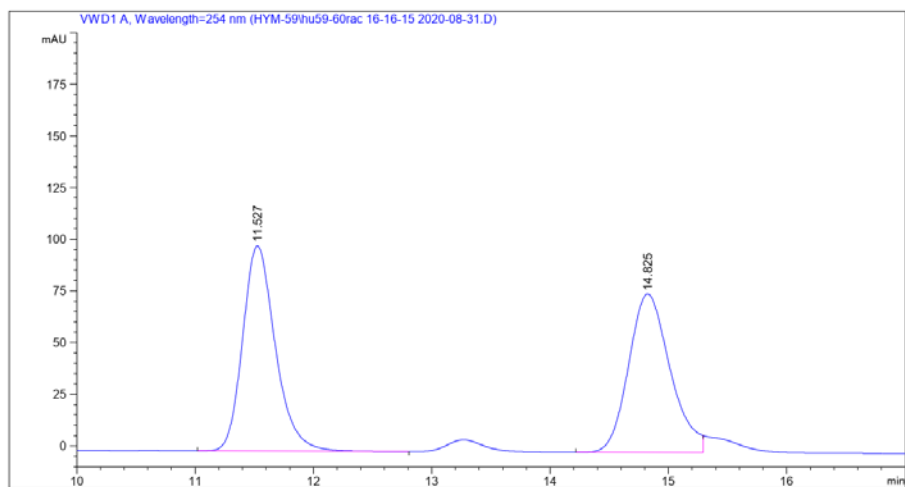
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 9.597 | BV | 0.2373 | 2239.57080 | 145.74062 | 49.9063 |
| 2 | 10.540 | VB | 0.2614 | 2247.97754 | 132.86018 | 50.0937 |

HPLC Chromatograms of chiral 3am



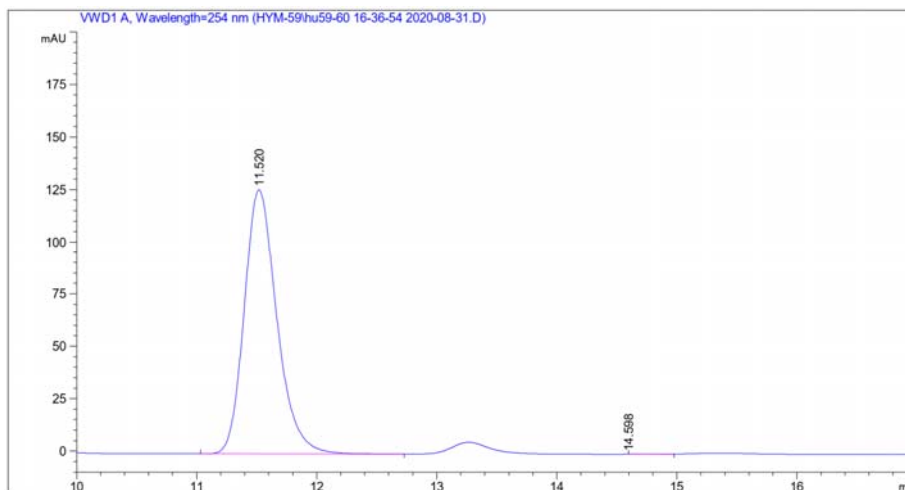
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 9.624 | BB | 0.2383 | 1472.15283 | 95.27745 | 99.9193 |
| 2 | 10.565 | MM R | 0.2252 | 1.18938 | 8.80101e ⁻² | 0.0807 |

HPLC Chromatograms of racemic 3a



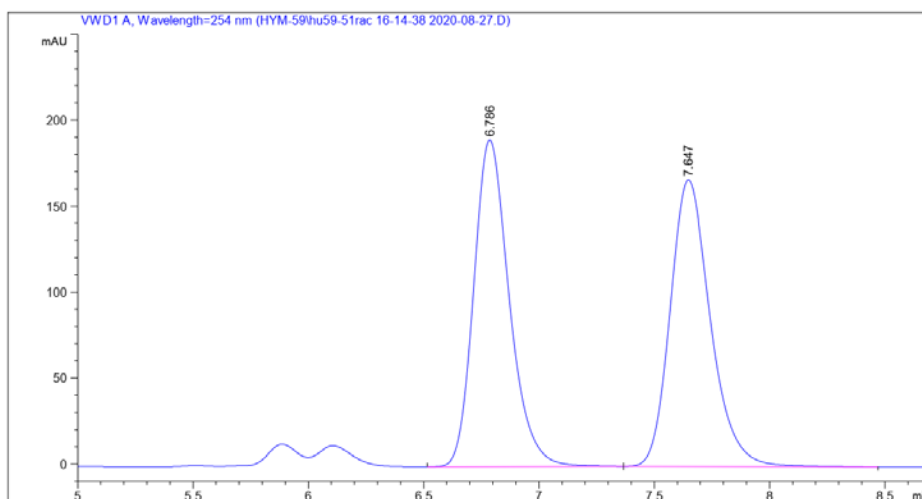
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 11.527 | BB | 0.2939 | 1904.44067 | 99.22999 | 50.4798 |
| 2 | 14.825 | MF R | 0.4061 | 1868.24097 | 76.67100 | 49.5202 |

HPLC Chromatograms of chiral 3a



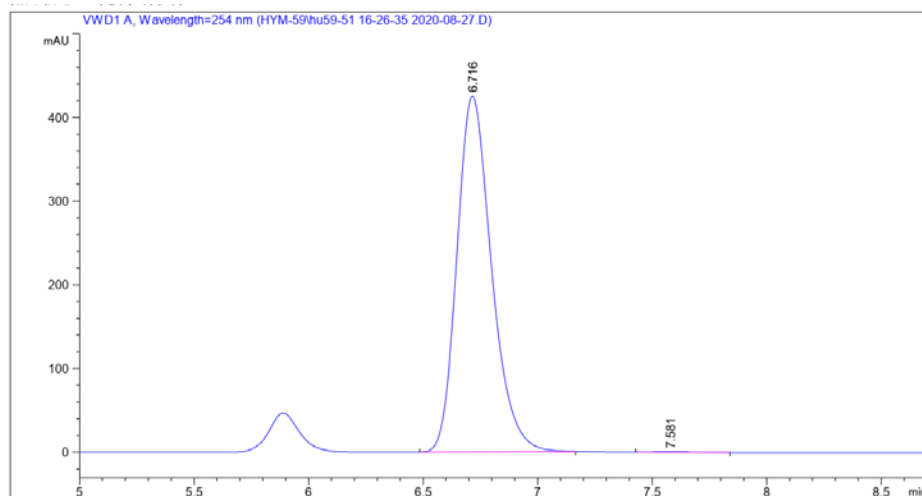
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 11.520 | BB | 0.2881 | 2381.54248 | 126.25974 | 99.9291 |
| 2 | 14.598 | MM R | 0.2033 | 1.69028 | 1.63633e ⁻³ | 0.0709 |

HPLC Chromatograms of racemic 3ao



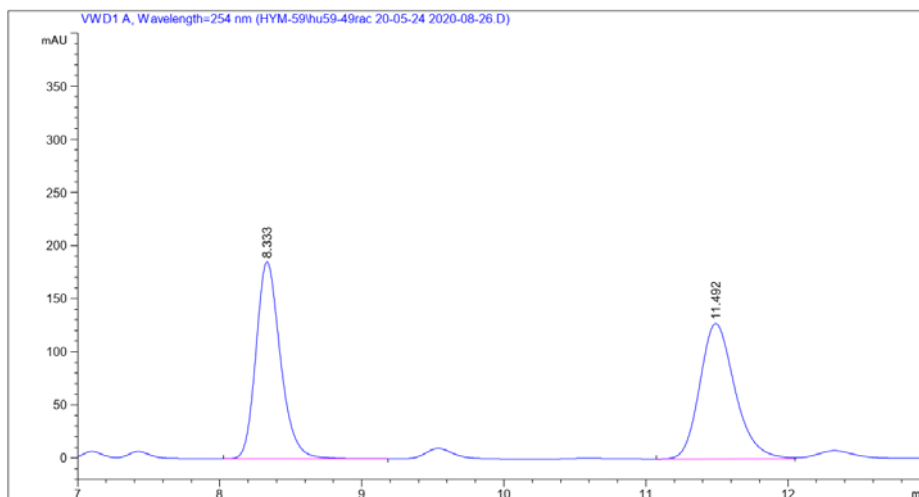
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 6.786 | BB | 0.1632 | 2021.52441 | 189.96301 | 50.0419 |
| 2 | 7.647 | BB | 0.1862 | 2018.14014 | 166.69490 | 49.958 |

HPLC Chromatograms of chiral 3ao



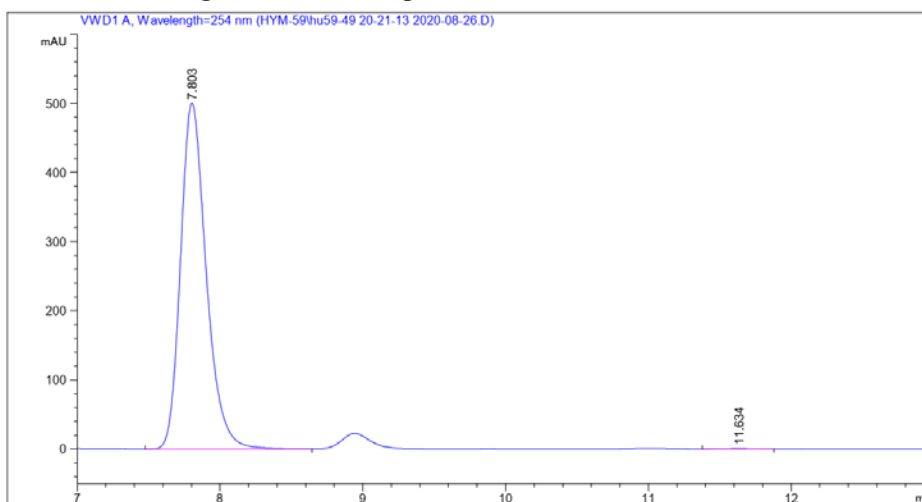
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 6.716 | MM R | 0.1749 | 4466.12158 | 425.59280 | 99.8345 |
| 2 | 7.581 | MM R | 0.2373 | 7.40263 | 5.19984e ⁻¹ | 0.1655 |

HPLC Chromatograms of racemic 3ap



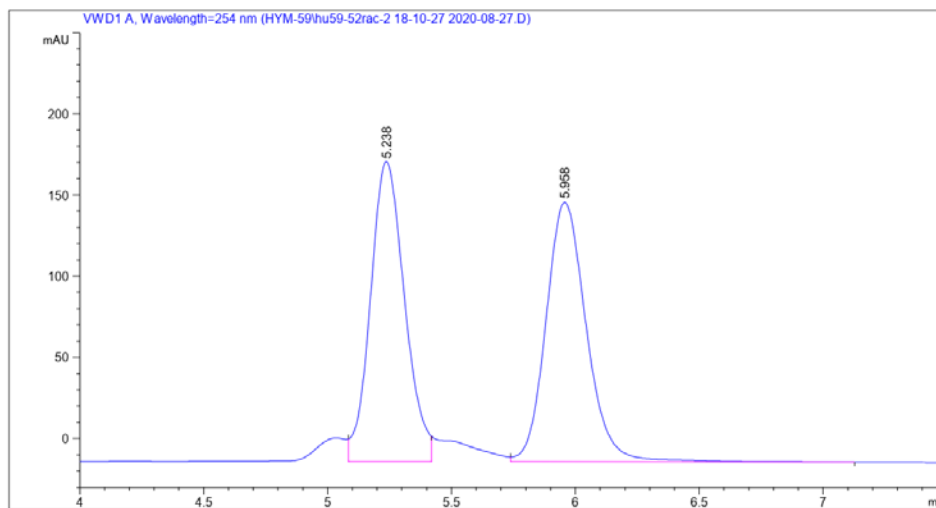
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 8.333 | BB | 0.1832 | 2210.49463 | 185.31058 | 50.2756 |
| 2 | 11.492 | MF R | 0.2860 | 2186.26147 | 127.40232 | 49.7244 |

HPLC Chromatograms of chiral 3ap



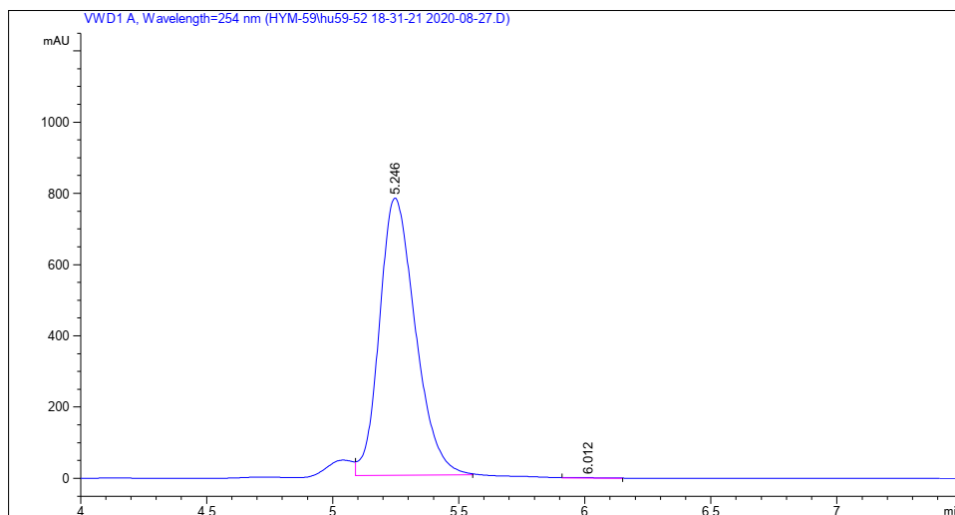
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.803 | BV | 0.1909 | 6262.02148 | 500.83163 | 99.8309 |
| 2 | 11.634 | MM R | 0.2580 | 10.60476 | 6.84947e ⁻¹ | 0.1691 |

HPLC Chromatograms of racemic 3aq



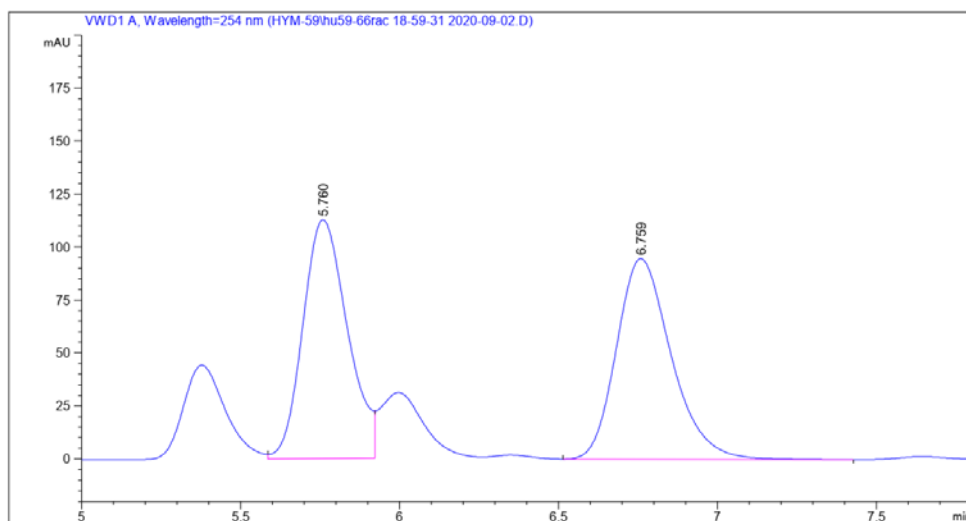
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 5.238 | MF R | 0.1600 | 1774.90662 | 184.90764 | 49.4204 |
| 2 | 5.958 | VB | 0.1744 | 1816.53784 | 160.02168 | 50.5796 |

HPLC Chromatograms of chiral 3aq



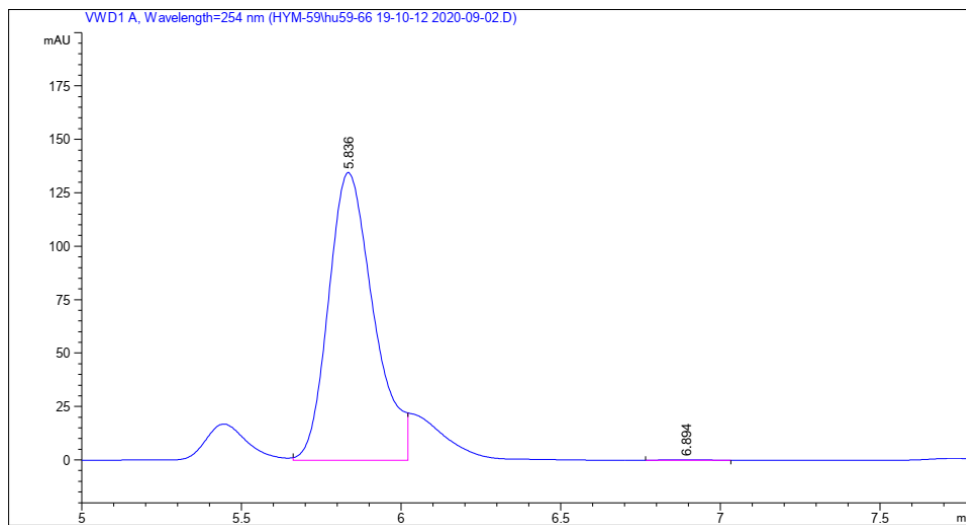
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 5.246 | MM R | 0.1650 | 7710.63037 | 778.79279 | 99.9226 |
| 2 | 6.012 | MM R | 0.1519 | 5.97459 | 6.55710e ⁻¹ | 0.0774 |

HPLC Chromatograms of racemic 3ar



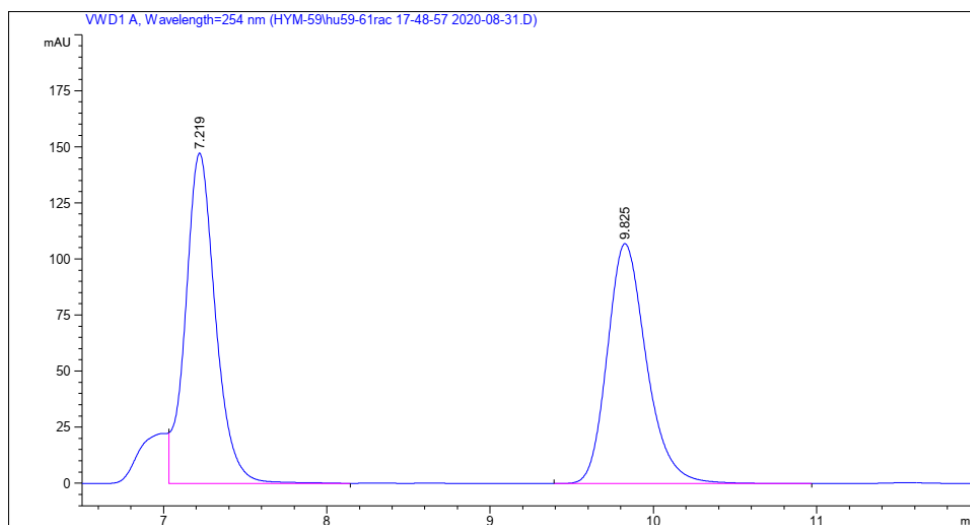
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 5.760 | VV | 0.1495 | 1095.84106 | 112.68318 | 49.1713 |
| 2 | 6.759 | BB | 0.1836 | 1132.77808 | 94.65282 | 50.8287 |

HPLC Chromatograms of chiral 3ar



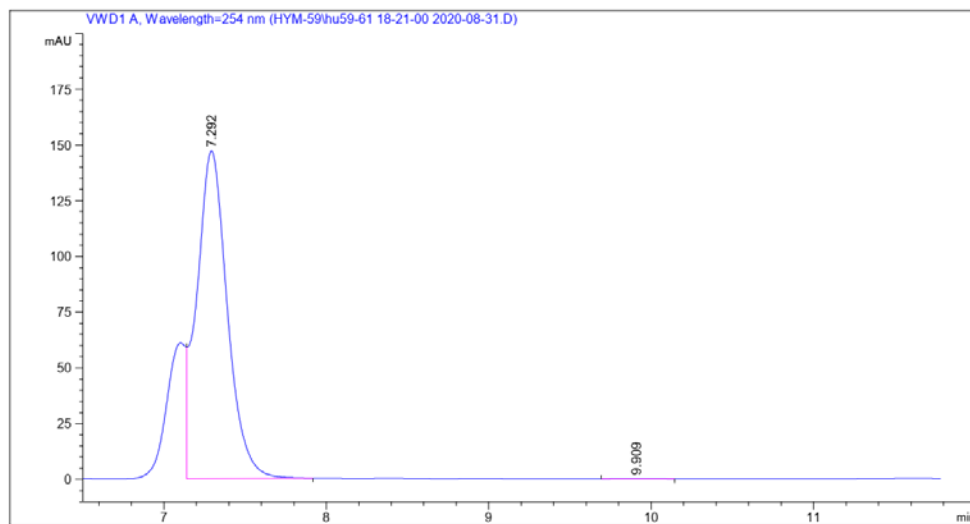
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 5.836 | MF R | 0.1633 | 1318.81909 | 134.59128 | 99.9239 |
| 2 | 6.894 | MM R | 0.1422 | 1.00430 | 1.17726e ⁻¹ | 0.0761 |

HPLC Chromatograms of racemic 3as



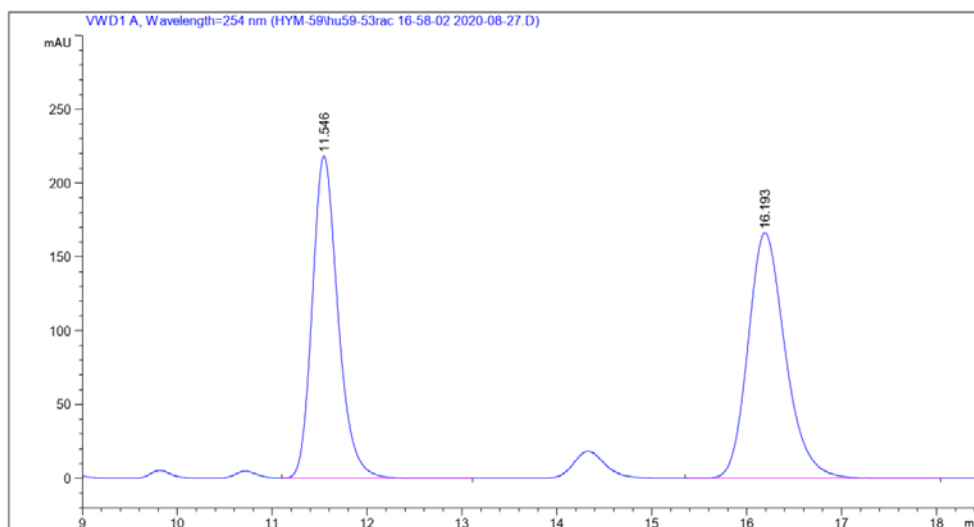
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.219 | FM R | 0.2128 | 1879.94739 | 147.26688 | 51.3789 |
| 2 | 9.825 | BB | 0.2541 | 1779.03711 | 106.94800 | 48.6211 |

HPLC Chromatograms of chiral 3as



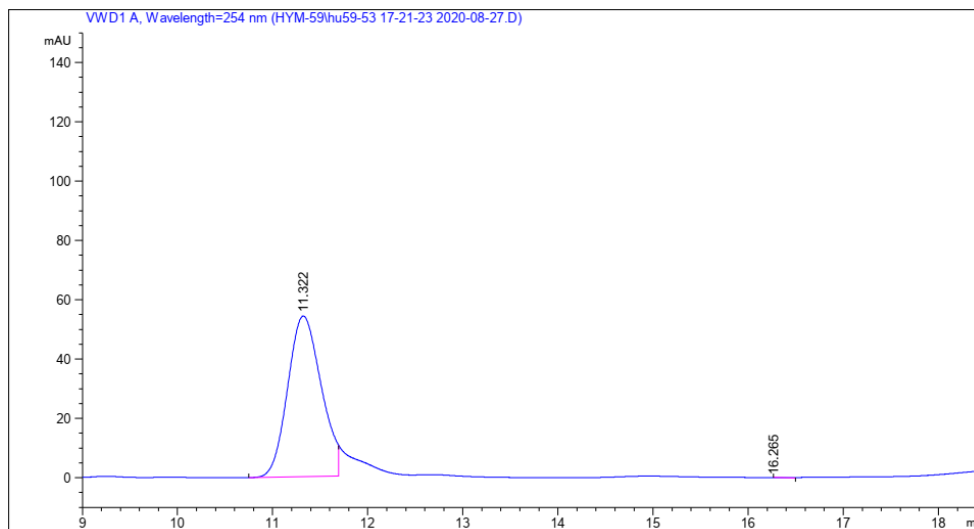
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.292 | VB | 0.1940 | 1914.34131 | 146.88785 | 99.8961 |
| 2 | 9.909 | MM R | 0.2702 | 1.99013 | 1.22751e ⁻¹ | 0.1039 |

HPLC Chromatograms of racemic 3at



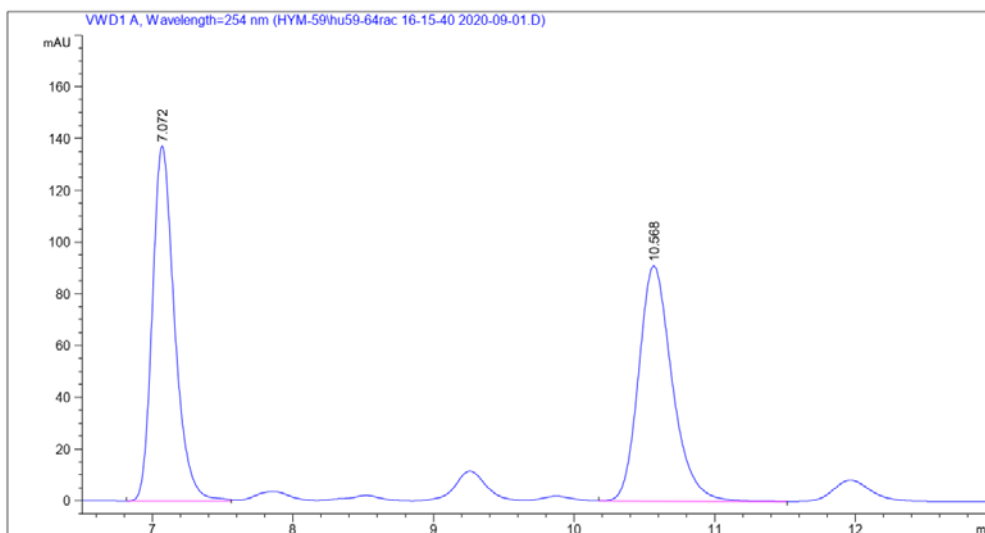
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 11.546 | VB | 0.2875 | 4106.51367 | 218.22406 | 47.5066 |
| 2 | 16.193 | BB | 0.4182 | 4537.58594 | 166.37326 | 52.4934 |

HPLC Chromatograms of chiral 3at



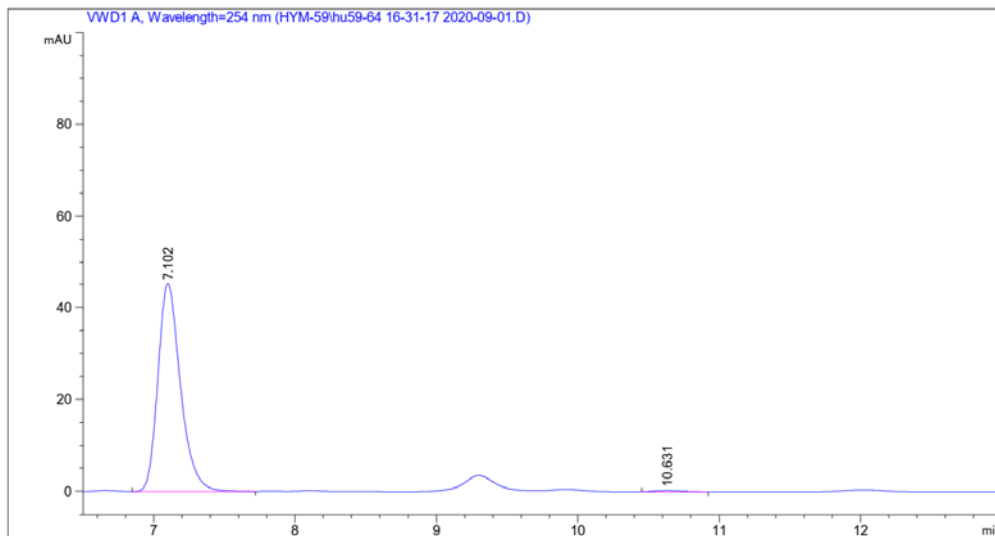
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 11.322 | MF R | 0.4073 | 1324.76172 | 54.21479 | 99.8961 |
| 2 | 16.265 | MM R | 0.0885 | 1.37829 | 6.53074e ⁻² | 0.1039 |

HPLC Chromatograms of racemic 3au



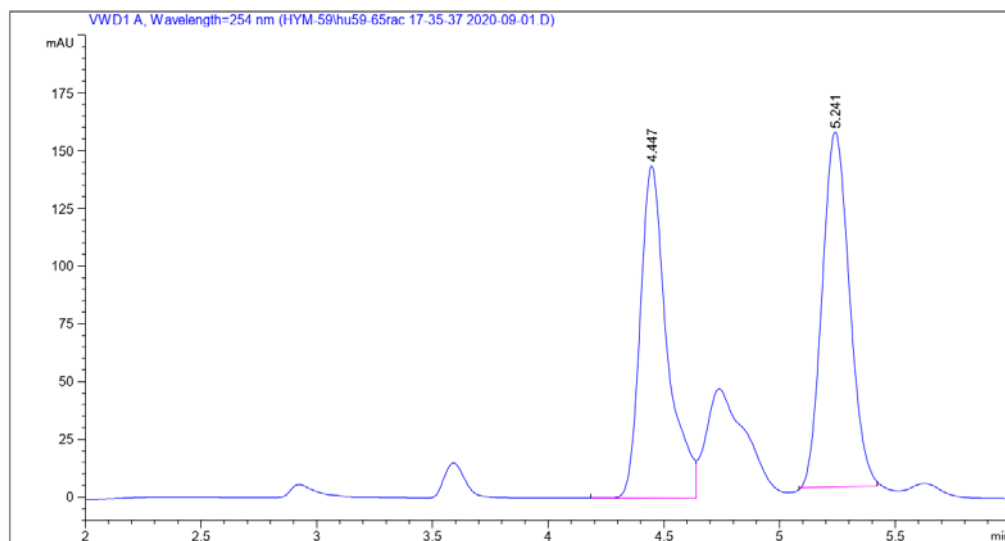
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.072 | MF R | 0.1827 | 1504.54663 | 137.21919 | 50.0041 |
| 2 | 10.568 | VB | 0.2529 | 1504.30054 | 90.97217 | 49.9959 |

HPLC Chromatograms of chiral 3au



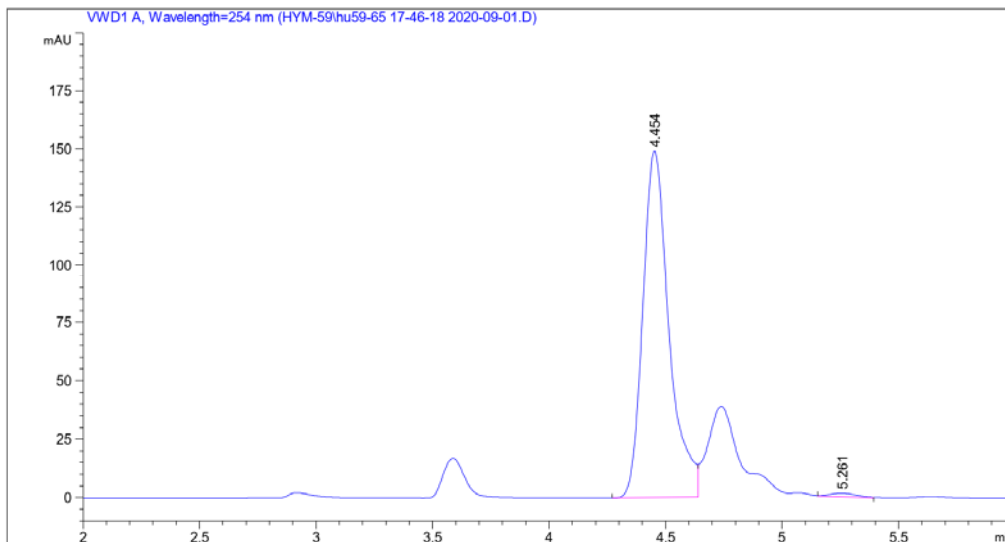
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.102 | BB | 0.1684 | 501.62079 | 45.22541 | 99.1082 |
| 2 | 10.631 | MM R | 0.2476 | 4.51370 | 3.03878e ⁻¹ | 0.8918 |

HPLC Chromatograms of racemic 3av



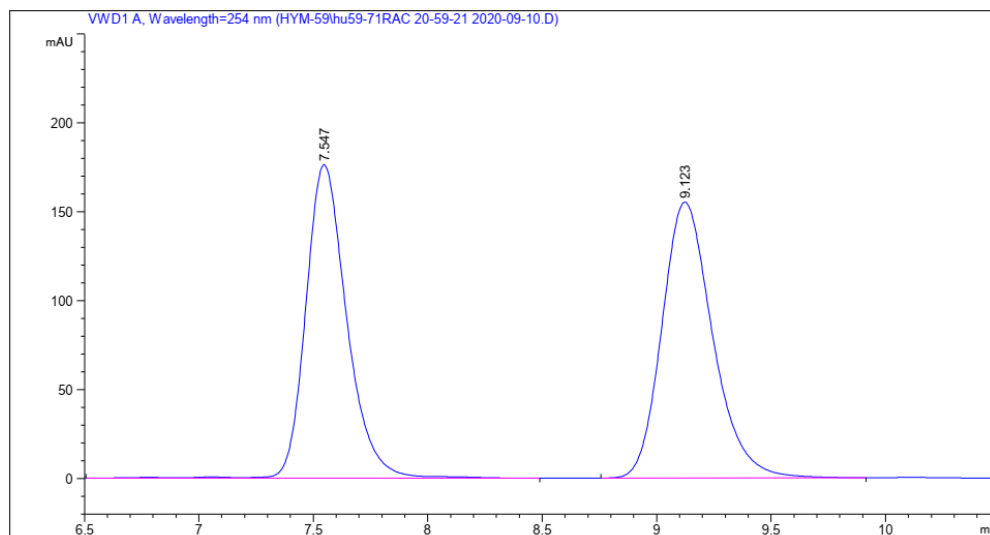
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 4.447 | BV | 0.1201 | 1160.20227 | 143.77599 | 48.0538 |
| 2 | 5.241 | MM R | 0.1361 | 1254.18213 | 153.63324 | 51.9462 |

HPLC Chromatograms of chiral 3av



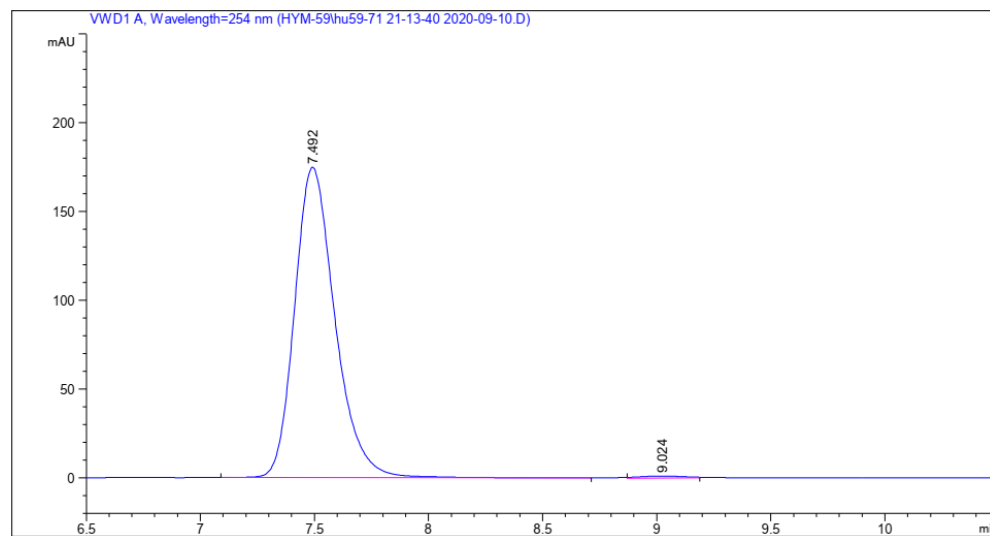
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 4.454 | BV | 0.1178 | 1160.56226 | 149.09399 | 98.8905 |
| 2 | 5.261 | MM R | 0.1344 | 13.02148 | 1.61430 | 1.1095 |

HPLC Chromatograms of racemic 3ba



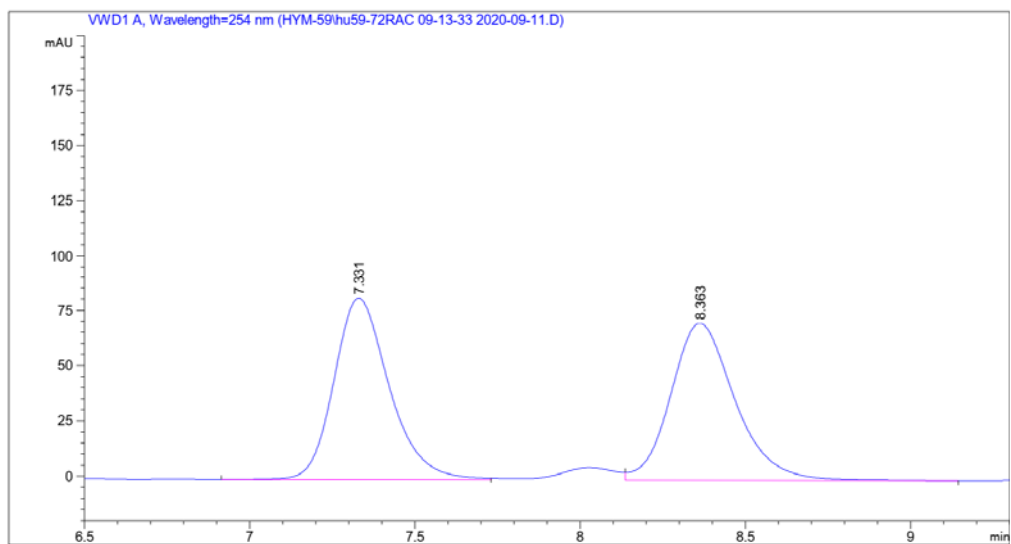
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.547 | VB R | 0.1905 | 2198.46606 | 176.30038 | 47.9075 |
| 2 | 9.123 | BB | 0.2357 | 2390.51538 | 155.20500 | 52.0925 |

HPLC Chromatograms of chiral 3ba



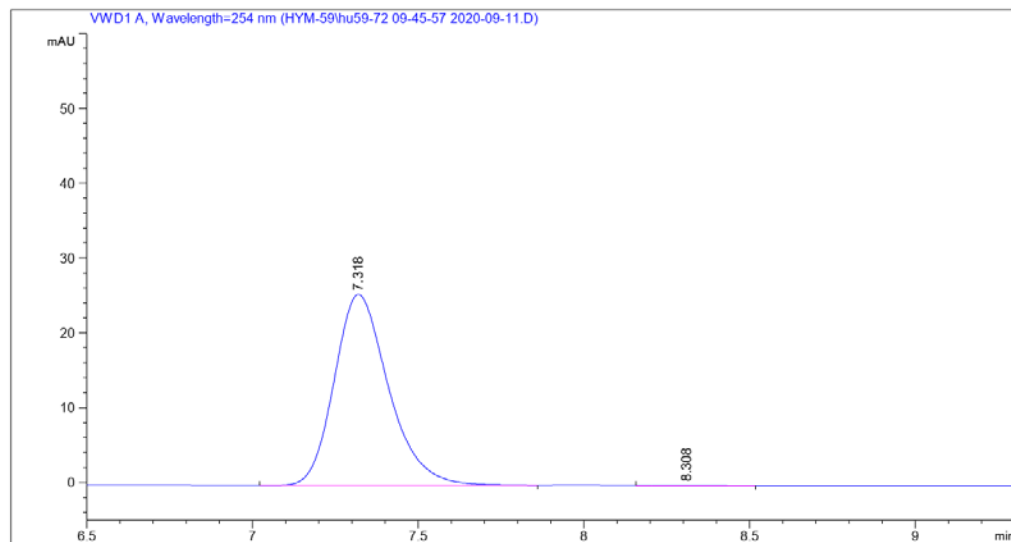
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.492 | BB | 0.1874 | 2150.52246 | 174.91290 | 99.3170 |
| 2 | 9.024 | MM R | 0.2254 | 14.78812 | 1.09361 | 0.6830 |

HPLC Chromatograms of racemic 3ca



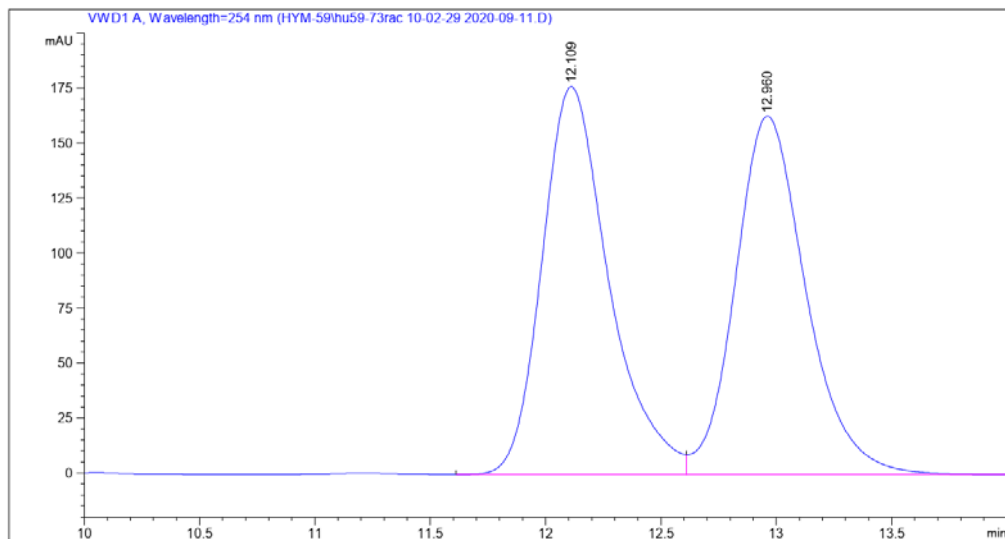
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.331 | MF R | 0.1947 | 958.27985 | 82.02325 | 49.9176 |
| 2 | 8.363 | VB | 0.2060 | 961.44446 | 70.99097 | 50.0824 |

HPLC Chromatograms of chiral 3ca



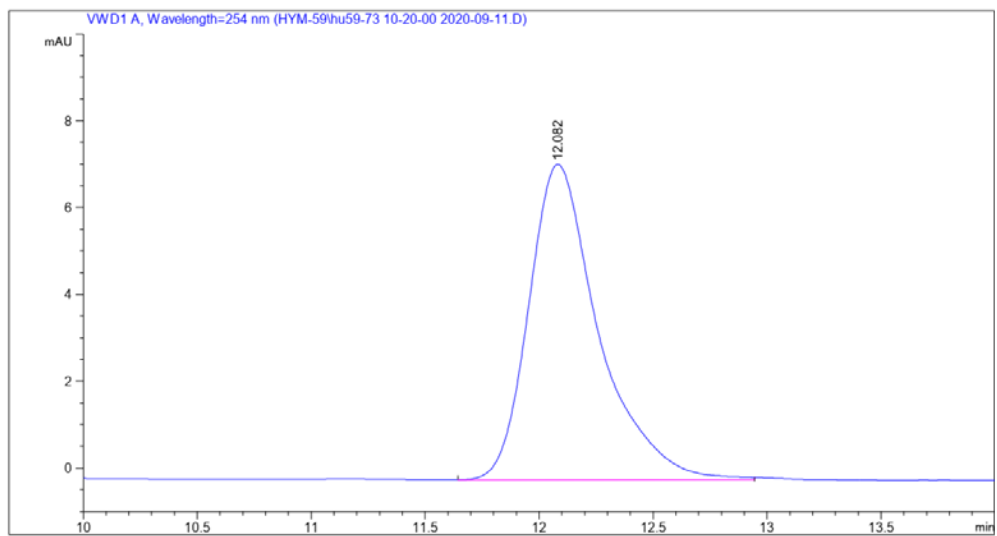
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 7.318 | BB | 0.1737 | 289.98093 | 25.50400 | 99.6514 |
| 2 | 8.308 | MM R | 0.2208 | 1.01436 | 7.65545e ⁻² | 0.3486 |

HPLC Chromatograms of racemic 3da



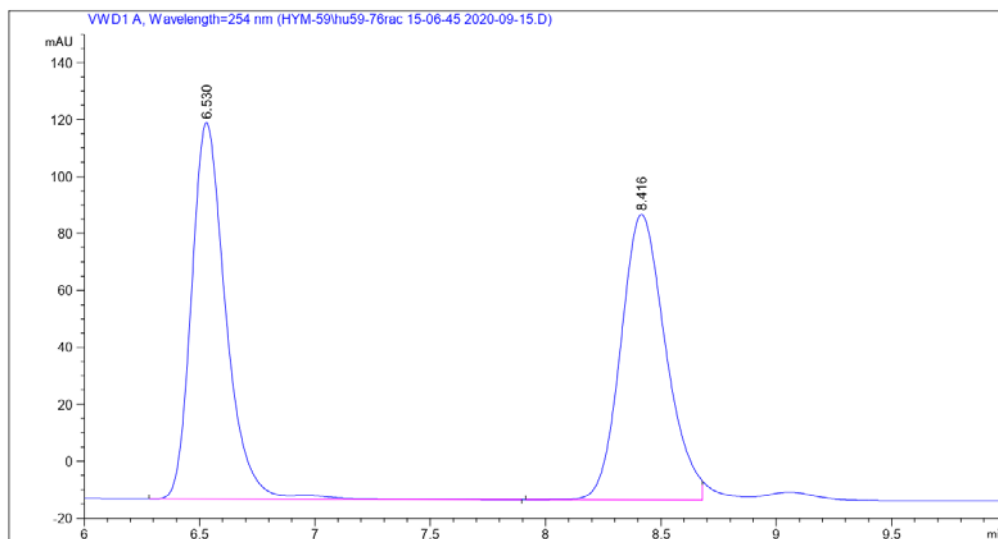
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 12.109 | BV | 0.3053 | 3552.83716 | 176.13202 | 50.6633 |
| 2 | 12.960 | VB | 0.3250 | 3459.81323 | 162.79056 | 49.3367 |

HPLC Chromatograms of chiral 3da



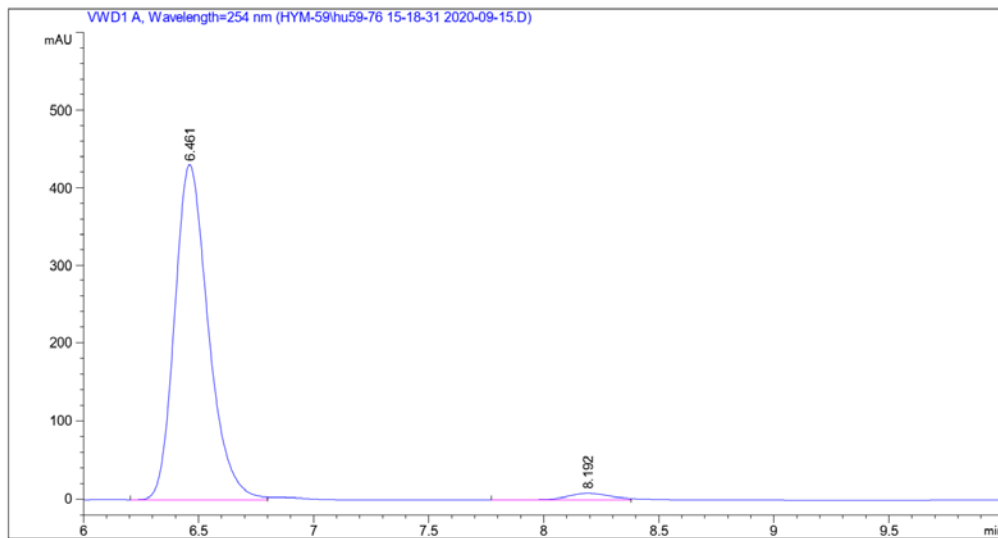
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|----------|
| 1 | 12.082 | MF R | 0.3549 | 154.69525 | 7.26490 | 100.0000 |

HPLC Chromatograms of racemic 3ea



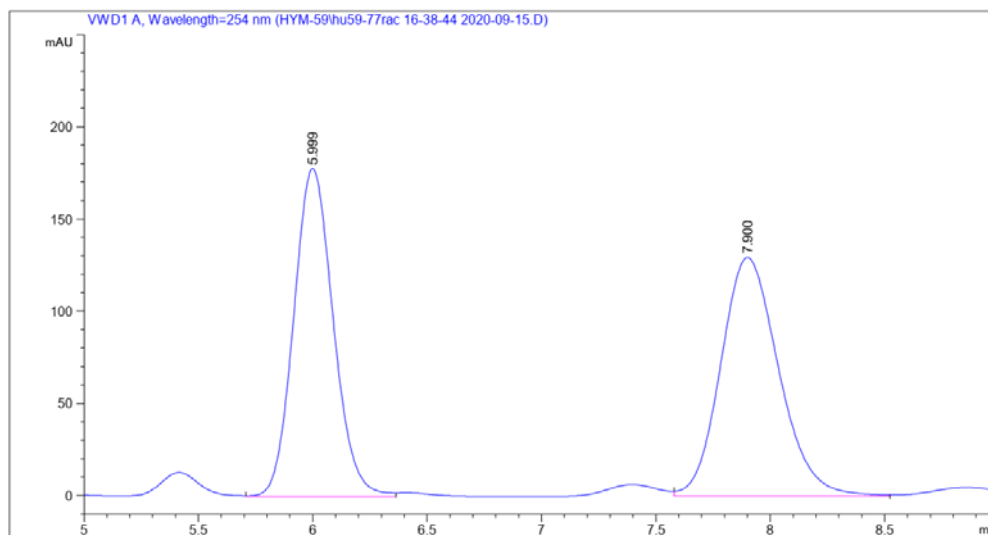
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 6.530 | BV R | 0.1564 | 1364.05139 | 132.22017 | 50.1873 |
| 2 | 8.416 | MF R | 0.2250 | 1353.86975 | 100.29630 | 49.8127 |

HPLC Chromatograms of chiral 3ea



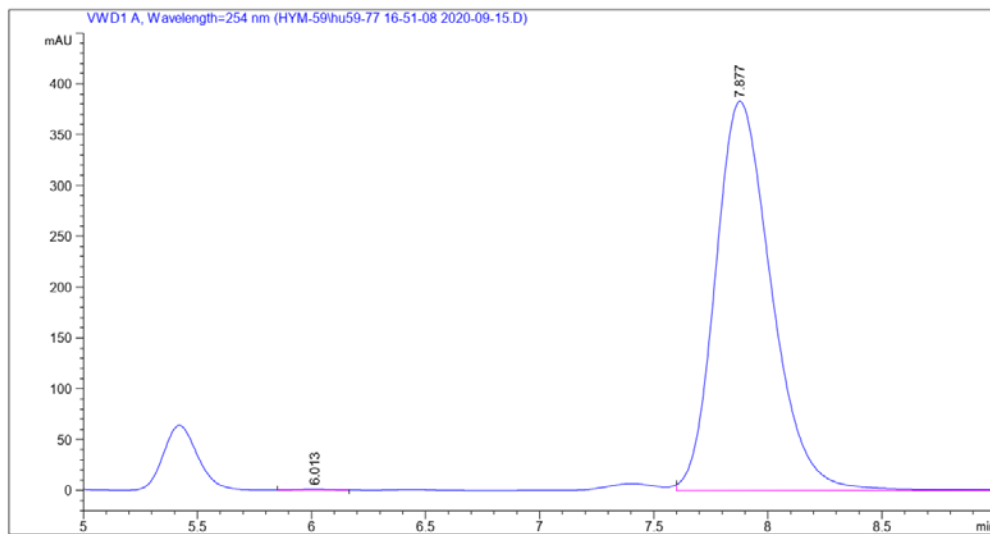
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 6.461 | FM R | 0.1691 | 4369.99365 | 430.69266 | 97.5346 |
| 2 | 8.192 | MF R | 0.2149 | 110.46120 | 8.56766 | 2.4654 |

HPLC Chromatograms of racemic 3fa



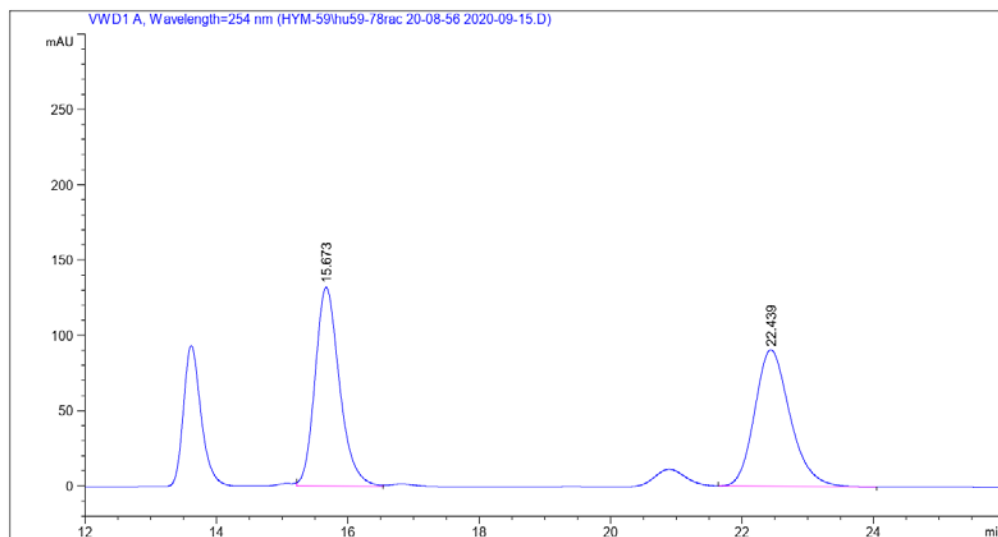
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 5.999 | MF R | 0.1999 | 2132.65527 | 177.79358 | 48.3601 |
| 2 | 7.900 | MM R | 0.2935 | 2277.29199 | 129.29793 | 51.6399 |

HPLC Chromatograms of chiral 3fa



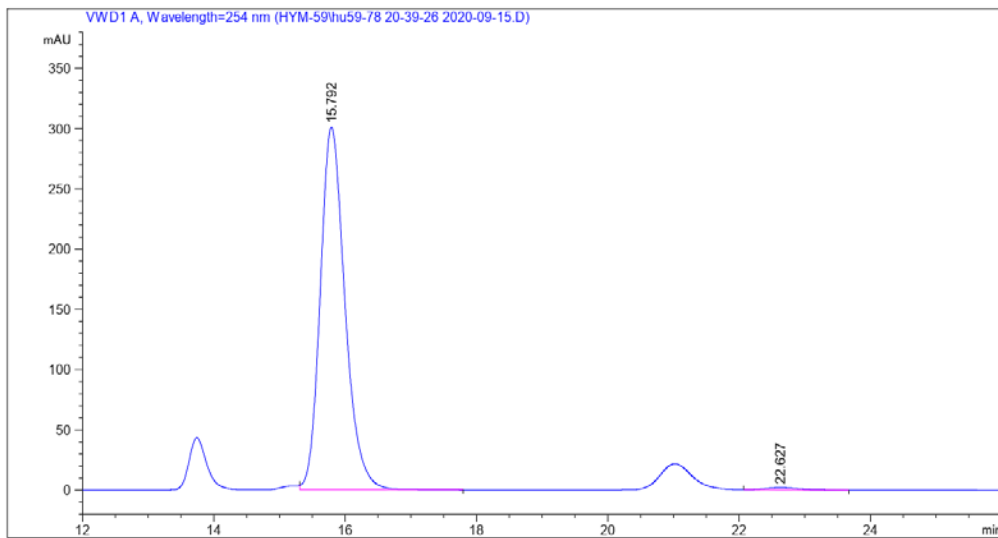
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 6.013 | MM R | 0.1602 | 8.53055 | 8.87540e ⁻¹ | 0.1302 |
| 2 | 7.877 | FM R | 0.2847 | 6541.18555 | 382.88135 | 99.8698 |

HPLC Chromatograms of racemic 3ga



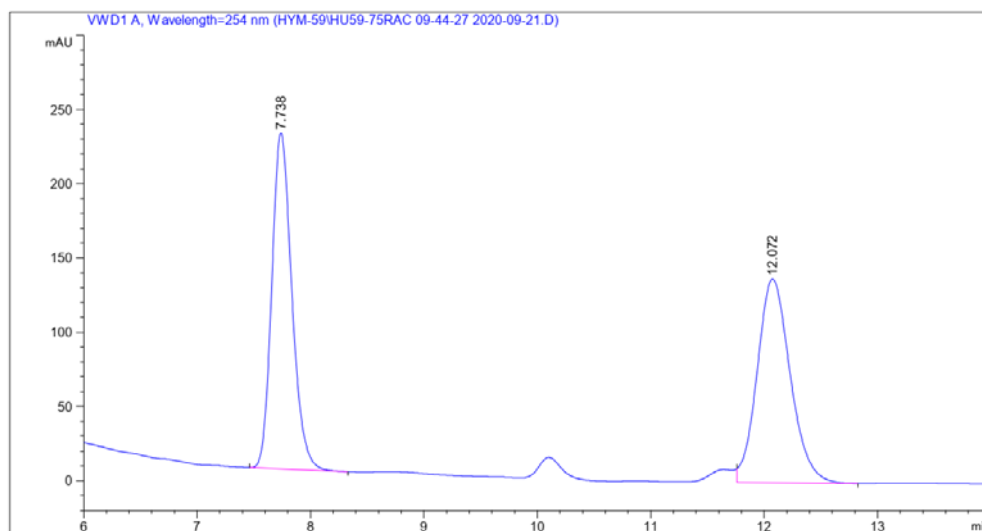
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 15.673 | MF R | 0.4310 | 3415.30493 | 132.07623 | 50.3154 |
| 2 | 22.439 | BB | 0.5719 | 3372.49390 | 90.47804 | 49.6846 |

HPLC Chromatograms of chiral 3ga



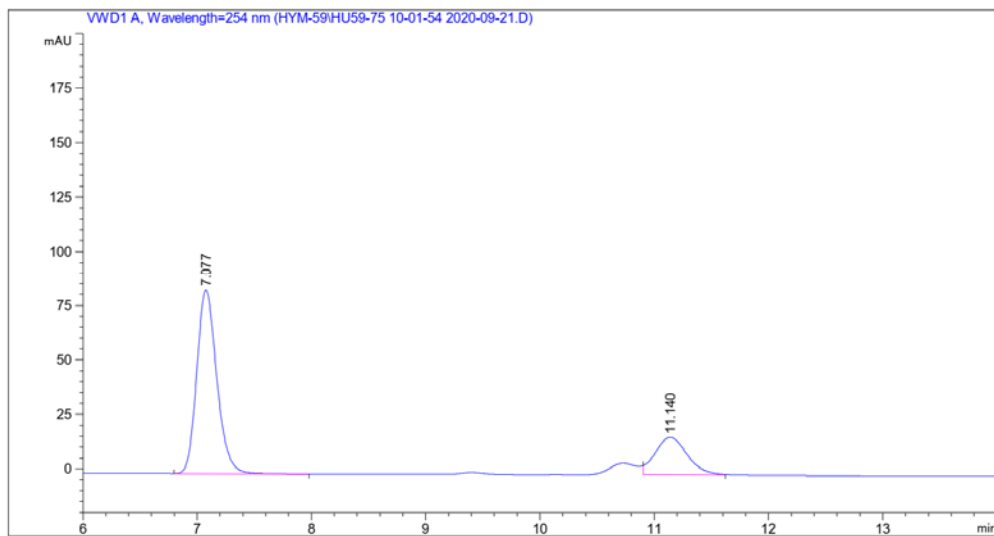
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 15.792 | FM R | 0.4359 | 7875.90088 | 301.12250 | 99.2182 |
| 2 | 22.627 | BB | 0.5076 | 62.05804 | 1.81170 | 0.7818 |

HPLC Chromatograms of racemic 3ha



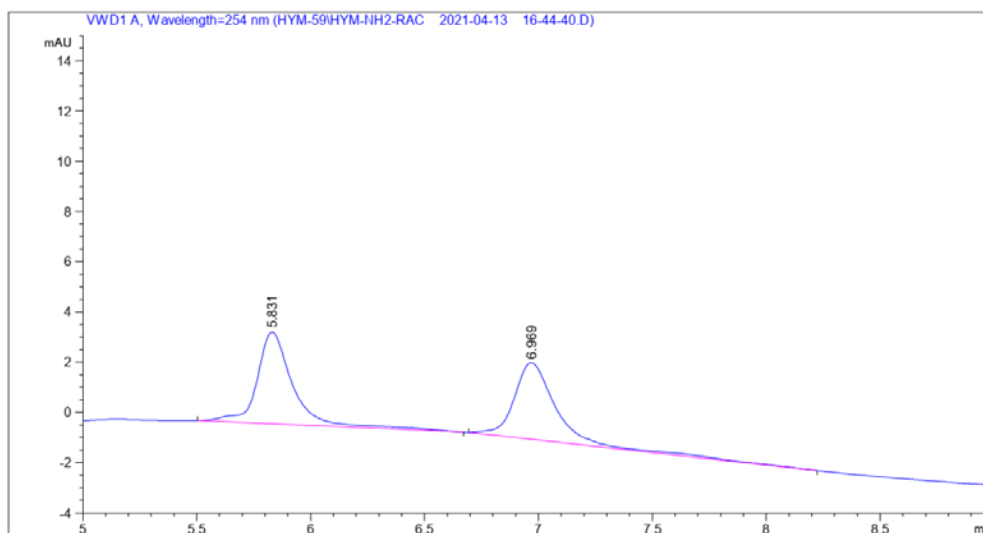
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.738 | BB | 0.1891 | 2774.67847 | 226.26335 | 49.9387 |
| 2 | 12.072 | FM R | 0.3378 | 2781.48560 | 137.24873 | 50.0613 |

HPLC Chromatograms of chiral 3ha



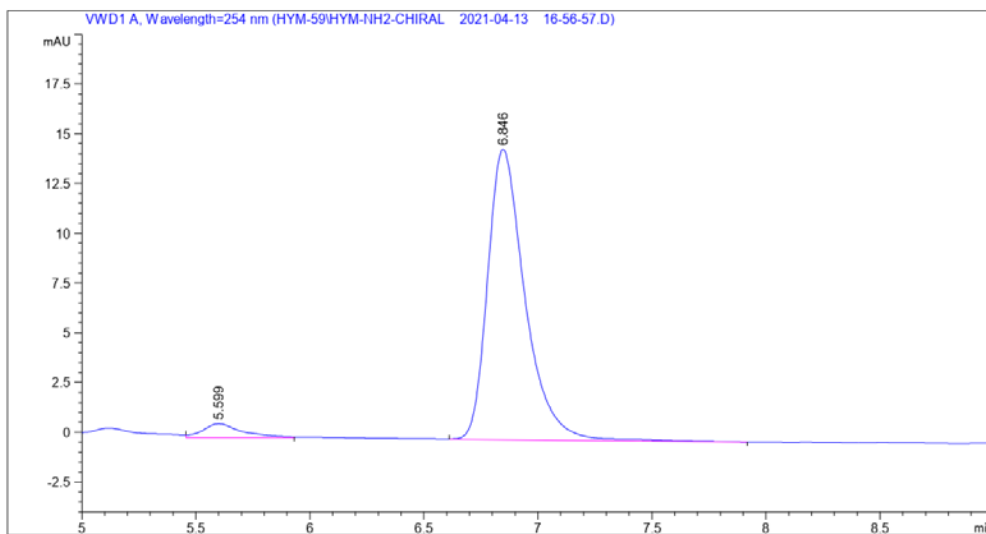
| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 7.077 | BB | 0.1875 | 1030.28088 | 84.34464 | 75.2950 |
| 2 | 11.140 | MM R | 0.3267 | 338.04517 | 17.24741 | 24.7050 |

HPLC Chromatograms of racemic 4



| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|--------------|---------|
| 1 | 5.831 | BB | 0.1605 | 39.85420 | 3.64752 | 50.5487 |
| 2 | 6.969 | BBA | 0.1887 | 38.98894 | 3.03892 | 49.4513 |

HPLC Chromatograms of chiral 4



| Peak # | RetTime [min] | Type | Width [min] | Area [mAU*s] | Height [mAU] | Area % |
|--------|---------------|------|-------------|--------------|------------------------|---------|
| 1 | 5.599 | MM R | 0.1952 | 8.19216 | 6.99317e ⁻¹ | 4.6942 |
| 2 | 6.846 | BB | 0.1721 | 166.32574 | 14.58009 | 95.3058 |

X-Ray Crystallographic Data of 3ea

Crystallographic data for **3ea** have been deposited with the Cambridge Crystallographic Data Centre as deposition number 2095226. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif, or by emailing data_request@ccdc.cam.ac.uk, or by contacting The Cambridge Crystallographic Data Centre, 12, Union Road, Cambridge CB2 1EZ, UK; fax: +44 1223 336033.

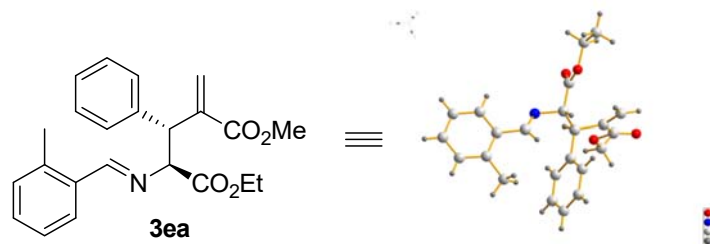


Table S1. Crystal data and structure refinement for **3ea**.

| | |
|------------------------------------|---------------------------------------------------------------|
| Identification code | 3ea |
| Empirical formula | C ₂₃ H ₂₅ NO ₄ |
| Formula weight | 379.44 |
| Temperature/K | 170.0 |
| Crystal system | triclinic |
| Space group | P1 |
| a/Å | 5.8434(2) |
| b/Å | 9.9102(3) |
| c/Å | 17.9362(5) |
| α/° | 82.4130(10) |
| β/° | 86.4550(10) |
| γ/° | 89.4660(10) |
| Volume/Å ³ | 1027.61(6) |
| Z | 2 |
| ρ _{calc} /cm ³ | 1.226 |
| μ/mm ⁻¹ | 0.676 |
| F(000) | 404.0 |
| Radiation | CuKα (λ = 1.54178) |
| 2θ range for data collection/° | 10.854 to 118.384 |
| Index ranges | -6 ≤ h ≤ 6, -11 ≤ k ≤ 11, -19 ≤ l ≤ 19 |
| Reflections collected | 9670 |
| Independent reflections | 5509 [R _{int} = 0.0297, R _{sigma} = 0.0413] |
| Data/restraints/parameters | 5509/405/511 |
| Goodness-of-fit on F ² | 1.049 |

Final R indexes [$I \geq 2\sigma(I)$] $R_1 = 0.0271$, $wR_2 = 0.0667$

Final R indexes [all data] $R_1 = 0.0281$, $wR_2 = 0.0674$

Largest diff. peak/hole / $e \text{ \AA}^{-3}$ 0.11/-0.11

Flack parameter 0.11(8)