Supporting Information for:

Introducing a sulfone-embedded anhydride to the anhydride-imine reaction for the modular synthesis of N-Heterocyclic Sulfones bearing vicinal stereocenters

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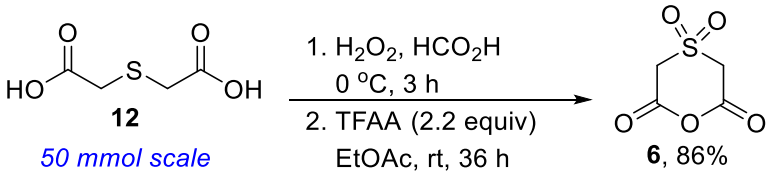
Contents:

2. Experimental Section

All experiments involving air and moisture-sensitive reagents were carried out under an inert atmosphere of nitrogen and using freshly distilled solvents. Freshly purchased 1,4-dioxane was stored under 4 A° molecular sieves for several days prior to use. THF was distilled from sodium benzophenone ketyl. All amines, alkenes and enals were newly purchased and used without further purification. Column chromatography was performed on silica gel (230-400 mesh). Thin-layer chromatography (TLC) was performed using Silicycle SiliaplateTM glass backed plates (250 µm thickness, 60 Å porosity, F-254 indicator) and visualized using UV (254 nm) or CAM, *p*-anisaldehyde, or $KMnO_4$ stain. All reported temperatures were internal to a reaction vessel. Unless otherwise indicated, ^1H, ^{13}C, and DEPT-135 spectra were acquired using $CDCl_3$ as solvent, at room temperature. Chemical shifts are quoted in parts per million (ppm). HRMS-EI^+ data were obtained using either electronspray ionization (ESI) or electron impact (EI) techniques. High-resolution ESI was obtained on an LTQ-FT (ion trap; analyzed using Excalibur). High resolution EI was obtained on an Autospec (magnetic sector; analyzed using MassLynx). Brine solutions are saturated solutions of aqueous sodium chloride. The 1,3-azadienes and aryl aldimines were prepared as previously reported.[1,2]

General Procedure A: Synthesis of anhydride 6.



To a solution of thioether **12** (7.5 g, 50 mmol) in formic acid (20 mL), was added 30% aqueous solution of H_2O_2 (120 mmol) at 0 °C. The resulting solution was stirred at this temperature for the desired length of time (TLC and GC-MS monitoring). After completion, it was concentrated *in vacuo* at room temperature, then diluted with 150 mL of EtOAc and 100 mL of water. The aqueous layer was separated and extracted with 150 mL EtOAc. The combined organic extracts were washed with water (3×100 mL), then with brine. It was dried over $MgSO_4$ and concentrated *in vacuo* to obtain the sulfone, which was directly advanced to the next step or stored in the freezer.

Cyclization of the diacid: To an oven-dried 500 mL round bottomed flask equipped with stir bar was added the diacid from step 1 and dry ethyl acetate (250 mL). Trifluoroacetic anhydride (15.4 mL, 110 mmol, 2.2 equiv) was added slowly under nitrogen. The cloudy mixture was stirred at

room temperature for 36 h (as judged by TLC and GCMS). The mixture was concentrated under reduced pressure and washed three times with ice-cold petroleum ether to afford the anhydride, which was immediately stored in the freezer until ready for use.

General Procedure B: Reaction of 1,3-azadienes with anhydride 6: A 20 mL screw-cap vial was flame-dried, evacuated and flushed with nitrogen. A solution of the 1,3-azadiene (5.0 mL, 0.10 M in freshly distilled 2-MeTHF) was added to the vial at room temperature followed by anhydride **6** (5 mmol, 1.0 equiv). The contents were placed in a pre-heated oil bath thermostatted 50 ^{o}C. After complete consumption of the 1,3-azadiene (as judged by TLC and NMR), the mixture/suspension was cooled to room temperature and washed several times with petroleum ether, then concentrated under reduced pressure to afford the lactam acid.

Methyl esterification of the lactam acid: To a stirring suspension of the acid (1 mmol), dissolved in acetone (5 mL), and K_2CO_3 (3 equiv) was added methyl iodide (2 equiv) under a nitrogen atmosphere. The reaction mixture was stirred for 12 h (TLC monitoring). After complete conversion, it was diluted with water and extracted with EtOAc (3×20 mL). The combined organic extracts were washed with brine, dried over Na_2SO_4 and concentrated *in vacuo* to give the desired ester, which was purified by flash chromatography on silica.

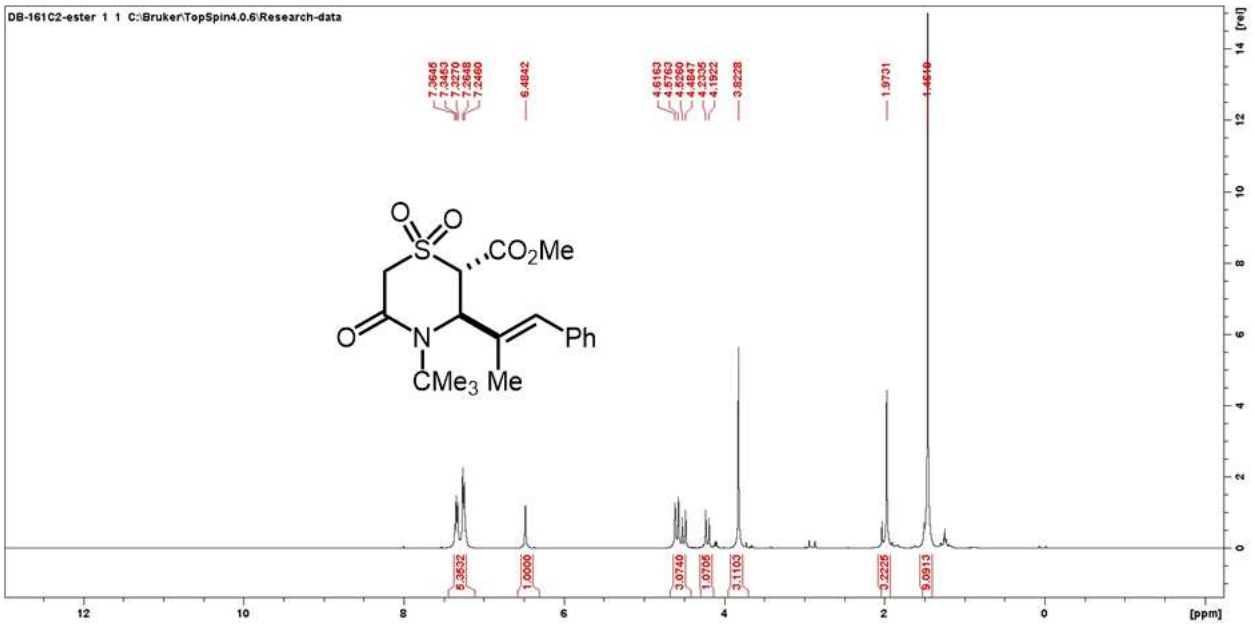
General Procedure C (CuBr-catalyzed cross-coupling with alkenes): To the *N*-iodoaryl sulfone (0.5 mmol) and alkene (2.0 mmol, 2.0 equiv), dissolved in 1,4-dioxane (2 mL), was added CuBr (0.05 mmol, 10 mol%) in an oven-dried vial equipped with a stir bar. A solution of potassium carbonate (138 mg, 2.0 mmol, 2.0 equiv) was next added. The suspension was heated to 100 ^{o}C. It was then monitored by TLC until complete consumption of the starting material (16 to 36 h). The reaction mixture was then filtered through a short plug of Celite with the aid of ethyl acetate. The filtrate was concentrated and the crude material was purified by flash chromatography on silica eluting with hexanes:EtOAc.

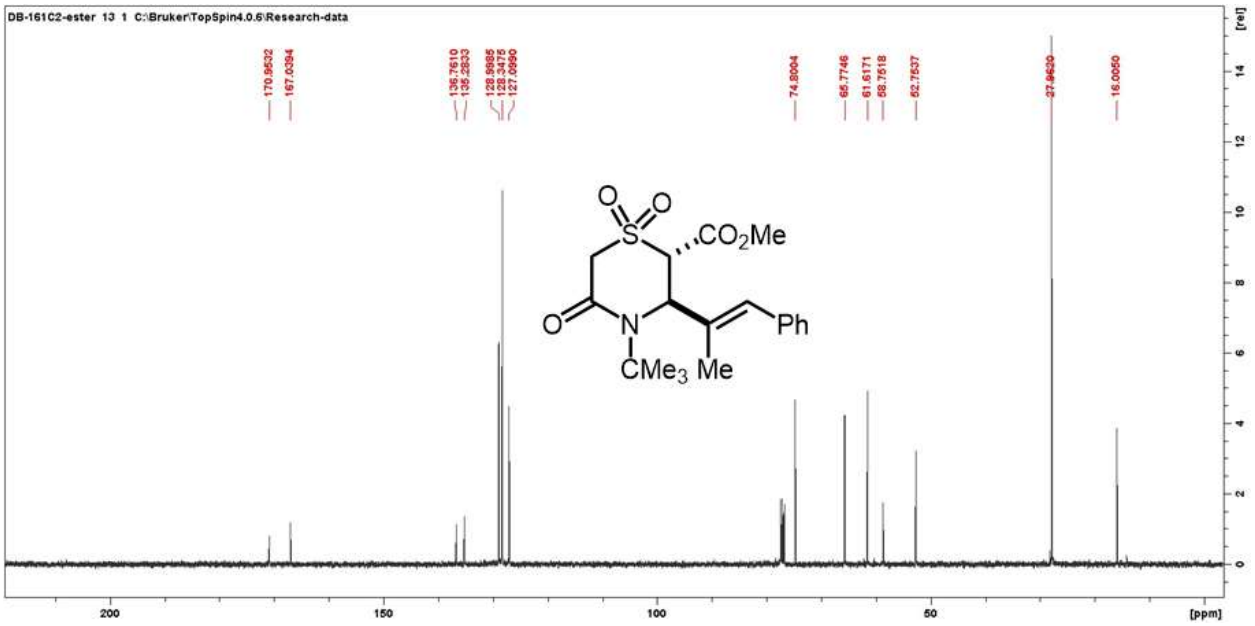
General Procedure D: Ni-catalyzed alkynylation: To an oven-dried, septum-capped 2-neck-round bottom flask equipped with a stir bar, was added the *N*-iodoaryl sulfone (0.5 mmol, 0.5 equiv) in 1,4-dioxane (5 mL) under a nitrogen atmosphere. The desired alkyne (1.2 equiv) was added as well as cesium carbonate base (3 equiv). After completely degassing the flask, $NiCl_2(PPh_3)_2$ (2 mol%) and CuI (4 mg, 4 mol%) were added rapidly and concurrently. The mixture was then stirred at the desired temperature for the desired length of time (as indicated by TLC and

LC-MS). Upon completion, the mixture was diluted with CH_2Cl_2 and concentrated to ~2 mL to give the crude product. Purification: Flash chromatography on silica eluting with hexane/EtOAc.

Compound 8a1

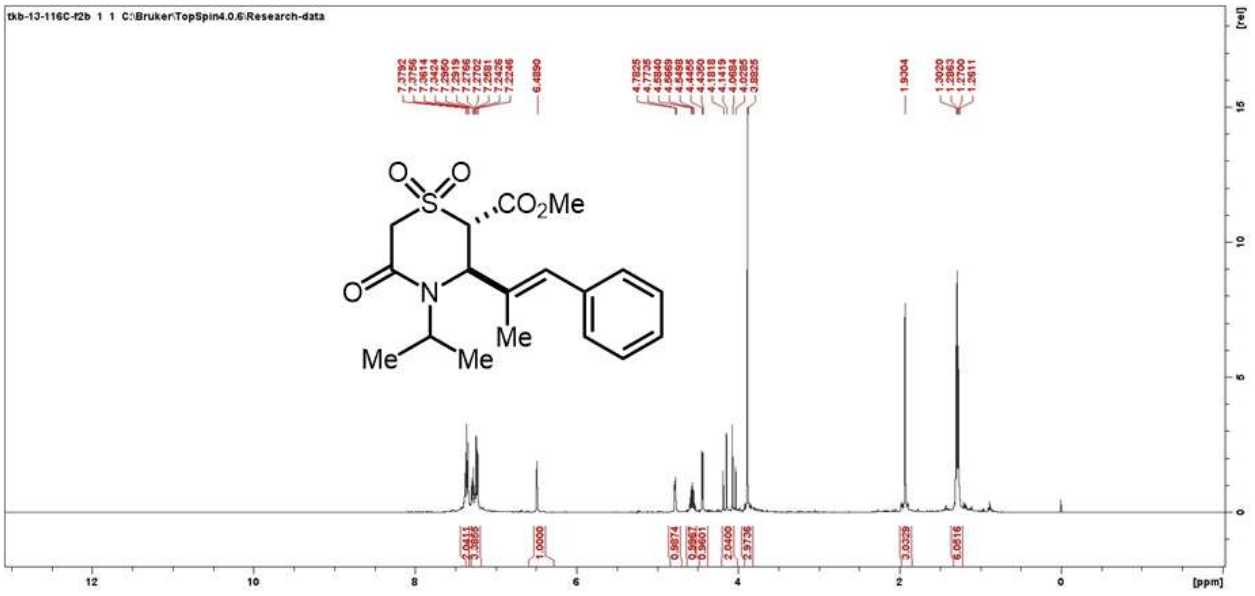
Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (90:10). Oily substance. Yield = 337.7 mg, 89%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 –7.26 (m, 5H), 6.48 (s, 1H), 4.64 – 4.55 (m, 2H), 4.51 (d, J = 16.5 Hz, 1H), 4.21 (d, J = 16.5 Hz, 1H), 3.82 (s, 3H), 1.97 (s, 3H), 1.46 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.9, 167.0, 136.7, 135.3, 128.9, 128.3, 127.1, 74.8, 65.8, 61.6, 58.7, 52.7, 27.9, 16.0. HRMS (ESI): calc'd for $C_{19}H_{25}NNaO_5S$ $[M + Na]^+$: 402.1351, found 402.1354. IR (neat): 2986, 2939, 1707, 1370, 1350, 1310, 1280, 1260, 1147, 1116 cm^{-1}

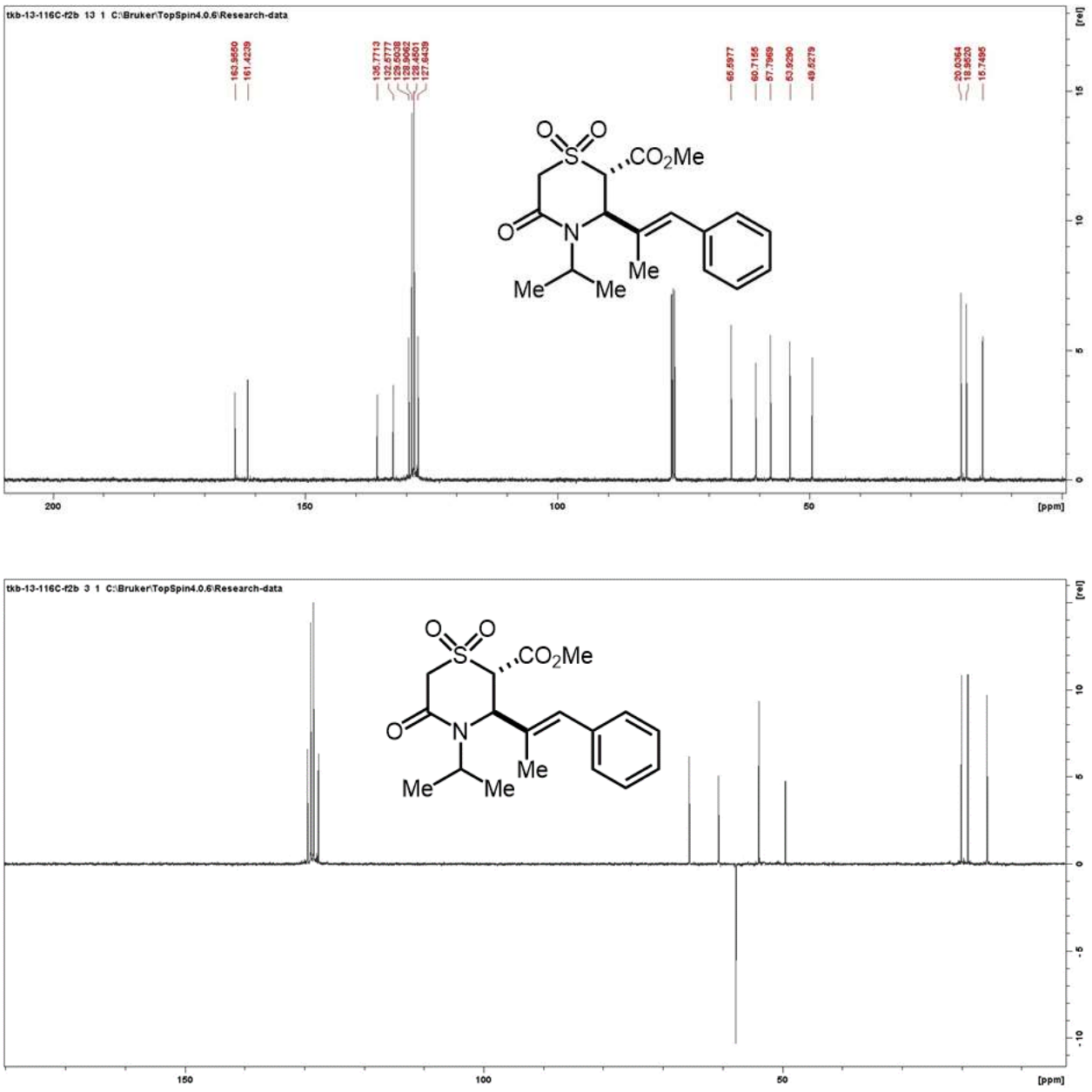




Compound 8a2

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (85:15). Oily substance. Yield = 299.6 mg, 82%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30-7.19 (m, 5H), 6.44 (s, 1H), 4.71 – 4.52 (m, 3H), 4.26 – 4.16 (m, 2H), 3.74 (s, 3H), 1.93 (s, 3H), 1.20 – 1.03 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.3, 166.1, 136.7, 135.6, 128.9, 128.5, 128.3, 127.1, 74.8, 64.9, 60.1, 52.6, 46.4, 19.6, 19.3, 15.5. HRMS (ESI): calc'd for $C_{18}H_{23}NNaO_5S$ $[M + Na]^+$: 388.1195, found 388.1192. FTIR (KBr): 2976.1, 2927.2, 1721.8, 1650.2, 1492.0, 1438.5, 1362.3, 1320.5, 1290.1, 1206.3, 1180.3, 1146.7, 1132.4, 995.8, 918.9, 700.1.

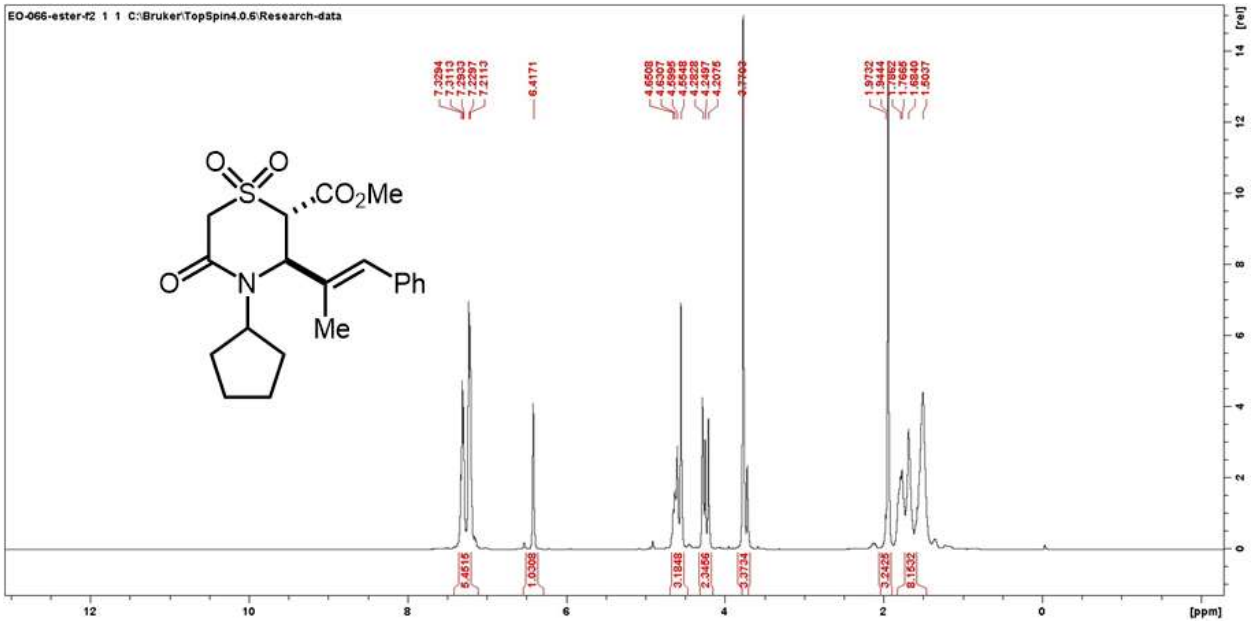


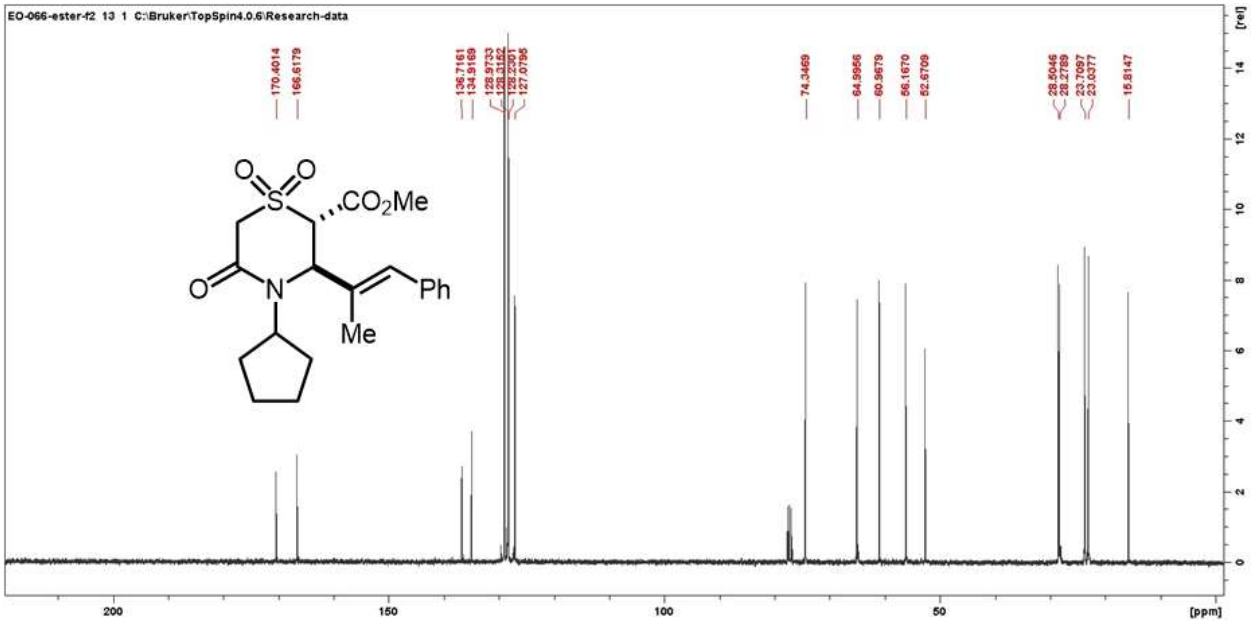


Compound 8a3

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (85:15). Oily substance. Yield = 332.8 mg, 85%, 95:5 dr. ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.30 – 7.18 (m, 5H), 6.41 (s, 1H), 4.70 – 4.58 (m, 3H), 4.27 (d, *J* = 13.2 Hz, 2H), 3.77 (s, 3H), 1.94 (s, 3H), 1.79 – 1.38 (m, 8H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.4, 166.6, 136.7, 134.9, 128.9, 128.3, 128.2, 127.1, 74.3, 64.8, 60.9, 56.2, 52.7, 28.5, 28.3, 23.7, 23.0, 15.8. FTIR (KBr):2930.9, 1721.7, 1664.2, 1606.9, 1576.9, 1511.8, 1422.4, 1359.3, 1300.0,

1250.9, 1175.8, 1113.2, 1031.2, 996.3, 970.3, 923.7, 826.6, 764.9. HRMS (ESI): calc'd for $C_{20}H_{25}NNaO_5S$ $[M + Na]^+$: 414.1351, found 414.1354.

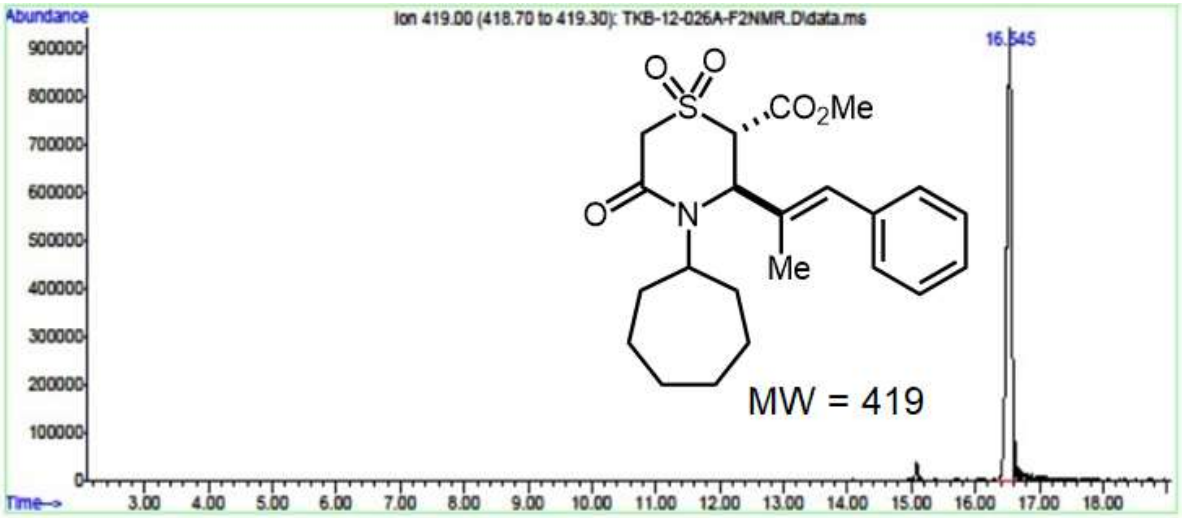


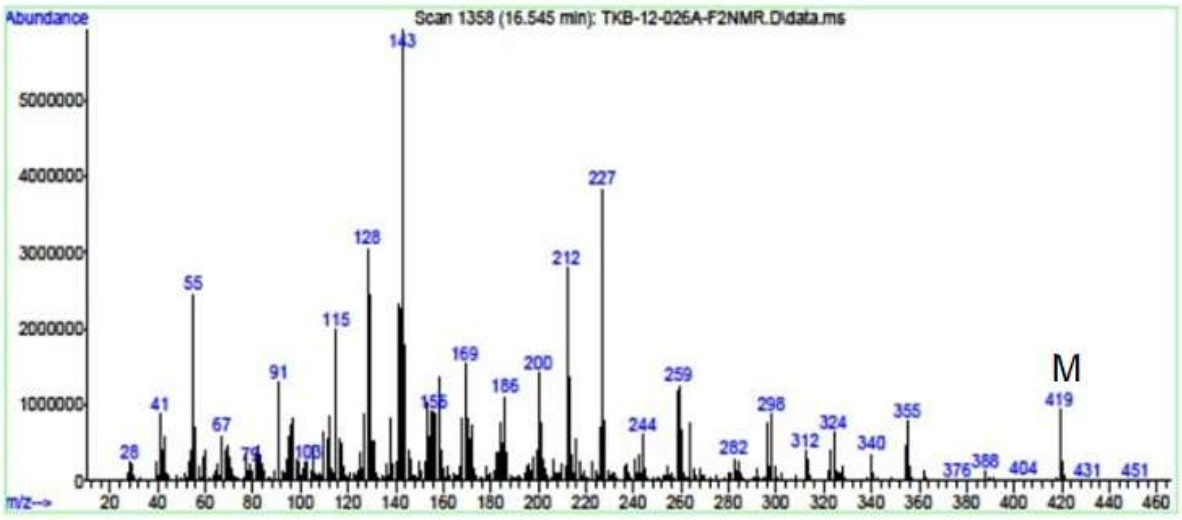


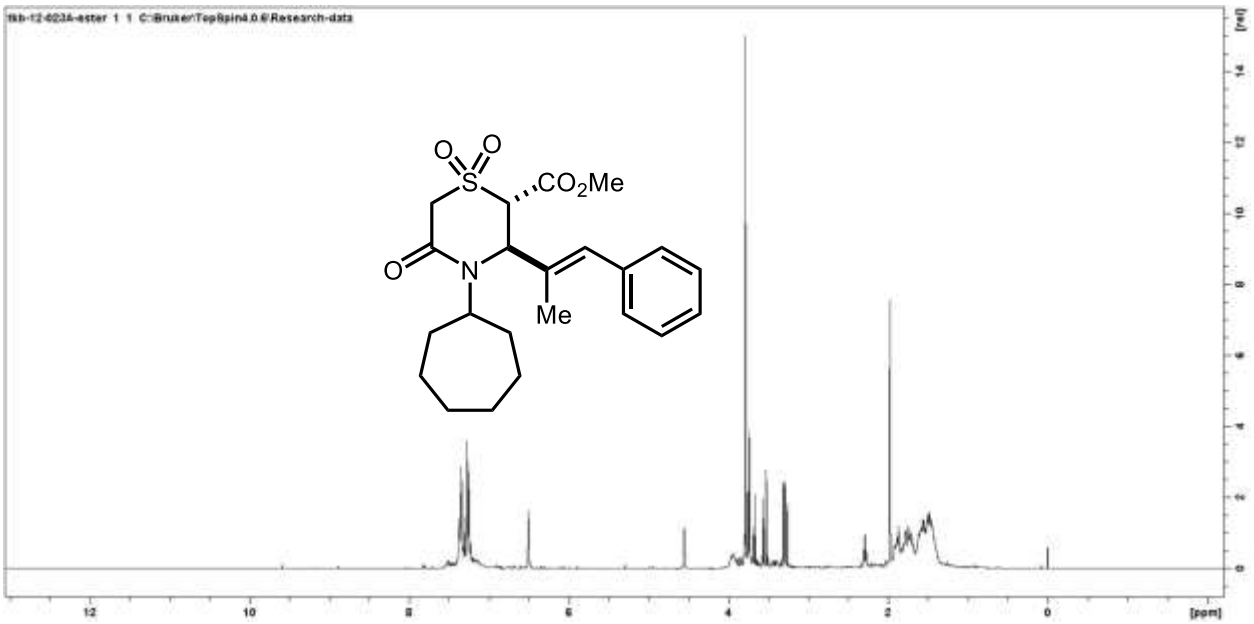
Compound 8a4

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (85:15). Oily substance. Yield = 335.6 mg, 80%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.21 (m, 5H), 6.31 (s, 1H), 4.39 (s, 1H), 3.70 (s, 3H), 3.67 – 3.52 (m, 2H), 3.55 – 3.40 (m, 1H), 3.40 – 3.29 (m, 1H), 1.98 (s, 3H), 1.76 – 1.26 (m, 12H). ^{13}C

NMR (101 MHz, $CDCl_3$) δ 170.9, 164.9, 136.8, 129.1, 129.0, 128.4, 127.1, 53.1, 44.2, 34.9, 33.5, 32.9, 30.9, 28.4, 28.1, 27.8, 27.3, 25.6, 25.5, 24.1, 16.5. HRMS (ESI): calc'd for $C_{22}H_{29}NNaO_5S$ $[M + Na]^+$: 442.1664, found 442.1666.



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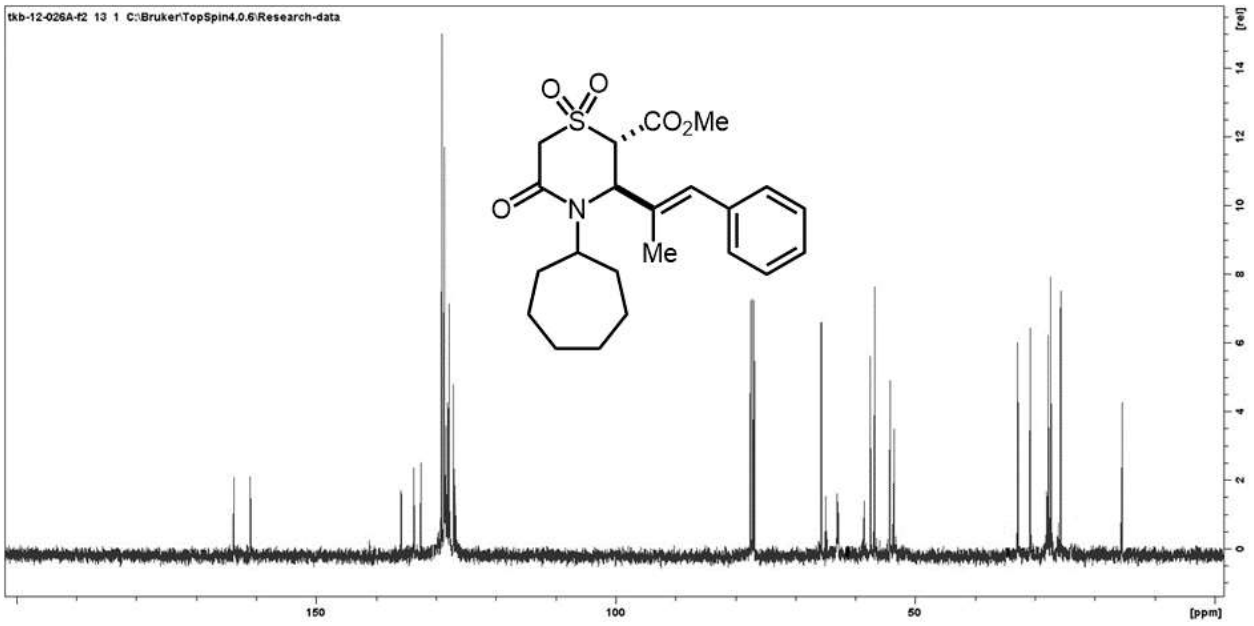
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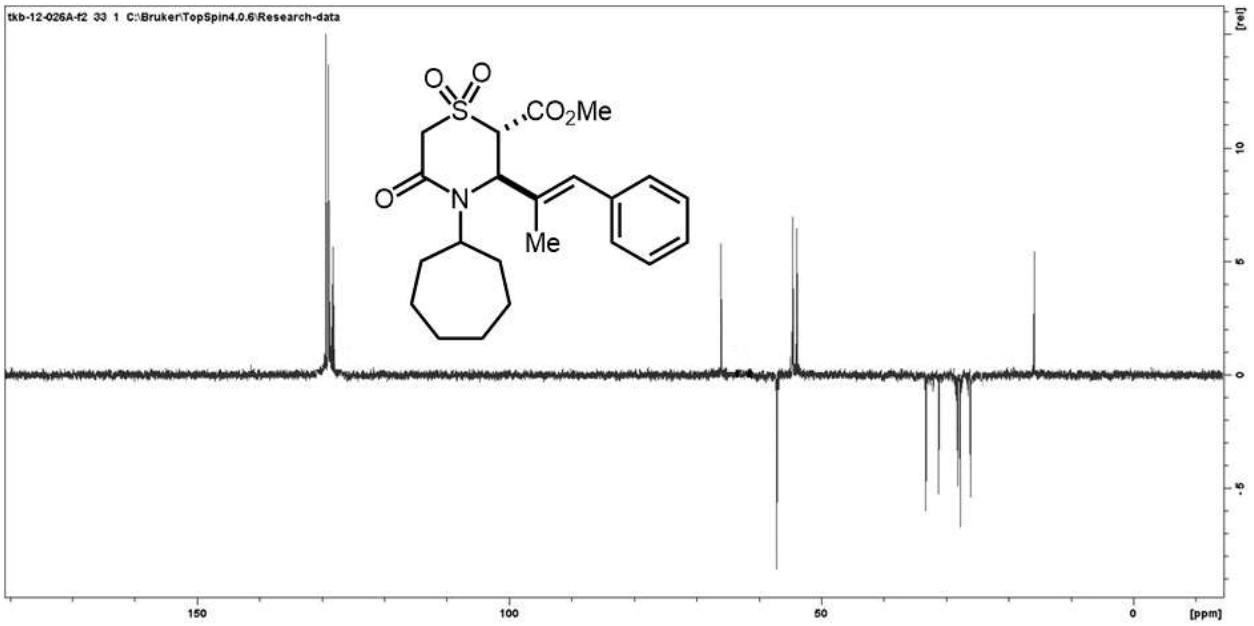
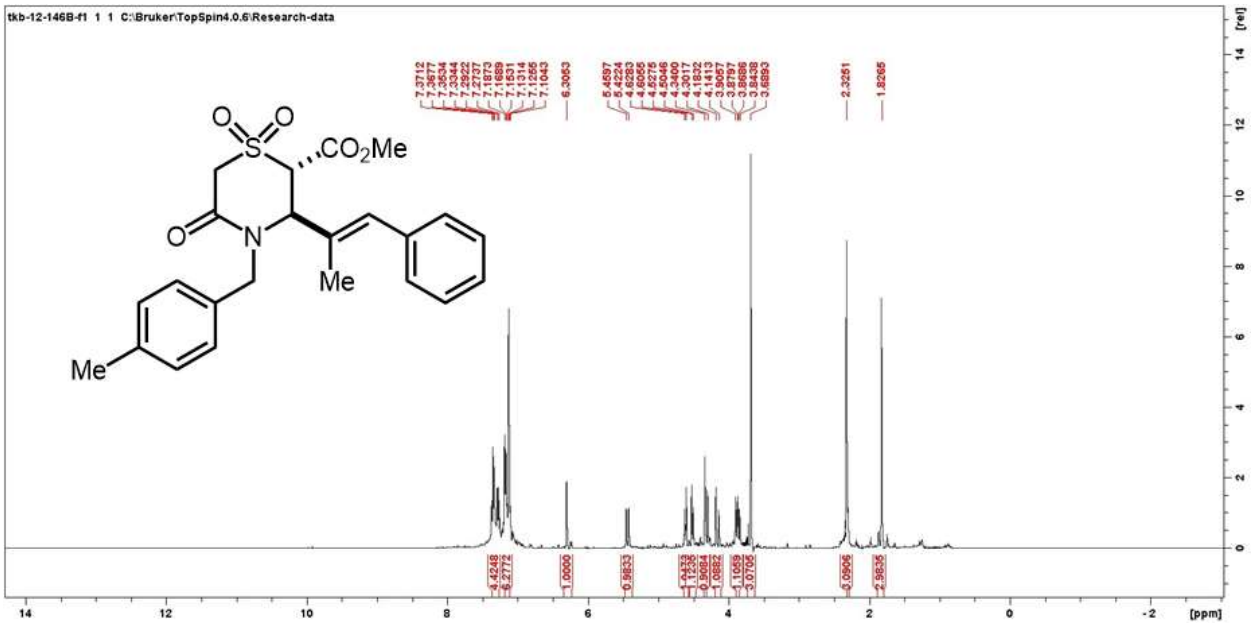


Compound 8a5

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 354.8 mg, 83%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.27 (m, 4H), 7.19 – 7.10 (m, 5H), 6.30 (s, 1H), 5.46 (d, *J* = 14.8 Hz, 1H), 4.61 (d, *J* = 8.1 Hz, 1H), 4.52 (d, *J* = 8.1 Hz, 1H), 4.32 (d, *J* = 16.1 Hz, 1H), 4.16 (d, *J* = 16.5 Hz, 1H), 3.90-3.84 (m, 1H), 3.68 (s, 3H), 2.32 (s, 3H), 1.82 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.5, 161.4, 137.7, 135.8, 132.8, 132.1, 130.0, 129.6, 129.5, 129.0, 128.9, 128.7, 128.6, 128.4, 128.1, 127.9, 65.2, 64.8, 56.3, 53.9, 48.1, 21.3, 13.3. FTIR (KBr): 2976.0, 1721.7, 1650.1, 1492.0, 1438.4, 1362.2, 1320.5, 1290.1, 1206.3, 1180.3, 1146.7, 1132.1, 995.8, 918.8, 700.1. HRMS (ESI): calc'd for $C_{23}H_{25}NNaO_5S$ $[M + Na]^+$: 450.1351, found 450.1347.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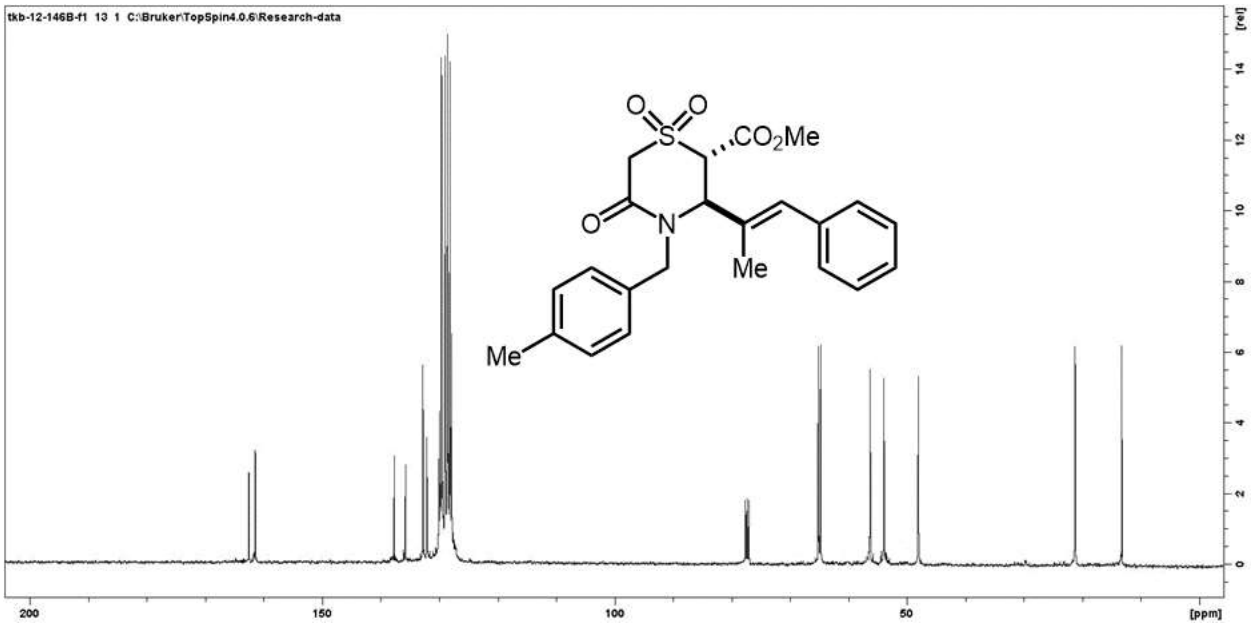
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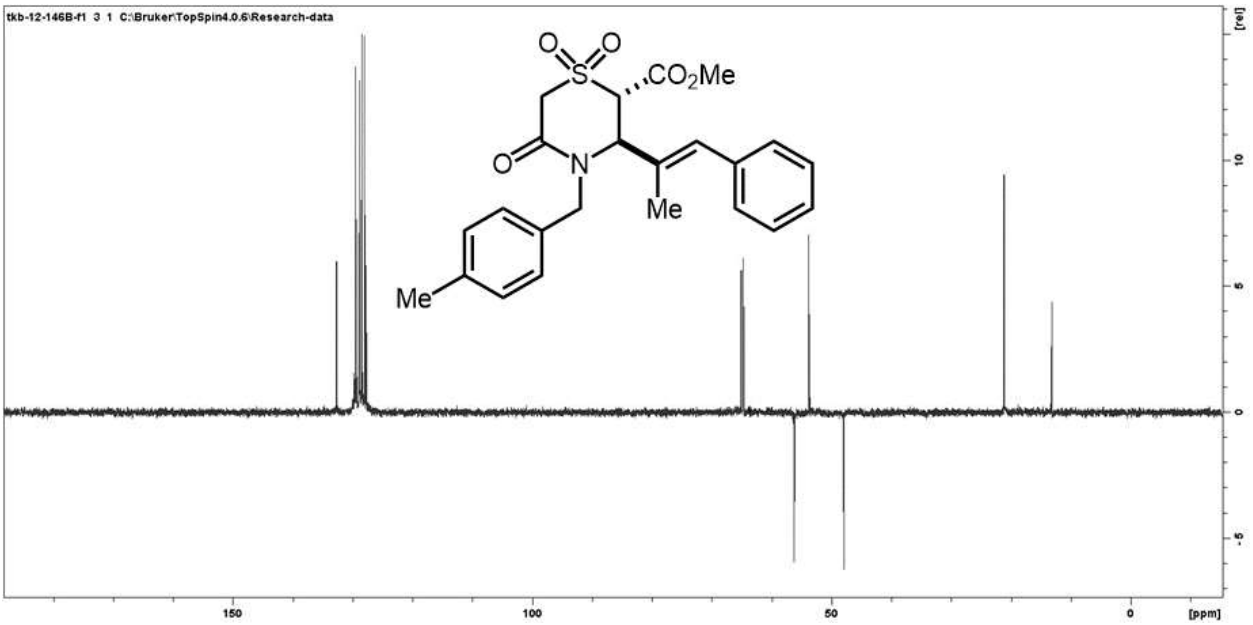
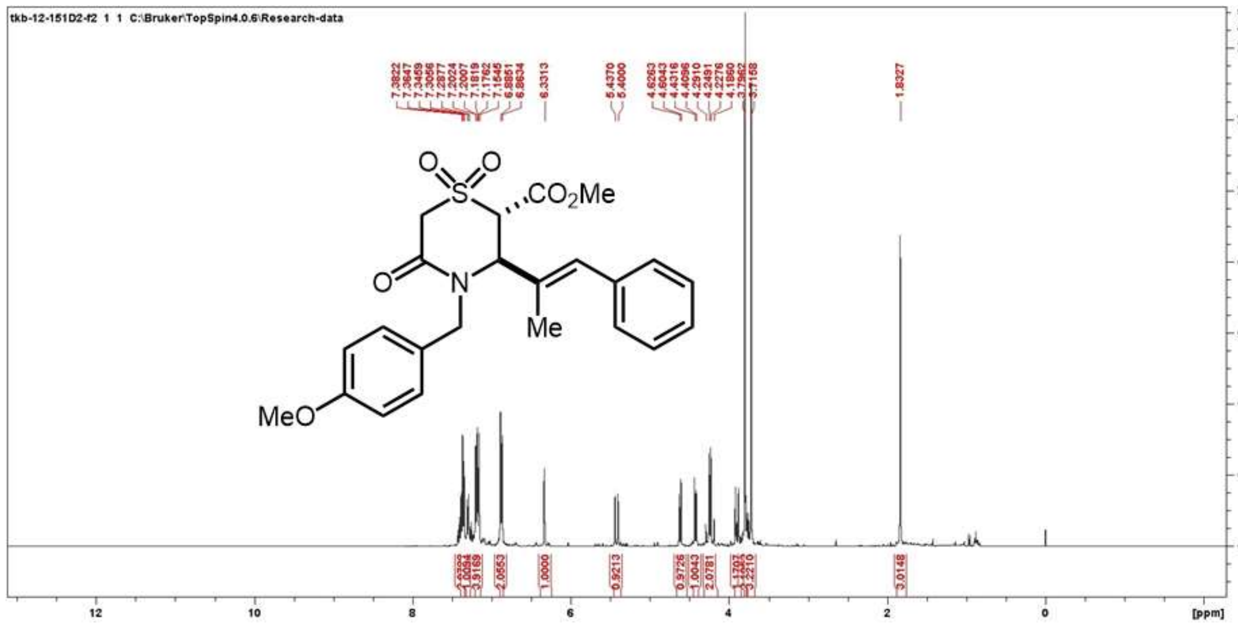


Compound 8a6

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (40:60). Oily substance. Yield = 381.4 mg, 86%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.28 (m, 3H), 7.18 – 7.15 (m, 4H), 6.87 (d, J = 8.2 Hz 2H), 6.33 (s, 1H), 5.42 (d, J = 14.8 Hz, 1H), 4.61 (d, J = 8.8 Hz, 1H), 4.42 (d, J = 8.8 Hz, 1H), 4.26 (d, J = 14.8 Hz, 1H), 3.85 – 3.80 (m, 2H), 3.79 (s, 3H), 3.71 (s, 3H), 1.83 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.5, 161.4, 159.4, 135.7, 133.7, 132.7, 129.9, 129.8, 129.6, 129.0, 128.6, 128.3, 127.9, 127.0, 114.3, 65.3, 64.6, 56.4, 55.4, 54.0, 47.9, 13.5. FTIR (KBr): 2932.5, 1721.4, 1665.4, 1607.2, 1511.1, 1431.8, 1414.7, 1344.9, 1298.4, 1245.6, 1179.4, 1135.3, 1031.8, 996.7, 921.8, 832.1, 701.6. HRMS (ESI): calc'd for $C_{23}H_{25}NNaO_6S$ $[M + Na]^+$: 466.1300, found 466.1304.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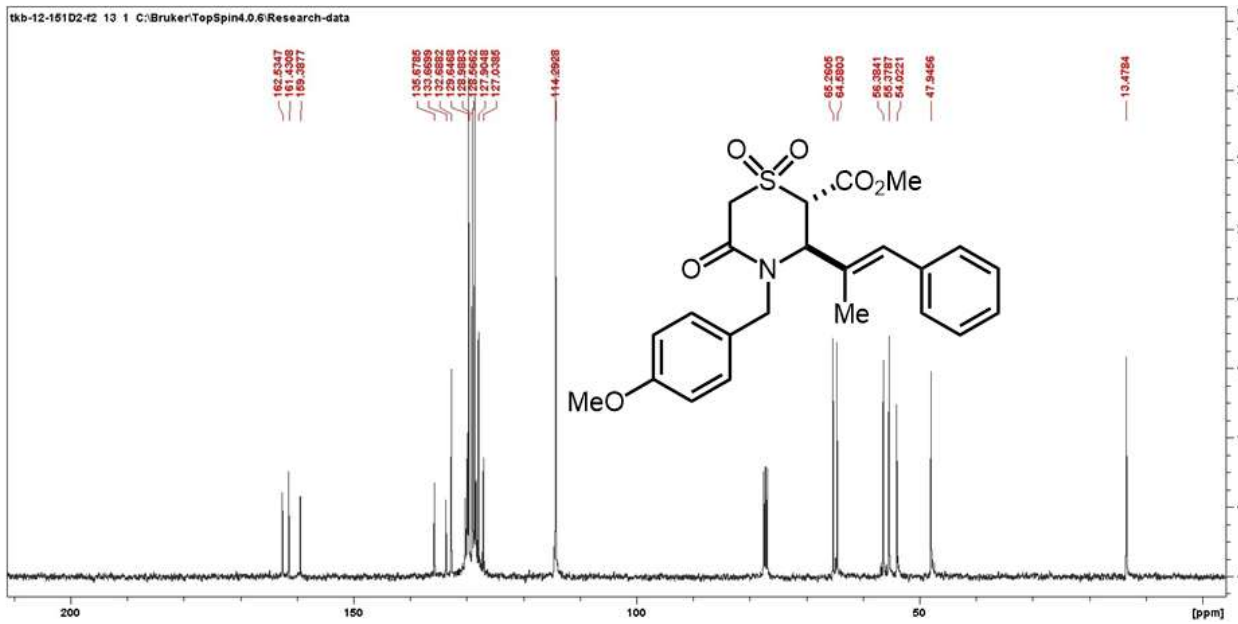
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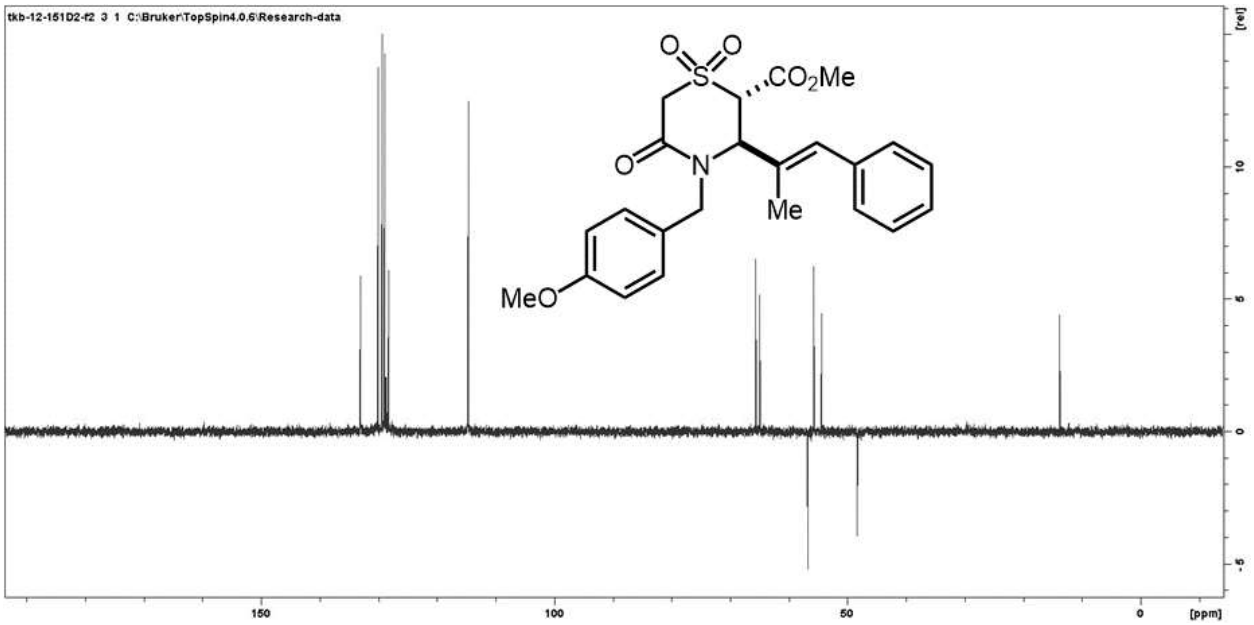
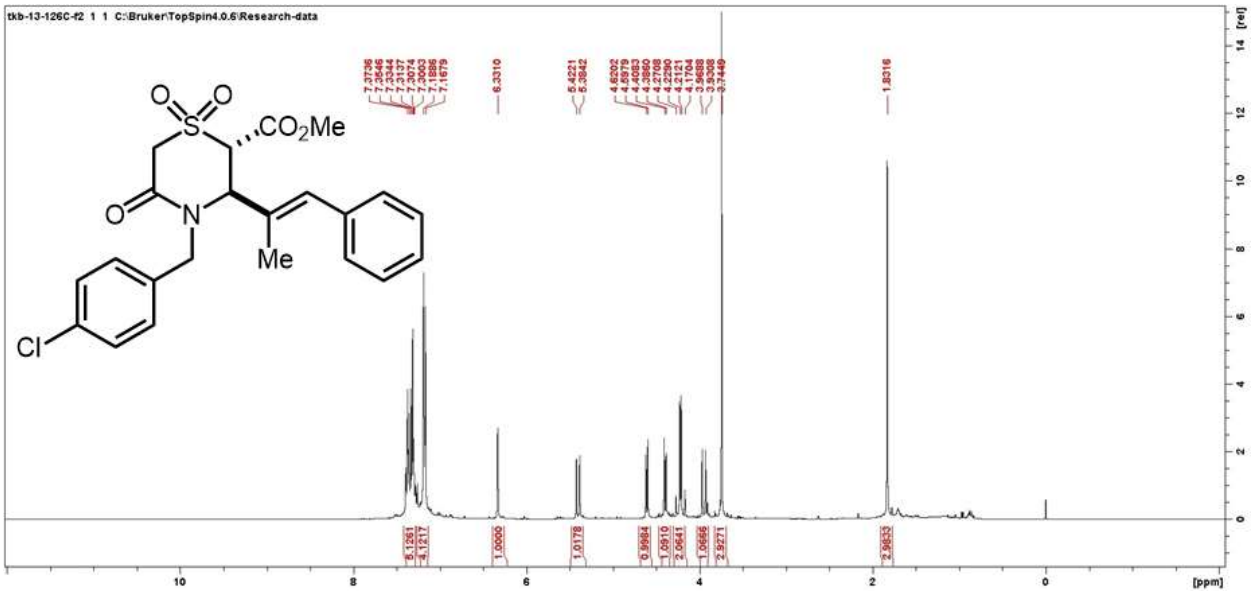
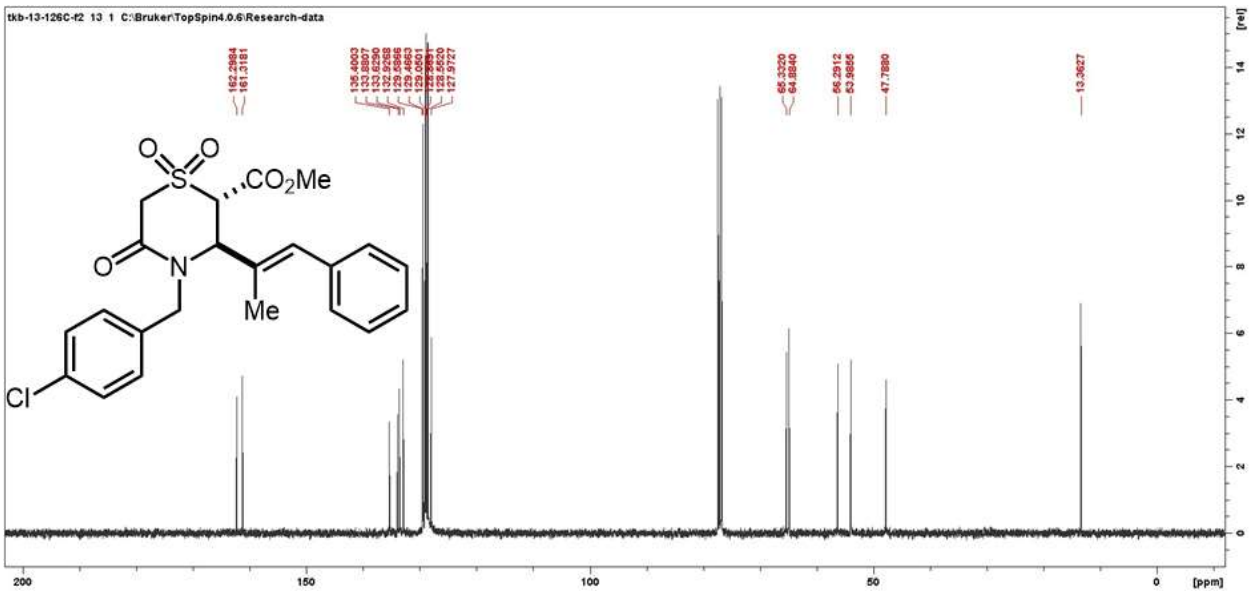


Compound 8a7

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (60:40). Oily substance. Yield = 353.8 mg, 79%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.19 (m, 9H), 6.36 (s, 1H), 5.42 (d, *J* = 15.1 Hz, 1H), 4.67 – 4.58 (m, 2H), 4.41 (d, *J* = 16.9 Hz, 1H), 4.21 (d, *J* = 16.9 Hz, 1H), 4.01 – 3.89 (m, 1H), 3.73 (s, 3H), 1.84 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.4, 161.6, 135.5, 133.9, 133.8, 133.1, 129.9, 129.5, 129.1, 129.0, 128.7, 128.1, 65.3, 65.2, 56.2, 54.1, 47.6, 13.2. FTIR (KBr): 2972.8, 1728.5, 1669.3, 1606.9, 1511.0, 1448.5, 1414.7, 1384.9, 1357.4, 1298.7, 1247.5, 1179.3, 1135.9, 1031.8, 992.8, 833.0. HRMS (ESI): calc'd for $C_{22}H_{22}ClNNaO_5S$ $[M + Na]^+$: 470.0805, found 470.0808.

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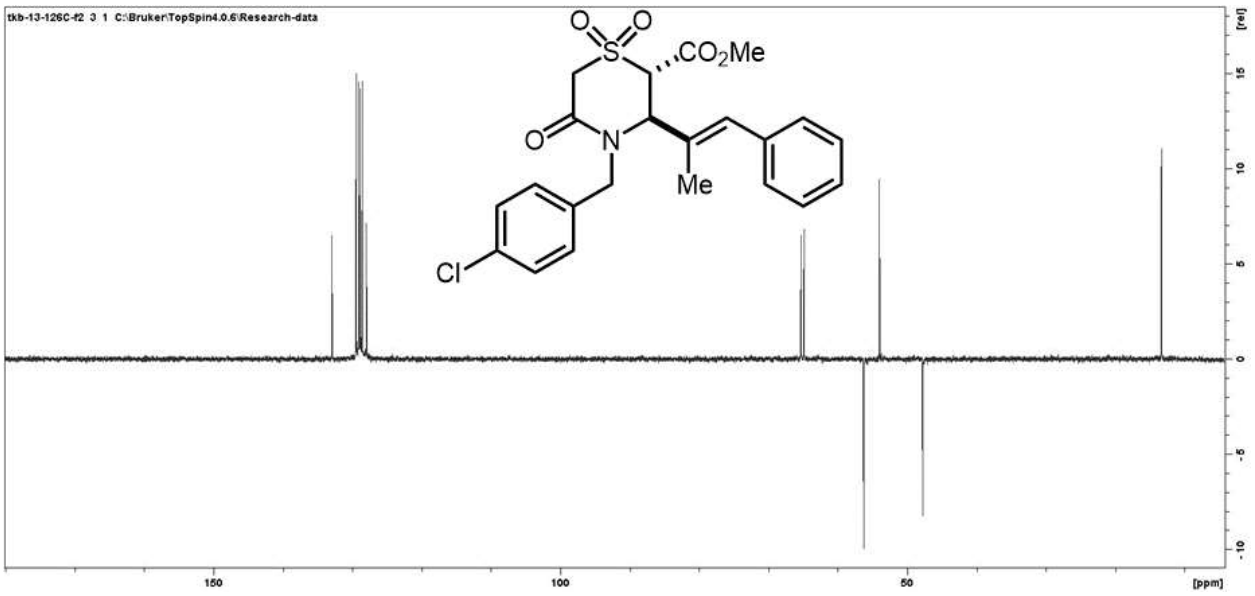
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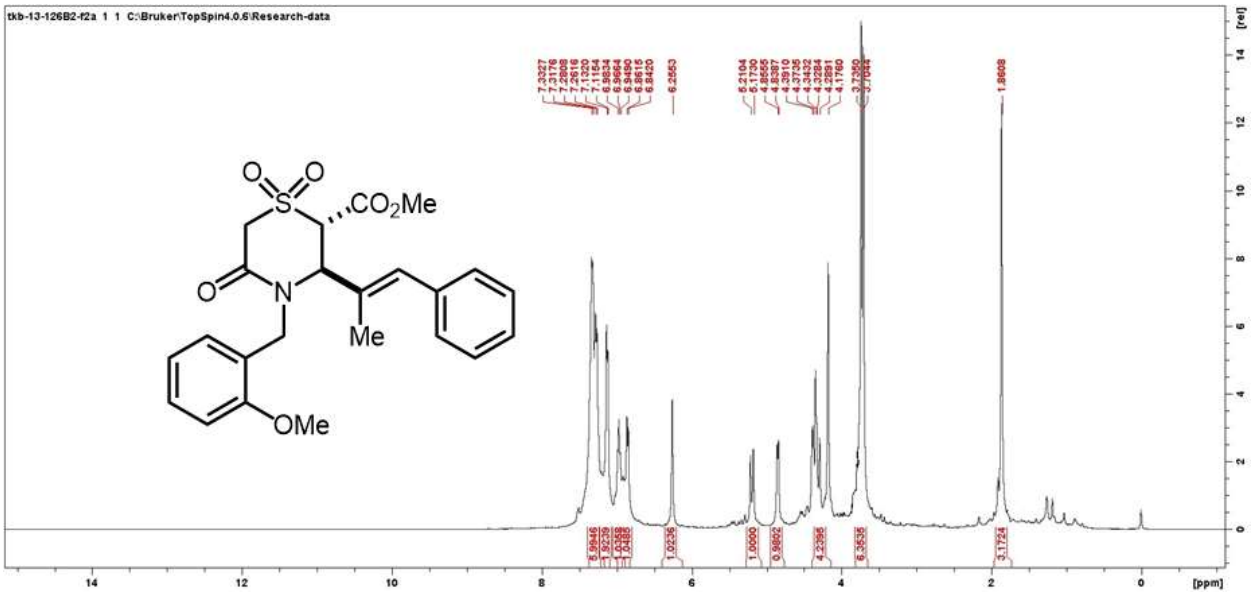
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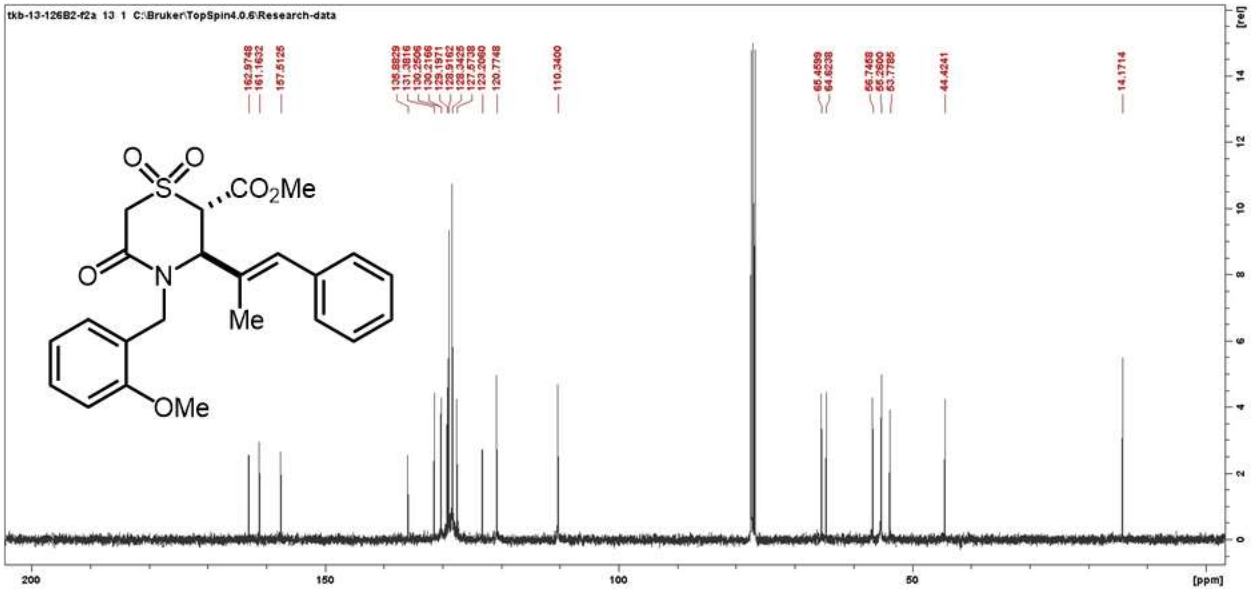
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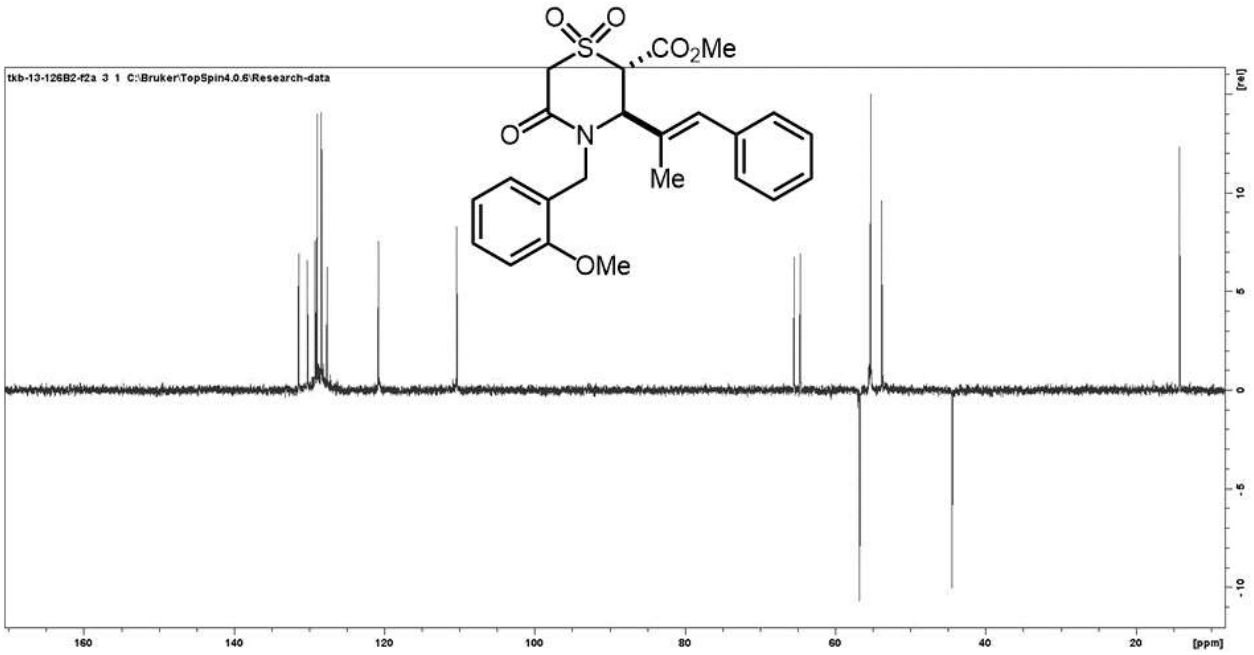
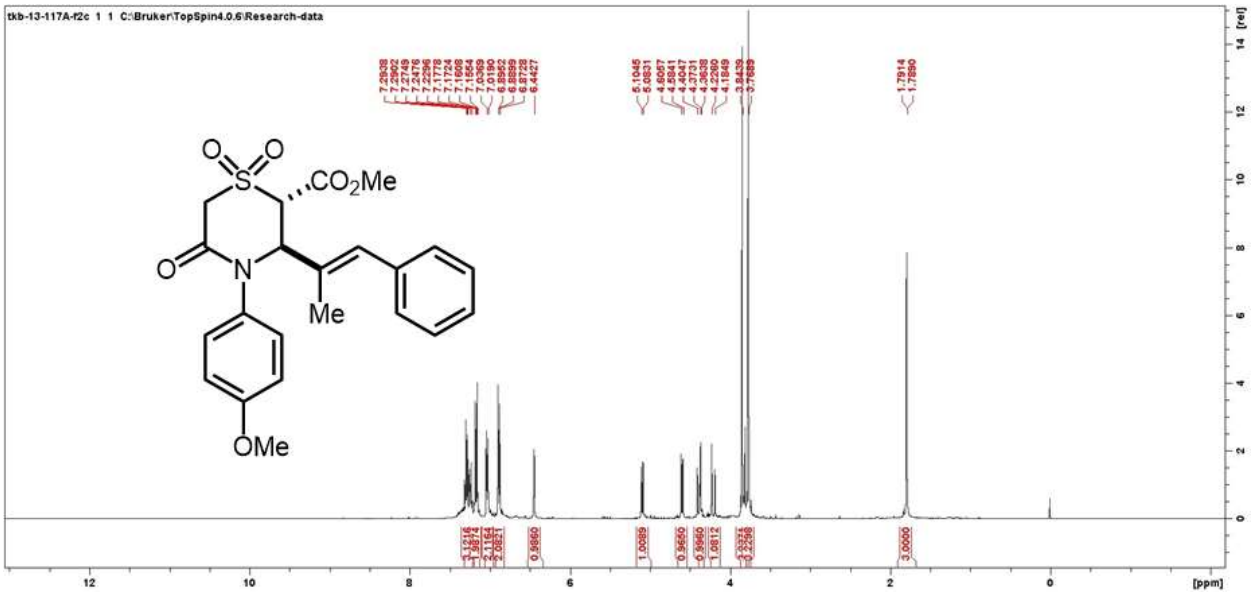


Compound 8a8

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 304.9 mg, 71%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.21 (m, 5H), 7.01 (d, *J* = 8.9 Hz, 2H), 6.86 (d, *J* = 8.9 Hz, 2H), 6.42 (s, 1H), 5.10 (d, *J* = 8.9 Hz, 1H), 4.68 (d, *J* = 8.9 Hz, 1H), 4.45 (d, *J* = 16.5 Hz, 1H), 4.18 (d, *J* = 16.5 Hz, 1H), 3.87 – 3.71 (m, 6H), 1.78 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.7, 161.6, 159.1, 135.8, 133.5, 132.2, 130.4, 128.8, 128.7, 128.4, 127.7, 114.6, 68.7, 65.9, 57.1, 55.5, 54.1, 14.3. FTIR (KBr): 2934.6, 1721.8, 1669.4, 1608.2, 1511.1, 1431.8, 1414.7, 1344.9, 1298.4, 1245.6, 1179.4, 1135.3, 1031.8, 996.7, 921.8, 832.1, 701.9. HRMS (ESI): calc'd for $C_{22}H_{23}NNaO_6S$ $[M + Na]^+$: 452.1144, found 452.1146.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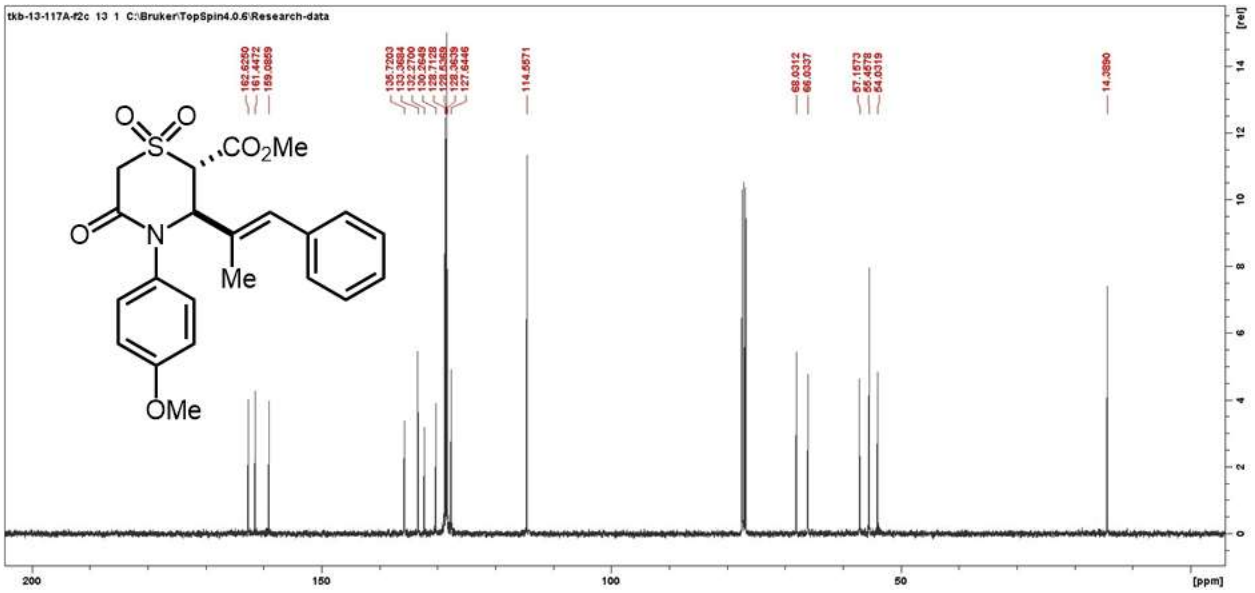
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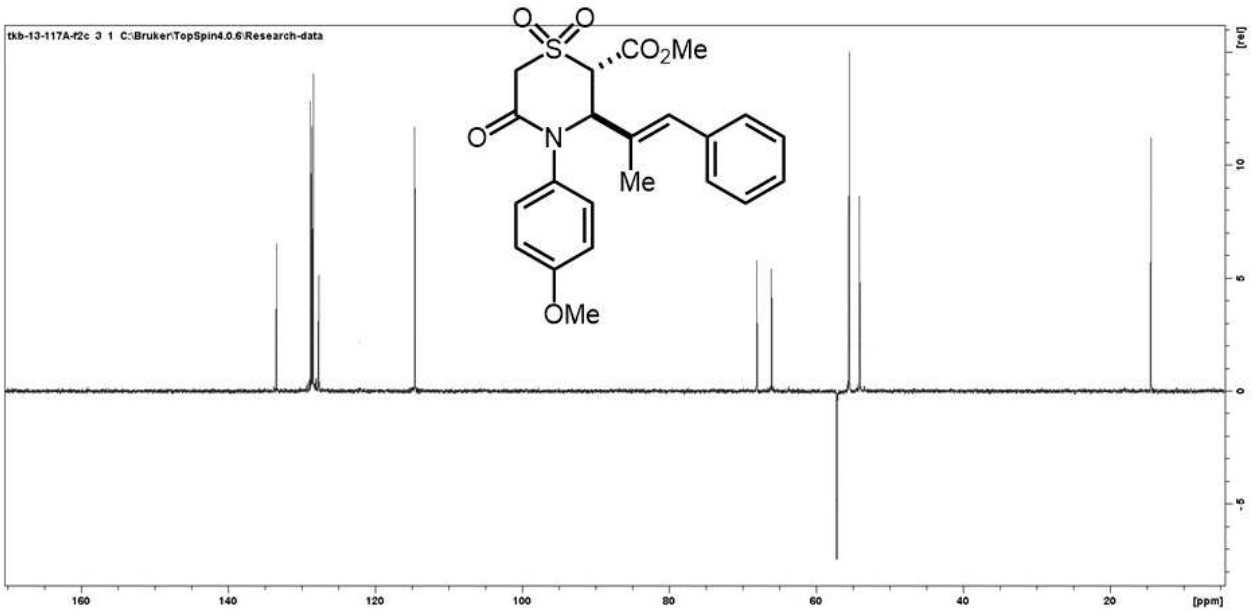
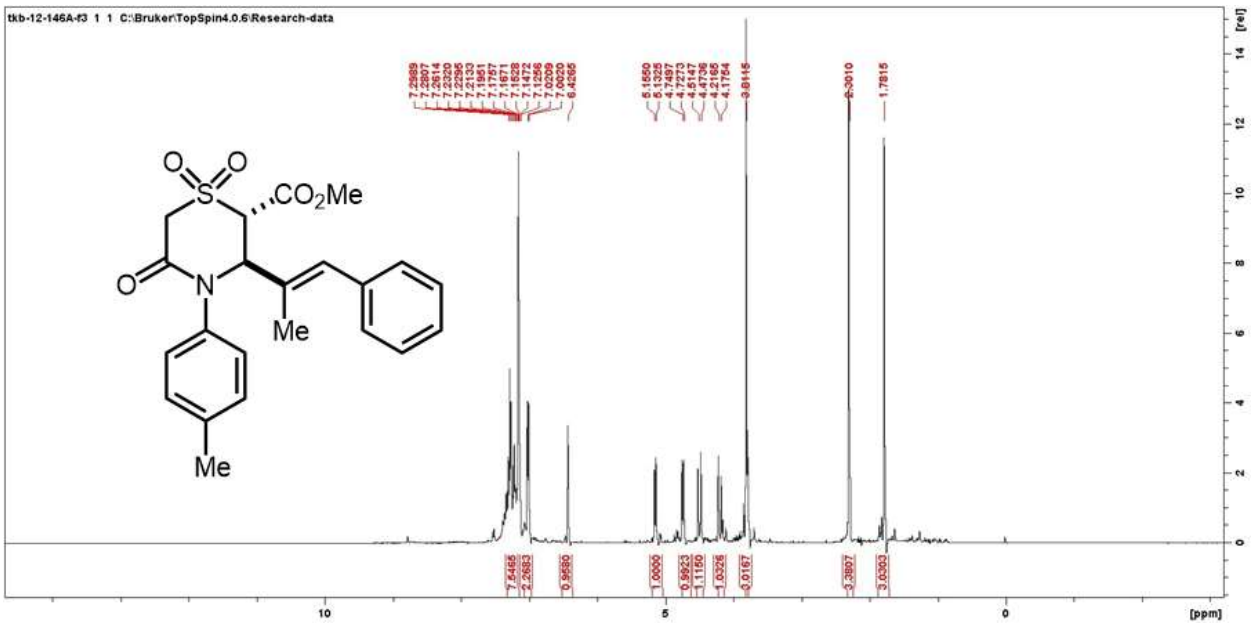


Compound 8a9

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 306.0 mg, 74%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.03 (m, 7H), 7.02 (d, *J* = 8.1 Hz, 2H), 6.43 (s, 1H), 5.14 (d, *J* = 9.1 Hz, 1H), 4.73 (d, *J* = 9.1 Hz, 1H), 4.49 (d, *J* = 16.5 Hz, 1H), 4.18 (d, *J* = 16.5 Hz, 1H), 3.81 (s, 3H), 2.30 (s, 3H), 1.78 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.7, 161.6, 138.2, 137.1, 135.9, 133.5, 130.4, 130.0, 128.8, 128.4, 127.7, 127.3, 68.1, 65.8, 57.1, 54.1, 21.2, 14.3. FTIR (KBr): 2984.1, 1723.4, 1669.4, 1608.2, 1511.1, 1431.8, 1414.7, 1344.9, 1298.4, 1135.3, 1031.8, 996.7, 702.4. HRMS (ESI): calc'd for $C_{22}H_{23}NNaO_5S$ $[M + Na]^+$: 436.1195, found 436.1193.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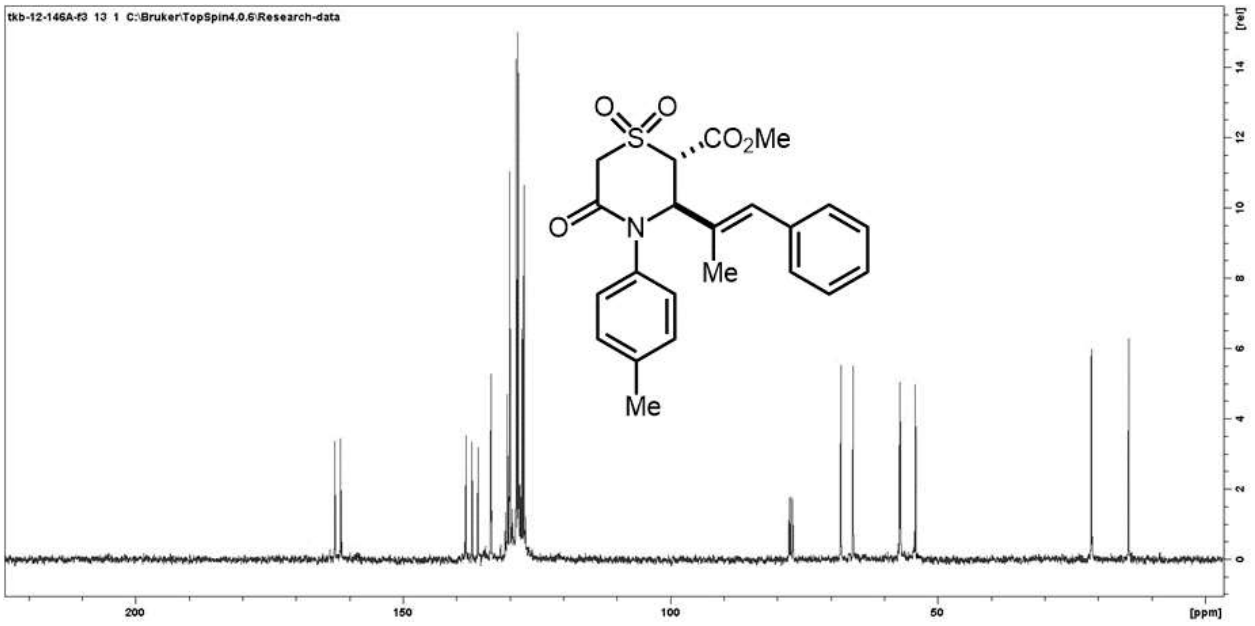
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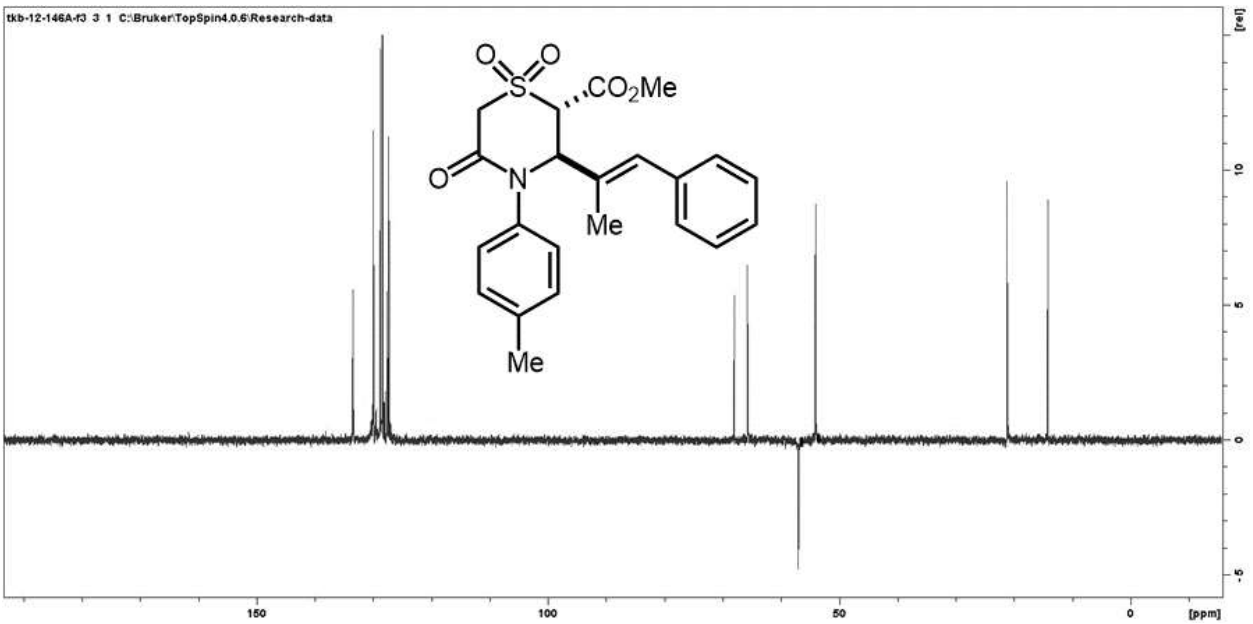
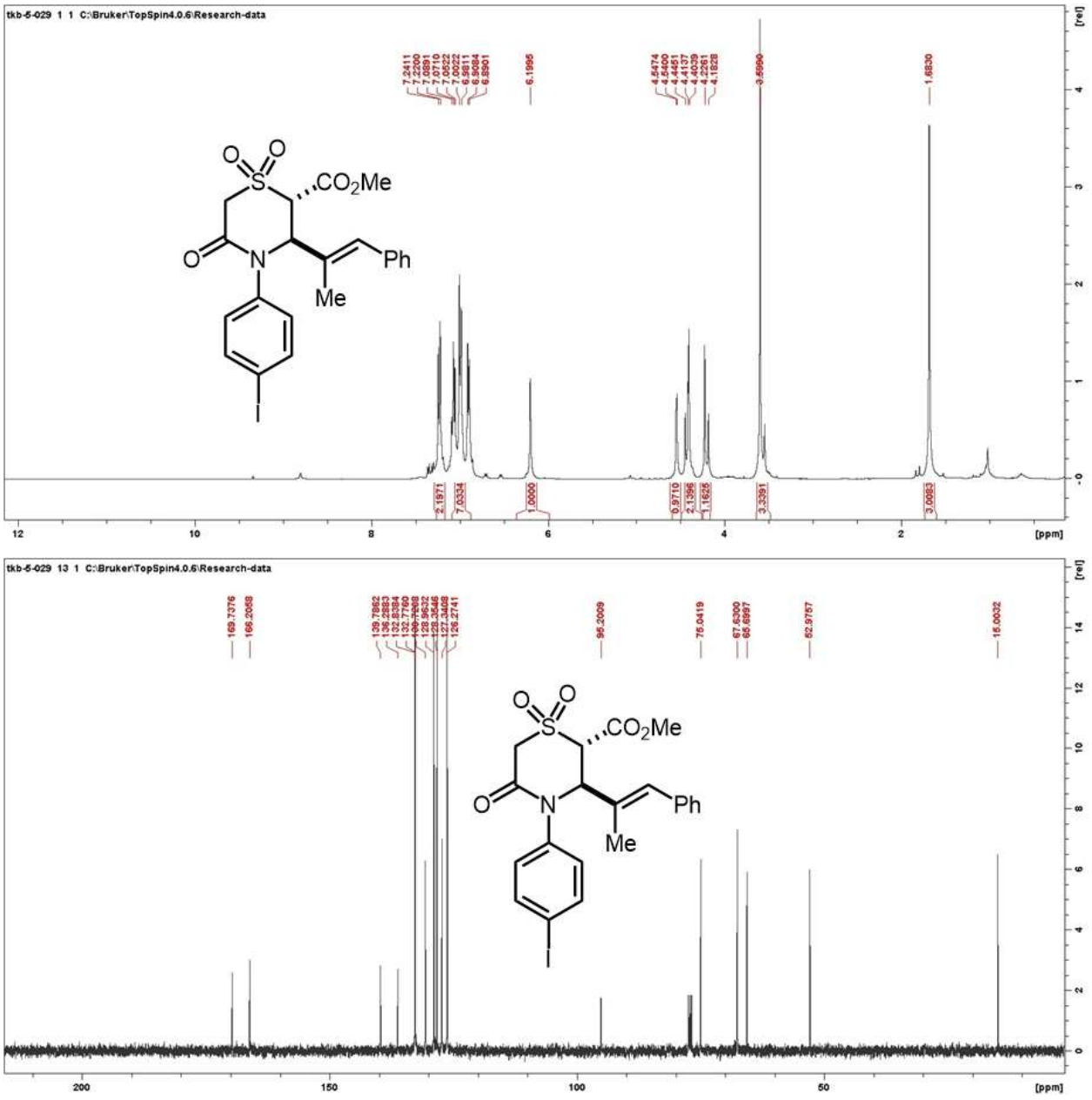


Compound 8a10

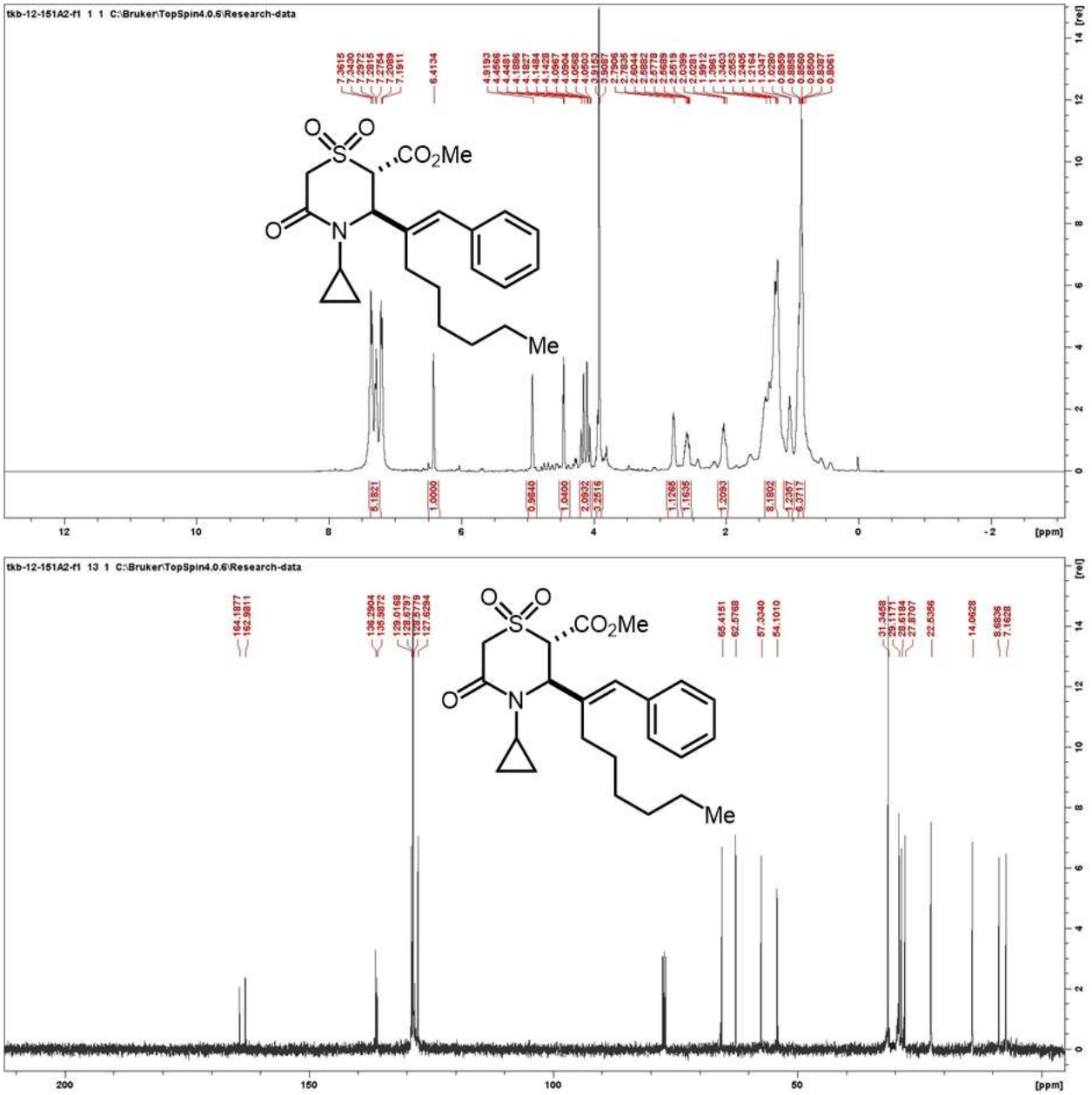
Prepared in 3 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (75:25). Oily substance. Yield = 1182 mg, 75%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (d, *J* = 8.4 Hz, 2H), 7.08 – 6.88 (m, 7H), 6.20 (s, 1H), 4.54 (d, *J* = 3.5 Hz, 1H), 4.44 – 4.41 (m, 2H), 4.20 (d, *J* = 17.3 Hz, 1H), 3.59 (s, 3H), 1.68 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 166.2, 139.8, 136.3, 132.9, 132.8, 132.8, 130.7, 128.9, 128.4, 128.4, 127.3, 126.3, 95.2, 75.0, 67.6, 65.7, 52.9, 15.0. FTIR (KBr): 2935.4, 1727.5, 1696.3, 1604.9, 1511.0, 1448.5, 1414.7, 1384.9, 1357.4, 1298.7, 1247.5, 1179.3, 1135.9, 1031.8, 995.8, 831.0. HRMS (ESI): calc'd for $C_{21}H_{20}INNaO_5S$ $[M + Na]^+$: 548.0005, found 548.0008.

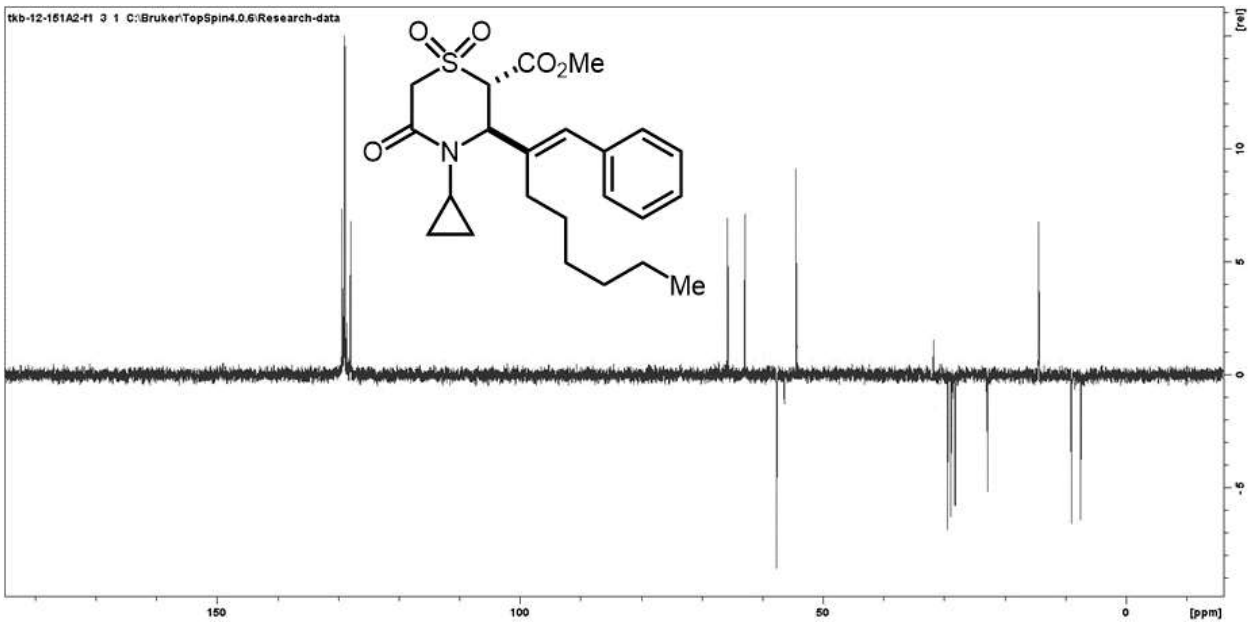


Compound 8a11

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (90:10). Oily substance. Yield = 333.8 mg, 77%, 92:8 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.19 (m, 5H), 6.41 (s, 1H), 4.93 (d, *J* = 3.3 Hz, 1H), 4.45 (d, *J* = 3.3 Hz, 1H), 4.17 (d, *J* = 16.0 Hz, 1H), 4.07 (d, *J* = 16.0 Hz, 1H), 3.90 (s, 3H) 2.79 – 2.75 (m, 1H), 2.59 – 2.53 (m, 1H), 2.03 (dt, *J* = 13.4, 3.6 Hz, 1H), 1.37 – 1.19 (m, 9H), 1.04 - 0.87 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.2, 162.9, 136.3, 135.9, 129.0, 128.8, 128.7, 128.6, 128.3, 127.6, 65.4, 62.6, 57.3, 54.1, 31.3, 29.1, 28.6, 27.9, 22.5, 14.1, 8.7, 7.2. . FTIR (KBr): 2924.8,

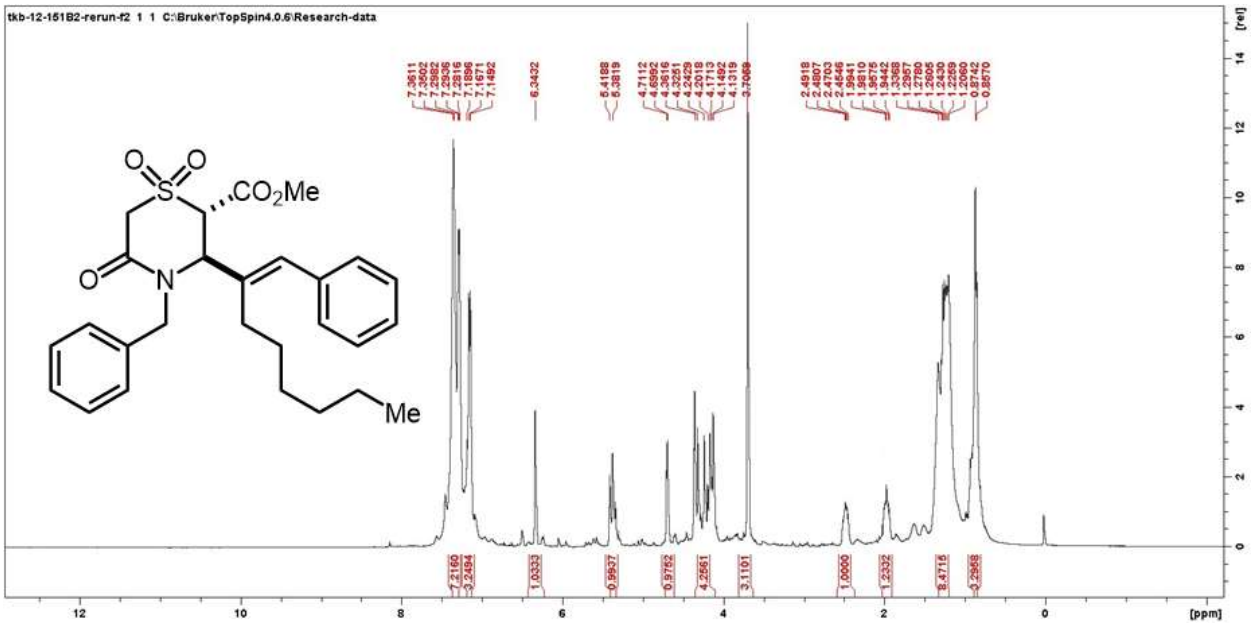
1642.2, 1494.9, 1448.8, 1427.0, 1393.4, 1361.6, 1328.7, 1289.7, 1223.6, 1198.9, 1130.1, 1074.1, 1030.4, 988.5, 966.1, 925.5, 741.6, 693.4. HRMS (ESI): calc'd for $C_{23}H_{31}NNaO_5S$ $[M + Na]^+$: 456.1821, found 456.1824.





Compound 8a12

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (80:20). Oily substance. Yield = 367.6 mg, 76%, 90:10 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.14 (m, 10H), 6.34 (s, 1H), 5.40 (d, *J* = 14.6 Hz, 1H), 4.70 (d, *J* = 4.8 Hz, 1H), 4.37 (d, *J* = 4.8 Hz, 1H), 4.33 (d, *J* = 7.7 Hz, 1H), 4.30 – 4.05 (m, 3H), 3.70 (s, 3H), 2.49 – 2.45 (m, 1H), 2.09 – 1.92 (m, 1H), 1.43 – 1.16 (m, 8H), 0.86 (t, *J* = 8.4 Hz, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 163.7, 161.7, 130.7, 129.0, 128.9, 128.8, 128.7, 128.6, 128.2, 127.6, 64.9, 61.4, 56.7, 53.9, 49.6, 31.3, 29.3, 28.4, 27.9, 22.5, 14.1. FTIR (KBr): 2965.2, 2872.3, 1716.4, 1650.8, 1612.9, 1585.9, 1513.1, 1455.3, 1359.3, 1304.1, 1251.3, 1177.4, 1135.5, 1033.8, 996.7, 896.0, 833.6, 804.9. HRMS (ESI): calc'd for $C_{27}H_{33}NNaO_5S$ $[M + Na]^+$: 506.1977, found 506.1974.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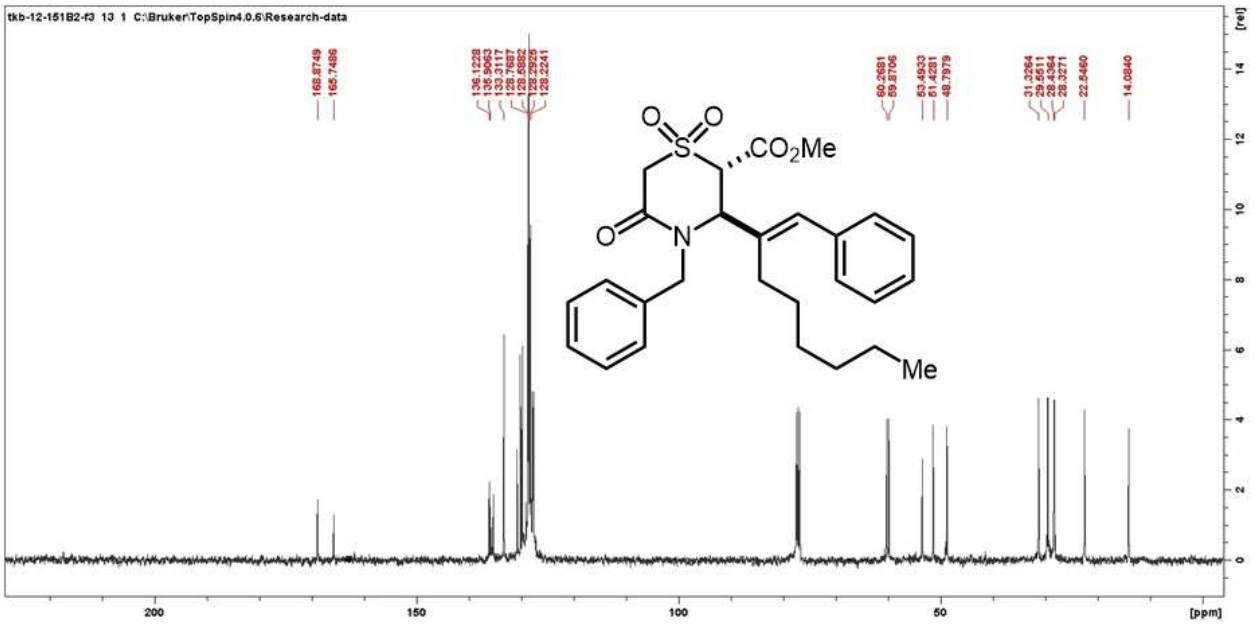
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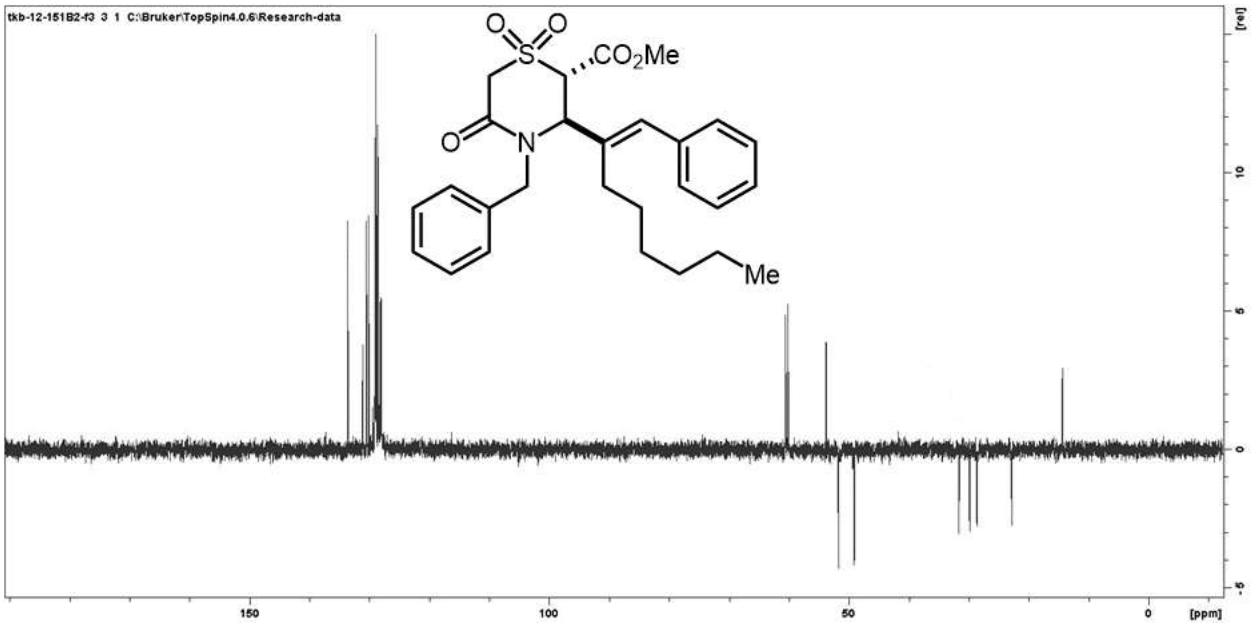
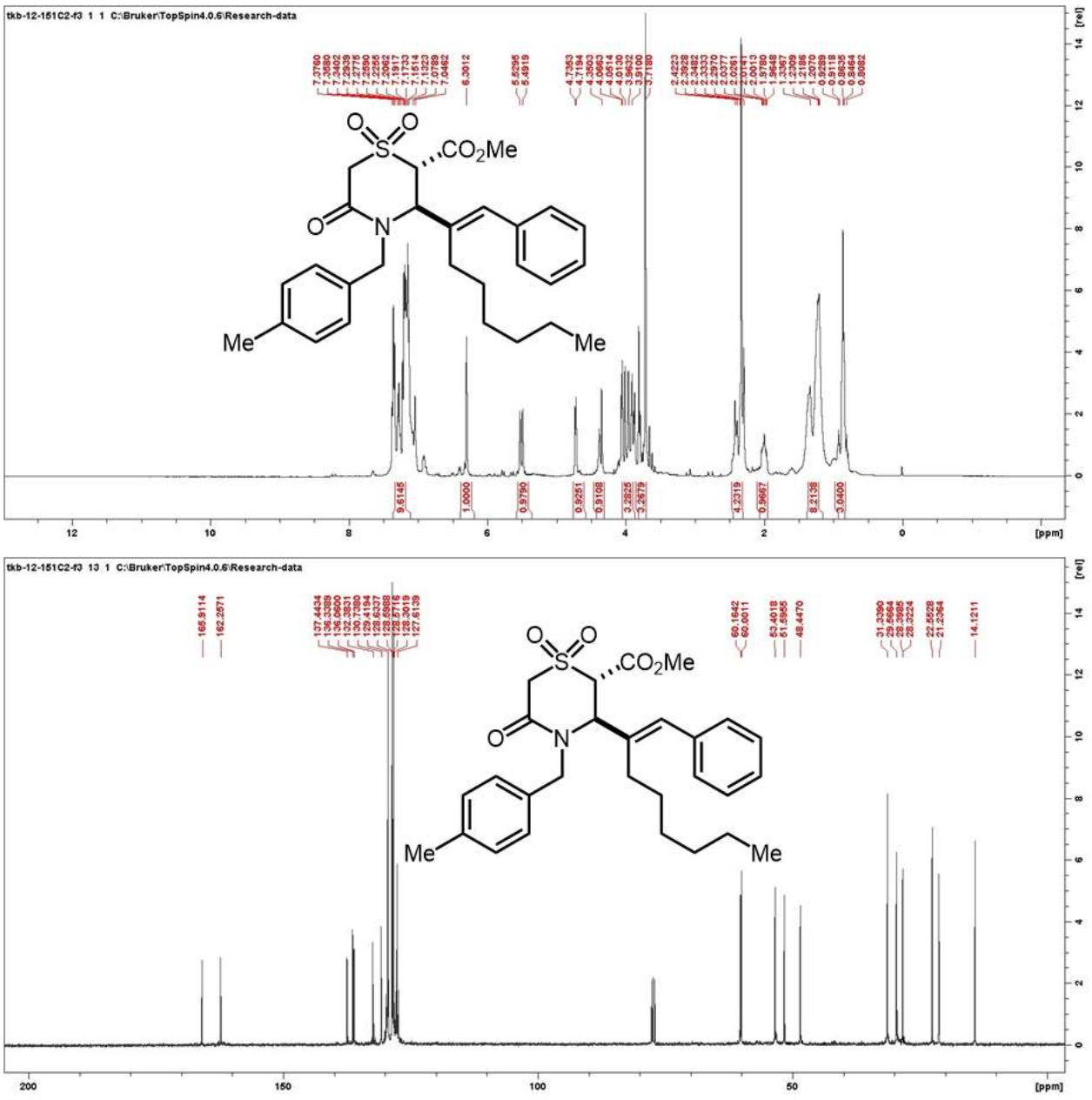


Compound 8a13

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (80:20). Oily substance. Yield = 388.2 mg, 78%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.04 (m, 9H), 6.30 (s, 1H), 5.51 (d, *J* = 15.0 Hz, 1H), 4.73 (d, *J* = 6.4 Hz, 1H), 4.37 (d, *J* = 14.0 Hz, 1H), 4.15 – 3.91 (m, 3H), 3.72 (s, 3H), 2.32 – 2.29 (m, 4H), 2.00 (ddd, *J* = 15.0, 10.2, 5.2 Hz, 1H), 1.33 – 1.20 (m, 8H), 0.91 – 0.86 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.9, 162.3, 137.4, 136.3, 136.1, 132.4, 130.7, 129.4, 128.6, 128.5, 128.5, 128.3, 127.6, 60.2, 60.0, 53.4, 51.6, 48.4, 31.3, 29.6, 28.4, 28.3, 22.6, 21.2, 14.1. FTIR (KBr): 2933.4, 1721.5, 1666.3, 1606.9, 1511.0, 1448.5, 1414.7, 1384.9, 1357.4, 1298.7, 1247.5, 1179.3, 1137.9, 1033.8, 995.8, 831.7. HRMS (ESI): calc'd for $C_{28}H_{35}NNaO_5S$ $[M + Na]^+$: 520.2134, found 520.2130.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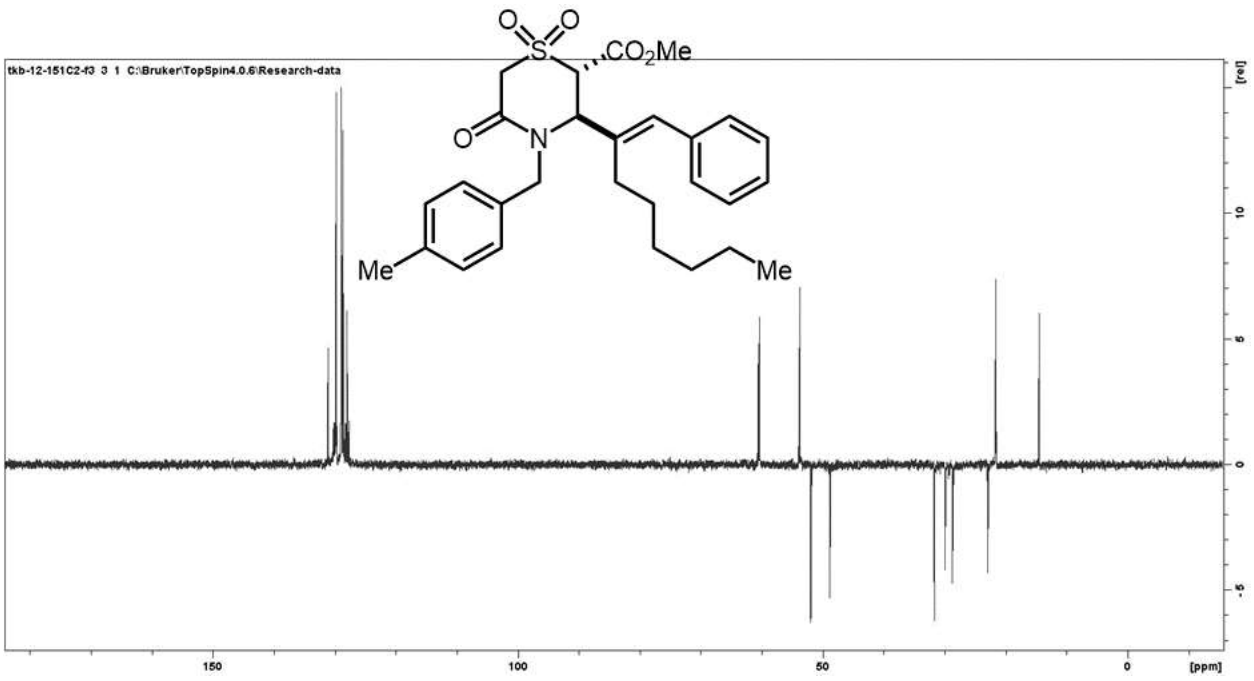
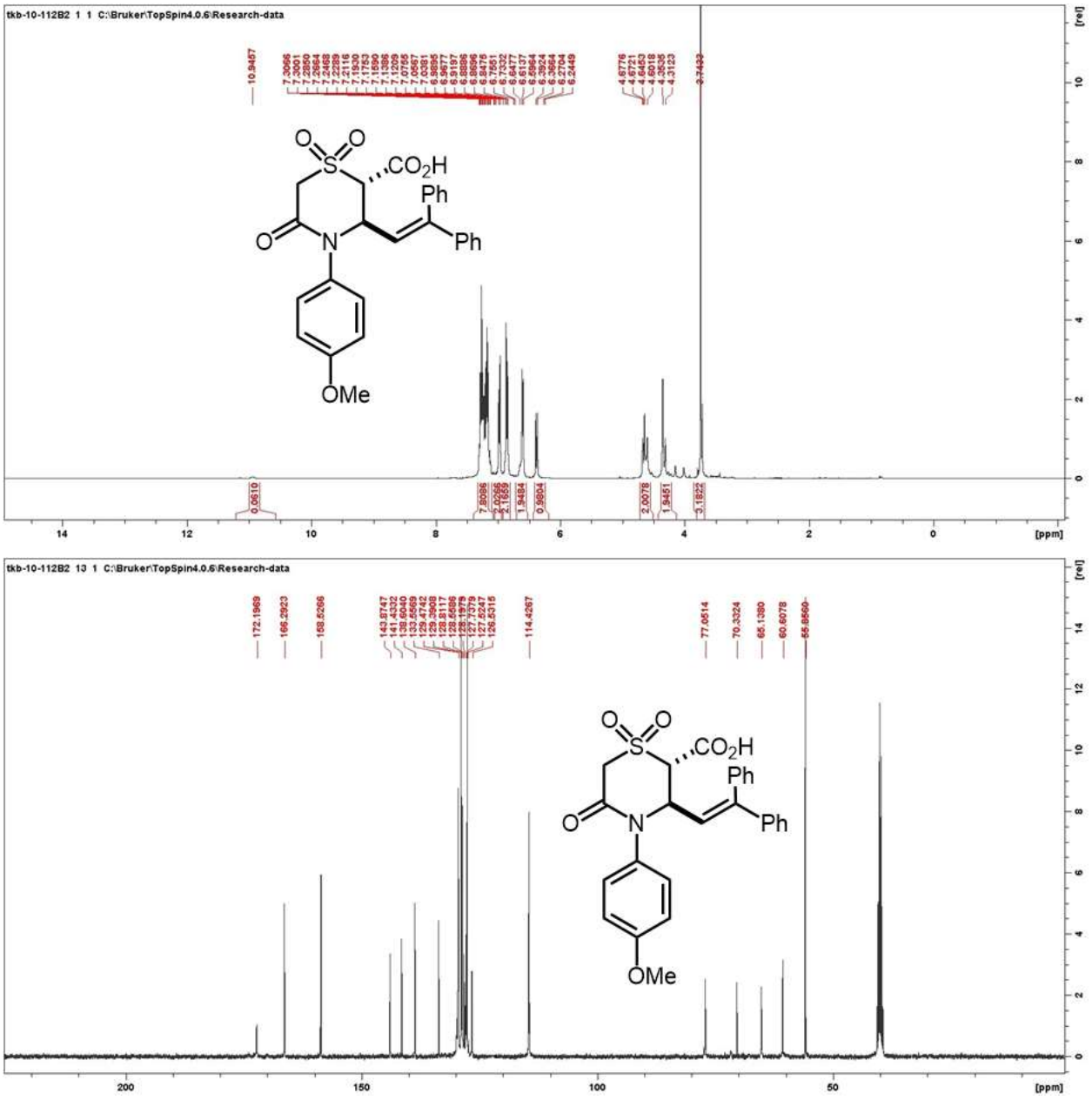


Compound 8a14

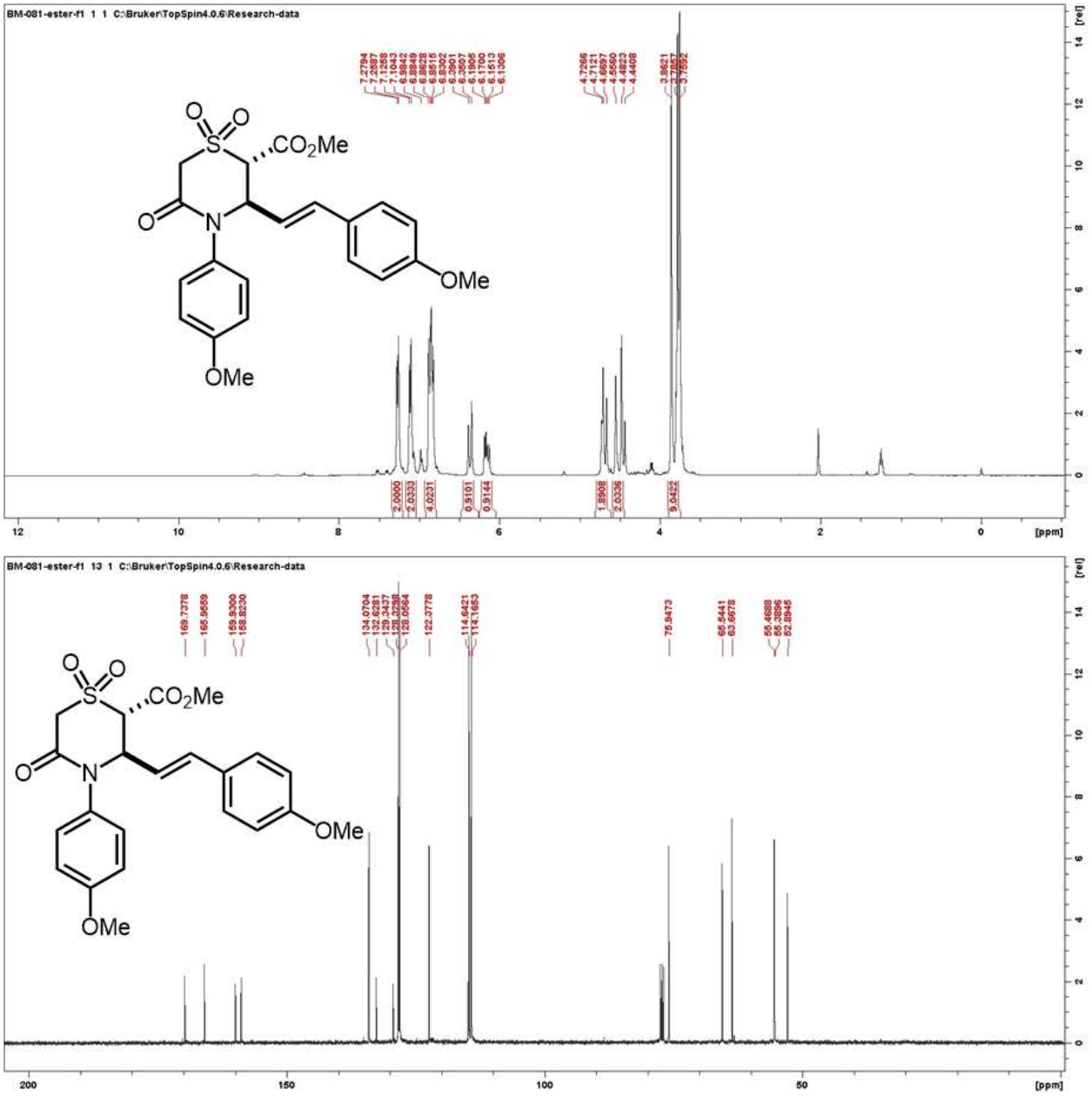
Prepared in 0.5 mmol scale using **General Procedure B** but prior to methylation. Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 188.6 mg, 79%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.94 (br. s, 1H) 7.34 – 7.09 (m, 8H), 6.98 (d, *J* = 8.4 Hz, 2H), 6.92 – 6.81 (m, 2H), 6.68 – 6.57 (m, 2H), 6.38 (d, *J* = 10.4 Hz, 1H), 4.70 – 4.55 (m, 2H), 4.33 (d, *J* = 16.5 Hz, 2H), 3.74 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.2, 166.3, 158.5, 143.9, 141.4, 138.6, 133.6, 129.5, 129.4, 128.8, 128.6, 127.7, 127.5, 126.5, 114.4, 77.1, 70.3, 65.1, 60.6, 55.9. FTIR (KBr): 2944.4, 2563.3, 2433.6, 2216.8, 1736.5, 1658.3, 1606.9, 1511.0, 1448.5, 1414.7, 1384.9, 1357.4, 1298.7, 1247.5, 1179.3, 1135.9, 1031.8, 995.9, 833.7. HRMS (ESI): calc'd for $C_{26}H_{23}NNaO_6S$ $[M + Na]^+$: 500.1144, found 500.1149.



Compound 8a15

Prepared in 0.5 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (40:60). Oily substance. Yield = 169.3 mg, 76%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (d, J = 8.3 Hz, 2H), 7.12 (d, J = 8.5 Hz, 2H), 6.86 – 6.83 (m, 4H), 6.37 (d, J = 15.8 Hz, 1H), 6.16 (dd, J = 15.8, 8.3 Hz, 1H), 4.73 – 4.71 (m, 2H), 4.55 (d, J = 2.7 Hz, 1H), 4.46 (d, J = 16.5 Hz, 1H), 3.86 (s, 3H), 3.77 – 3.75 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 166.0, 159.9, 158.8, 134.1, 132.6, 129.3, 128.3, 128.1, 122.4, 114.6, 114.2, 75.9, 65.6, 63.7, 55.5, 55.4, 52.9. FTIR (KBr): 3027.4, 2924.0, 1724.2, 1646.3, 1474.3, 1452.8, 1361.9, 1342.0,

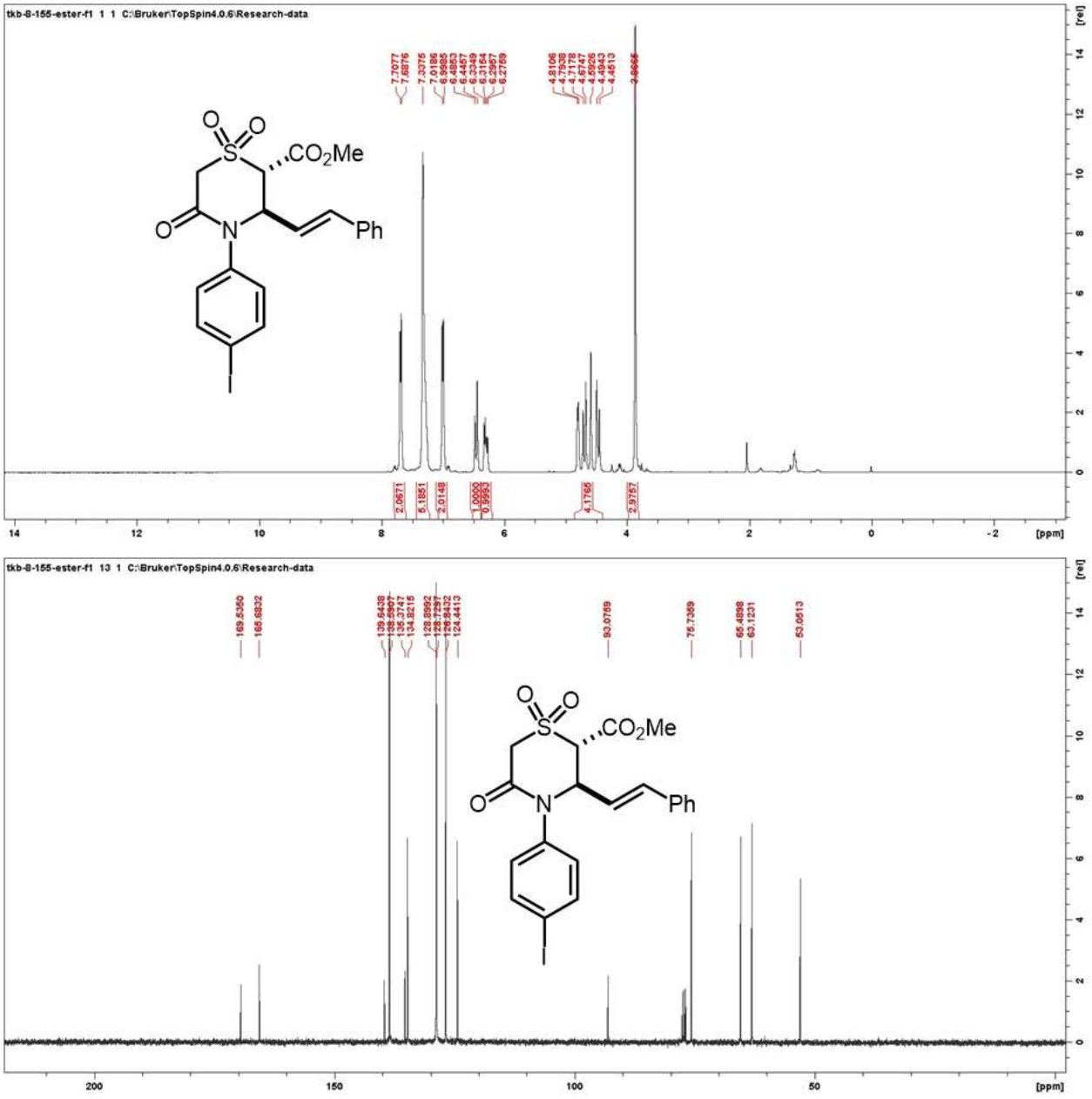
1205.6, 1140.2, 1071.7, 1028.3, 996.4, 735.4. HRMS (ESI): calc'd for $C_{22}H_{23}NNaO_7S$ $[M + Na]^+$: 468.1093, found 468.1096.



Compound 8a16

Prepared in 5 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (75:25). Oily substance. Yield = 1866 mg, 73%, 95:5 dr. ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.1 Hz, 2H), 7.36 – 7.24 (m, 5H), 7.01 (d, *J* = 8.1 Hz, 2H), 6.47 (d, *J* = 15.8 Hz, 1H), 6.31 (dd, *J* = 15.9, 7.9 Hz, 1H), 4.84 – 4.77 (m, 1H), 4.70 (d,

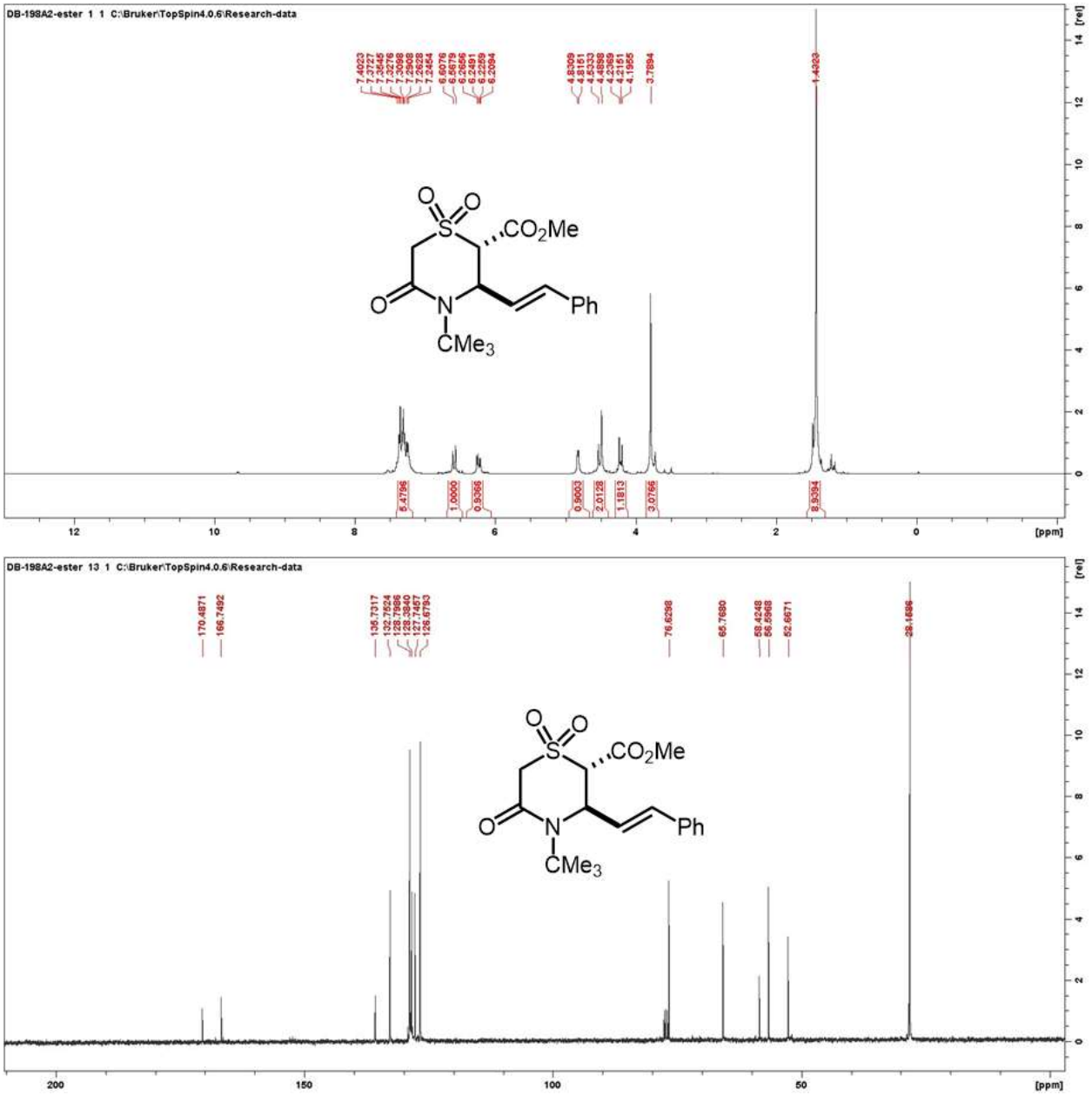
J = 17.3 Hz, 1H), 4.59 (d, J = 2.7 Hz, 1H), 4.52 – 4.43 (m, 1H), 3.87 (s, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.5, 165.7, 139.6, 138.6, 135.4, 134.8, 130.3, 128.9, 128.8, 128.7, 126.8, 124.4, 93.1, 75.7, 68.1, 65.5, 63.1, 53.1. HRMS (ESI): calc'd for $C_{20}H_{18}INNaO_5S$ $[M + Na]^+$: 533.9848, found 533.9844.



Compound 8a17

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (90:10). Oily substance. Yield = 299.6 mg, 82%, 90:10 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 to 7.16 (5H, m), 6.66, (1H, d), 6.26 to 6.09 (1H, dd), 4.83 (1H,

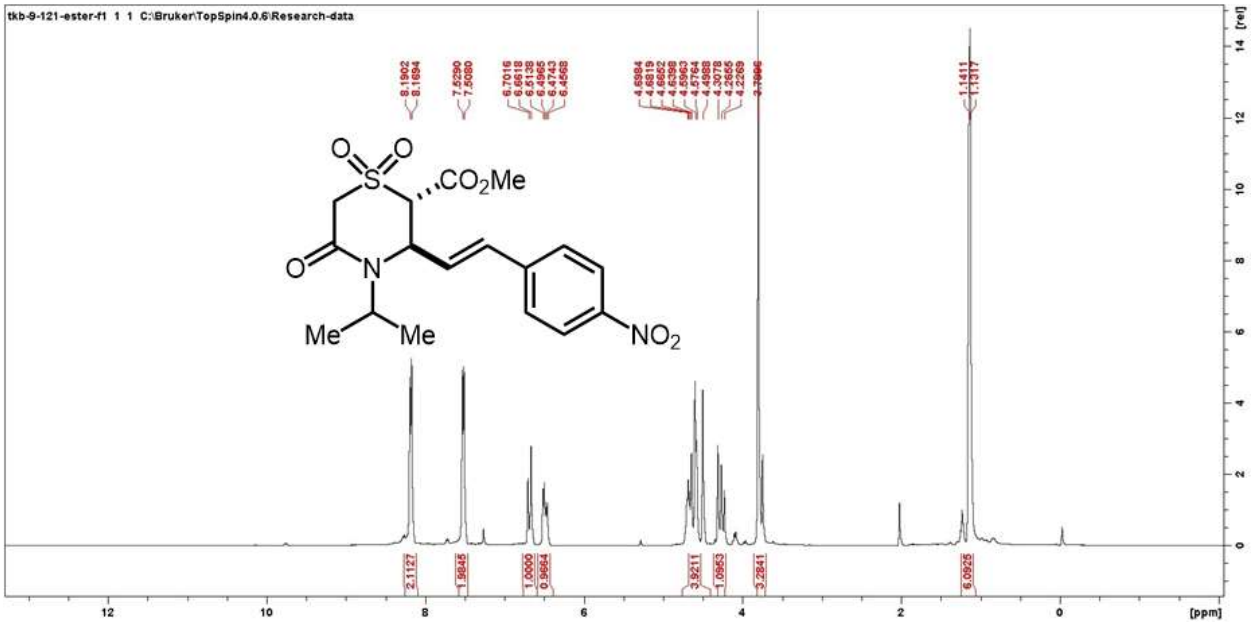
d), 4.58 to 4.32 (2H, dd), 4.25 (1H, d), 3.74 (3H, s), 1.43 (9H, s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.5, 166.7, 135.7, 132.7, 128.8, 128.4, 127.7, 126.7, 76.6, 65.8, 58.4, 56.6, 52.7, 28.2. HRMS (ESI): calc'd for $C_{18}H_{23}NNaO_5S$ $[M + Na]^+$: 388.1195, found 388.1198.

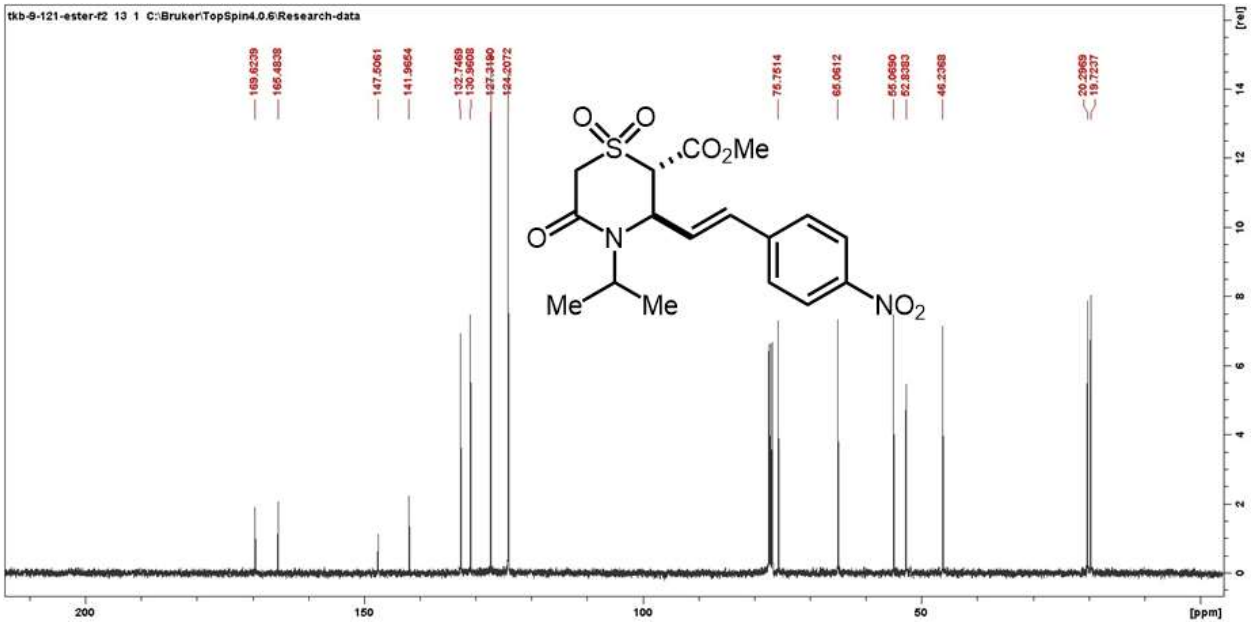


Compound 8a18

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 289.4 mg, 73%, 95:5 dr. ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.18 (d, *J* = 8.3 Hz, 2H), 7.52 (d, *J* = 8.3 Hz, 2H), 6.68 (d, *J* =

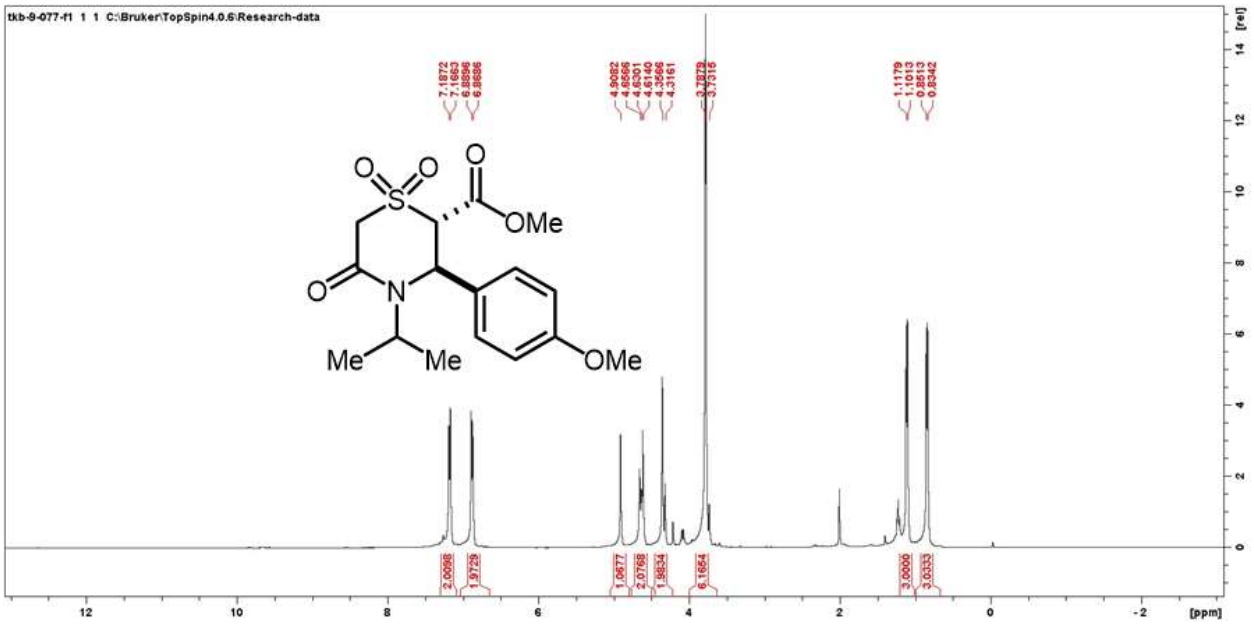
15.9 Hz, 1H), 6.49 (dd, J = 15.9, 7.1 Hz, 1H), 4.68 (p, J = 7.3 Hz, 1H), 4.66 – 4.55 (m, 2H), 4.50 (s, 1H), 4.33 – 4.20 (m, 1H), 3.80 (s, 3H), 3.74 (s, 0H), 1.14 (dd, J = 7.2, 3.2 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.6, 165.5, 147.5, 142.0, 132.8, 130.9, 127.3, 124.2, 75.7, 68.1, 65.0, 55.1, 52.8, 52.0, 46.2, 20.3, 19.7. HRMS (ESI): calc'd for $C_{17}H_{20}N_2NaO_7S$ $[M + Na]^+$: 419.0889, found 419.0885.

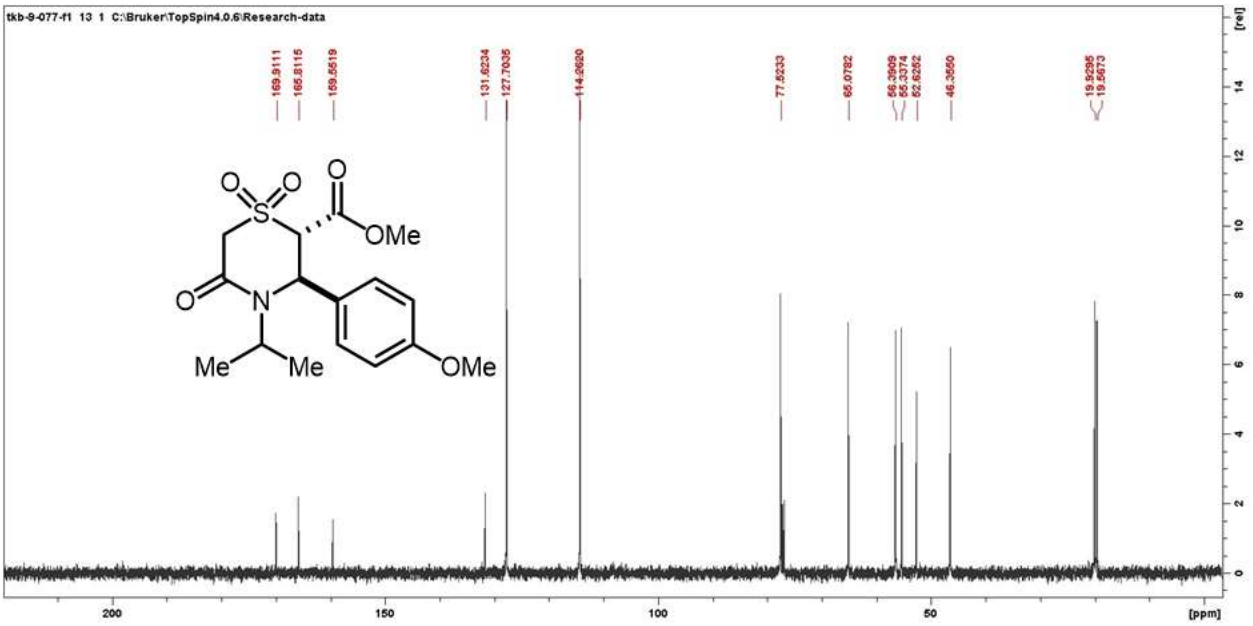




Compound 8b1

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 263 mg, 74%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (d, *J* = 8.3 Hz, 2H), 6.88 (d, *J* = 8.2 Hz, 2H), 4.91 (s, 1H), 4.71 – 4.57 (m, 2H), 4.38 – 4.29 (m, 2H), 3.86 – 3.81 (m, 6H), 1.11 (d, *J* = 6.7 Hz, 3H), 0.84 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.9, 165.8, 159.6, 131.6, 127.7, 114.3, 77.5, 65.1, 56.4, 55.3, 52.6, 46.4, 19.9, 19.6. FTIR (KBr): 3009.7, 2933.6, 1647.4, 1607.2, 1577.1, 1512.0, 1454.2, 1427.6, 1359.8, 1299.2, 1250.9, 1176.0, 1151.5, 1119.6, 1031.3, 990.3, 927.8, 825.4, 765.0. HRMS (ESI): calc'd for $C_{16}H_{21}NNaO_6S$ $[M + Na]^+$: 378.0987, found 378.0990.

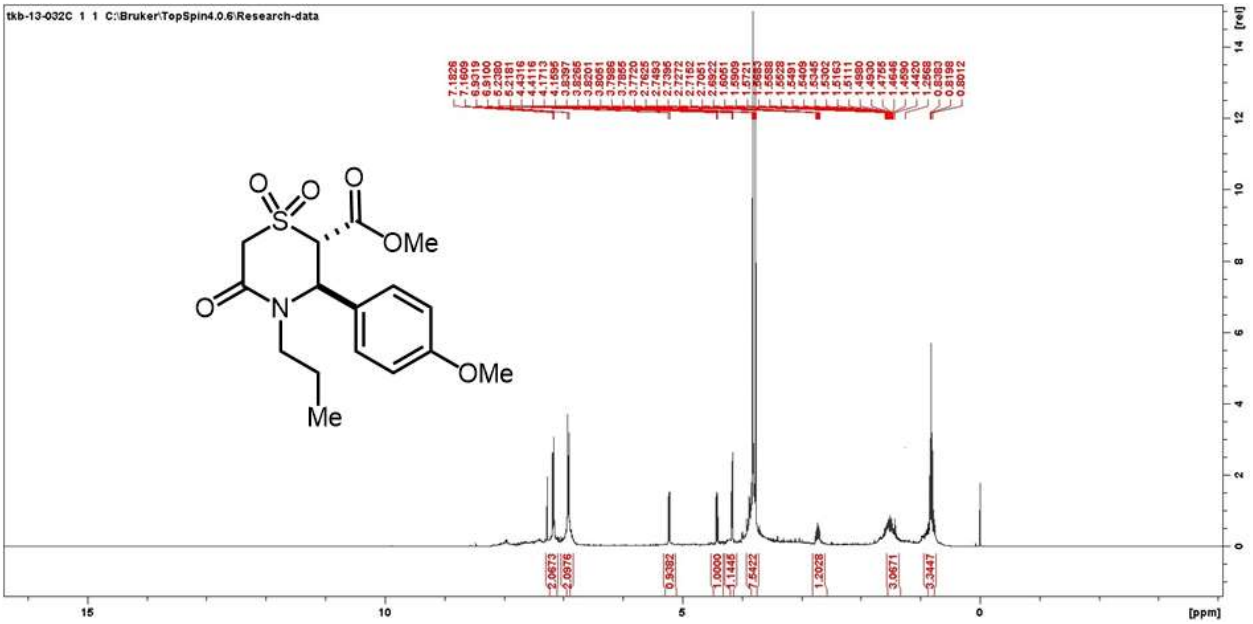


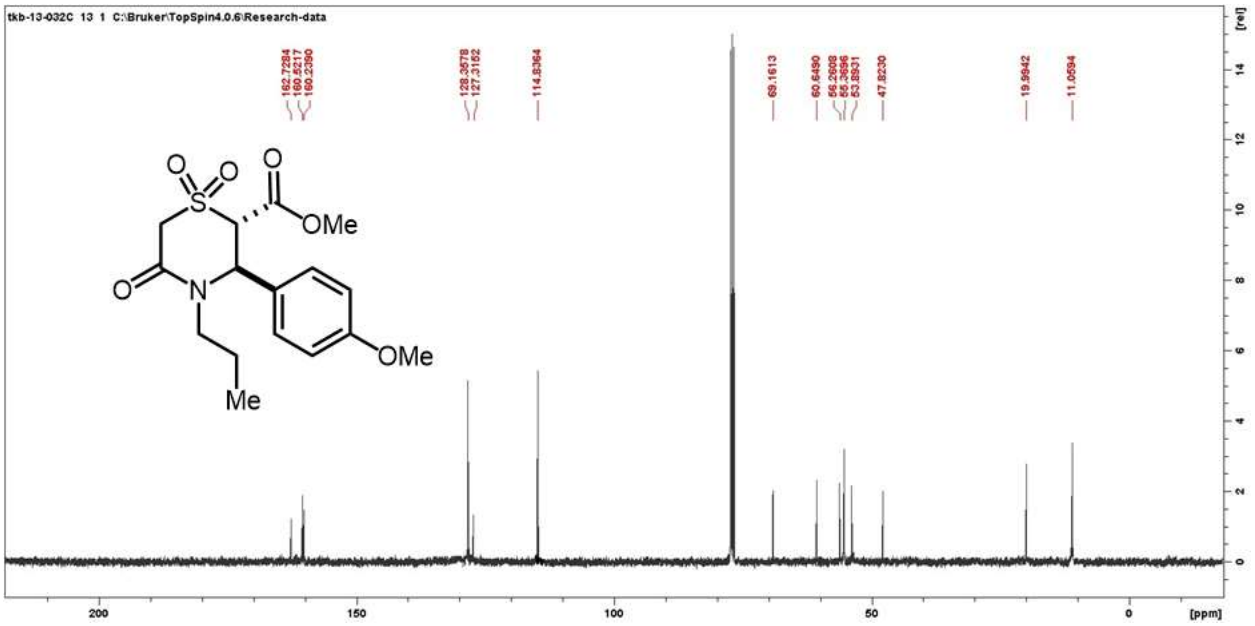


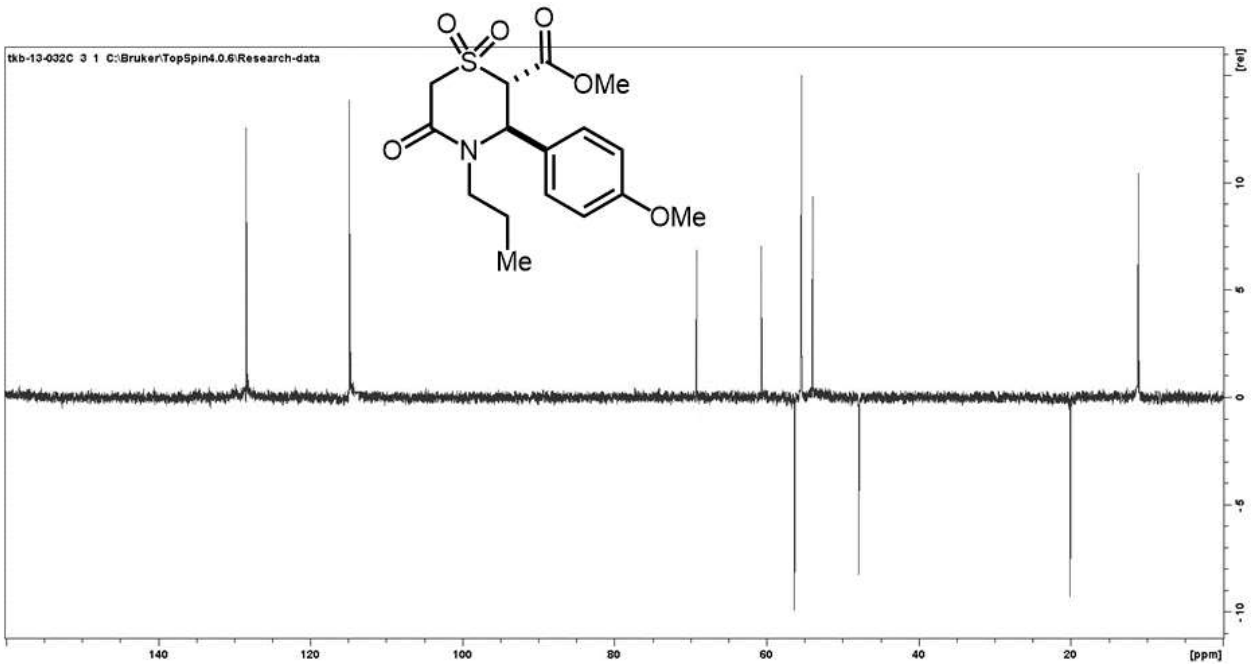
Compound 8b2

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 252.1 mg, 71%, 95:5 dr.

FTIR (KBr): 3029.9, 2925.0, 1724.9, 1646.3, 1474.3, 1452.8, 1361.9, 1342.0, 1205.6, 1140.2, 1071.9, 1028.3, 996.8, 775.4.



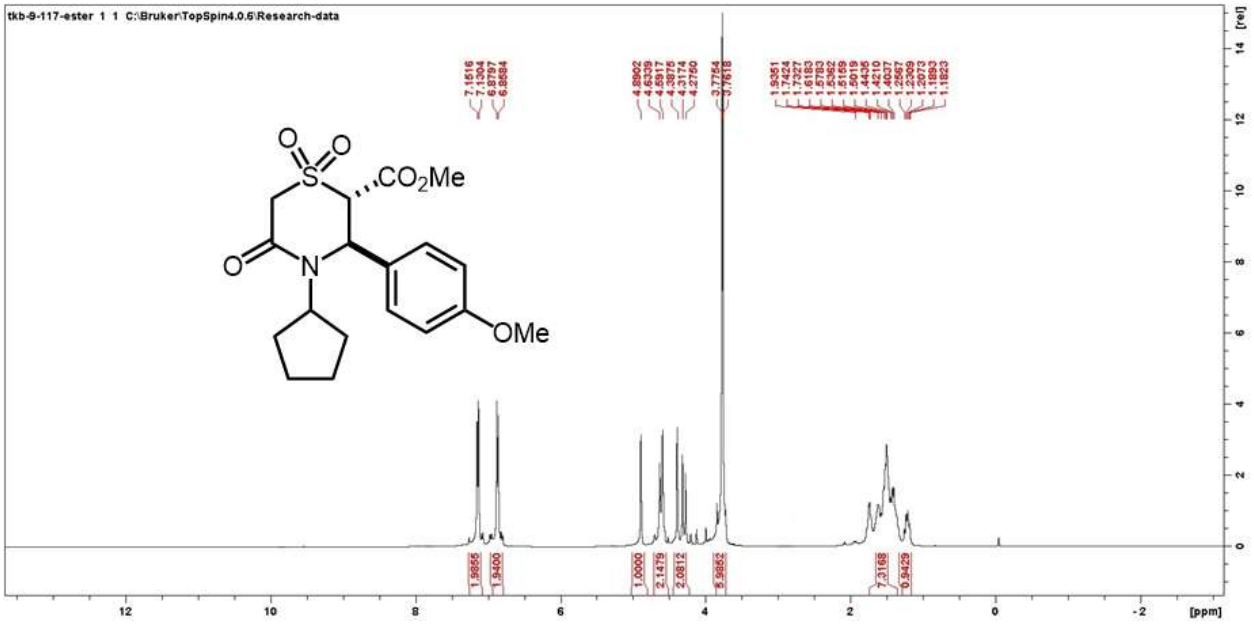


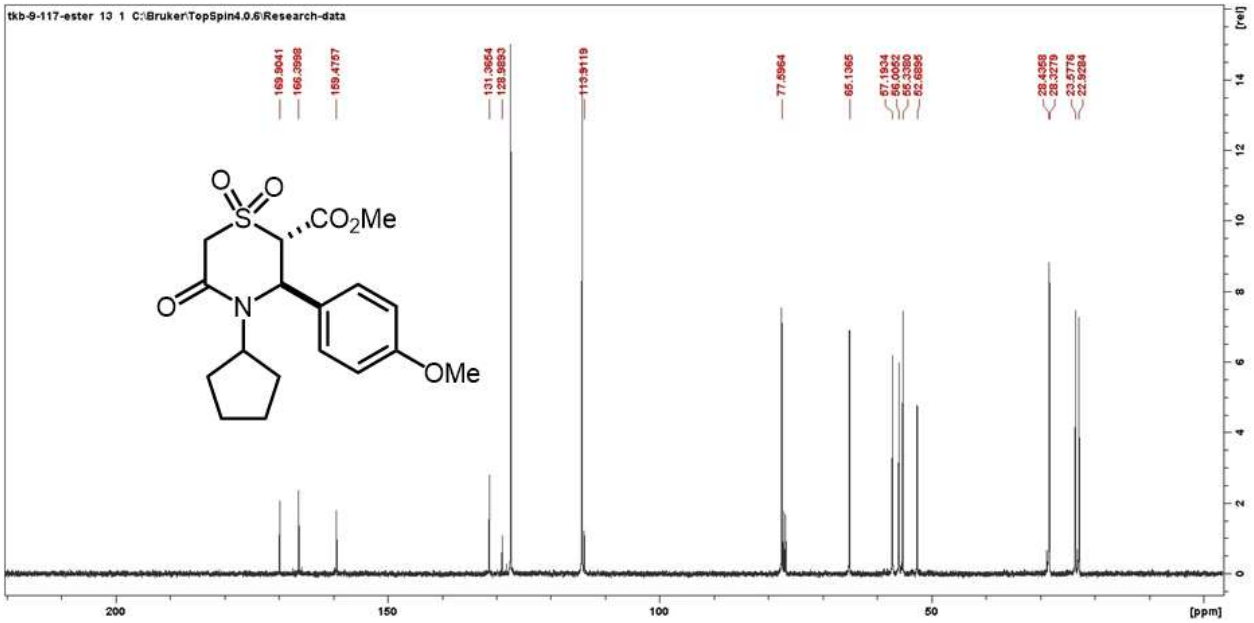


Compound 8b3

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 293.7 mg, 77%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.14 (d, J = 8.4 Hz, 2H), 6.88 (d, J = 8.4 Hz, 2H), 4.89 (d, J = 2.1 Hz, 1H), 4.60 (td, J = 11.9, 6.3 Hz, 2H), 4.39 (d, J = 2.0 Hz, 1H), 4.30 (d, J = 17.0 Hz, 1H), 3.77 –

3.74 (m, 6H), 1.68 – 1.31 (m, 7H), 1.28 – 1.16 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.9, 166.4, 159.5, 131.4, 127.4, 114.3, 77.6, 65.1, 57.2, 56.0, 55.3, 52.7, 28.4, 28.3, 23.6, 22.9. HRMS (ESI): calc'd for $C_{18}H_{23}NNaO_6S$ $[M + Na]^+$: 404.1144, found 404.1148.

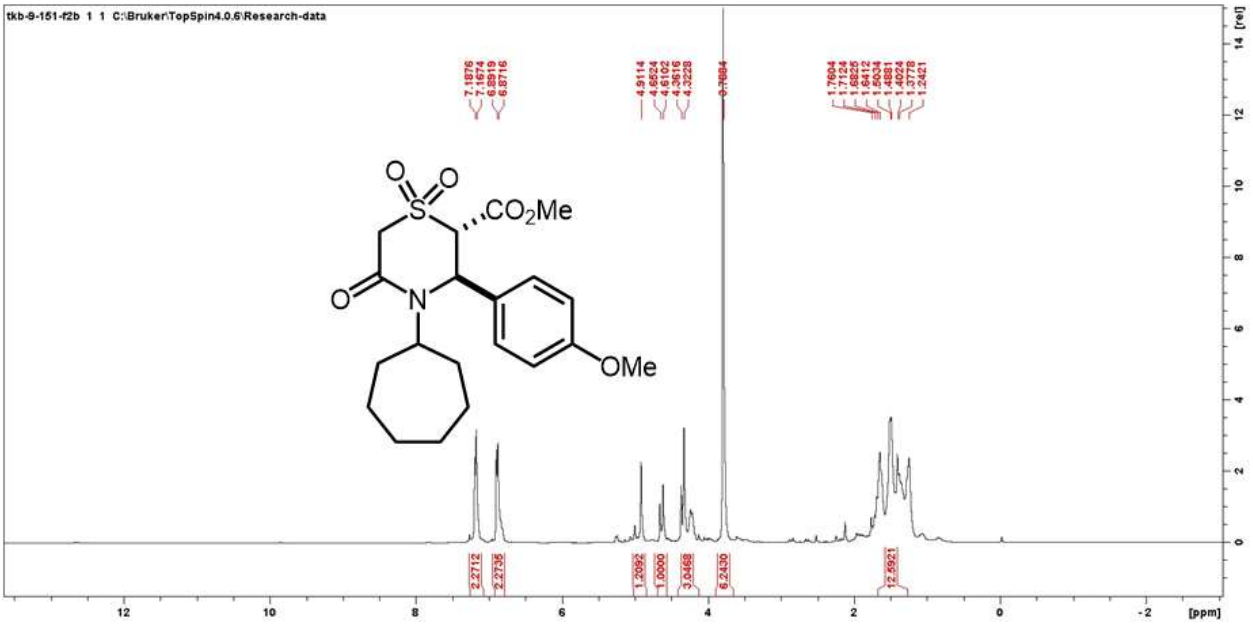


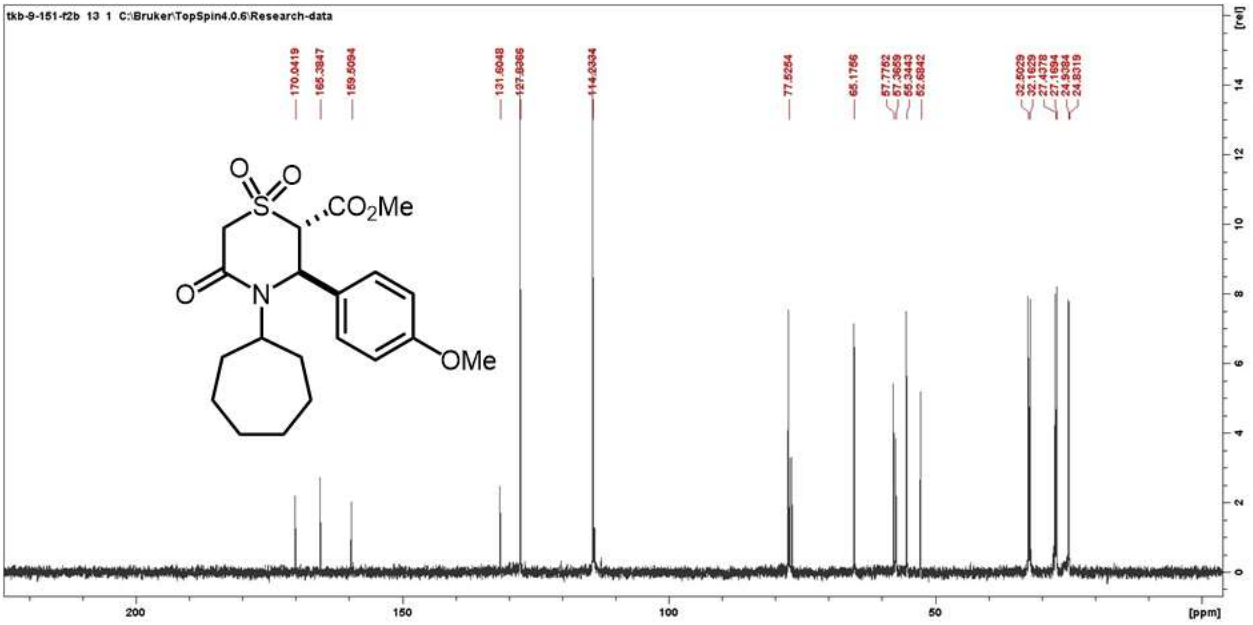


Compound 8b4

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 290.7 mg, 71%, 95:5 dr. ^{1}H

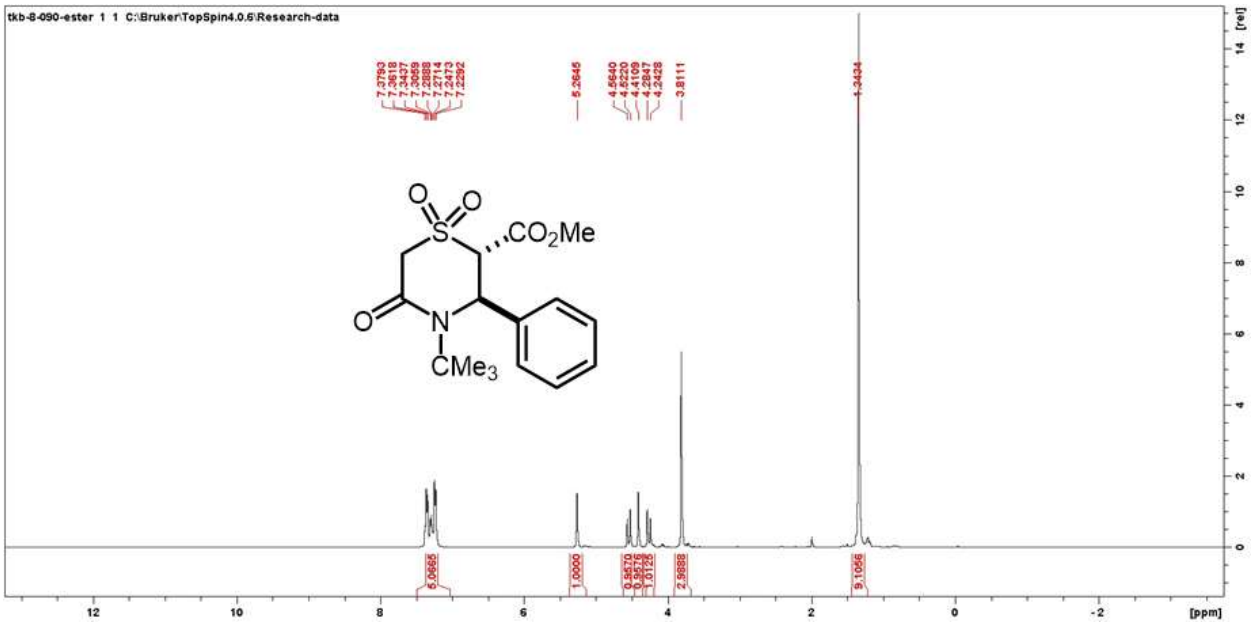
NMR (400 MHz, $CDCl_3$) δ 7.18 (d, J = 8.4 Hz, 2H), 6.87 (d, J = 8.4 Hz, 2H), 4.91 (s, 1H), 4.63 (d, J = 16.9 Hz, 1H), 4.34 (d, J = 15.6 Hz, 1H), 4.22 (d, J = 11.1 Hz, 2H), 3.79 (s, 6H), 1.76 – 1.24 (m, 12H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.0, 165.4, 159.5, 131.6, 127.8, 114.2, 77.5, 65.2, 57.8, 57.4, 55.3, 52.7, 32.5, 32.2, 27.4, 27.2, 24.9, 24.8. HRMS (ESI): calc'd for $C_{20}H_{27}NNaO_6S$ $[M + Na]^+$: 432.1457, found 432.1455.

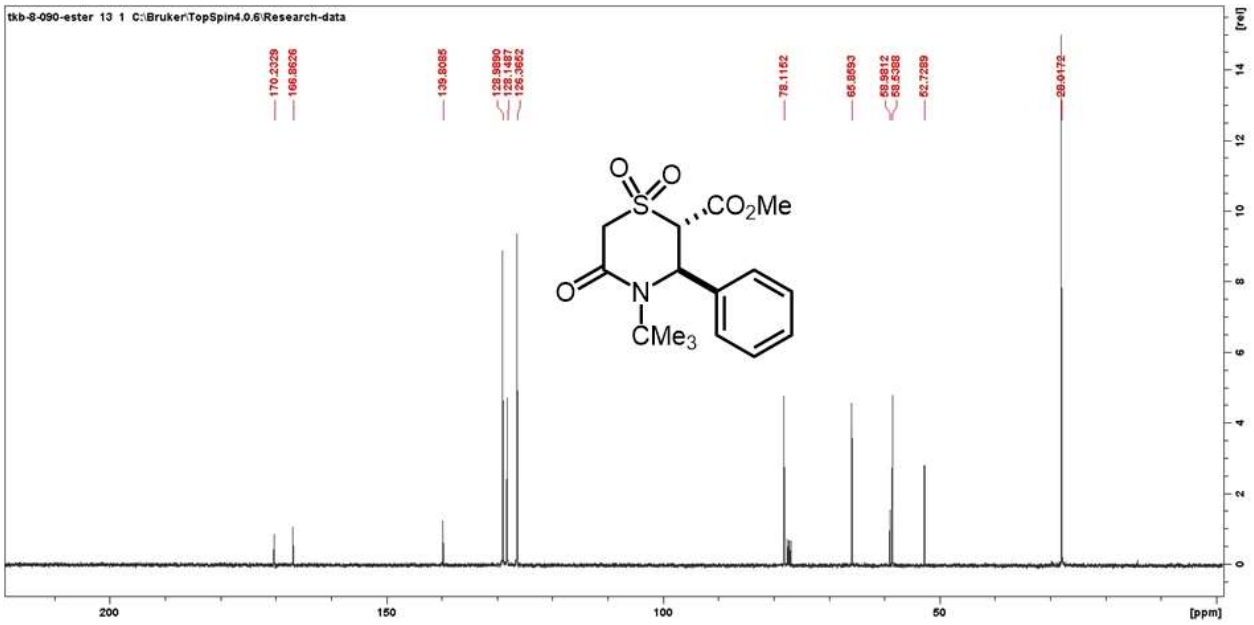




Compound 8b5

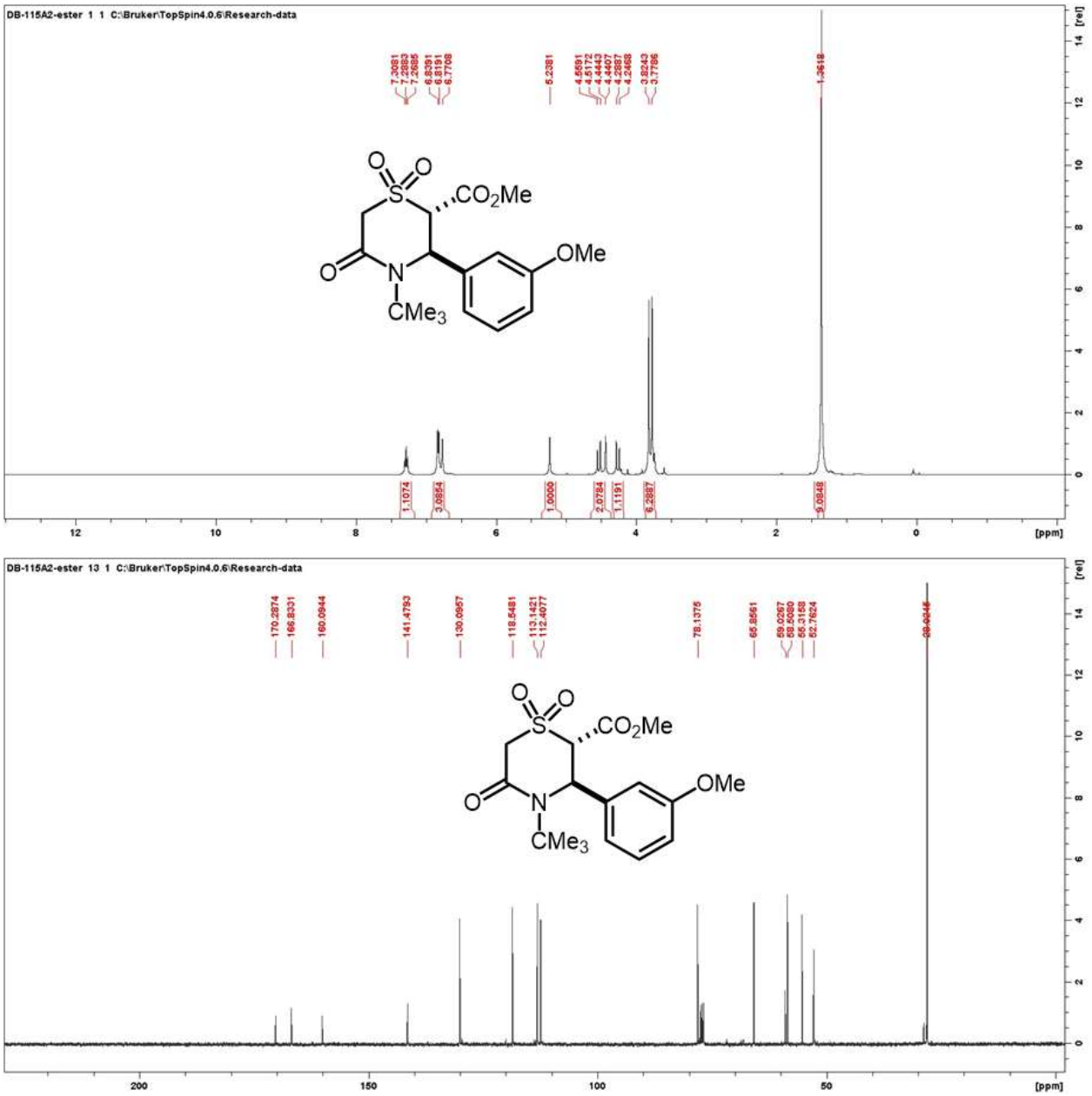
Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (80:20). Oily substance. Yield = 237.6 mg, 70%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.21 (m, 5H), 5.26 (s, 1H), 4.54 (d, *J* = 16.8 Hz, 1H), 4.41 (s, 1H), 4.26 (d, *J* = 16.8 Hz, 1H), 3.81 (s, 3H), 1.34 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.2, 166.9, 139.8, 129.0, 128.1, 126.4, 78.1, 65.9, 59.0, 58.5, 52.7, 28.0. HRMS (ESI): calc'd for $C_{16}H_{21}NNaO_5S$ $[M + Na]^+$: 362.1038, found 362.1043.





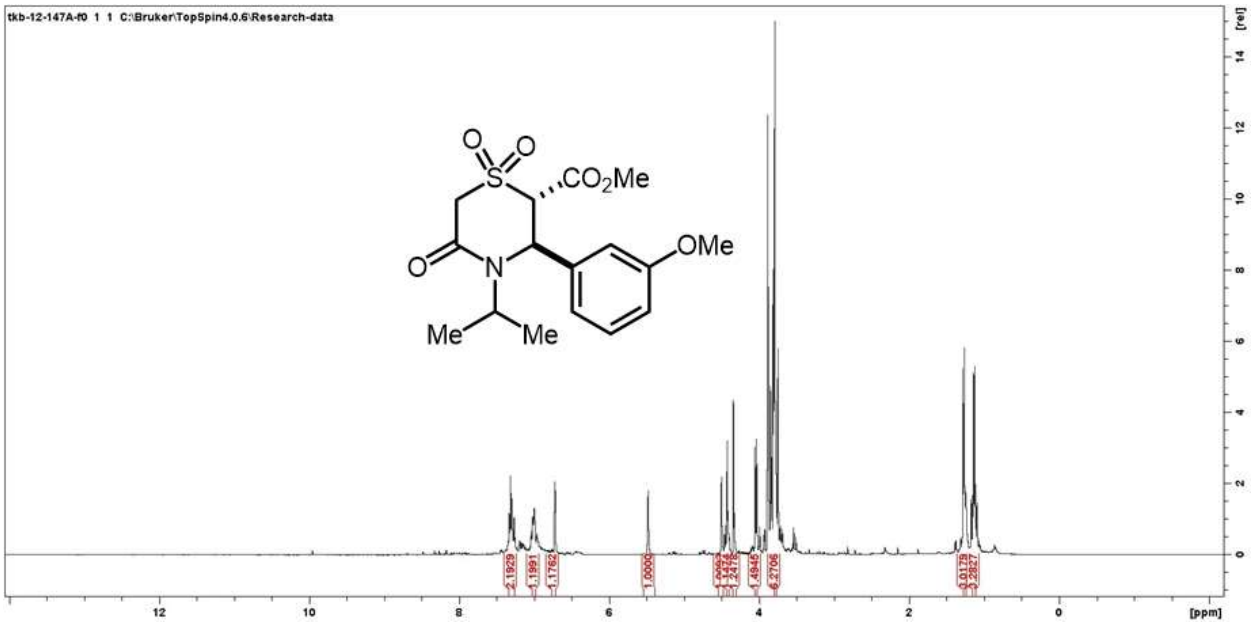
Compound 8b6

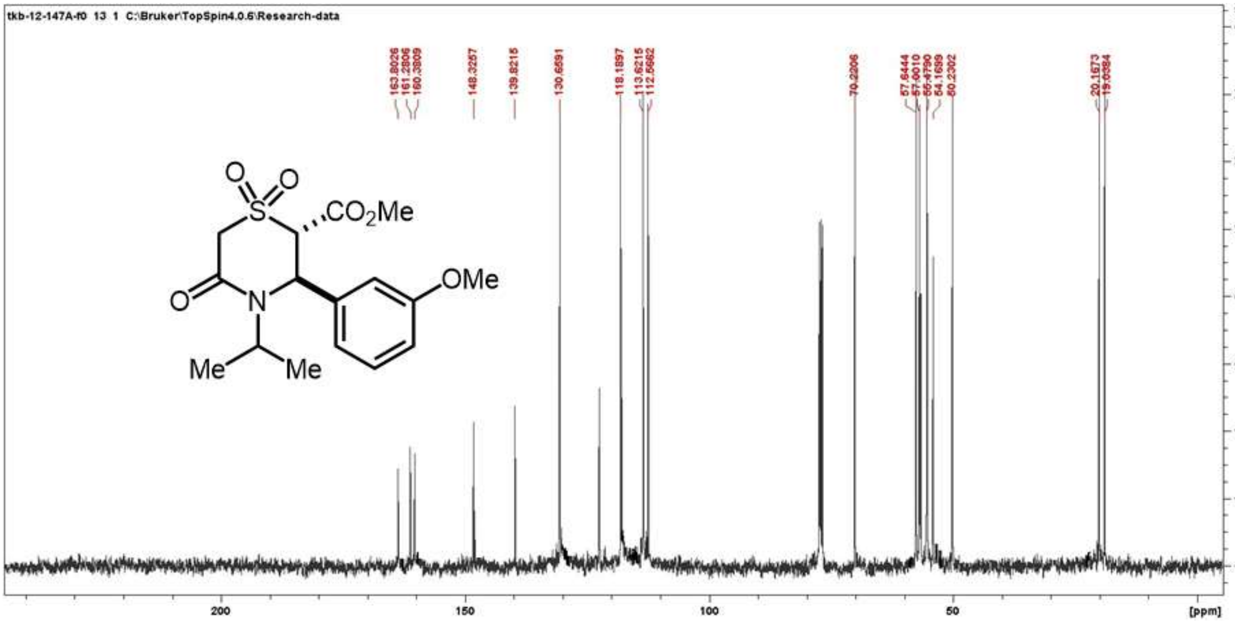
Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 277.1 mg, 75%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (t, J = 7.9 Hz, 1H), 6.83 – 6.79 (m, 2H), 6.77 (d, J = 2.1 Hz, 1H), 5.26 (s, 1H), 4.54 (d, J = 16.8 Hz, 1H), 4.44 (d, J = 1.9 Hz, 1H), 4.27 (d, J = 16.7 Hz, 1H), 3.82 (s, 3H), 3.78 (s, 3H), 1.36 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.3, 166.8, 160.1, 130.1, 118.5, 113.1, 112.4, 78.1, 65.9, 59.0, 58.5, 55.3, 52.8, 28.0. HRMS (ESI): calc'd for $C_{17}H_{23}NNaO_6S$ $[M + Na]^+$: 392.1144, found 392.1148.



Compound 8b7

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 245.2 mg, 69%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.26 (m, 2H), 7.02 – 6.94 (m, 1H), 6.71 (s, 1H), 5.44 (d, J = 4.0 Hz, 1H), 4.47 – 4.23 (m, 3H), 4.08 (d, 1H), 3.81 – 3.78 (m, 6H), 1.20 (d, J = 8.3 Hz, 3H), 1.13 (d, J = 8.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 163.8, 161.3, 160.4, 148.3, 130.7, 118.2, 113.6, 112.6, 70.2, 57.6, 57.0, 55.5, 55.4, 54.3, 50.2, 20.2, 19.0. FTIR (KBr): 2944.8, 1642.2, 1494.9, 1448.8, 1427.0, 1393.4, 1289.7, 1223.6, 1198.9, 1130.1, 1074.1, 1030.4, 988.5, 966.1, 925.5, 741.8, 673.4. HRMS (ESI): calc'd for $C_{16}H_{21}NNaO_6S$ $[M + Na]^+$: 378.0987, found 378.0990.

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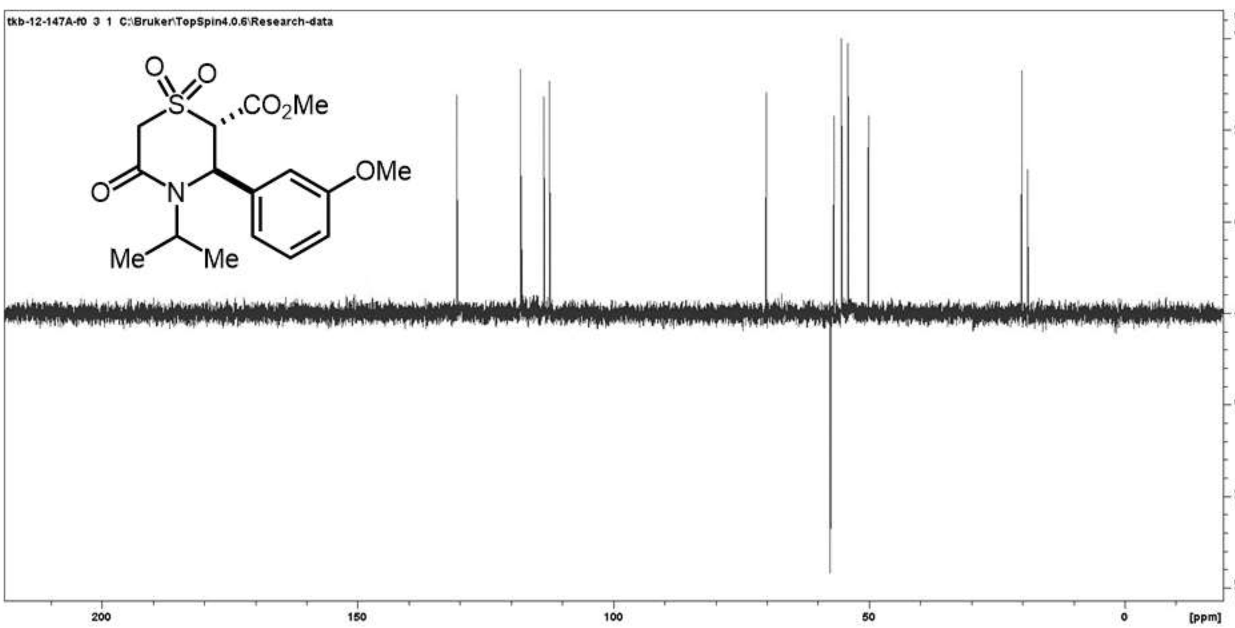
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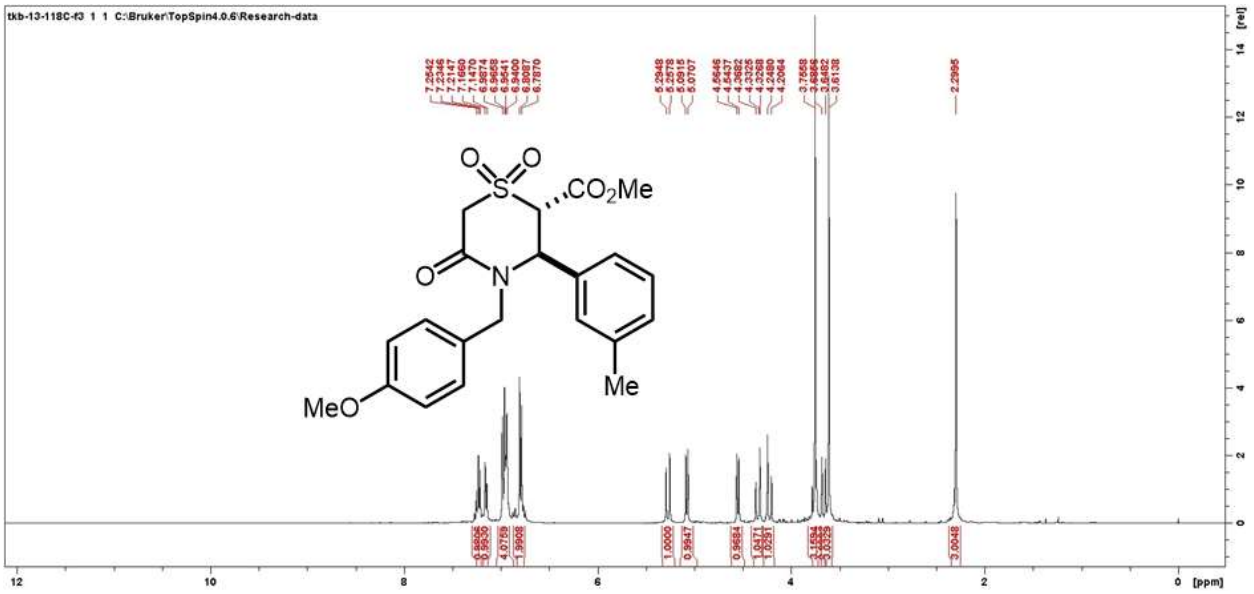
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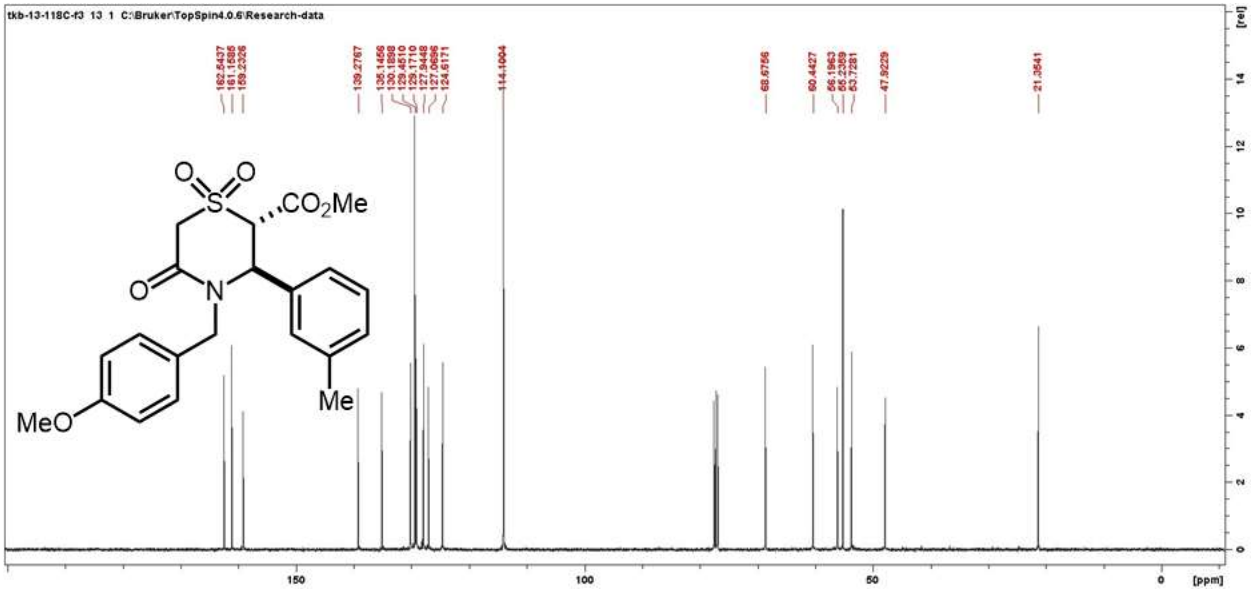
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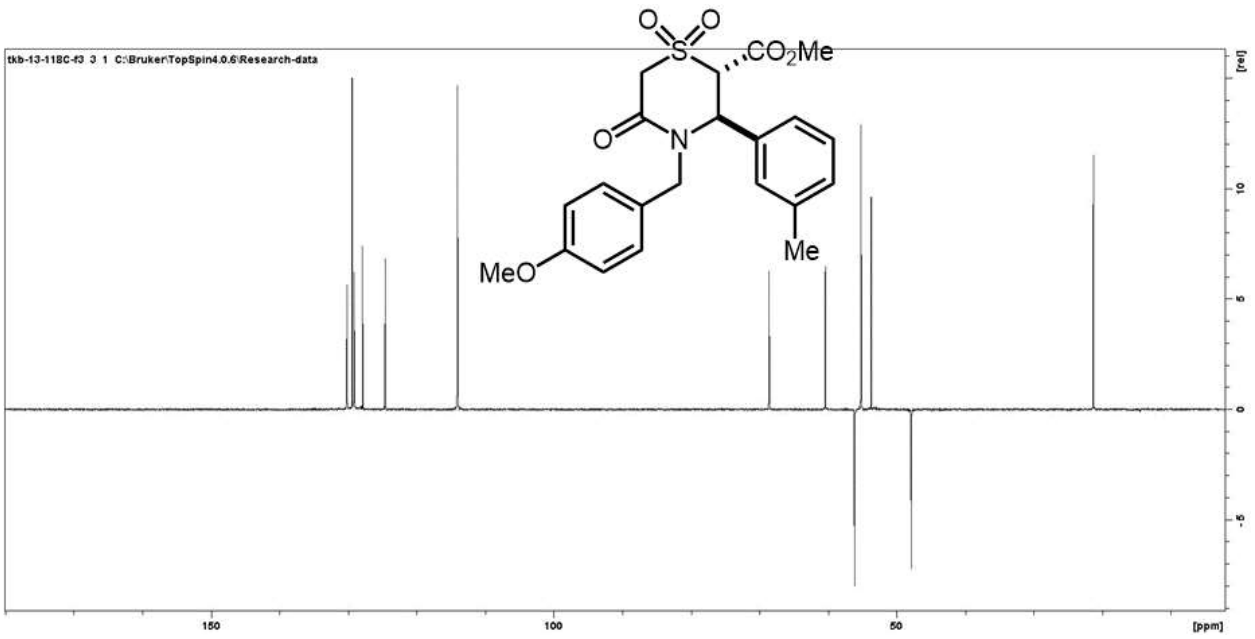
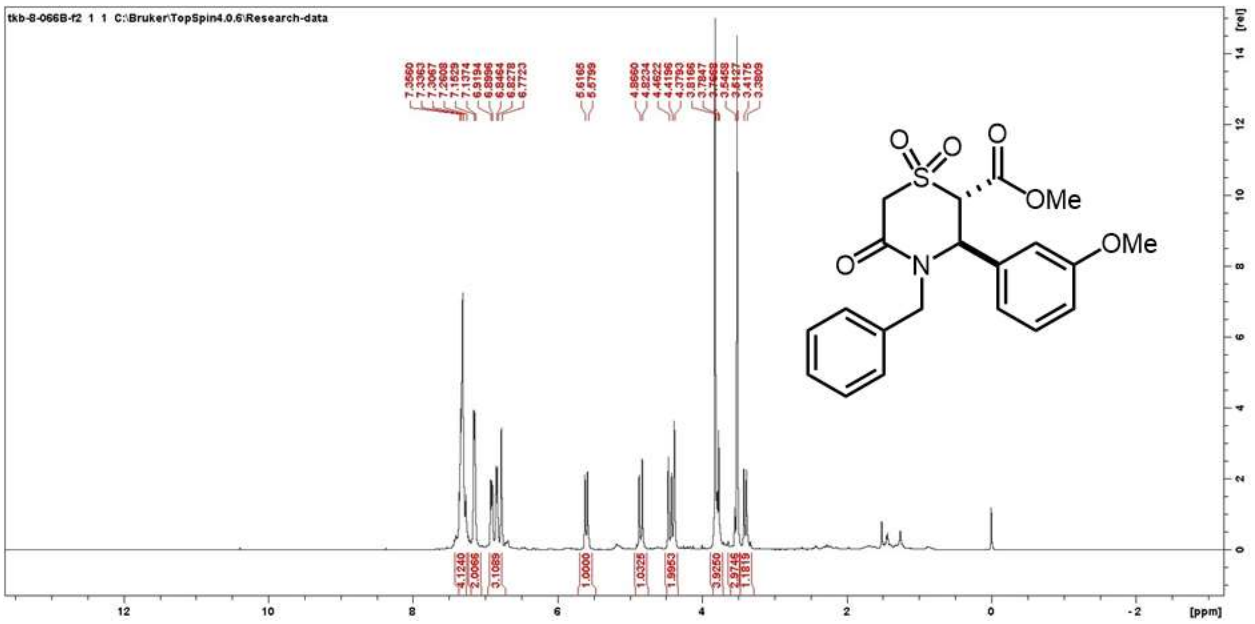
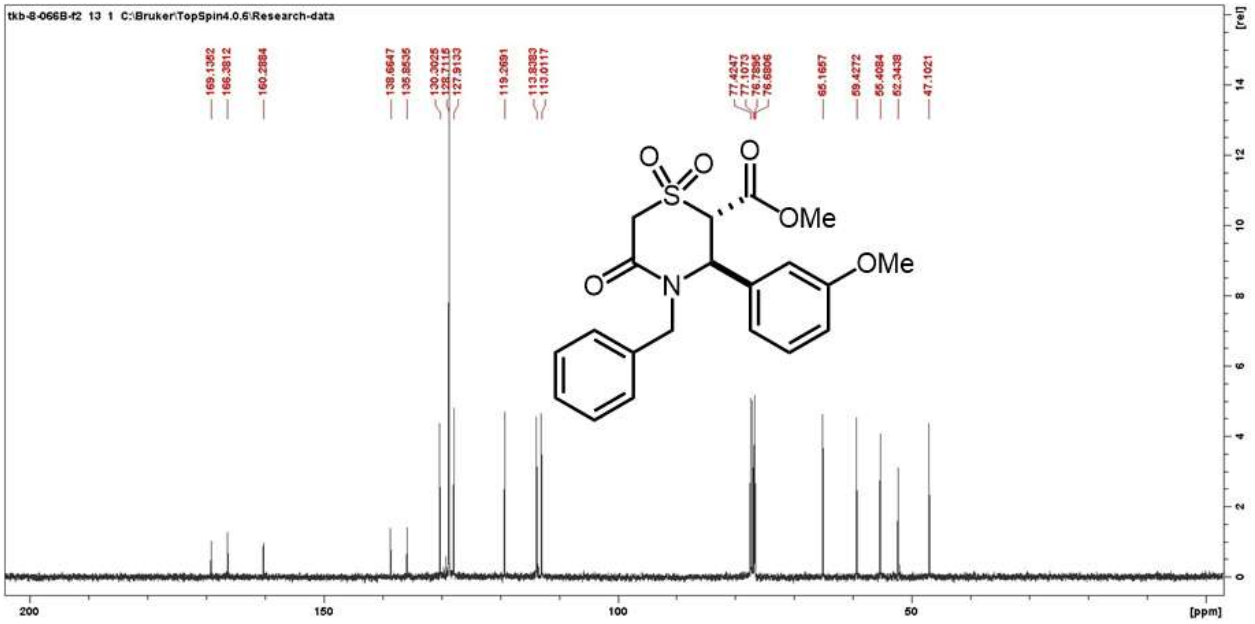


Compound 8b8

Prepared in 1 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 290.5 mg, 72%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.21 (m, 4H), 7.18 – 7.11 (m, 2H), 6.84 – 6.77 (m, 3H), 5.60 (d, *J* = 14.6 Hz, 1H), 4.84 (d, *J* = 17.0 Hz, 1H), 4.66 (d, *J* = 2.6 Hz, 1H), 4.44 (d, *J* = 17.0 Hz, 1H), 3.79 – 7.71 (m, 4H), 3.51 (s, 3H), 3.40 (d, *J* = 14.6 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.1, 166.4, 160.3, 138.7, 135.9, 130.3, 128.7, 127.9, 119.3, 113.8, 113.0, 76.7, 65.2, 59.4, 55.4, 52.3, 47.1. HRMS (ESI): calc'd for $C_{20}H_{21}NNaO_6S$ $[M + Na]^+$: 426.0987, found 426.0985.

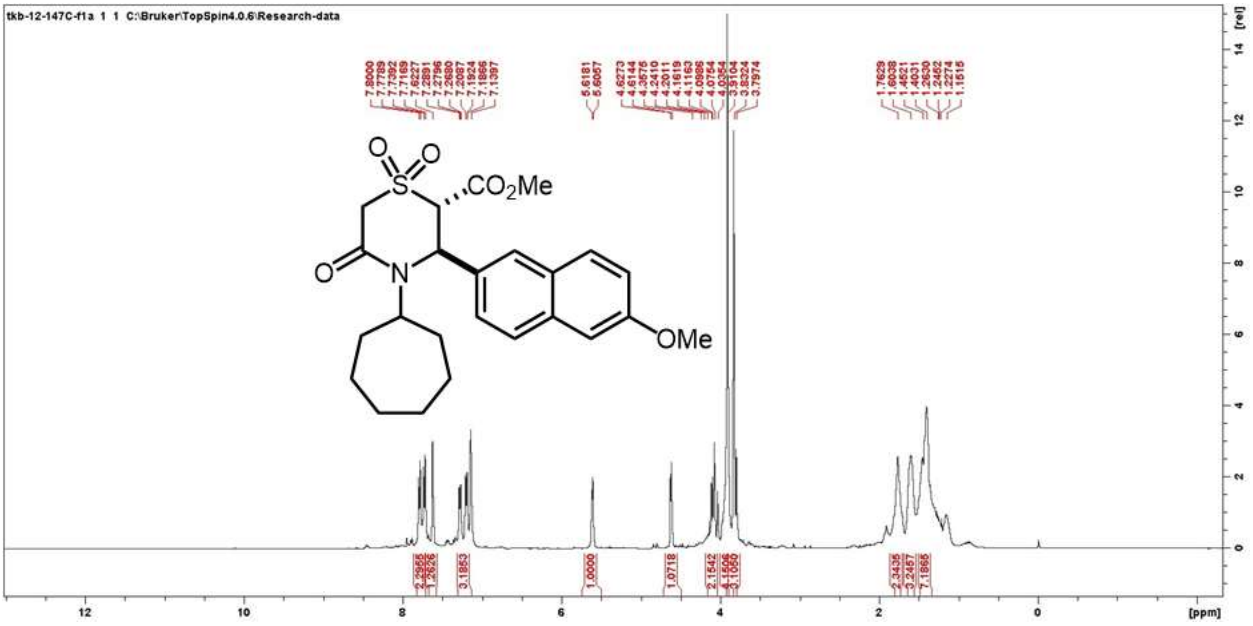


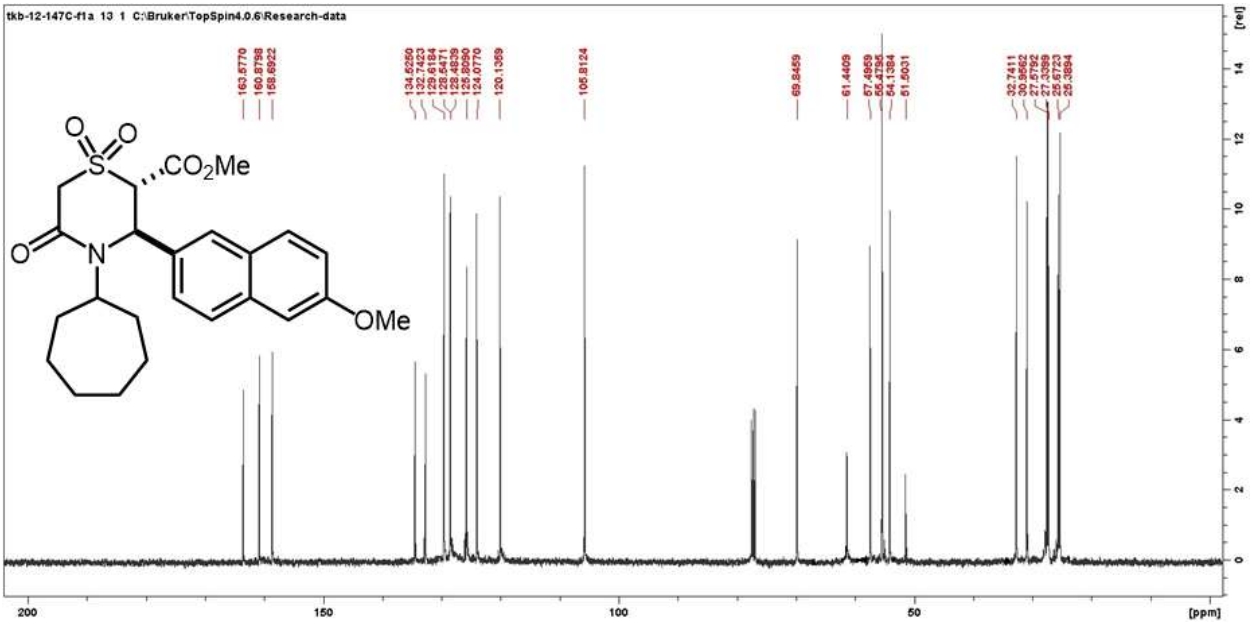


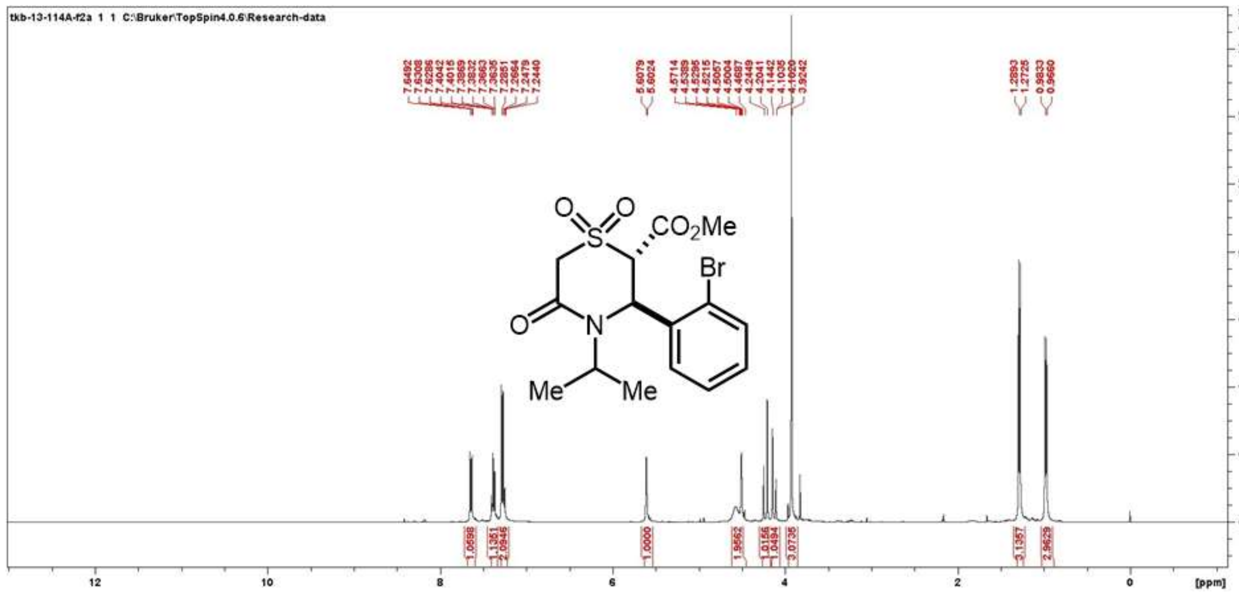
Compound 8b9

Prepared in 0.5 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 160.8 mg, 70%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.4 Hz, 1H), 7.72 (dd, *J* = 9.1, 3.1 Hz, 1H), 7.62 (d, *J* = 3.1 Hz, 1H), 7.38 – 7.23 (m, 3H), 5.61 (d, *J* = 5.4 Hz, 1H), 4.62 (d, *J* = 5.4 Hz, 1H), 4.29 – 4.14 (m, 2H), 4.00 – 3.79 (m, 7H), 1.76 – 1.15 (m, 12H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 163.6, 160.9,

158.7, 134.5, 132.7, 129.6, 128.6, 128.5, 125.8, 124.1, 120.1, 105.8, 69.9, 61.4, 57.5, 55.5, 54.1, 51.5, 32.8, 30.9, 27.6, 27.3, 25.7, 25.4. FTIR (KBr): 3070.2, 2934.6, 2912.8, 2836.5, 1721.4, 1631.8, 1510.6, 1395.7, 1247.4, 1031.3, 820.5, 698.2. HRMS (ESI): calc'd for $C_{24}H_{29}NNaO_6S$ [M + Na]$^+$: 482.1613, found 482.1616.



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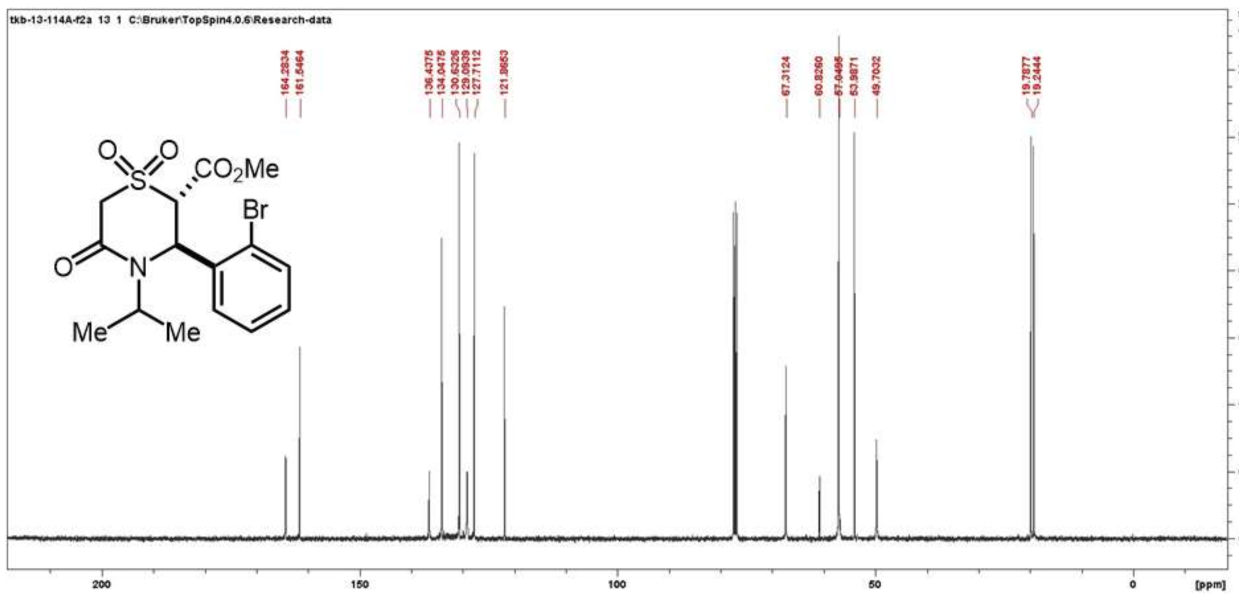
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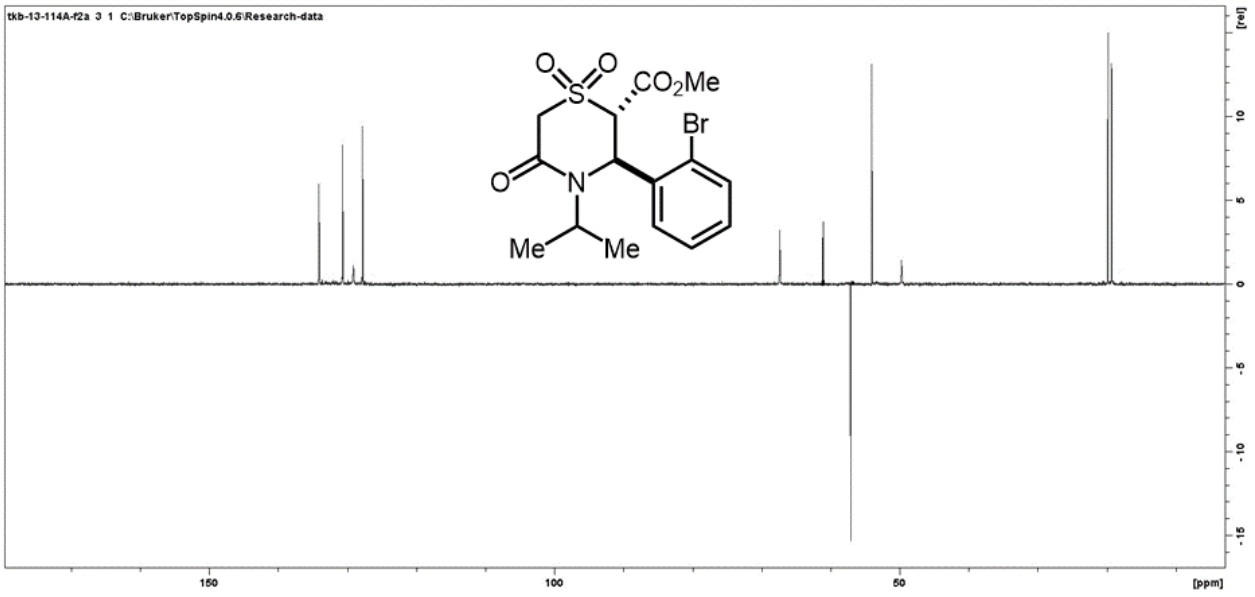
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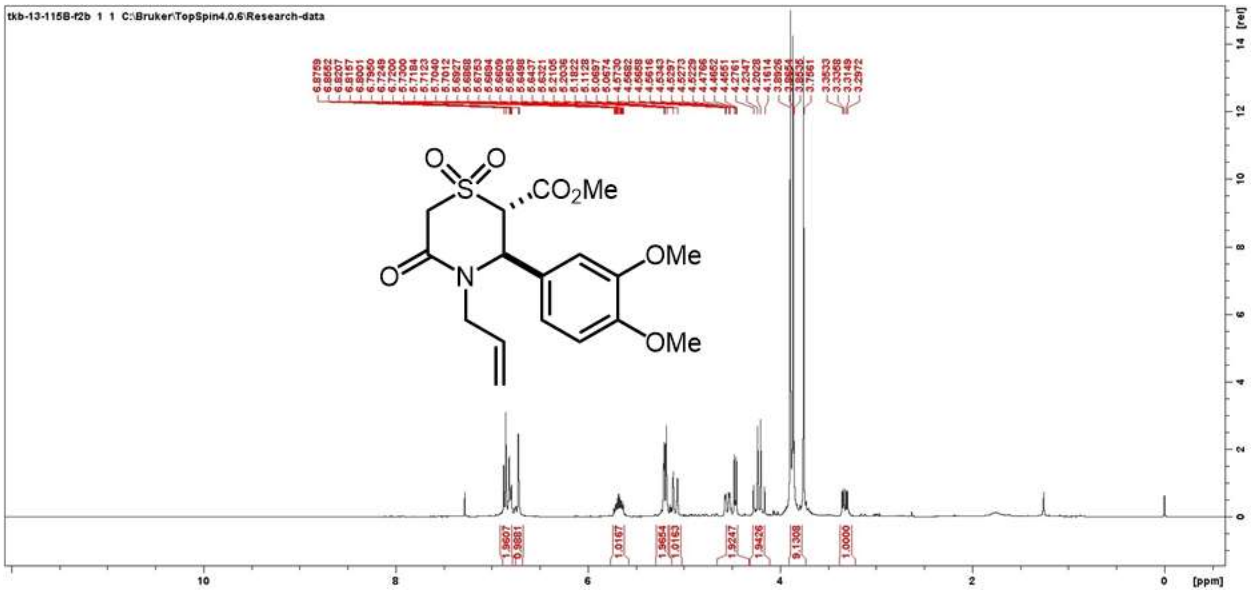
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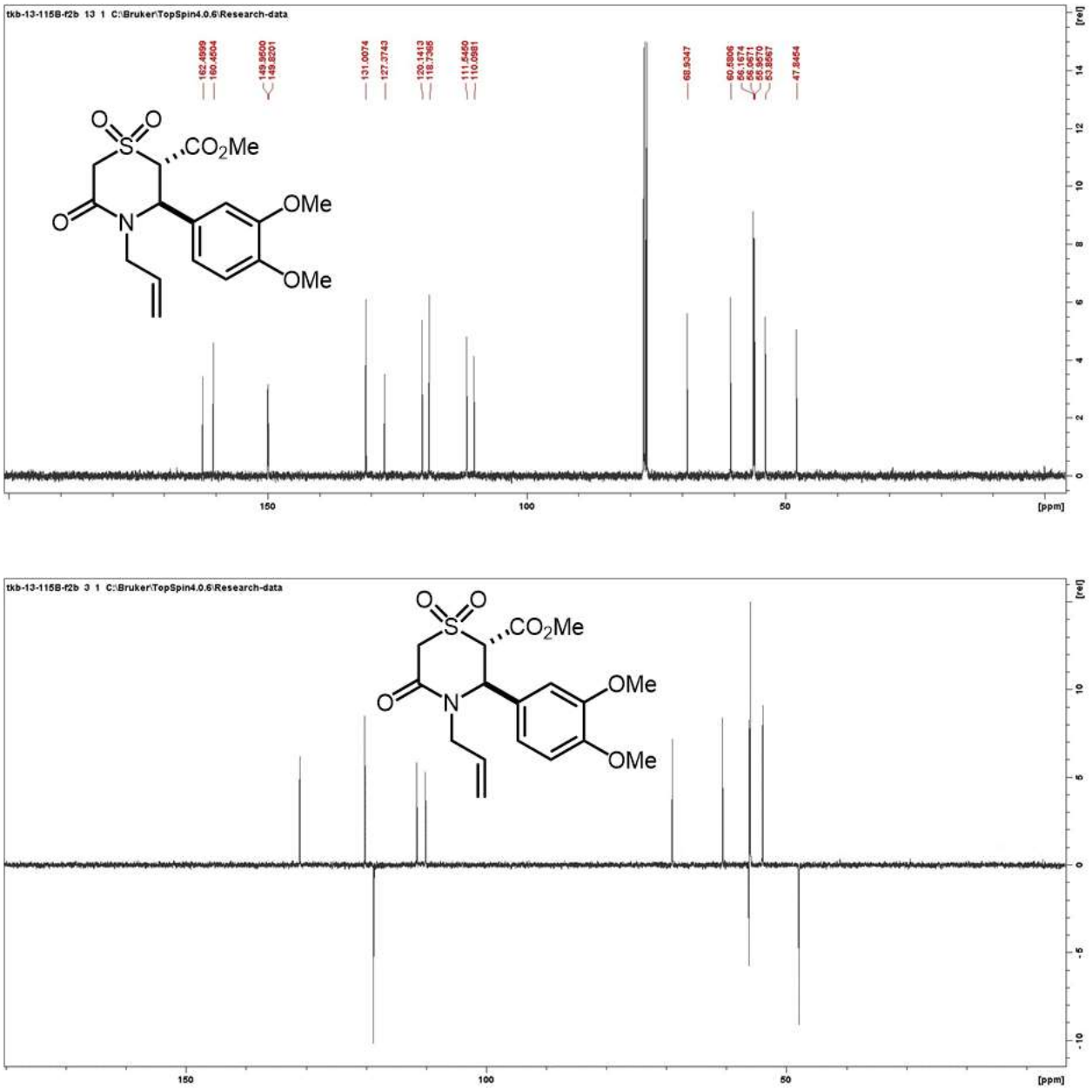
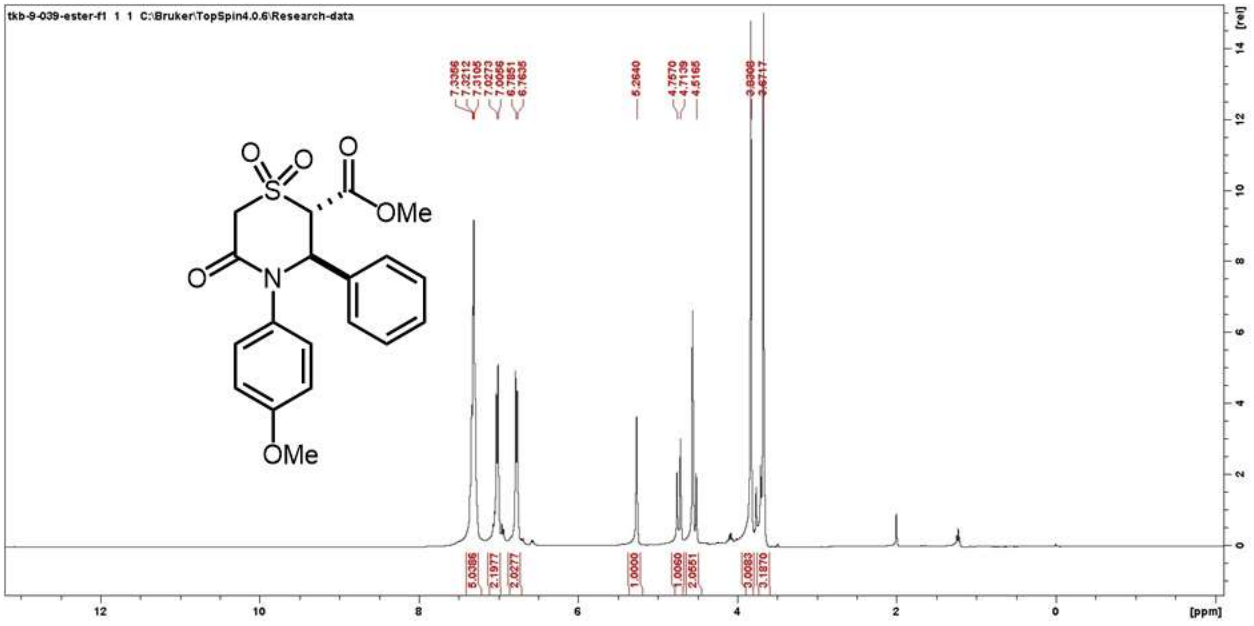
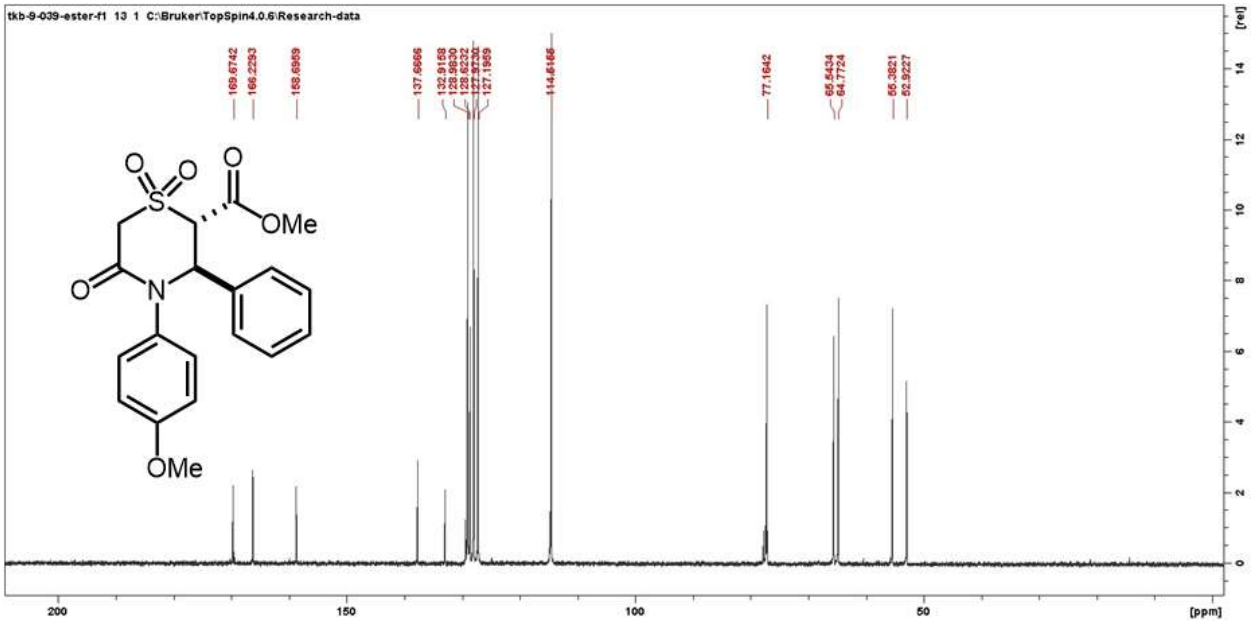


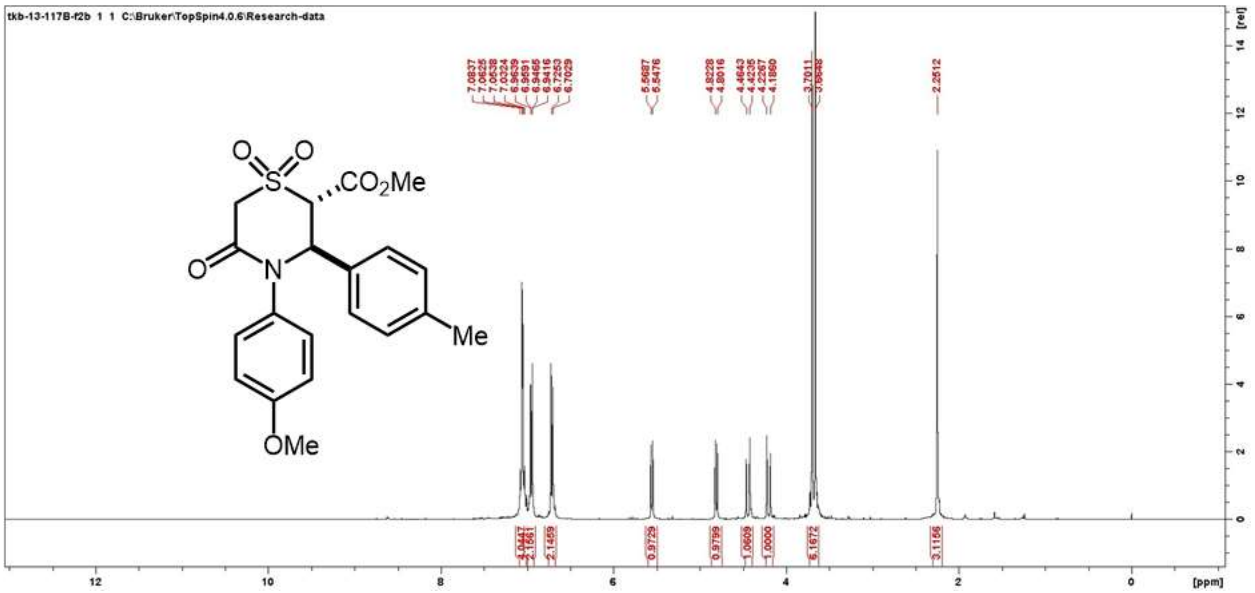
Compound 8b11

Prepared in 0.5 mmol scale using **General Procedure B.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 118.7 mg, 61%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.25 (m, 5H), 7.02 (d, J = 8.3 Hz, 2H), 6.81 (d, J = 8.3 Hz, 2H), 5.27 (d, J = 2.7 Hz, 1H), 4.74 (d, J = 17.2 Hz, 1H), 4.61 – 4.49 (m, 2H), 3.83 (s, 3H), 3.67 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 166.2, 158.7, 137.7, 132.9, 128.9, 128.6, 127.9, 127.2, 114.5, 77.2, 65.5, 64.8, 55.4, 52.9. FTIR (KBr): 2990.1, 2934.1, 2910.4, 2836.5, 1721.4, 1631.8,

1510.6, 1395.7, 1247.4, 1031.3, 833.8, 687.2. HRMS (ESI): calc'd for $C_{19}H_{19}NNaO_6S$ $[M + Na]^+$: 412.0831, found 412.0831.



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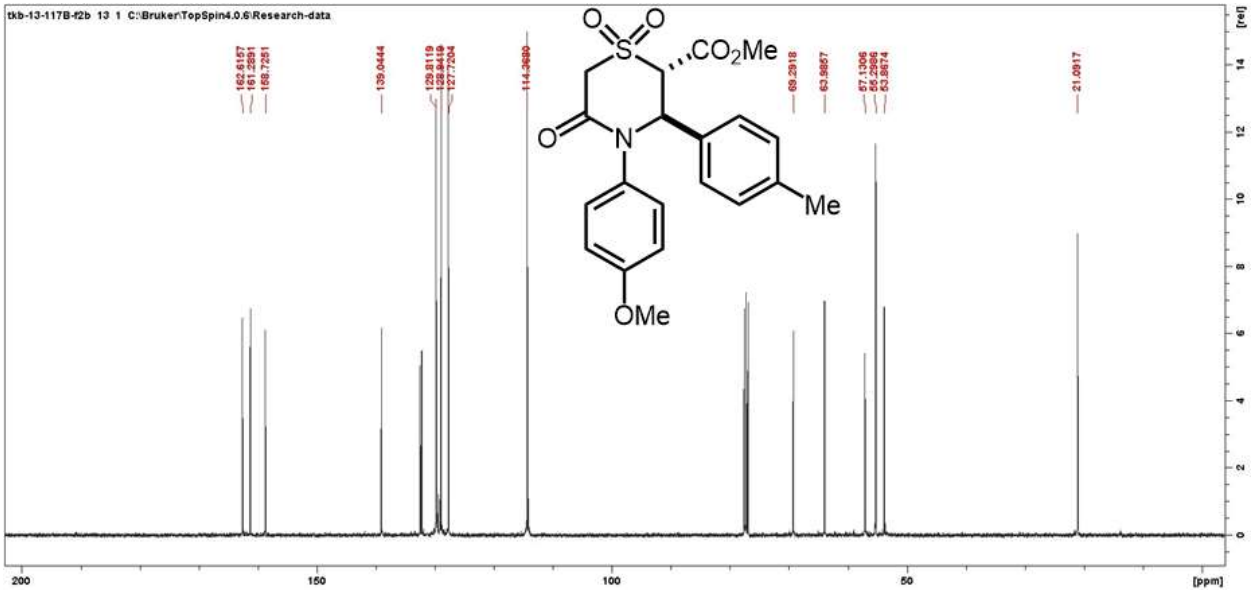
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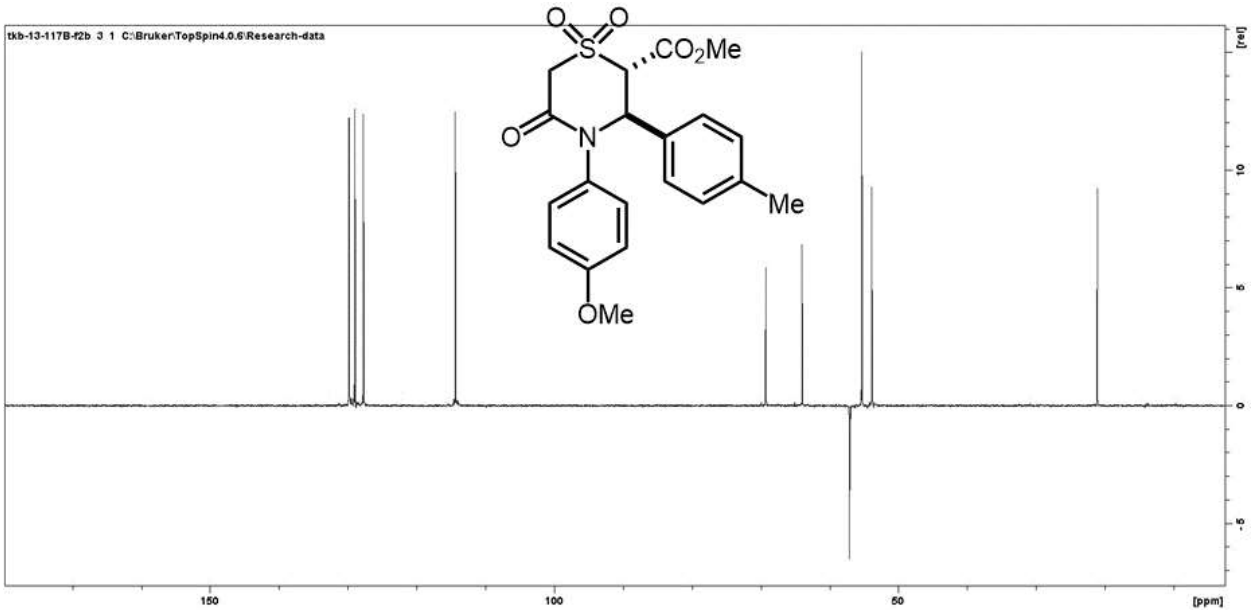
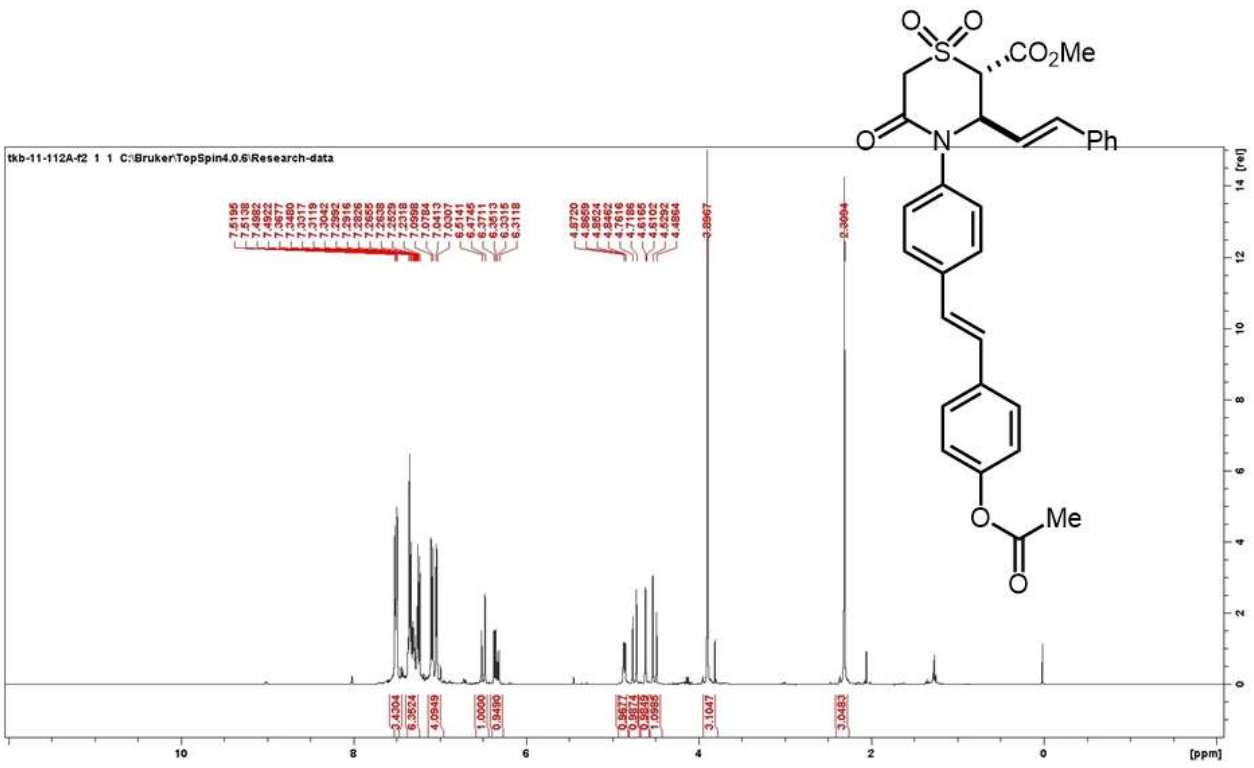


Alkenylation

Compound 13a

Prepared in 0.25 mmol scale using **General Procedure C.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (30:70). Oily substance. Yield = 118.7 mg, 87%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.49 (m, 3H), 7.37 – 7.23 (m, 6H), 7.10 – 7.03 (m, 4H), 6.47 (d, *J* = 15.9 Hz, 1H), 6.33 (dd, *J* = 7.9, 0.8 Hz, 1H), 4.87 – 4.84 (m, 1H), 4.75 (d, *J* = 17.3 Hz, 1H), 4.61 (d, *J* = 2.6 Hz, 1H), 4.50 (dd, *J* = 17.2, 0.8 Hz, 1H), 3.89 (s, 3H), 2.31 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 169.6, 165.8, 150.3, 139.1, 136.8, 135.6, 135.0, 134.7, 128.8, 128.7, 127.9, 127.6, 127.4, 127.2, 126.8, 124.7, 121.9, 77.2, 75.8, 65.6, 63.2, 53.0, 21.3. FTIR (KBr): 2932.5571, 1721.483, 1665.4081, 1607.2449, 1511.11, 1431.8598, 1414.7076, 1344.99, 1298.4941, 1245.6515, 1179.4413, 1135.306, 1031.8607, 996.7789, 921.8434, 832.167, 701.6744. HRMS (ESI): calc'd for $C_{30}H_{27}NNaO_7S$ $[M + Na]^+$: 568.1406, found 568.1411.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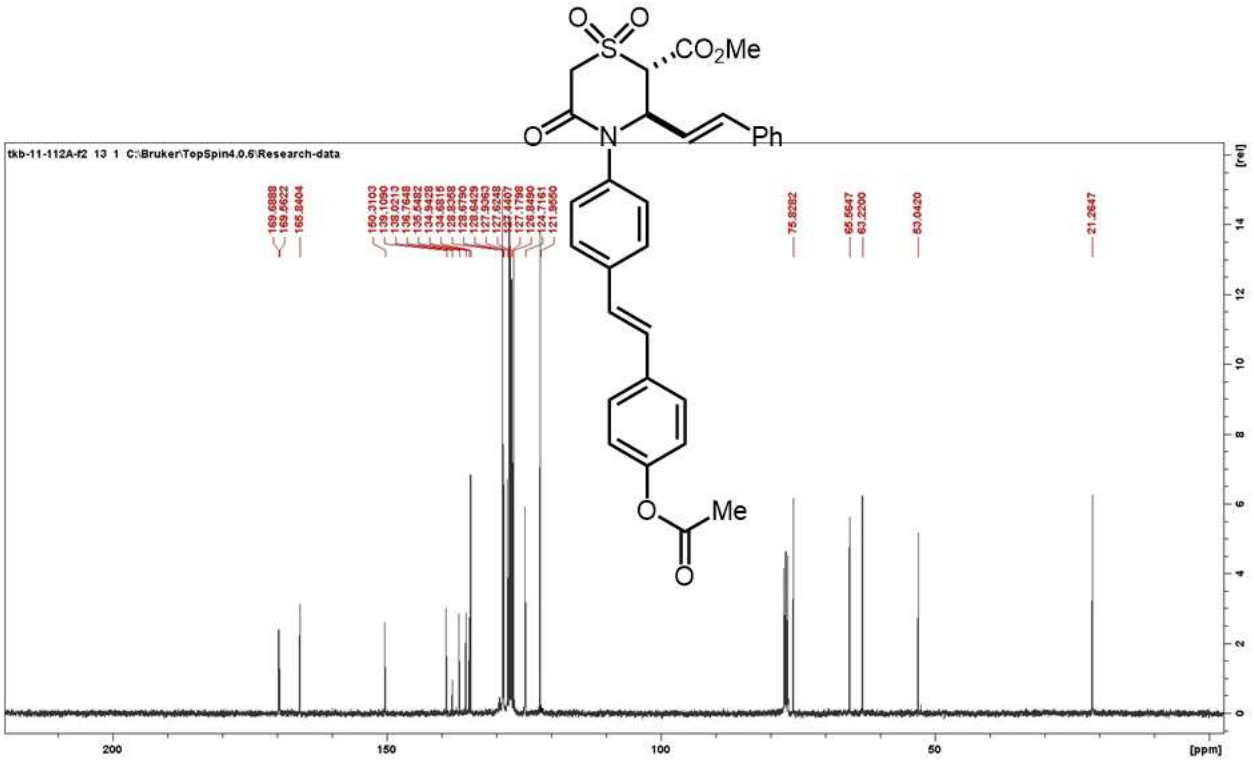
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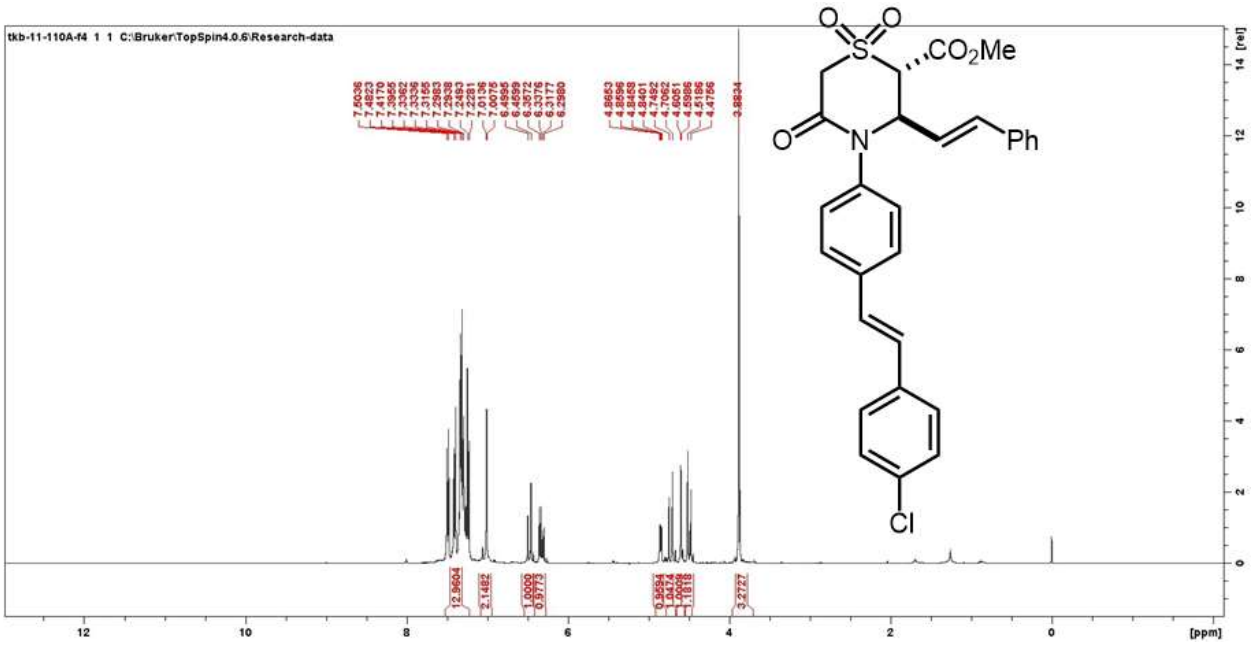
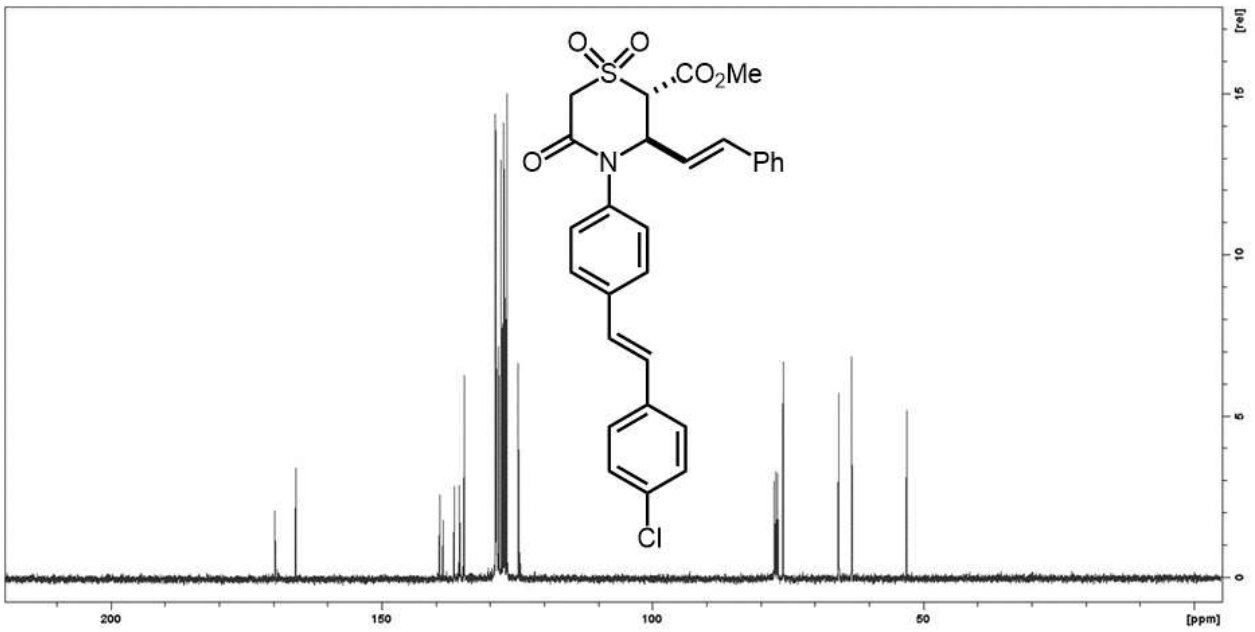
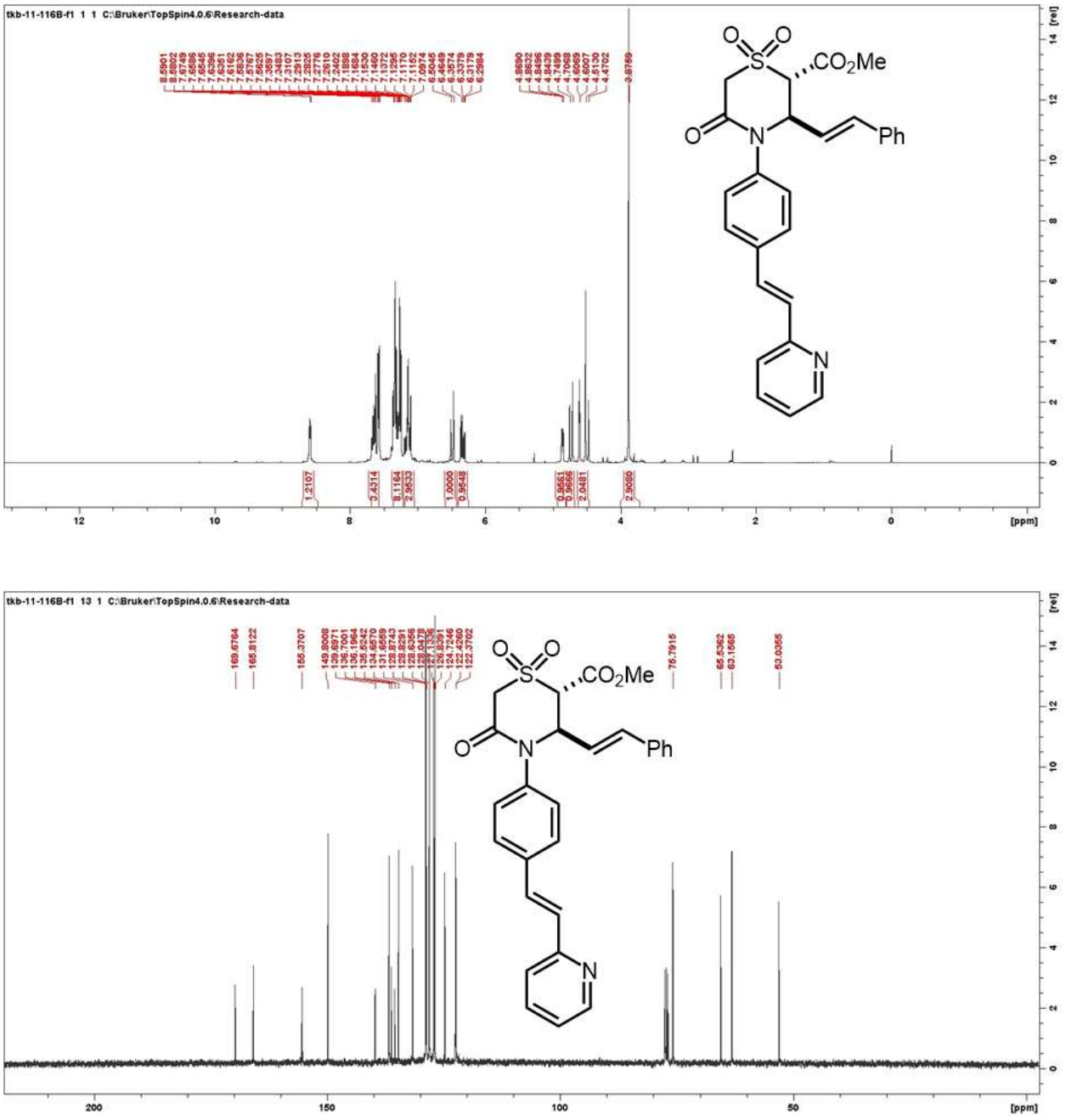
Ph
Me
[ppm]

Compound 13b: Prepared in 0.25 mmol scale using **General Procedure C.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Oily substance. Yield = 104.4 mg, 80%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.22 (m, 13H), 7.01 (s, 2H), 6.47 (d, *J* = 15.9 Hz, 1H), 6.36 – 6.29 (m, 2H), 4.86 (dd, *J* = 7.9, 2.7 Hz, 2H), 4.70 (d, *J* = 17.2 Hz, 1H), 4.61 (d, *J* = 17.2 Hz, 1H), 4.51 (d, *J* = 2.7 Hz, 1H), 3.88 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 165.8, 139.3, 138.6, 136.6, 135.7, 135.5, 134.7, 133.5, 129.0, 128.9, 128.8, 128.7, 128.4, 128.3, 127.9, 127.5, 127.2, 126.9, 124.7, 75.8, 65.6, 63.2, 53.1. HRMS (ESI): calc'd for $C_{28}H_{24}ClNNaO_5S$ [M + Na]$^{+}$: 544.0961, found 544.0964.



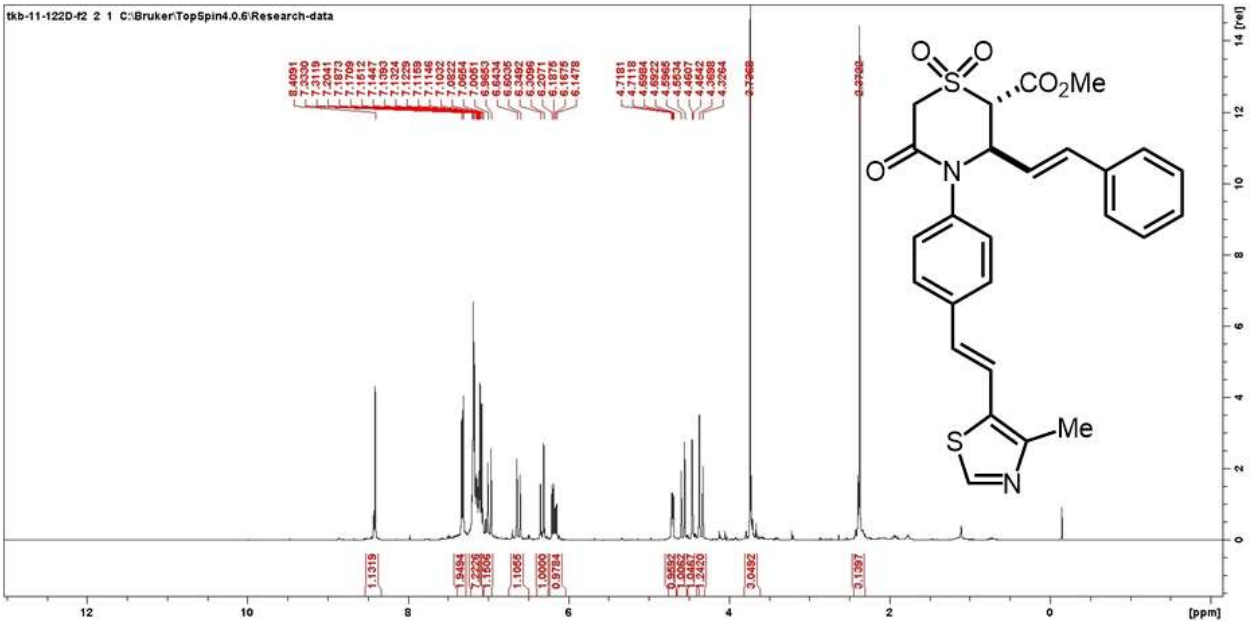


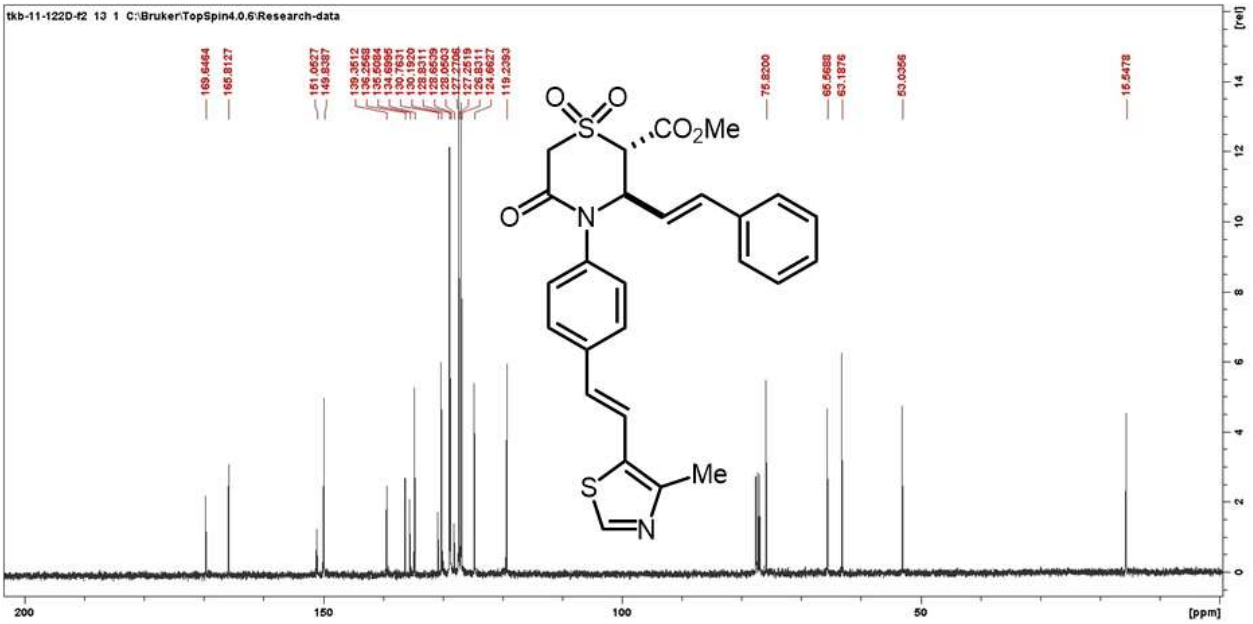
Compound 13c: Prepared in 0.25 mmol scale using **General Procedure C.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (30:70). Oily substance. Yield = 86.7 mg, 71%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.59 (d, 1H), 7.67 – 7.57 (m, 3H), 7.37 – 7.24 (m, 8H), 7.19 – 7.09 (m, 3H), 6.50 (d, J = 15.8 Hz, 1H), 6.28 (dd, J = 15.8, 7.8 Hz, 1H), 4.87 (dd, J = 7.8, 2.6 Hz, 1H), 4.75 (d, J = 17.2 Hz, 1H), 4.60 (d, J = 2.6 Hz, 1H), 4.51 (d, J = 17.2 Hz, 1H), 3.87 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 165.8, 155.4, 149.8, 139.7, 136.7, 136.2, 135.5, 134.7, 131.7, 128.9, 128.8, 128.7, 128.6, 128.0, 127.1, 126.8, 124.7, 122.4, 122.3, 75.8, 65.5, 63.2, 53.0. HRMS (ESI): calc'd for $C_{27}H_{24}N_2NaO_5S$ $[M + Na]^+$: 511.1304, found 511.1300.



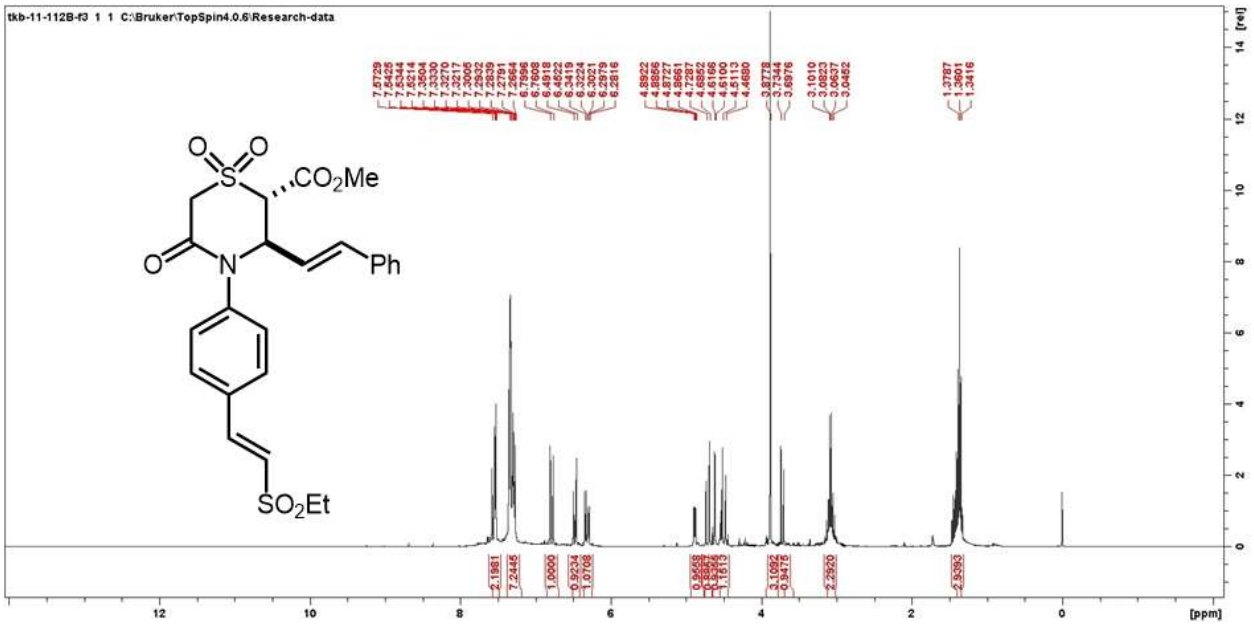
Compound 13d: Prepared in 0.25 mmol scale using **General Procedure C.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Amorphous solid. Yield = 92.8 mg, 73%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.41 (s, 1H), 7.36 – 7.28 (m, 2H), 7.26 – 7.14 (m, 7H), 7.14 (d, *J* = 2.3 Hz, 1H), 6.62 (d, *J* = 15.9 Hz, 1H), 6.33 (d, *J* = 15.8 Hz, 1H), 6.18 (dd, *J* = 15.9, 7.9 Hz, 1H), 4.71 (dd, *J* = 7.9, 2.6 Hz, 1H), 4.58 (d, *J* = 17.2 Hz, 1H), 4.46 (d, *J* = 2.7 Hz, 1H), 4.39 (d, *J* = 2.7 Hz, 1H), 3.76 (s, 3H), 2.37 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7,

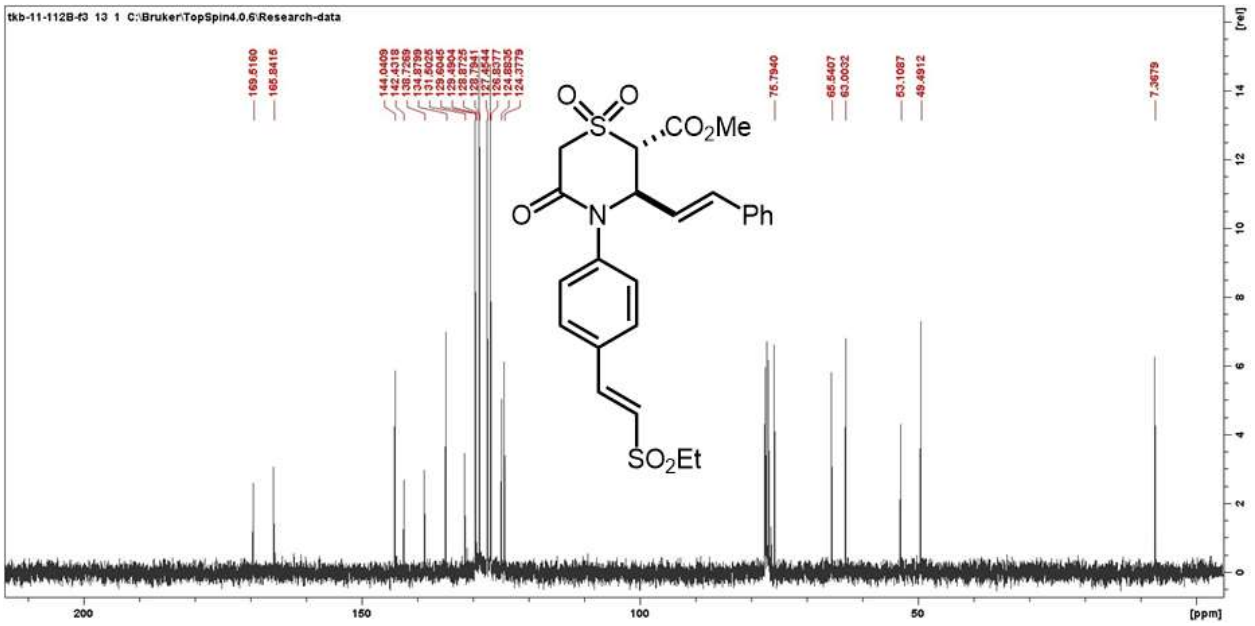
165.8, 151.1, 149.8, 139.3, 136.3, 135.5, 134.7, 130.2, 128.8, 128.7, 127.3, 126.8, 124.7, 119.2, 75.8, 65.6, 63.2, 53.0, 15.6. HRMS (ESI): calc'd for $C_{26}H_{24}N_2NaO_5S_2$ $[M + Na]^+$: 531.1024, found 531.1027.





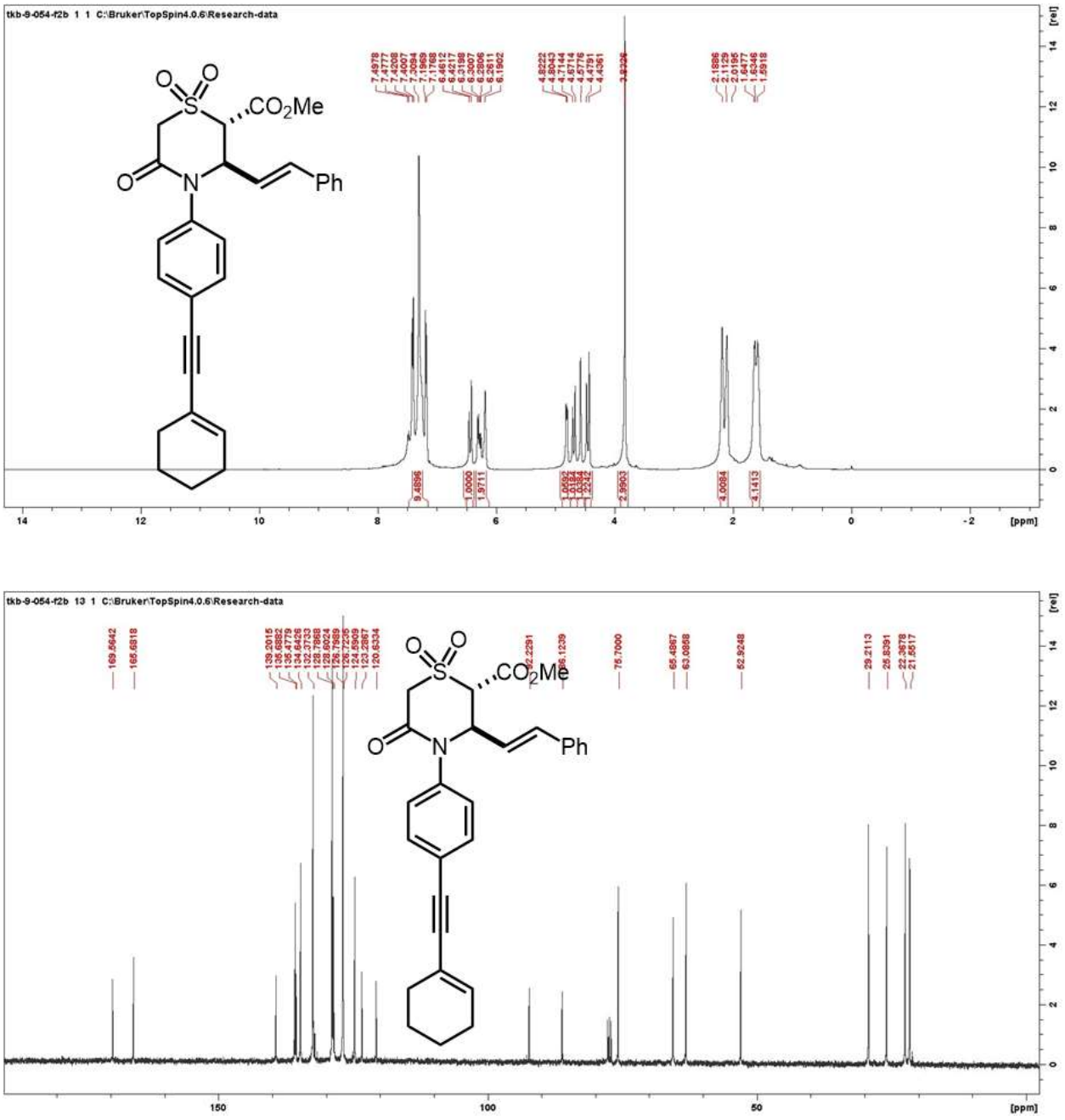
Compound 13e: Prepared in 0.25 mmol scale using **General Procedure C.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (75:25). Oily substance. Yield = 99.5 mg, 79%, 95:5 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 – 7.56 (m, 2H), 7.37 – 7.26 (m, 7H), 6.77 (d, *J* = 17.4 Hz, 1H), 6.47 (d, *J* = 15.9 Hz, 1H), 6.31 – 6.28 (dd, *J* = 15.9, 0.8 Hz, 1H), 4.88 (m, 1H), 4.72 (d, *J* = 17.4 Hz, 1H), 4.61 (d, 1H), 4.51 (d, 1H), 3.88 (s, 3H), 3.70 (d, 1H), 3.10 – 3.04 (q, 2H), 1.37 – 1.34 (t, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.5, 165.9, 144.0, 142.4, 138.7, 134.9, 131.5, 129.6, 129.5, 128.9, 128.8, 127.5, 126.9, 126.8, 124.9, 124.4, 75.8, 65.5, 63.0, 53.1, 49.5, 7.4. HRMS (ESI): calc'd for $C_{24}H_{25}NNaO_7S_2$ $[M + Na]^+$: 526.0970, found 526.0975.





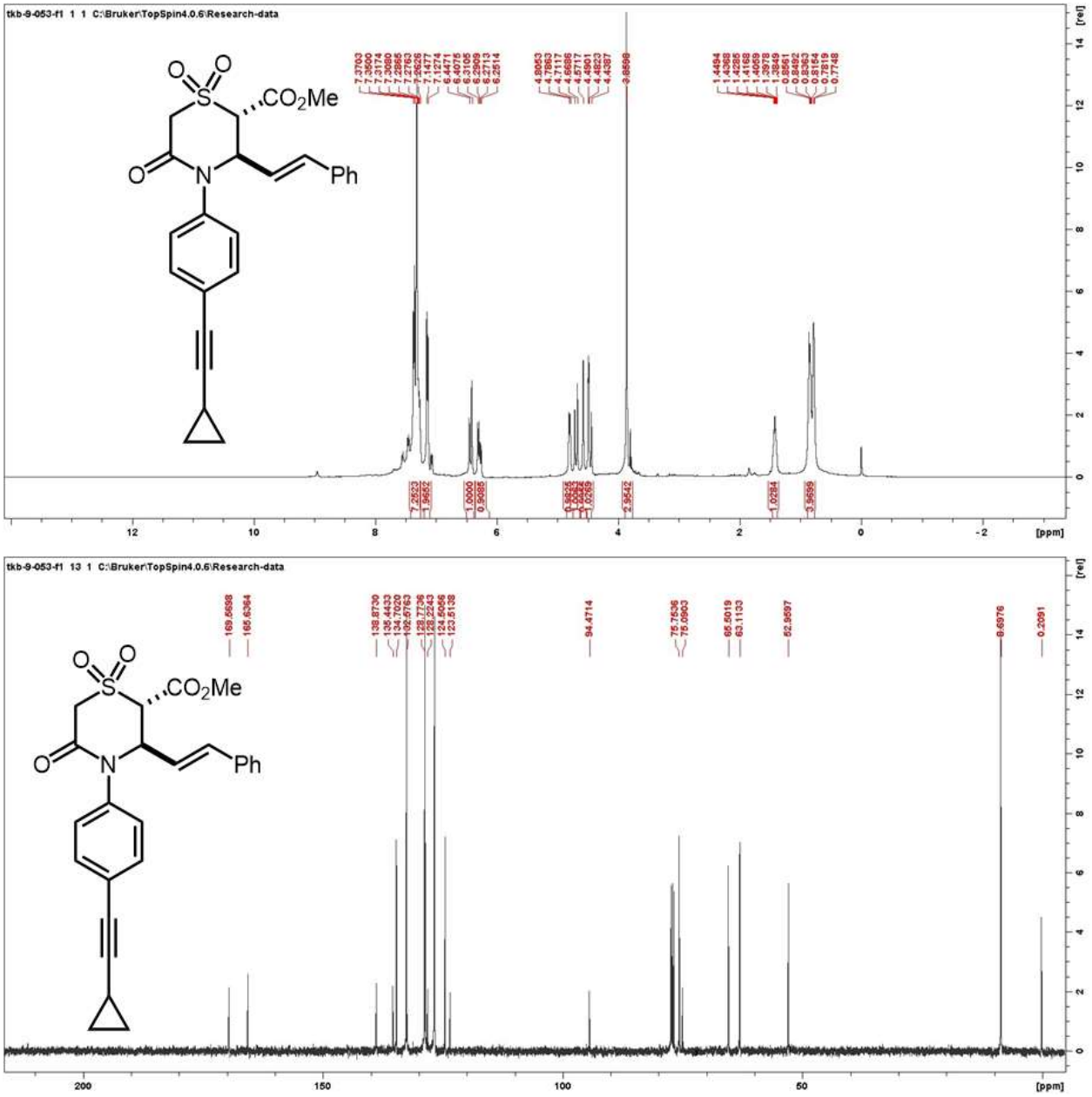
Alkynylation

Compound 14a: Prepared in 0.25 mmol scale using **General Procedure D.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (80:20). Oily substance. Yield = 113.8 mg, 93%, 95:5 dr. ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.49 – 7.14 (m, 9H), 6.44 (d, *J* = 15.9 Hz, 1H), 6.29 (dd, *J* = 15.8, 7.8 Hz, 1H), 6.20 (t, *J* = 5.6 Hz, 1H), 4.85 – 4.78 (m, 1H), 4.69 (d, *J* = 17.3 Hz, 1H), 4.58 (d, *J* = 2.7 Hz, 1H), 4.46 (d, *J* = 17.3 Hz, 1H), 3.83 (s, 3H), 2.23 – 2.07 (m, 4H), 1.61 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.6, 165.7, 139.2, 135.7, 135.5, 134.6, 132.4, 128.8, 128.6, 126.8, 126.7, 124.6, 123.3, 120.6, 92.2, 86.1, 75.7, 65.5, 63.1, 52.9, 29.2, 25.8, 22.4, 21.6. HRMS (ESI): calc'd for $C_{28}H_{27}NNaO_5S$ $[M + Na]^+$: 512.1508, found 512.1512.



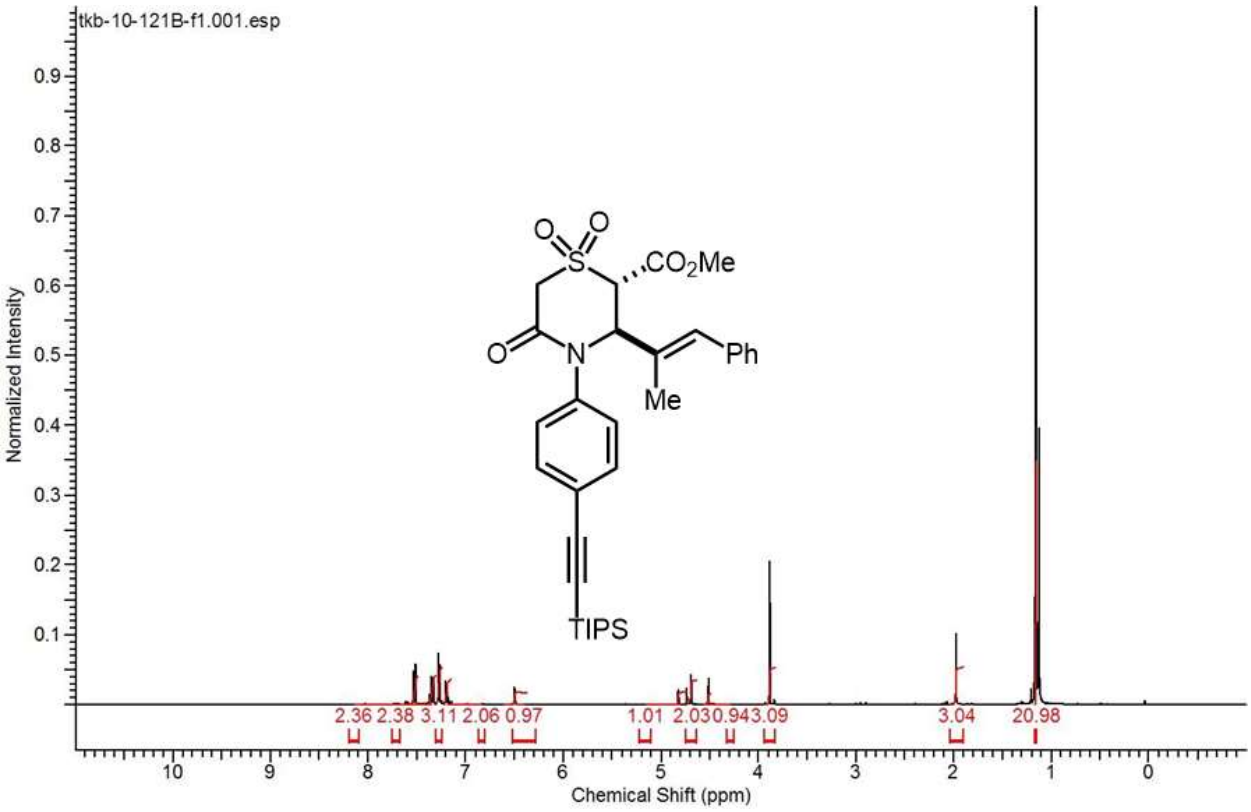
Compound 14b: Prepared in 0.25 mmol scale using **General Procedure D.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (80:20). Oily substance. Yield = 98.9 mg, 88%, 95:5 dr. ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.37 – 7.26 (m, 7H), 7.14 (d, *J* = 8.1 Hz, 2H), 6.43 (d, *J* = 15.9 Hz, 1H), 6.28 (dd, *J* = 15.8, 7.9 Hz, 1H), 4.80 (dd, *J* = 8.0, 2.7 Hz, 1H), 4.69 (d, *J* = 17.3 Hz, 1H), 4.57 (d, *J* = 2.7 Hz, 1H), 4.51 – 4.42 (m, 1H), 3.85 (s, 3H), 1.42 (tt, *J* = 8.8, 5.1 Hz, 1H), 0.92 – 0.73 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.6, 165.6, 138.9, 135.4, 134.7,

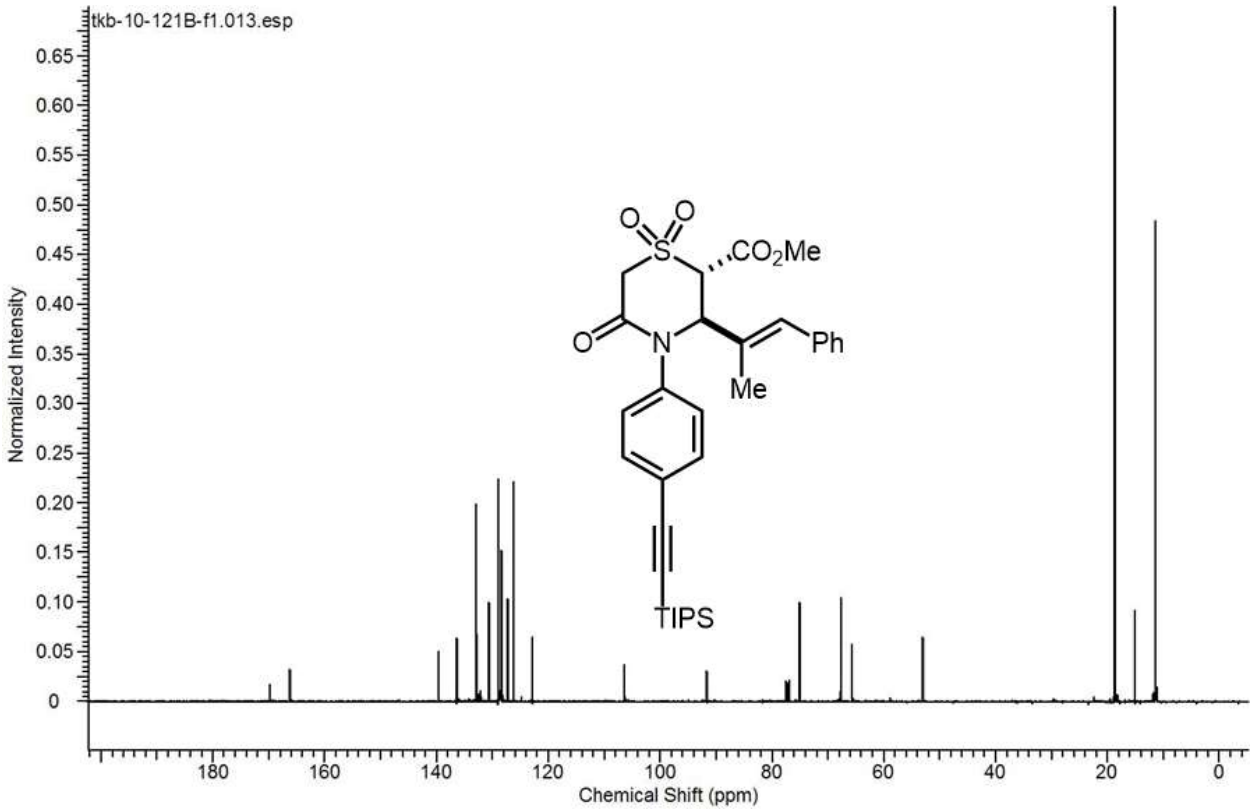
132.6, 132.5, 128.8, 128.6, 128.2, 126.8, 126.7, 124.5, 123.5, 119.4, 94.5, 75.7, 68.2, 65.5, 63.1, 52.9, 8.7, 0.2. HRMS (ESI): calc'd for $C_{25}H_{23}NNaO_5S$ $[M + Na]^+$: 472.1195, found 472.1192.



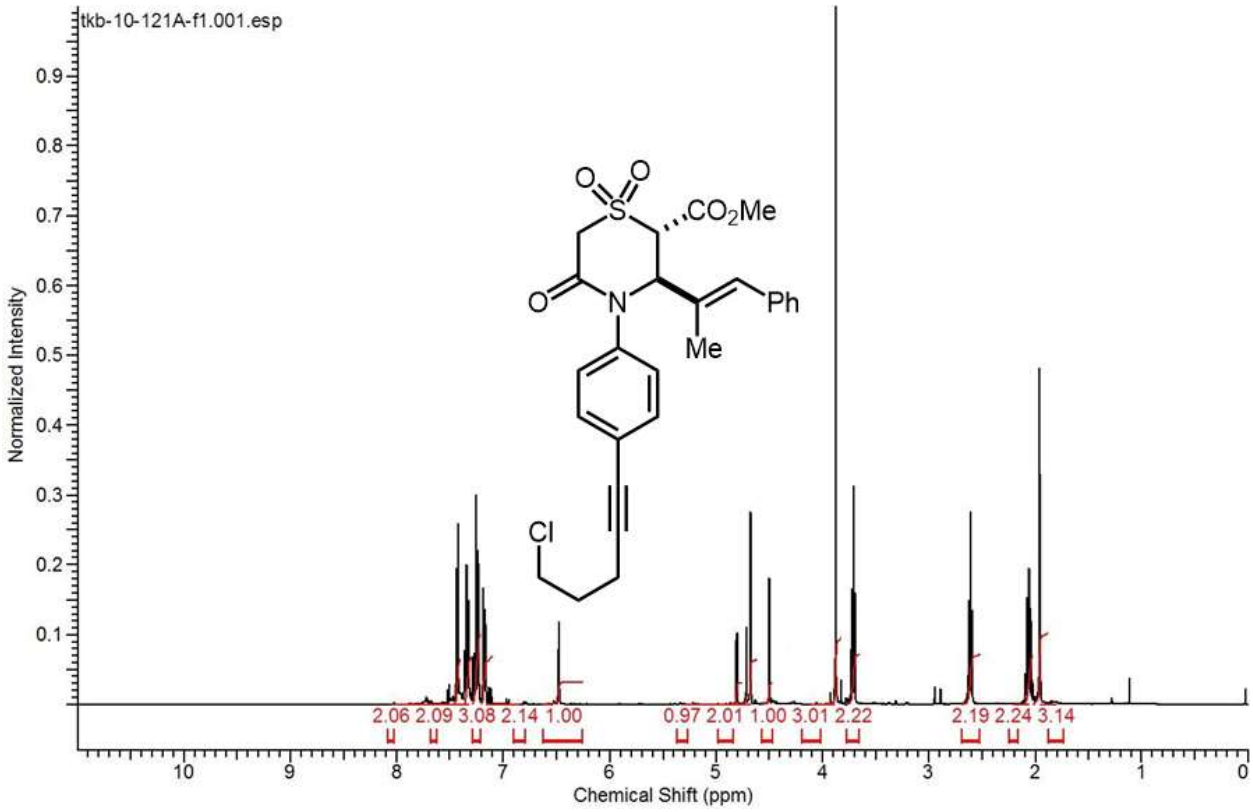
Compound 14c: Prepared in 0.25 mmol scale using **General Procedure D.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (95:5). Viscous oil. Yield = 137.7 mg, 95%, 95:5 dr. ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.58 – 7.46 (m, 2H), 7.42 – 7.30 (m, 2H), 7.27 (d, *J* = 8.4 Hz, 2H), 7.28 – 7.14 (m, 2H), 4.76 – 4.66 (m, 1H), 4.54 – 4.44 (m, 1H), 3.88 (s, 1H), 1.98 (s, 3H), 1.14 (s, 21H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.78, 166.24, 139.69, 136.32, 132.92,

132.88, 130.62, 128.99, 128.36, 127.34, 126.28, 122.84, 106.33, 91.67, 75.04, 67.66, 65.69, 52.97, 18.74, 18.65, 15.08, 11.39, 11.36. HRMS (ESI): calc'd for $C_{32}H_{41}NNaO_5SSi$ $[M + Na]^+$: 602.2372, found 602.2378.





Compound 14d: Prepared in 0.25 mmol scale using **General Procedure D.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Viscous oil. Yield = 106.3 mg, 85%, 95:5 dr. ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.55 – 7.47 (m, 2H), 7.45 – 7.41 (m, 2H), 7.43 – 7.30 (m, 3H), 7.33 – 7.21 (m, 2H), 6.48 (s, 1H), 4.81 (dd, *J* = 3.5, 1.0 Hz, 1H), 4.76 – 4.65 (m, 2H), 4.53 – 4.43 (m, 1H), 3.87 (s, 3H), 3.71 (t, *J* = 6.4 Hz, 2H), 2.61 (t, *J* = 6.8 Hz, 2H), 2.07 (q, *J* = 6.6 Hz, 2H), 1.96 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.8, 166.2, 139.2, 136.3, 132.9, 132.4, 130.7, 129.0, 128.4, 127.3, 126.4, 122.9, 89.1, 80.9, 75.0, 67.7, 65.7, 52.9, 43.8, 31.4, 16.9, 15.0. HRMS (ESI): calc'd for $C_{26}H_{26}ClNNaO_5S$ $[M + Na]^+$: 522.1118, found 522.1114.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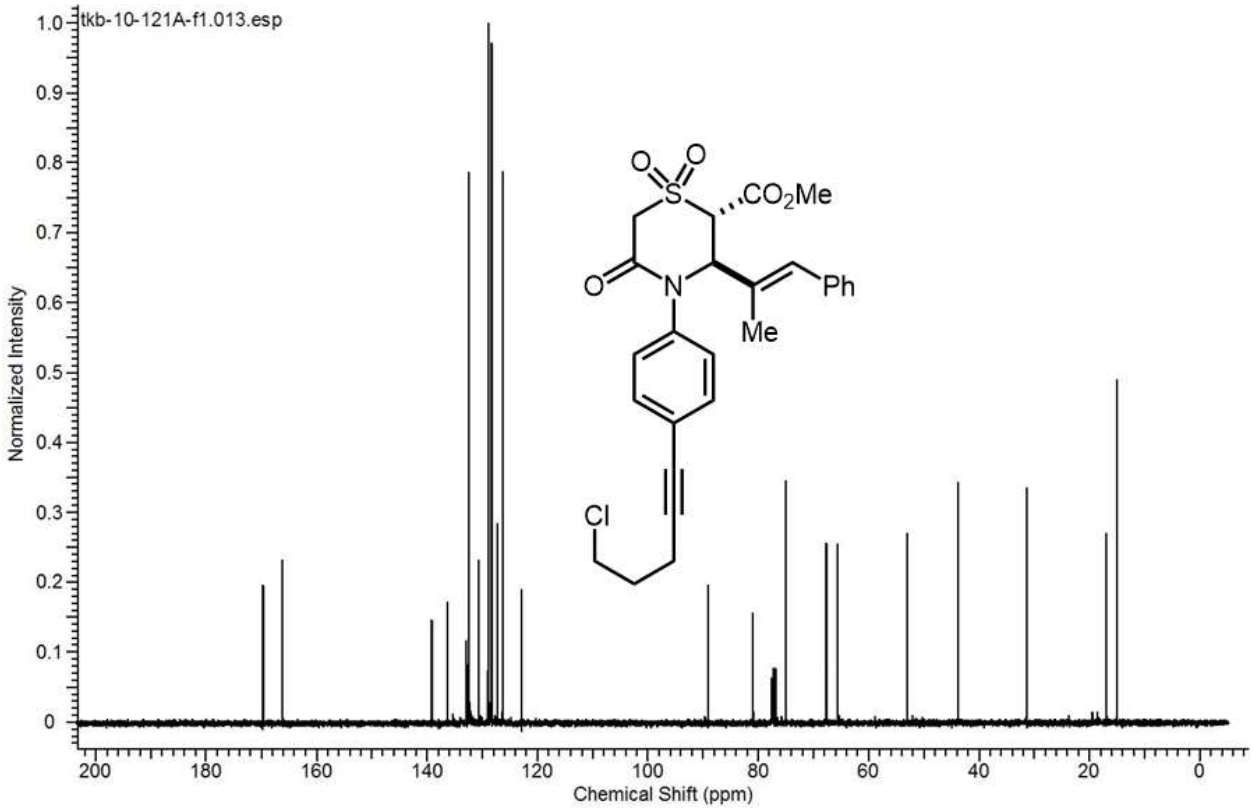
Ph
Me
Cl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Chemical Shift (ppm)
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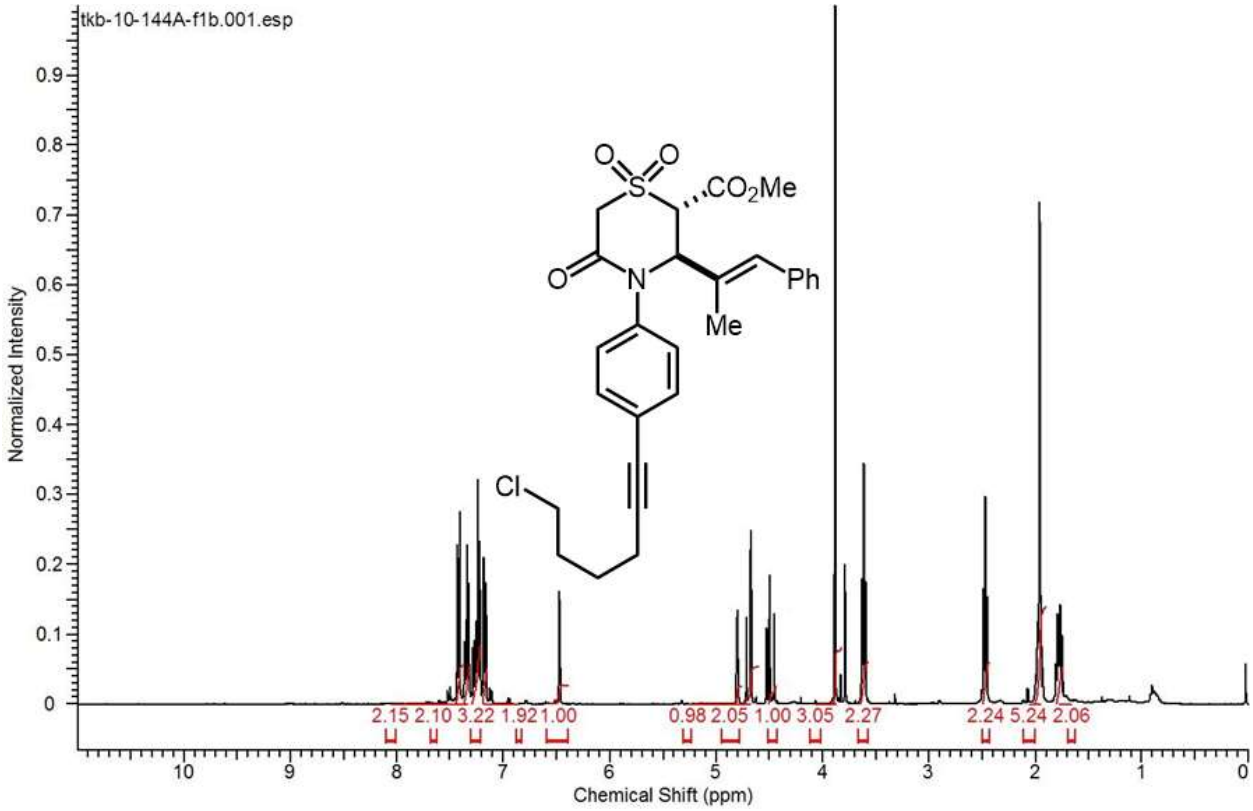
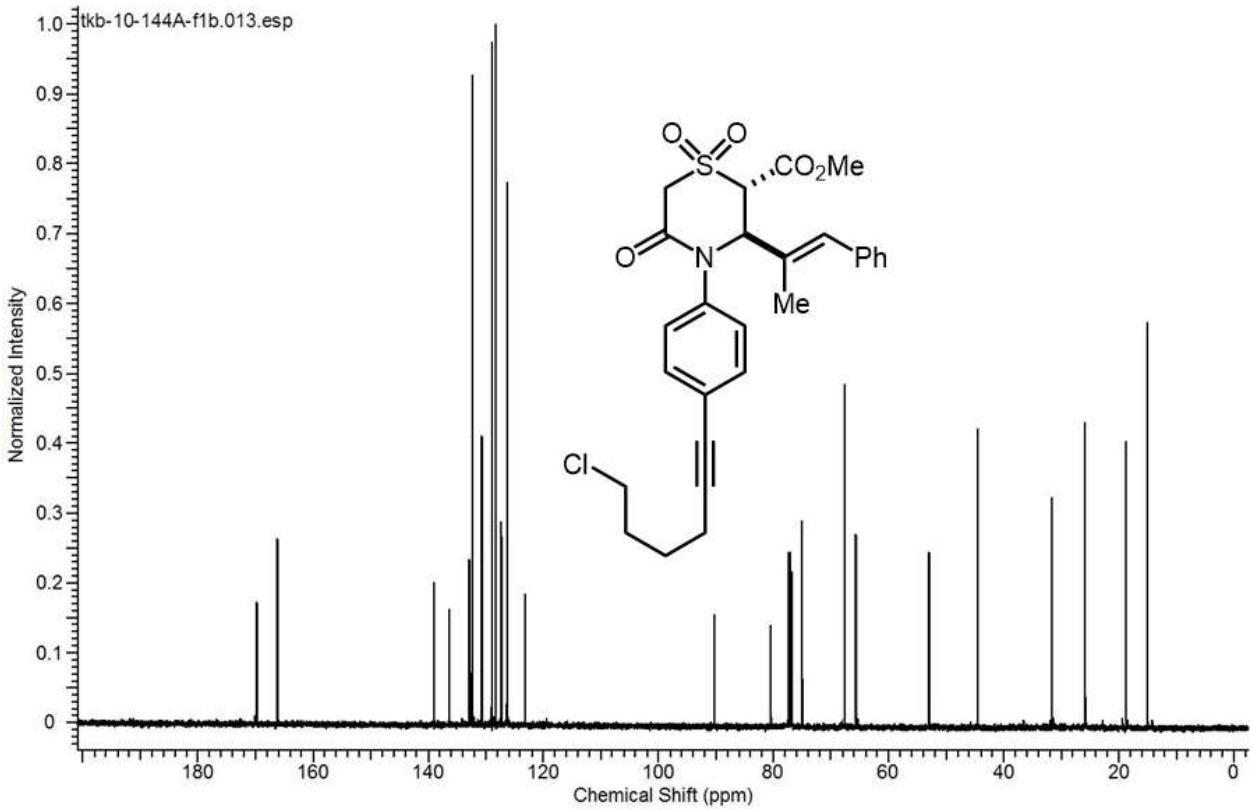
Cl

Compound 14e: Prepared in 0.25 mmol scale using **General Procedure D.** Purification: Flash chromatography on silica eluting with hexane/EtOAc (50:50). Viscous oil. Yield = 111.8 mg, 87%, 95:5 dr. ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.45 – 7.39 (m, 2H), 7.34 (dd, *J* = 8.1, 6.7 Hz, 2H), 7.31 – 7.20 (m, 3H), 7.20 – 7.08 (m, 2H), 6.47 (s, 1H), 4.80 (d, *J* = 3.3 Hz, 1H), 4.74 – 4.65 (m, 2H), 4.55 – 4.43 (m, 1H), 3.88 (s, 3H), 3.81 (d, *J* = 16.4 Hz, 1H), 3.61 (t, *J* = 6.5 Hz, 2H), 2.47 (t, *J* = 6.9 Hz, 2H), 2.02 – 1.91 (m, 5H), 1.77 (p, *J* = 7.0 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.8, 166.2, 139.1, 136.3, 132.9, 132.4, 130.7, 129.0, 128.3, 128.3, 127.3, 126.3, 123.1, 90.3, 80.6, 75.0, 67.7, 65.7, 53.0, 44.6, 31.7, 25.9, 18.8, 15.0. HRMS (ESI): calc'd for $C_{27}H_{28}ClNNaO_5S$ $[M + Na]^+$: 536.1274, found 536.1277.

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Ph
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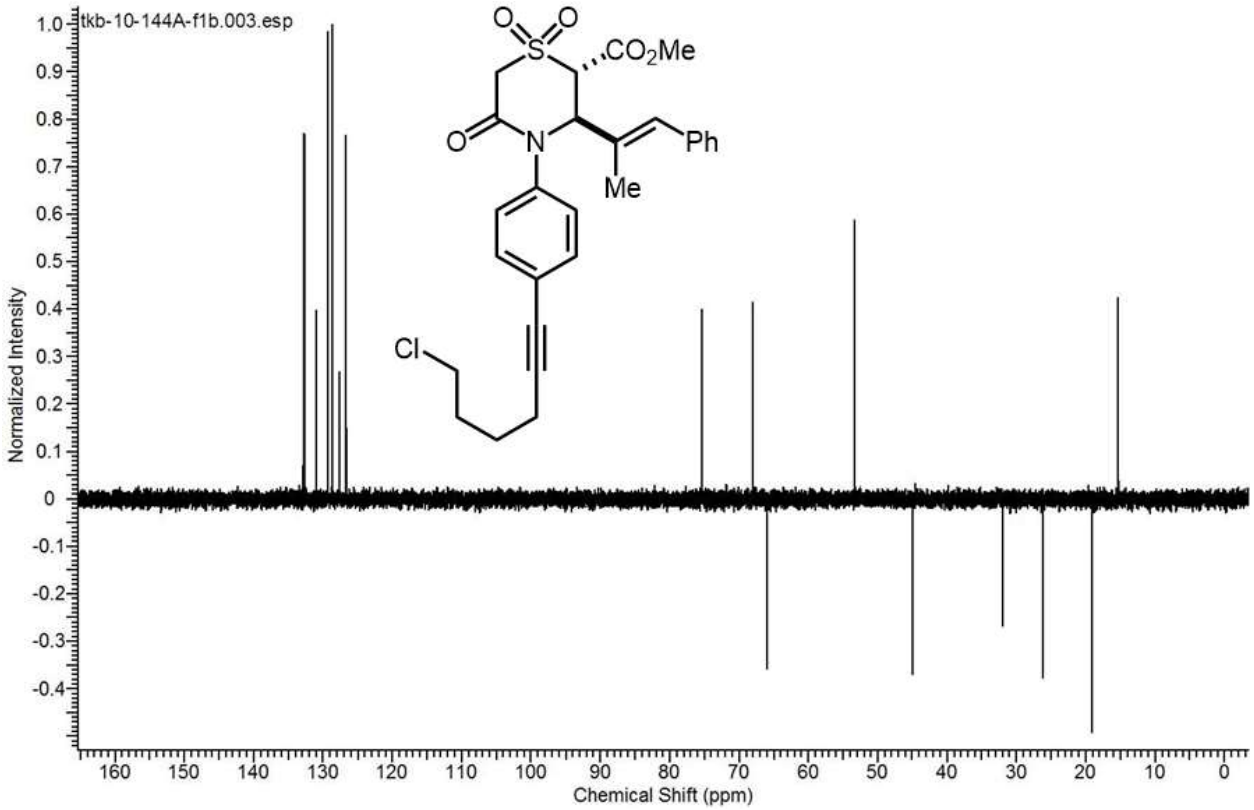
Cl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Normalized Intensity
Chemical Shift (ppm)
CO2Me
Ph
Me
Cl

References

(1) Braunstein, H.; Langevin, S.; Khim, M.; Adamson, J.; Hovenkotter, K.; Kotlarz, L.; Mansker, B.; Beng, T. K. *Org. Biomol. Chem.* **2016**, *14*, 8864.
(2) Dar'in, D.; Bakulina, O.; Chizhova, M.; Krasavin, M. *Org. Lett.* **2015**, *17*, 3930.