Supporting Information

Racemic Trinorsesquiterpenoids from the Beihai Sponge *Spongia officinalis*: Structure and Biomimetic Total Synthesis

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General

All the chemicals were obtained from commercial sources. Optical rotations were measured on a Perkin-Elmer 241MC polarimeter. NMR spectra were measured on a Bruker DRX-400 (for ^{1}H NMR) or Bruker DRX-500 (for ^{13}C NMR) spectrometer (Bruker Biospin AG, Fällanden, Germany). MS spectra were recorded on a Finnigan-MAT-95 mass spectrometer (FinniganMAT, San Jose, CA, USA). Commercial silica gel (Qingdao Haiyang Chemical Group Co., Ltd., Qingdao, China, 200-300 and 300-400 mesh) was used for column chromatography, and precoated silica gel plates (Yan Tai Zi Fu Chemical Group Co., Yantai, China, G60 F-254) were used for analytical TLC. All solvents for CC were of analytical grade.

Extraction and Isolation

The frozen sponge specimens (510 g, dry weight) were cut into pieces and exhaustively extracted with acetone at room temperature (6 × 2.0 L). The organic extract was evaporated to give a residue, which was successively partitioned between Et_2O and H_2O, *n*-BuOH and H_2O. The *n*-BuOH soluble portion was concentrated under reduced pressure to give a yellow residue (16.0 g), which was subjected to silica gel column chromatography eluted with CH_2Cl_2/MeOH [0-50% MeOH in CH_2Cl_2], yielding eight fractions. Fraction 1 was subjected to silica gel column chromatography eluted with CH_2Cl_2/Et_2O [50-100% Et_2O in CH_2Cl_2] to give compound **1** (3.2 mg, 60% Et_2O) and compound **2** (5.0 mg, neat Et_2O). **1a** (R_t = 9.5 min) and **1b** (R_t = 8.2 min) was obtained through the chiral-phase HPLC resolution (CHIRAPAK® IA, Lot No. IA00CE-QH006) (15% isopropanol, flow rate: 1 mL/min); **2a** (R_t = 12.9 min) and **2b** (R_t = 13.8 min) was afforded through the same chiral-phase HPLC resolution (15% isopropanol, flow rate: 1 mL/min).

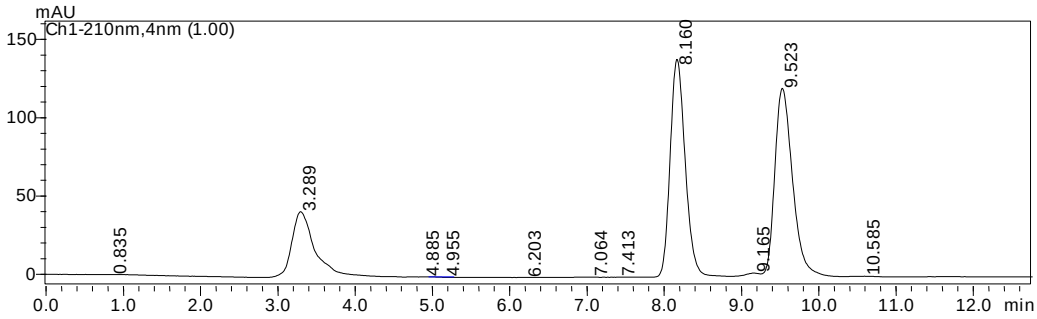


Figure S1. HPLC chiral resolution of **1a** (R_t = 9.5 min) and **1b** (R_t = 8.2 min)

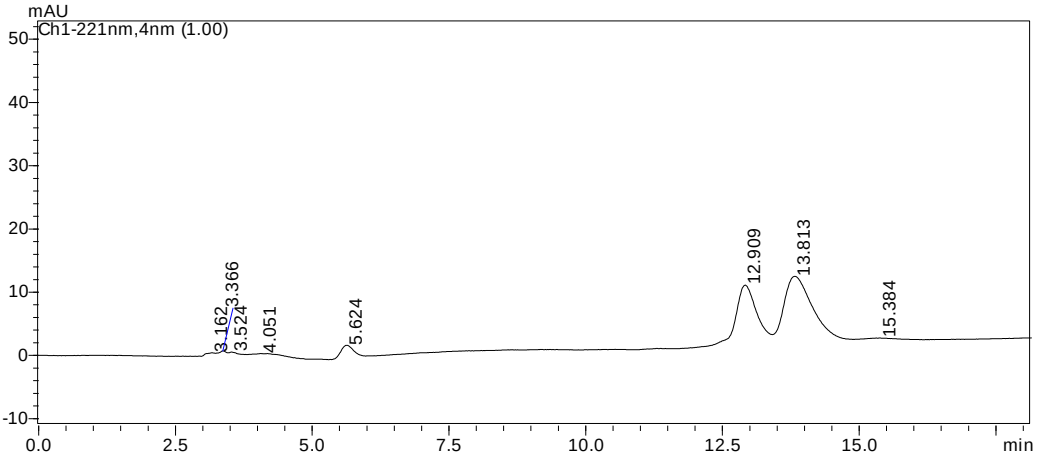
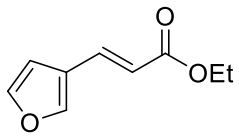


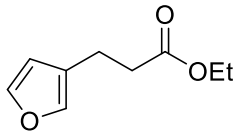
Figure S2. HPLC chiral resolution of **2a** (R_t = 12.9 min) and **2b** (R_t = 13.8 min)

Experimental Procedure



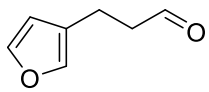
Ethyl (*E*)-3-(furan-3-yl)acrylate (8)

Compound **7** (5.0 g, 52 mmol) was dissolved in 70 mL CH_2Cl_2 and added to Ph_3PCHCO_2Et (18.1 g, 52 mmol) in a 250 mL round bottom. After heated under reflux for 16 h, more than half CH_2Cl_2 was evaporated and hexane (30 mL) was added. The solvents were removed in vacuo and the crude product was purified by flash chromatography on silica gel, eluting with EtOAc/hexane (1:50). Compound **8** was obtained as colorless liquid (7.0 g, 81%). ^1H and ^{13}C NMR data were the same as those reported in the literature (*Journal of Organic Chemistry*, **2005**, *36*, 4414-4422)



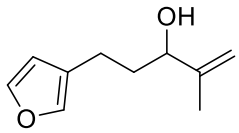
Ethyl 3-(furan-3-yl)propanoate (9)

$Pd/CaCO_3$ (5%, 0.87g) was added to a solution of compound **8** (5.8 g, 35 mmol) in dry methanol (150 mL). The mixture was heated to 40 ℃ under a hydrogen atmosphere for 6 h. Then it was filtered through Buchner funnel, washed through with methanol (30 mL). The solvents were removed in vacuo and the crude product was purified by flash chromatography on silica gel, eluting with EtOAc/hexane (1:19). Compound **9** was obtained as colorless liquid (5.9 g, 99%). ^{1}H and ^{13}C NMR data were the same as those reported in the literature (*Journal of Organic Chemistry*, **2005**, *36*, 4414-4422)



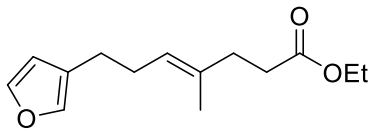
3-(furan-3-yl)propanal (10)

To a solution of compound **9** (5.9 g, 35 mmol) in ether (150 mL) at -78 ℃ was dropwise added DIBAL-H (1.5M in THF; 26 mL, 39 mmol) so that the temperature was maintained below -70 ℃. The mixture was stirred for 0.5 h. Then it was quenched with sat. aq. NH_4Cl (40 mL). The product was extracted with ether (3 × 100 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane =1:9) to give compound **10** as colorless oil (3.5 g, 80%). ^{1}H and ^{13}C NMR data were the same as those reported in the literature (*Journal of Organic Chemistry*, **2005**, *36*, 4414-4422)



5-(furan-3-yl)-2-methylpent-1-en-3-ol (11)

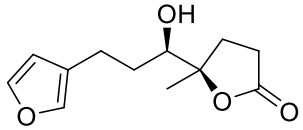
To a solution of compound **10** (3.5 g, 28 mmol) in dry ether (140 mL) at −10 ℃ was added isopropenylmagnesium bromide (0.5M in THF; 86 mL, 43 mmol) and the mixture was stirred for 5 h between -10 and 0 ℃. Then it was quenched with sat. aq. NH_4Cl (50 mL). The product was extracted with ether (3 × 100 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by flash silica gel column chromatography with EtOAc/hexane (1:19) to obtain compound **11** as yellowish liquid (2.5 g, 55%). ^{1}H and ^{13}C NMR data were the same as those reported in the literature (*Journal of Organic Chemistry*, **2005**, *36*, 4414-4422)



Ethyl (*E*)-7-(furan-3-yl)-4-methylhept-4-enoate (12)

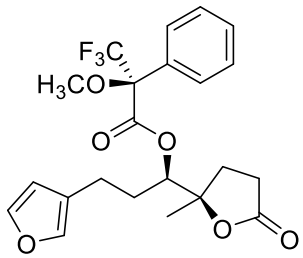
A mixture of compound **11** (2.5 g, 15 mmol), $MeC(OEt)_3$ (12.2 g, 75mmol), and propanoic acid (10%; 0.11 g, 1.5 mmol) in a 100 mL round bottom was stirred at 120 ℃ to distill excessive EtOH product, then heated to reflux at 150 ℃ for 24 h. The product was extracted with ether (3 × 100 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane =1:19) to give compound **12** as colorless oil (2.5 g, 70%). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.25 (t, 3H, *J* = 7.2 Hz), 1.60 (s, 3H), 2.23-2.26 (m, 2H),

2.30-2.32 (m, 2H), 2.37-2.39 (m, 2H), 2.42-2.46 (m, 2H), 4.11 (q, 2H, *J* = 7.2 Hz), 5.19 (t, 1H, *J* = 7.5 Hz), 6.26 (s, 1H), 7.20 (s, 1H), 7.33 (s, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 14.4, 16.1, 25.0, 28.5, 33.3, 34.8, 60.4, 111.2, 124.6, 124.9, 134.3, 139.0, 142.7, 173.6. HRMS (EI): *m/z* [M^+] calcd for $C_{14}H_{20}O_3$: 236.1412; Found: 236.1413.



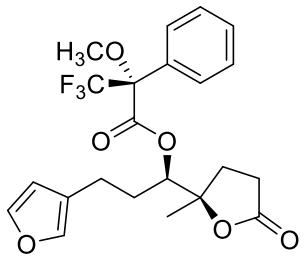
8-epi-(+)-sponalisolide A (1c)

To an ice-cold mixture of AD-mix-β (1.2g) and $MeSO_2NH_2$ (0.076 g, 0.8 mmol) in *t*-BuOH (5 mL) and H_2O (5mL), compound **12** (0.2 g, 0.8 mmol) was added. The mixture was stirred at 0 ℃ for 5 h and the excess reagent was destroyed with $NaHSO_3$ (1.2 g, 12 mmol). The resulting mixture was poured into water and extracted with ether (3 × 20 mL), and the solvent removed by evaporation under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane = 1:1) to give **1c** as colorless liquid (0.14 g, 78%). $[\alpha]_D^{20}$ = +7.5 (c 0.5, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.36 (s, 3H), 1.68 (m, 2H), 1.92 (ddd, 1H, *J* = 12.8, 9.6, 5.5 Hz), 2.15 (dt, 1H, *J* = 12.8, 9.0 Hz), 2.54 (m, 1H), 2.62 (m, 2H), 2.72 (m, 1H), 3.54 (dd, 1H, *J* = 7.5, 5.1 Hz), 6.28 (brs, 1H), 7.26 (brs, 1H), 7.37 (t, 1H, *J* = 1.6 Hz). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 21.0, 21.4, 29.2, 30.7, 31.4, 76.2, 88.9, 110.9, 124.1, 139.3, 143.2, 176.6.



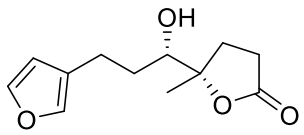
(*R*)-3-(furan-3-yl)-1-((*R*)-2-methyl-5-oxotetrahydrofuran-2-yl)propyl (*S*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoate (1c-*S*)

1c (2.0 mg, 0.009mmol) was dissolved in dry pyridine (1 mL) in a 5mL round bottom flask and *R*-MTPCl (3mg, 0.012mmol) was added. 2h later, brine was added to stop the reaction. It was extracted with Et_2O (3 x 5mL), and the combined organic extracts were dried over Na_2SO_4, evaporated under reduced pressure. The reaction mixture was purified by silica gel column chromatography (EtOAc/ hexane = 1:2). **1c-*S***, the *S*-MTPA ester was obtained as colorless oil (2.7 mg, 69%). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.35 (s, 3H), 1.83-1.91 (m, 2H), 1.93-1.96 (m, 1H), 1.98-2.02 (m, 1H), 2.27-2.31 (m, 1H), 2.39-2.47 (m, 2H), 2.49-2.55 (m, 1H), 3.59 (s, 3H), 5.18 (dd, 1H, *J* = 2.7, 9.2 Hz), 6.25 (brs, 1H), 7.24 (brs, 1H), 7.37 (t, 1H, *J* = 1.6 Hz), 7.41-7.44 (m, 3H), 7.61-7.63 (m, 2H).



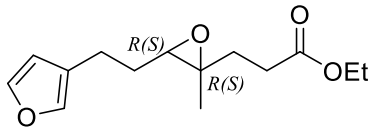
(*R*)-3-(furan-3-yl)-1-((*R*)-2-methyl-5-oxotetrahydrofuran-2-yl)propyl (*R*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoate (1c-*R*)

1c (2.0 mg, 0.009mmol) was dissolved in dry pyridine (1 mL) in a 5mL round bottom flask and *S*-MTPCl (3mg, 0.012mmol) was added. 2h later, brine was added to stop the reaction. It was extracted with Et_2O (3 × 5mL), and the combined organic extracts were dried over Na_2SO_4, evaporated under reduced pressure. The reaction mixture was purified by silica gel column chromatography (EtOAc/ hexane = 1:2). **1c-*R***, the *R*-MTPA ester was obtained as colorless oil (2.6 mg, 66%). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.36 (s, 3H), 1.79-1.86 (m, 2H), 1.98-1.95 (m, 1H), 1.97-2.03 (m, 1H), 2.31-2.37 (m, 1H), 2.39-2.47 (m, 1H), 2.48-2.59 (m, 2H), 3.53 (s, 3H), 5.22 (dd, 1H, *J* = 2.6, 9.4 Hz), 6.22 (brs, 1H), 7.21 (brs, 1H), 7.36 (t, 1H, *J* = 1.6 Hz), 7.42-7.45 (m, 3H), 7.62-7.64 (m, 2H).



8-epi-(−)-sponalisolide A (1d)

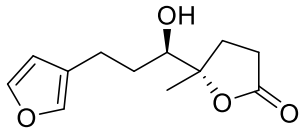
To an ice-cold mixture of AD-mix-α (1.2g) and $MeSO_2NH_2$ (0.076 g, 0.8 mmol) in t-BuOH (5 mL) and H_2O (5mL), compound **12** (0.2 g, 0.8 mmol) was added. The mixture was stirred at 0 ℃ for 5 h and the excess reagent was destroyed with $NaHSO_3$ (1.2 g, 12 mmol). The resulting mixture was poured into water and extracted with ether (3 × 20 mL), and the solvent removed by evaporation under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane = 1:1) to give **1d** as colorless liquid (0.15 g, 84%). $[\alpha]_D^{20}$ = −13.3 (c 0.3, $CHCl_3$). ^{1}H NMR and ^{13}C NMR data were the same as **1c**.



Ethyl 3-(3-(2-(furan-3-yl)ethyl)-2-methyloxiran-2-yl)propanoate (13)

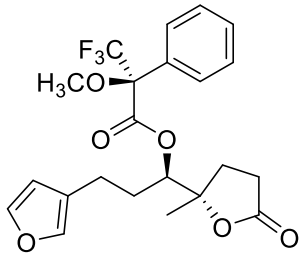
A mixture of compound **12** (0.75 g, 3.2 mmol) and m-CPBA (0.7 g, 4 mmol) in CH_2Cl_2 (50 mL) was stirred at room temperature for 1 h, then KOH aq. was added to PH = 9. The product was extracted with ether (3 × 50 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane =1:9) to give compound **13** as colorless oil (0.73 g, 90%). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.22 (s, 3H), 1.24 (t, 3H, *J* = 7.1 Hz), 1.75-1.79 (m, 2H), 1.80-1.88 (m, 2H), 2.33-2.37 (m, 2H), 2.50-2.56 (m, 1H), 2.58-2.64 (m, 1H), 2.76 (t, 1H, *J* = 6.2 Hz), 4.11 (t, 2H, *J* = 7.1 Hz), 6.28 (brs, 1H), 7.24 (brs, 1H), 7.35 (t, 1H, *J* =

1.6 Hz).^{13}C NMR (125 MHz, $CDCl_3$) δ: 14.3, 16.8, 21.7, 29.2, 29.9, 33.4, 60.1, 60.6, 62.8, 111.0, 124.1, 139.1, 143.0, 173.2. HRMS (EI): m/z [M + Na^+] calcd. for $C_{14}H_{20}O_4$: 252.1362; Found: 252.1367.



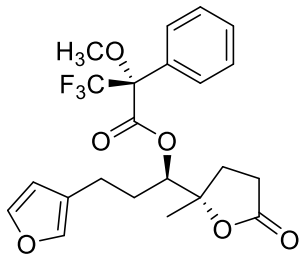
(+)-sponalisolide A (1a)

To an ice-cold HCl aq. (1.2eq) in MeOH (50 mL) of compound **13** (0.1 g, 0.4 mmol) was added. The mixture was stirred at 0 ℃ for 0.5 h. The product was extracted with ether (3 × 50 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane =1:9) to give the mixture of **1a** and **1b** as colorless oil (0.085 g, 95%). HPLC chiral resolution towards **1a** (3.0 mg, 33%) $[\alpha]_D^{20}$ = +7.4 (c 0.3, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.35 (s, 3H), 1.61 (m, 2H), 1.69 (m, 1H), 1.81 (ddd, 1H, *J* = 12.8, 8.6, 6.6 Hz), 2.43 (ddd, 1H, *J* = 12.8, 10.1, 8.6 Hz), 2.55 (m, 1H), 2.62 (m, 1H), 2.64 (m, 1H), 2.73 (ddd, 1H, *J* = 14.2, 9.2, 4.8 Hz), 3.71 (dd, 1H, *J* = 10.6, 2.2 Hz), 6.29 (brs, 1H), 7.26 (brs, 1H), 7.37 (t, 1H, *J* = 1.6 Hz). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 21.5, 23.1, 27.6, 29.5, 31.4, 75.1, 88.9, 111.0, 124.2, 139.2, 143.2, 177.1. HRMS (EI): *m/z* [M^+] calcd. for $C_{12}H_{16}O_4$: 224.1049; Found: 224.1048.



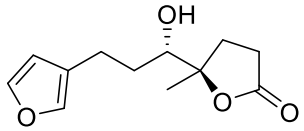
(*R*)-3-(furan-3-yl)-1-((*S*)-2-methyl-5-oxotetrahydrofuran-2-yl)propyl (*S*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoate (1a-*S*)

1a (1.0 mg, 0.0045mmol) was dissolved in dry pyridine (1 mL) in a 5mL round bottom flask and *R*-MTPCl (1.5mg, 0.006mmol) was added. 2h later, brine was added to stop the reaction. It was extracted with Et_2O (3 × 5mL), and the combined organic extracts were dried over Na_2SO_4, evaporated under reduced pressure. The reaction mixture was purified by silica gel column chromatography (EtOAc/ hexane = 1:2). **1a-*S***, the *S*-MTPA ester was obtained as colorless oil (1.2 mg, 61%). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.36 (s, 3H), 1.81–1.89 (m, 2H), 1.95-1.99 (m, 1H), 2.16-2.19 (m, 1H), 2.42-2.46 (m, 2H), 2.52-2.58 (m, 2H), 3.54 (s, 3H), 5.27 (dd, 1H, *J* = 2.5, 9.8 Hz), 6.24 (brs, 1H), 7.21 (brs, 1H), 7.36 (t, 1H, *J* = 1.6 Hz), 7.42-7.43 (m, 3H), 7.56-7.58 (m, 2H).



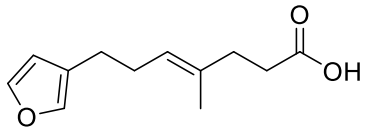
(*R*)-3-(furan-3-yl)-1-((*S*)-2-methyl-5-oxotetrahydrofuran-2-yl)propyl (*R*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoate (1a-*R*)

1a (1.0 mg, 0.0045mmol) was dissolved in dry pyridine (1 mL) in a 5mL round bottom flask and *S*-MTPCl (1.5mg, 0.006mmol) was added. 2h later, brine was added to stop the reaction. It was extracted with Et_2O (3 × 5mL), and the combined organic extracts were dried over Na_2SO_4, evaporated under reduced pressure. The reaction mixture was purified by silica gel column chromatography (EtOAc/ hexane = 1:2). **1a-*R***, the *R*-MTPA ester was obtained as colorless oil (1.3 mg, 66%). 1.37 (s, 3H), 1.77–1.85 (m, 2H), 1.88-1.93 (m, 1H), 2.16-2.19 (m, 1H), 2.39-2.47 (m, 3H), 2.52-2.59 (m, 1H), 3.50 (s, 3H), 5.28 (dd, 1H, *J* = 2.6, 9.6 Hz), 6.22 (brs, 1H), 7.21 (brs, 1H), 7.35 (t, 1H, *J* = 1.6 Hz), 7.43-7.47 (m, 3H), 7.53-7.54 (m, 2H).



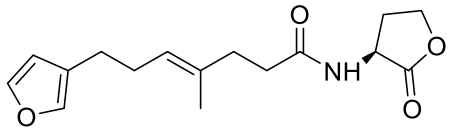
(−)-sponalisolide A (1b)

HPLC chiral resolution towards **1b** (3.0 mg, 33%). $[\alpha]_D^{20}$ = −6.3 (c 0.1, $CHCl_3$). ^1H NMR and ^{13}C NMR data were the same as **1a**.



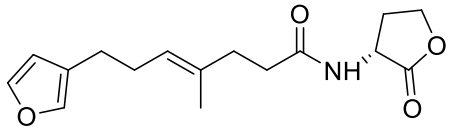
(*E*)-7-(furan-3-yl)-4-methylhept-4-enoic acid (4)

Compound **12** (0.3 g, 1.3 mmol) in MeOH (50 mL) was added to KOH aq (2eq). After stirring for 0.5 h at room temperature, the product was extracted with ether (3 × 50 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane =1:9) to give compound **4** as colorless oil (0.27 g, 99%). ^1H and ^{13}C NMR data were the same as those reported in the literature (*Tetrahedron Letters*, **1969**, *10*, 1329-1332)



(+)-sponalisolide B (2a)

A mixture of compound **4** (0.1 g, 0.48 mmol), L-Homoserine lactone hydrochloride (0.07 g, 0.5 mmol), DCC (0.12 g, 0.58 mmol), DMAP (0.006g, 0.05 mmol) in CH_2Cl_2 (50 ml) was stirred at room temperature overnight, then concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane =1:1) to give compound **2a** as white amorphous powder (0.12 g, 86%). $[\alpha]_D^{20}$ = +7.5 (c 0.5, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.60 (s, 3H), 2.08 (ddd, 1H, *J* = 11.7, 9.1 Hz), 2.24 (ddd, 2H, *J* = 14.6, 7.3, 7.0 Hz), 2.33 (m, 4H), 2.44 (dd, 2H, *J* = 7.7, 7.3 Hz), 2.82 (ddd, 1H, *J* = 12.2, 8.6, 5.8 Hz), 4.27 (ddd, 1H, *J* = 11.3, 9.5, 5.8 Hz), 4.45 (t, 1H, *J* = 9.5 Hz), 4.52 (ddd, 1H, *J* = 11.7, 8.6, 5.8 Hz), 5.22 (t, 1H, *J* = 7.0 Hz), 6.16 (brs, 1H), 6.26 (brs, 1H), 7.20 (brs, 1H), 7.33 (t, 1H, *J* = 1.6 Hz). ^{13}C NMR (125 MHz, $CDCl_3$) δ: 16.1, 24.9, 28.5, 30.7, 34.9, 35.1, 49.4, 66.2, 111.1, 124.9, 125.2, 134.2, 139.0, 142.7, 173.5, 175.6. HRMS (ESI): m/z [M+Na^+] calcd. for $C_{16}H_{21}NO_4Na$: 314.1363; Found: 314.1362.



(−)-sponalisolide B (2b)

A mixture of compound **4** (0.1 g, 0.48 mmol), D-Homoserine lactone hydrochloride (0.07 g, 0.5 mmol), DCC (0.12 g, 0.58 mmol), DMAP (0.006g, 0.05 mmol) in CH_2Cl_2 (50 ml) was stirred at room temperature overnight, then concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, EtOAc/hexane =1:1) to give compound **2b** as white amorphous powder (0.11 g, 79%). $[\alpha]_D^{20}$ = −10.9 (c 0.5, $CHCl_3$). ^{1}H NMR and ^{13}C NMR data were the same as **2a**.

Bioassay

PAO1 genomic DNA was prepared and used as the template in PCR reactions in this study. Briefly, the *lasA* promoter fusion (p-*lasA*-*lux*) was constructed by amplifying the *lasA* promoter region (-508 to +11 of the start codon) with the following primers: forward, CCGCTCGAGACGA GGACGATGGTTACCAG (*XhoI* sites underlined), and reverse, CGGGATCCTTGTGCTGCATGGGTAGCTC (*BamHI* sites underlined), and then cloned into the *plasmid pMS402* with a promoterless luxCDABE operon (K. M. Duan, C. Dammel, J. Stein, H. Rabin, and M. G. Surette, *Mol. Microbiol.,* 2003, **50**, 1477–1491). The plasmid p-*lasA*-*lux* was transformed into PAO1 by electroporation. The PAO1/p-*lasA*-*lux* strain was growth in Luria-Bertani (LB) broth at 37 ℃ for 9 h and diluted 80-fold in fresh LB supplemented with indicated concentrations of compounds. Promoter activities were measured as counts per second (CPS) of light production with a Synergy 2 Multi-Mode Microplate Reader (Biotek) following the manufacturer's as described previously (N. Yang, S. Ding, F. Chen, X. Zhang, Y. Xia, H. Di, Q. Cao, S. Deng, M. Wu, C. C. L. Wong, X. -X. Tian, C. -G. Yang, J. Zhao, and L. Lan, *Mol. Microbiol.,* 2015, **96**, 526–547). Each sample was tested in triplicate.

Figures for the spectra

Figure 1a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **12**

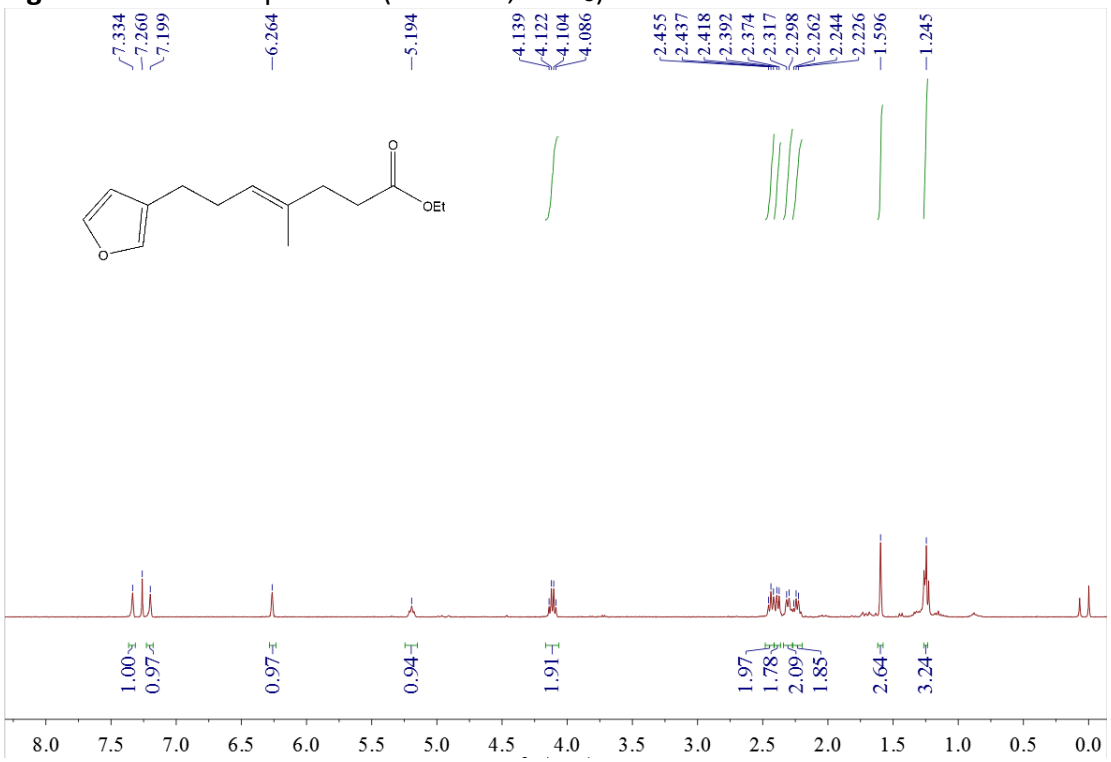


Figure 1b. ^{13}C NMR spectrum (125 MHz, $CDCl_3$) of **12**

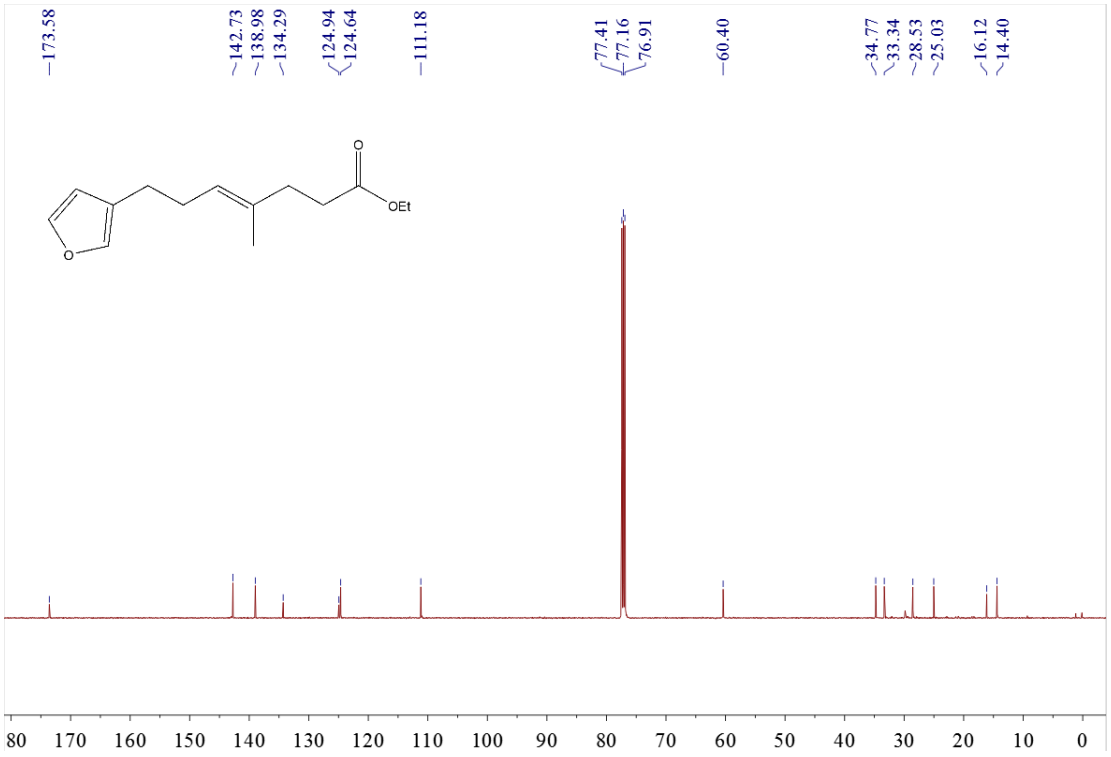


Figure 2a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **1a**

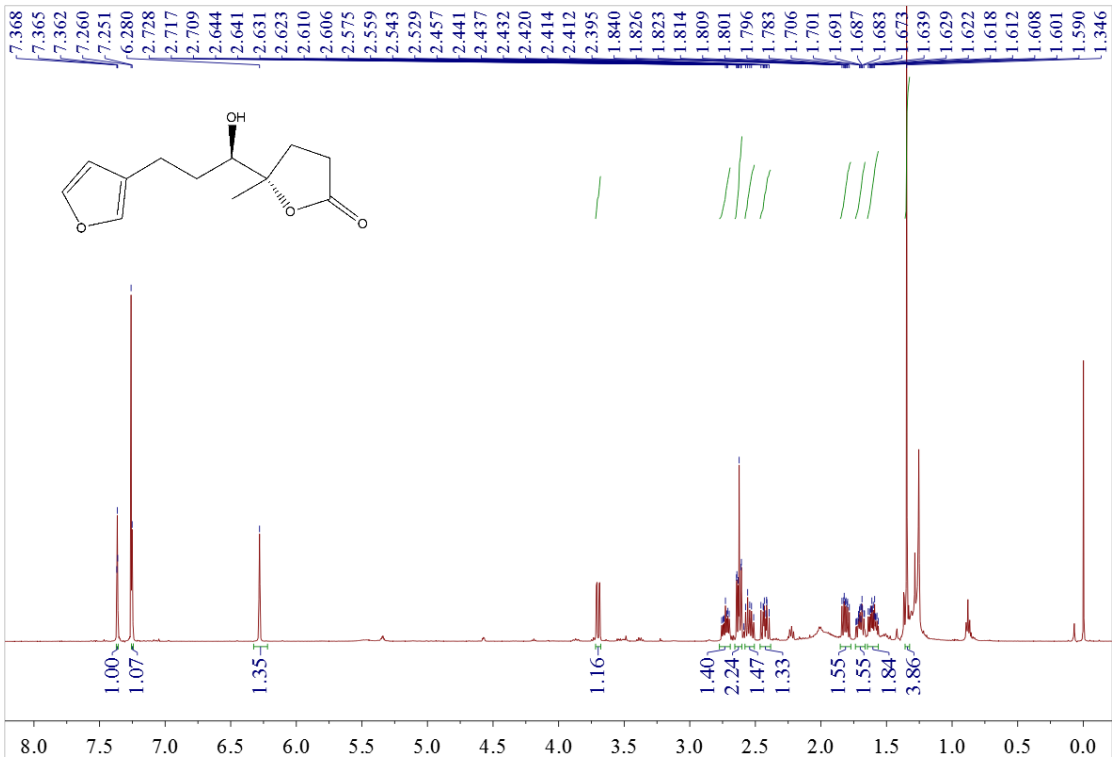


Figure 2b. ^{13}C NMR spectrum (125 MHz, $CDCl_3$) of **1a**

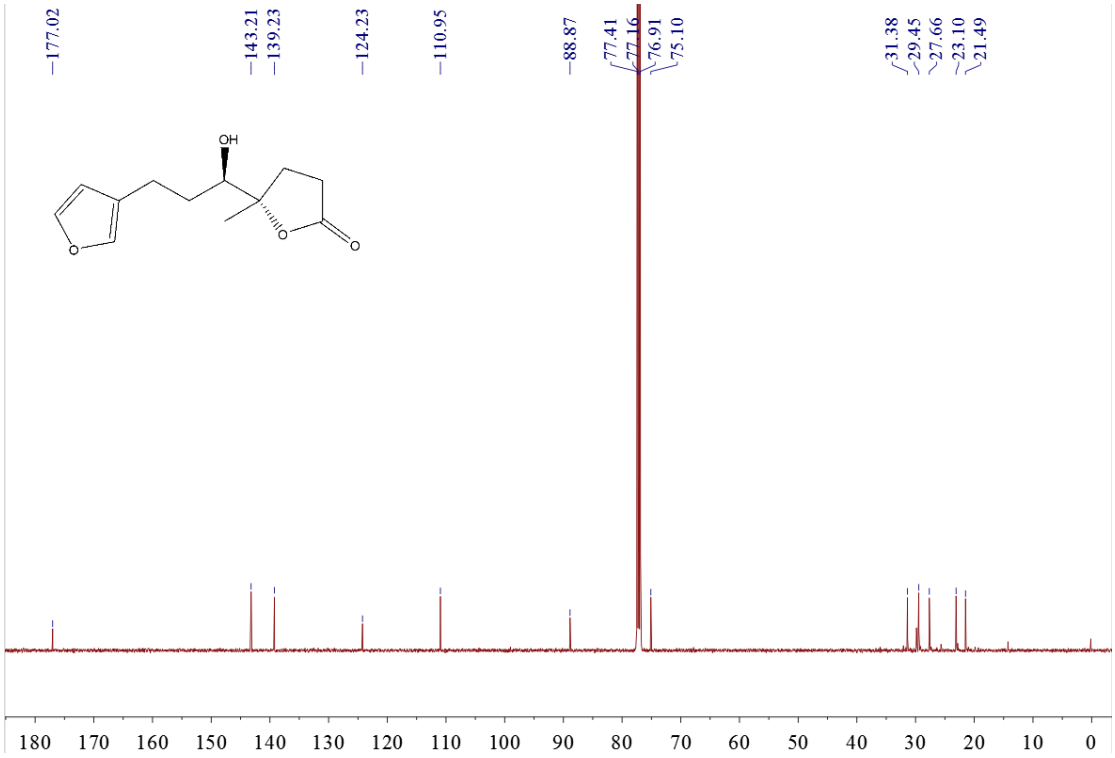


Figure 3a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **1a-*S***

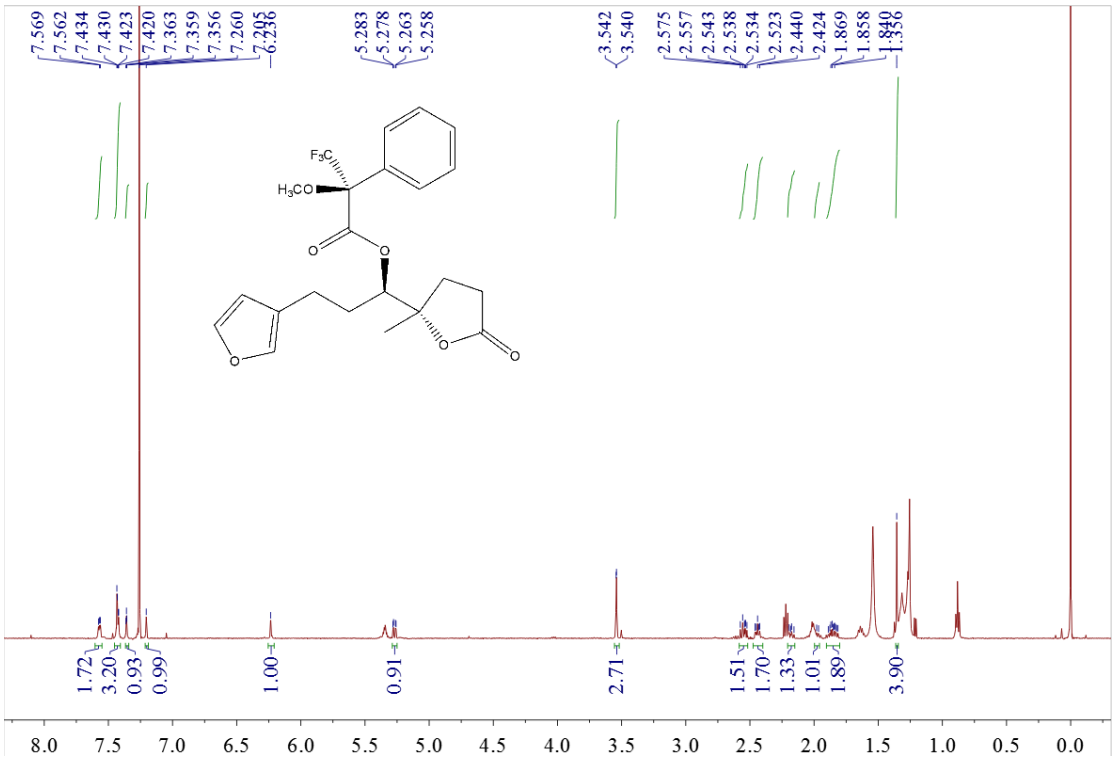


Figure 3b. ^{1}H-^{1}H COSY (400 MHz, $CDCl_3$) of **1a-*S***

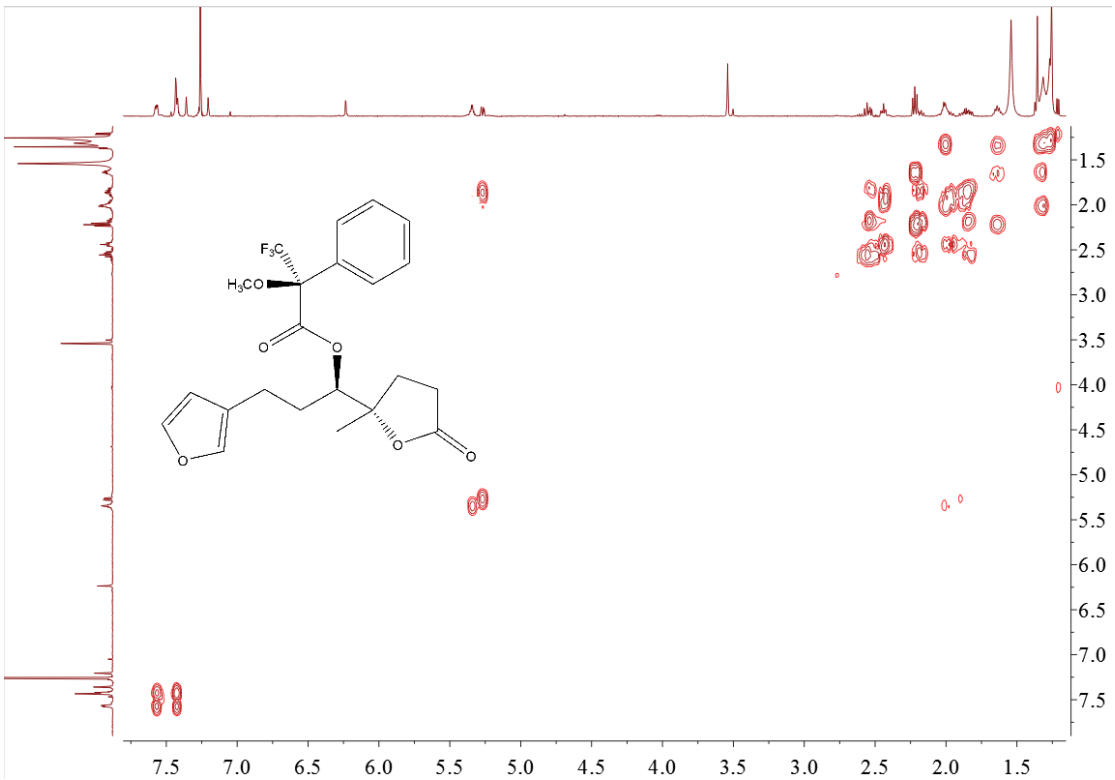


Figure 4a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **1a-*R***

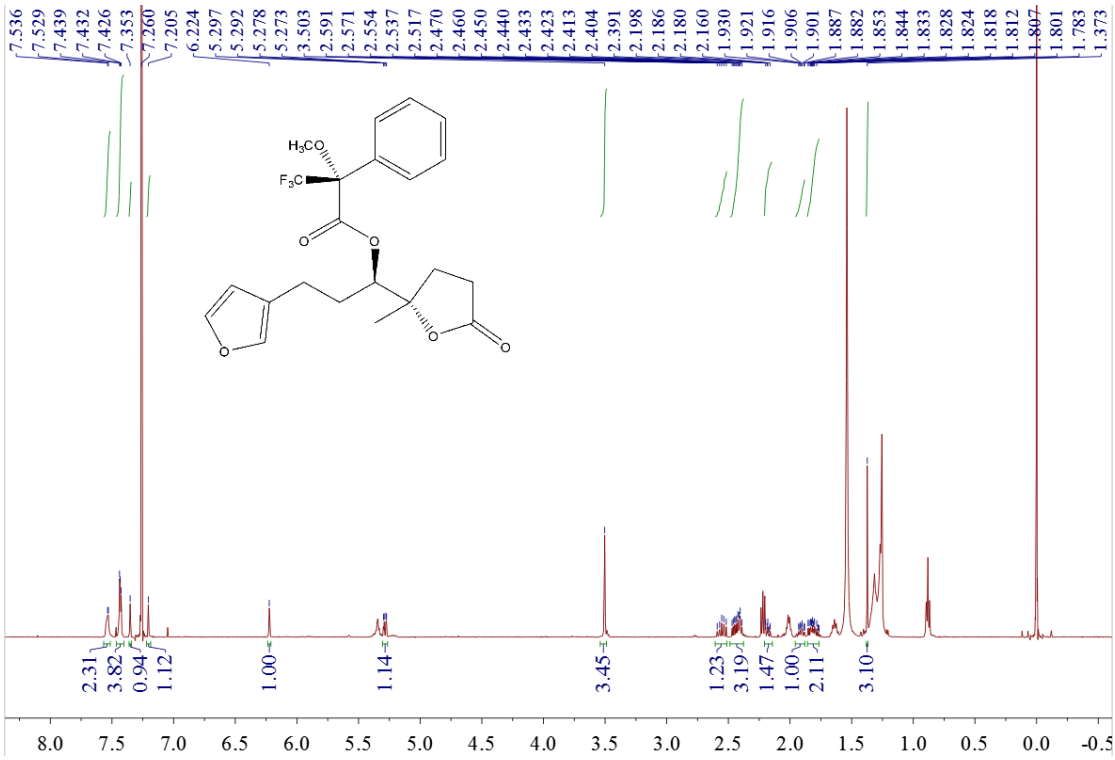


Figure 4b. ^{1}H-^{1}H COSY (400 MHz, $CDCl_3$) of **1a-*R***

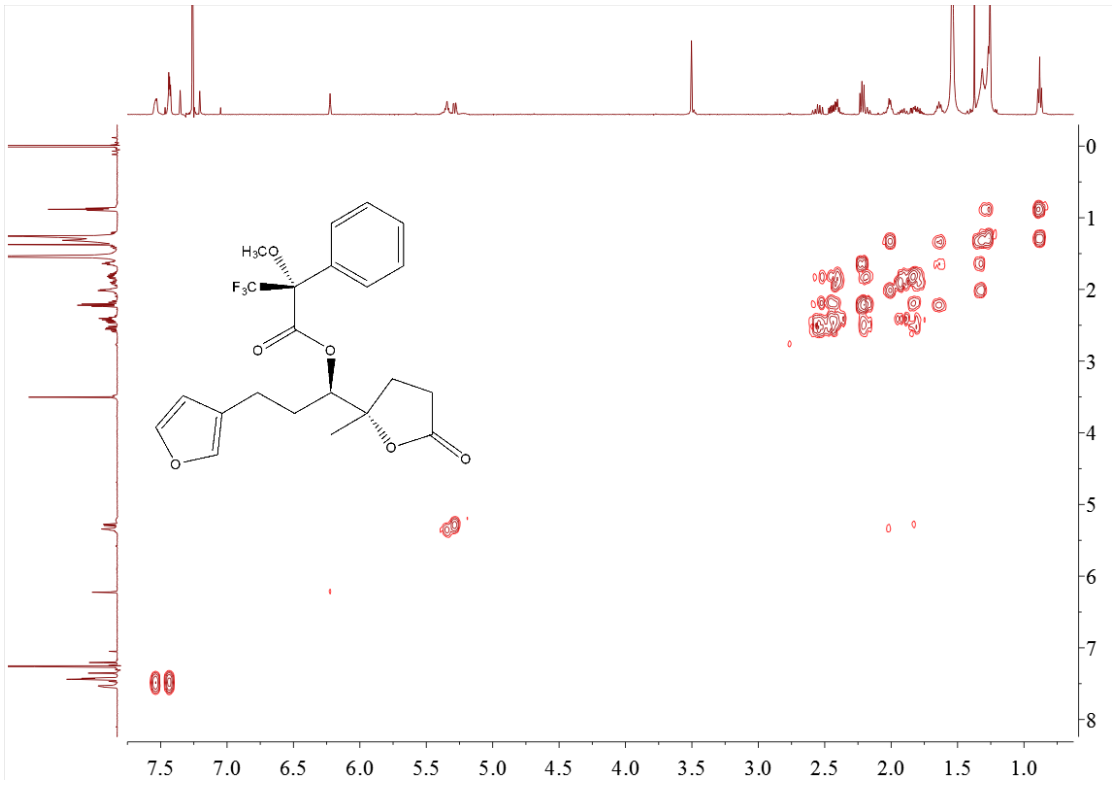


Figure 5a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **13**

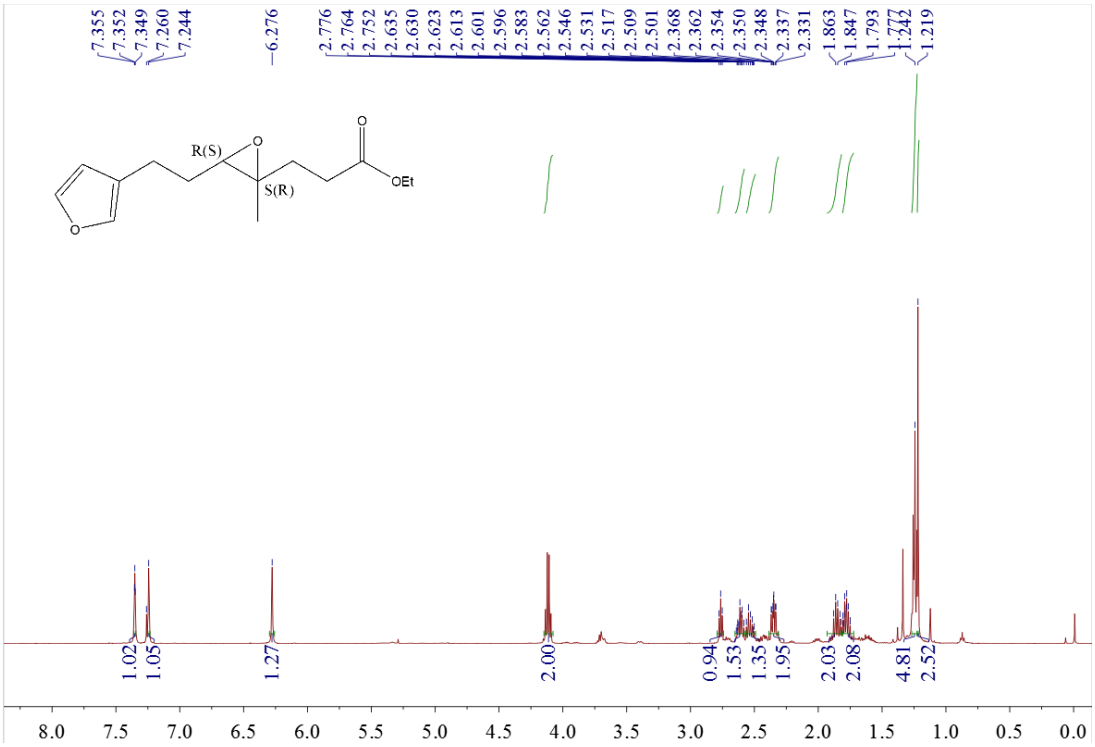


Figure 5b. ^{13}C NMR spectrum (125 MHz, $CDCl_3$) of **13**

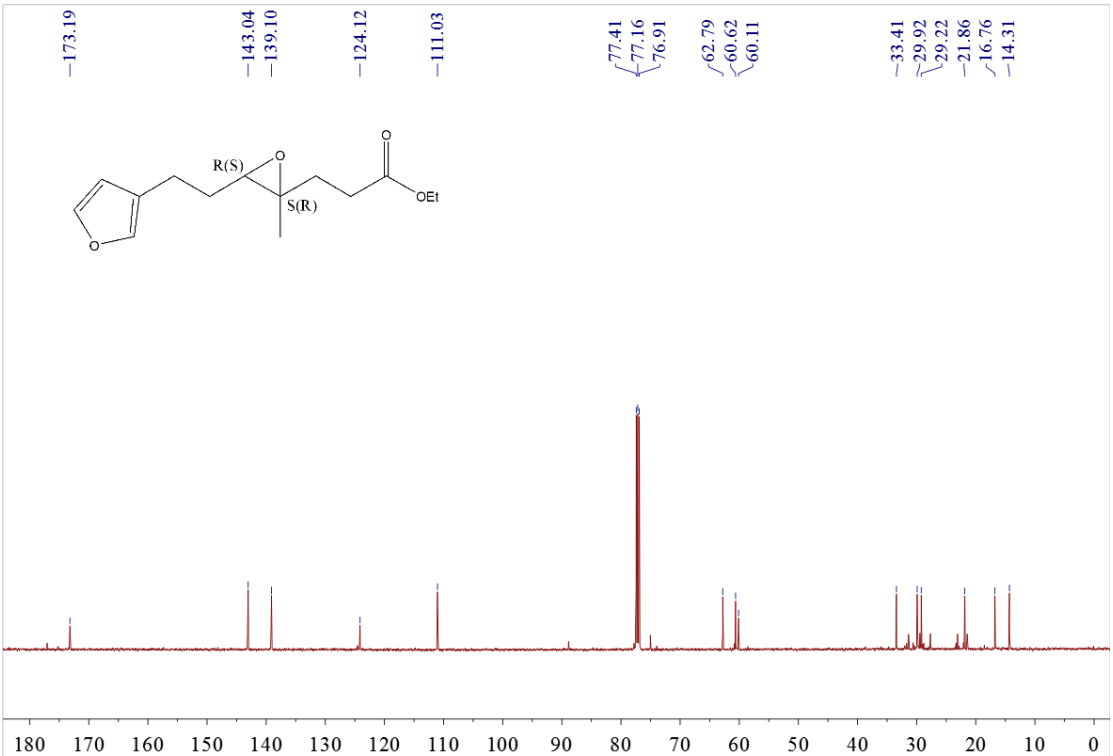


Figure 6a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **1c**

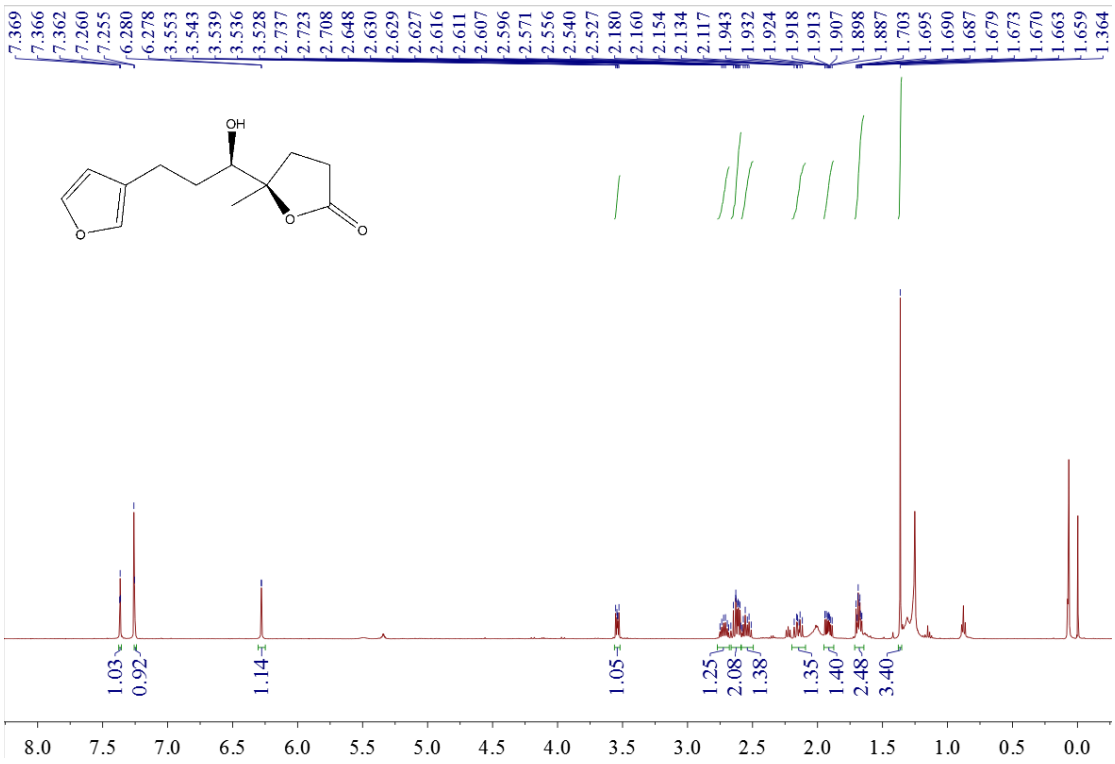


Figure 6b. ^{13}C NMR spectrum (125 MHz, $CDCl_3$) of **1c**

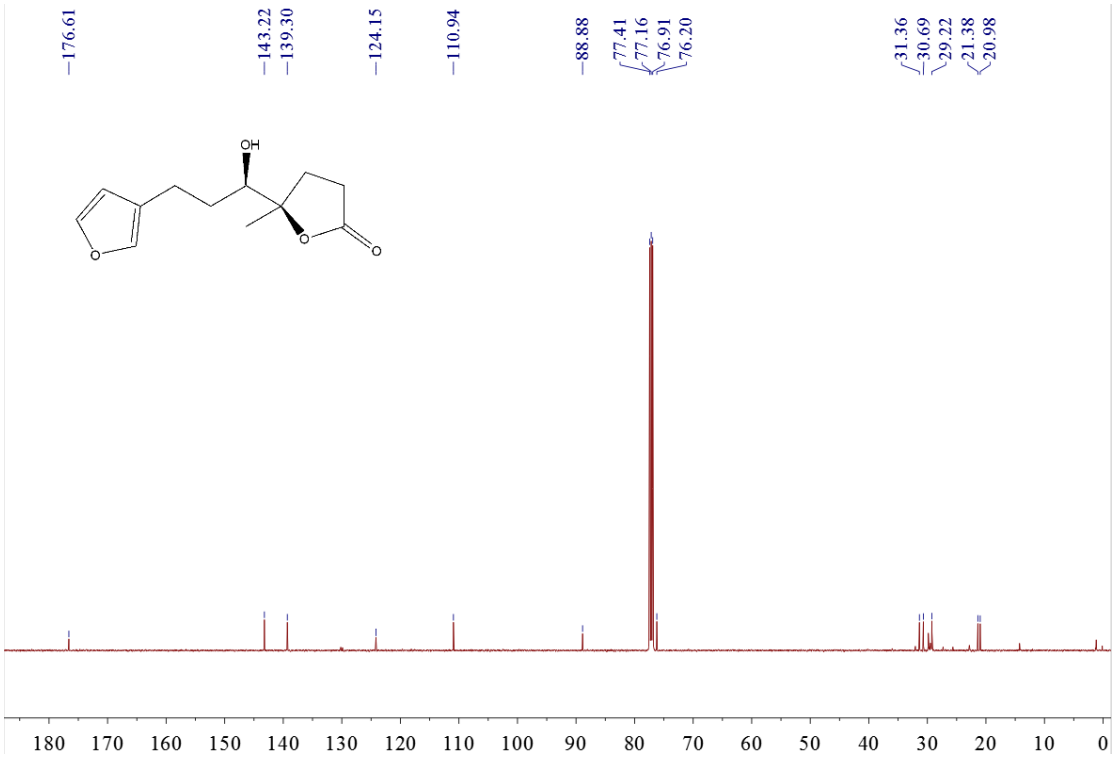


Figure 7a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **1c-*S***

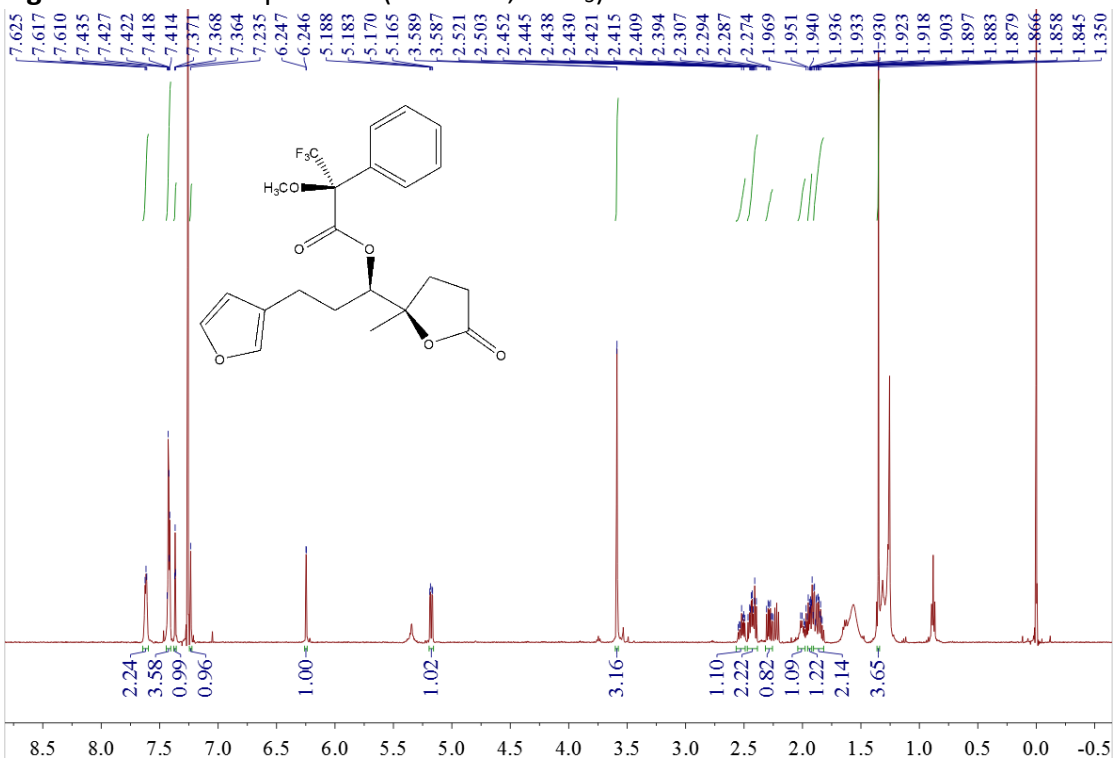


Figure 7b. ^{1}H-^{1}H COSY (400 MHz, $CDCl_3$) of **1c-*S***

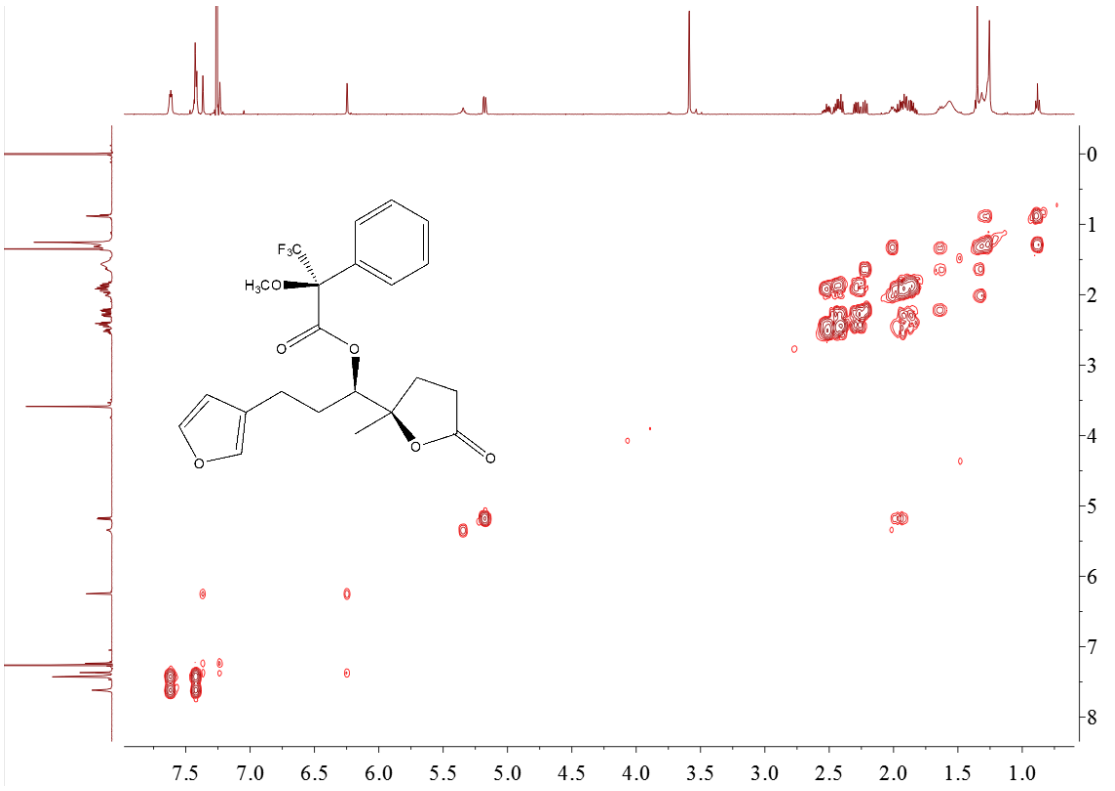


Figure 8a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **1c-*R***

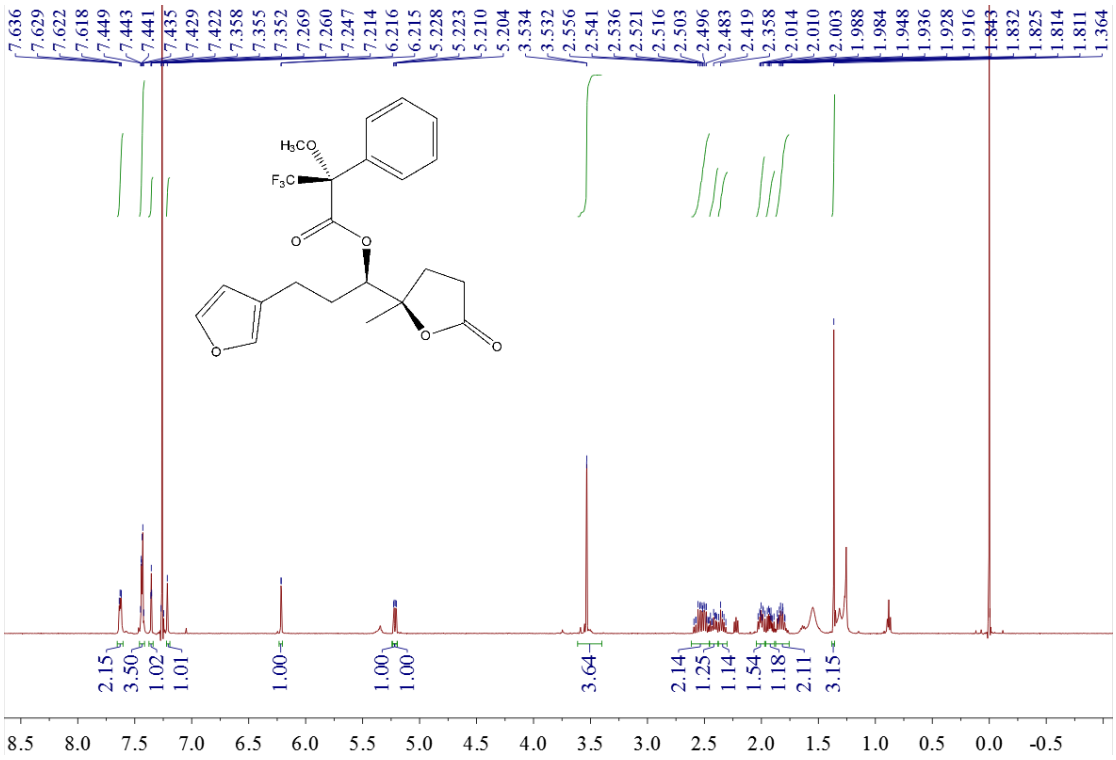


Figure 8b. ^{1}H-^{1}H COSY (400 MHz, $CDCl_3$) of **1c-*R***

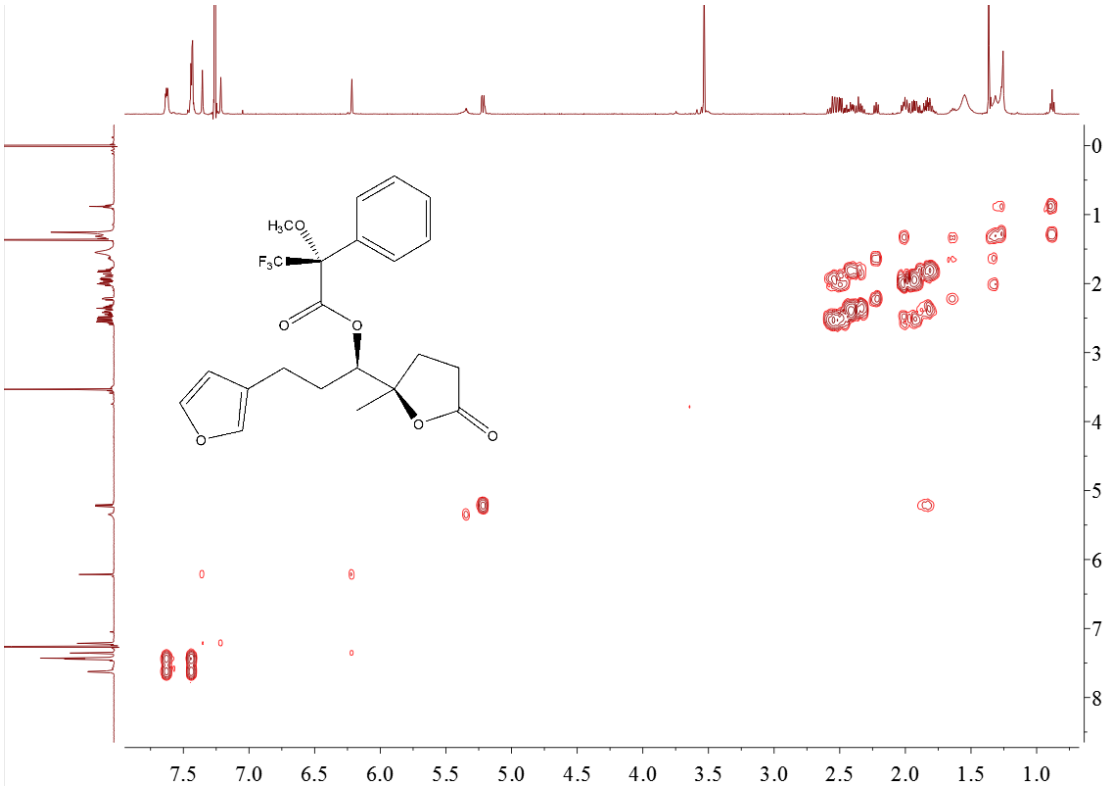


Figure 9a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of **2a**

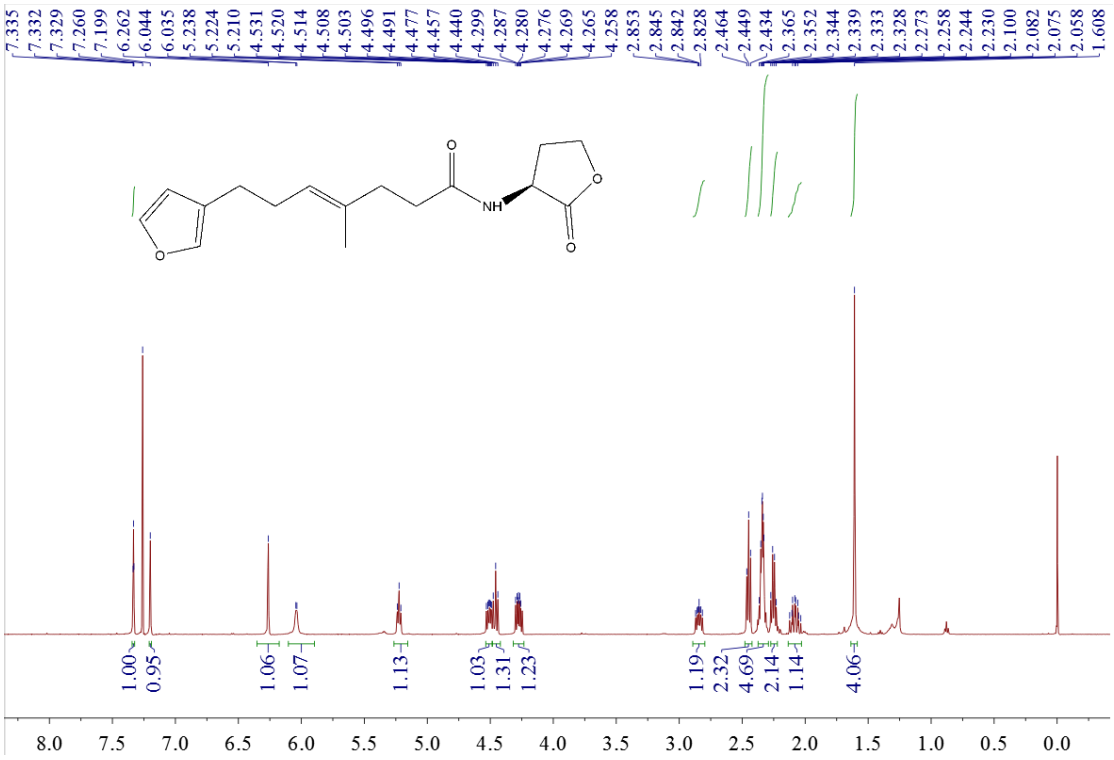


Figure 9b. ^{13}C NMR spectrum (125 MHz, $CDCl_3$) of **2a**

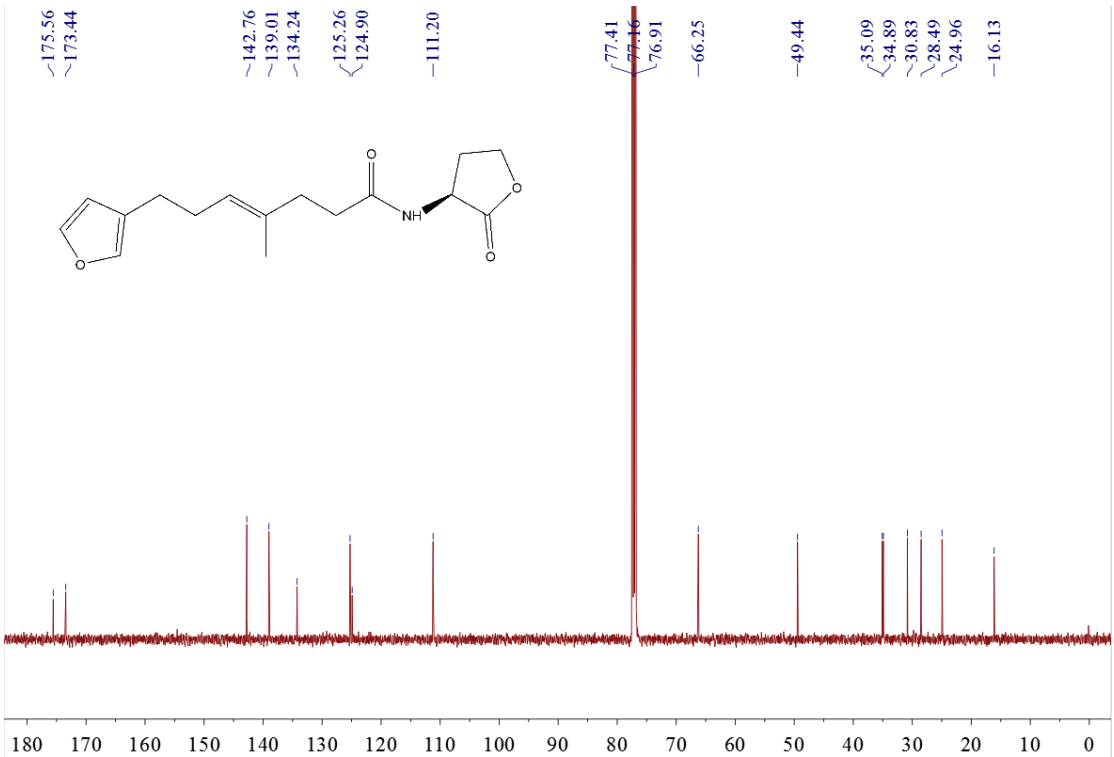


Figure 10a. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of natural products **1**

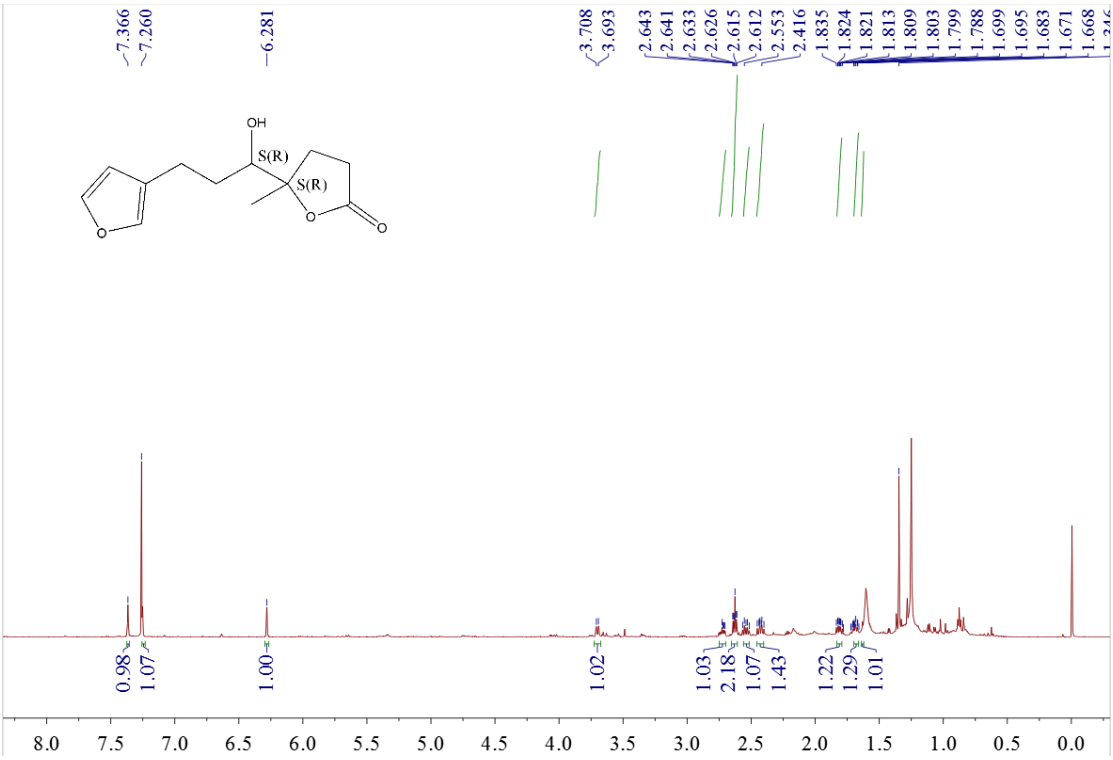


Figure 10b. ^{13}C NMR spectrum (125 MHz, $CDCl_3$) of natural products **1**

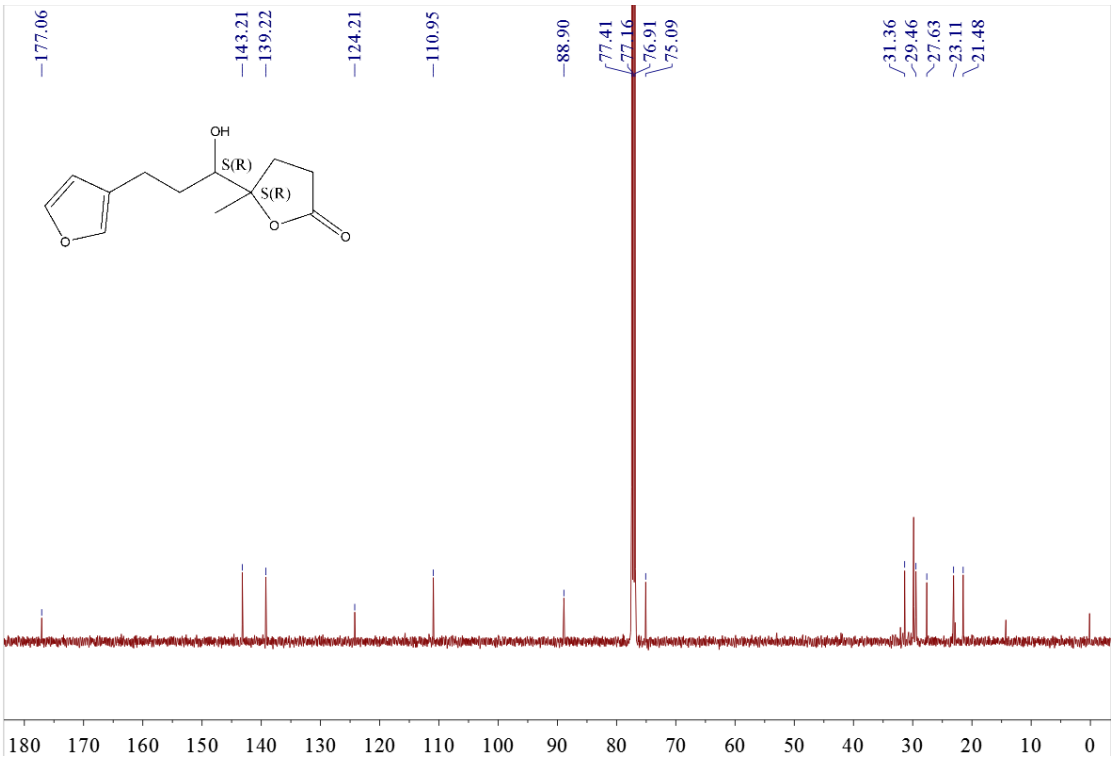


Figure 11a. ^{1}H-^{1}H COSY (400 MHz, $CDCl_3$) of natural products **1**

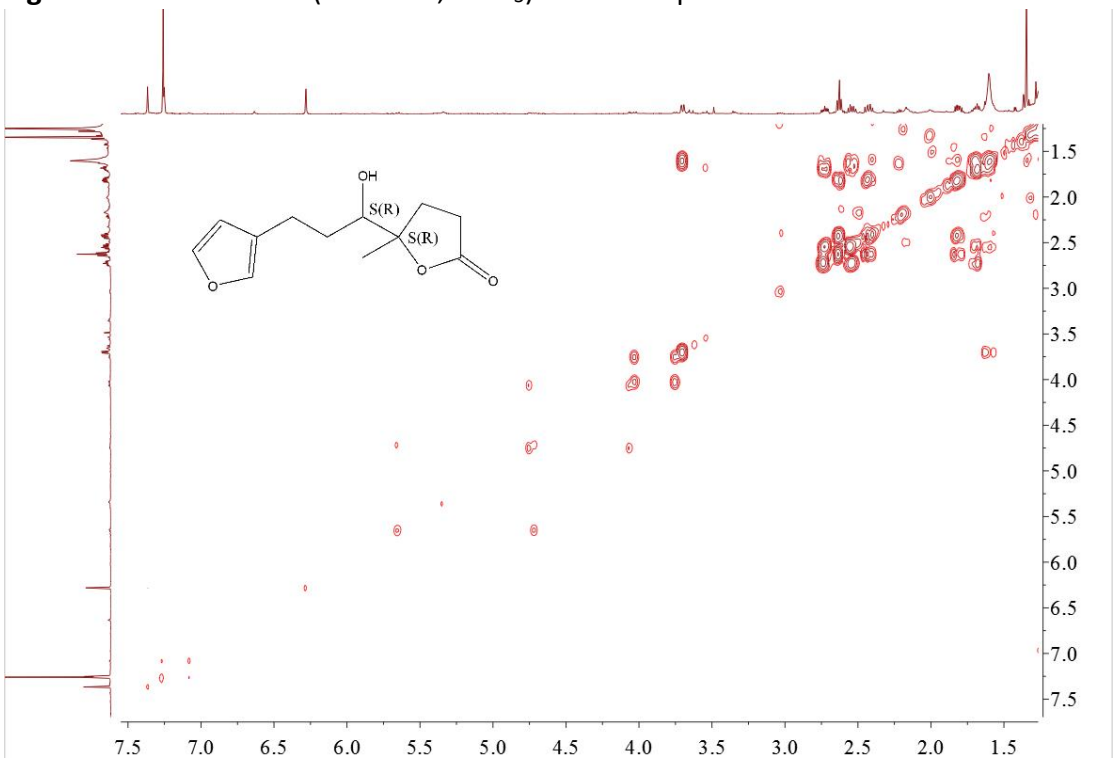


Figure 11b. HSQC (400 MHz, $CDCl_3$) of natural products **1**

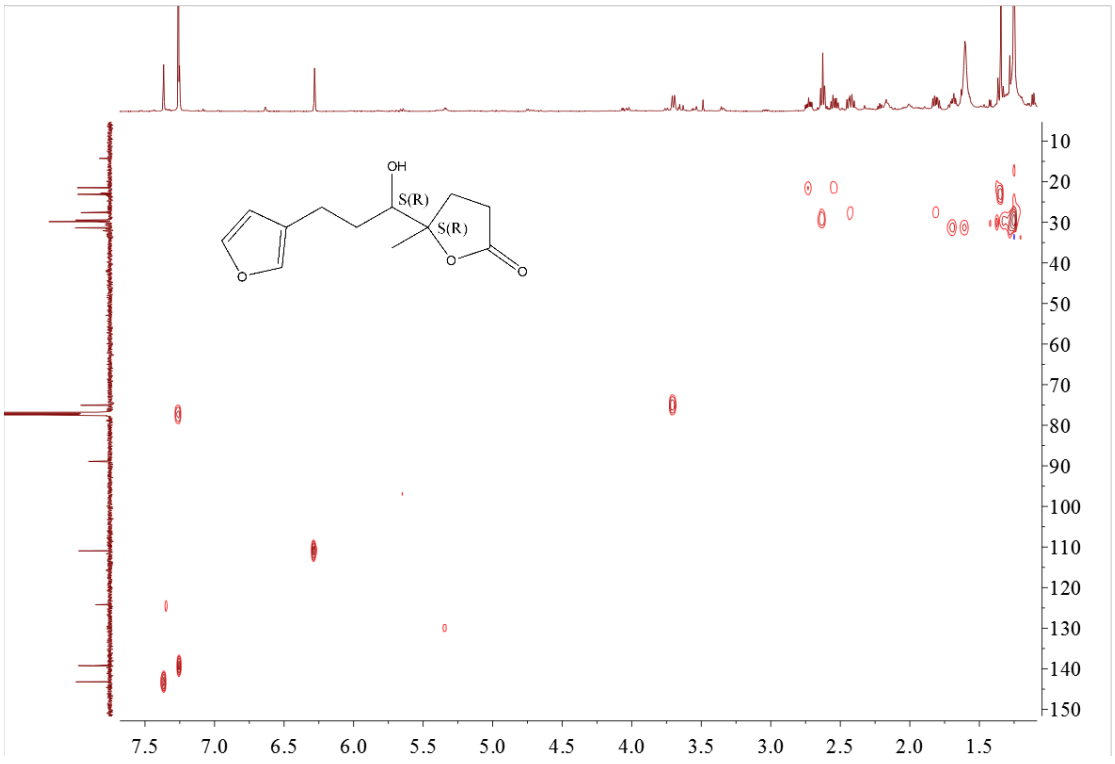


Figure 12a. HMBC (125 MHz, $CDCl_3$) of natural products **1**

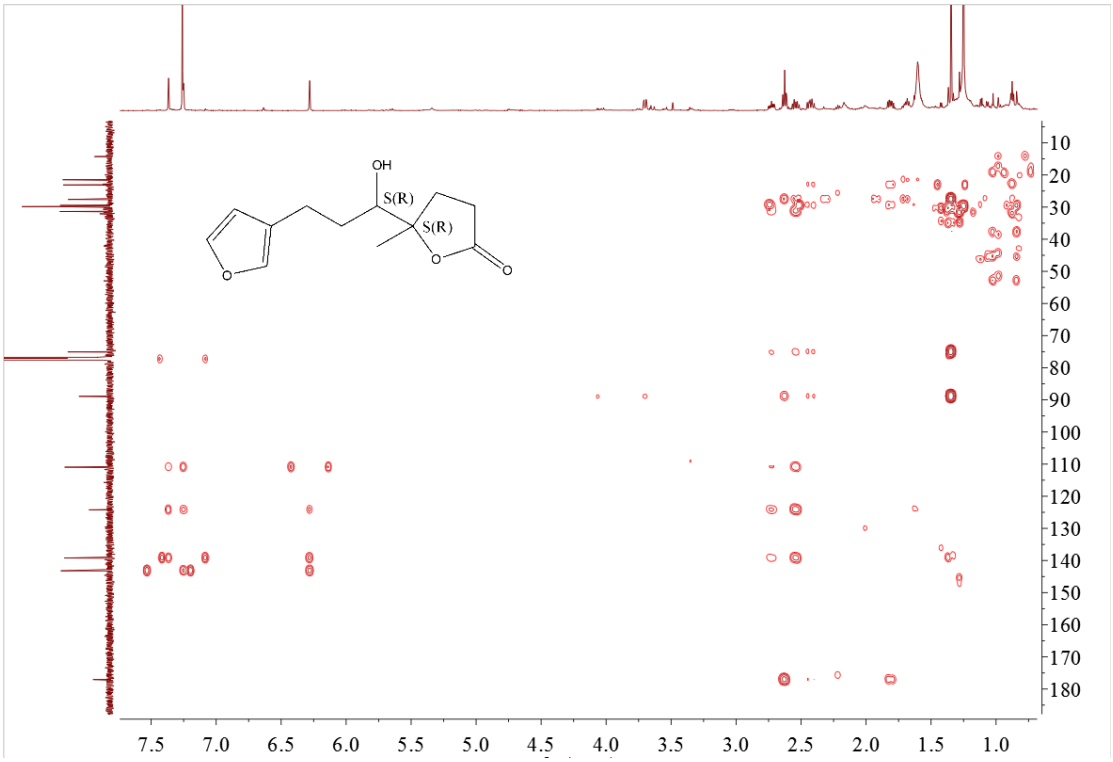


Figure 12b. ^1H NMR spectrum (400 MHz, $CDCl_3$) of natural products **2**

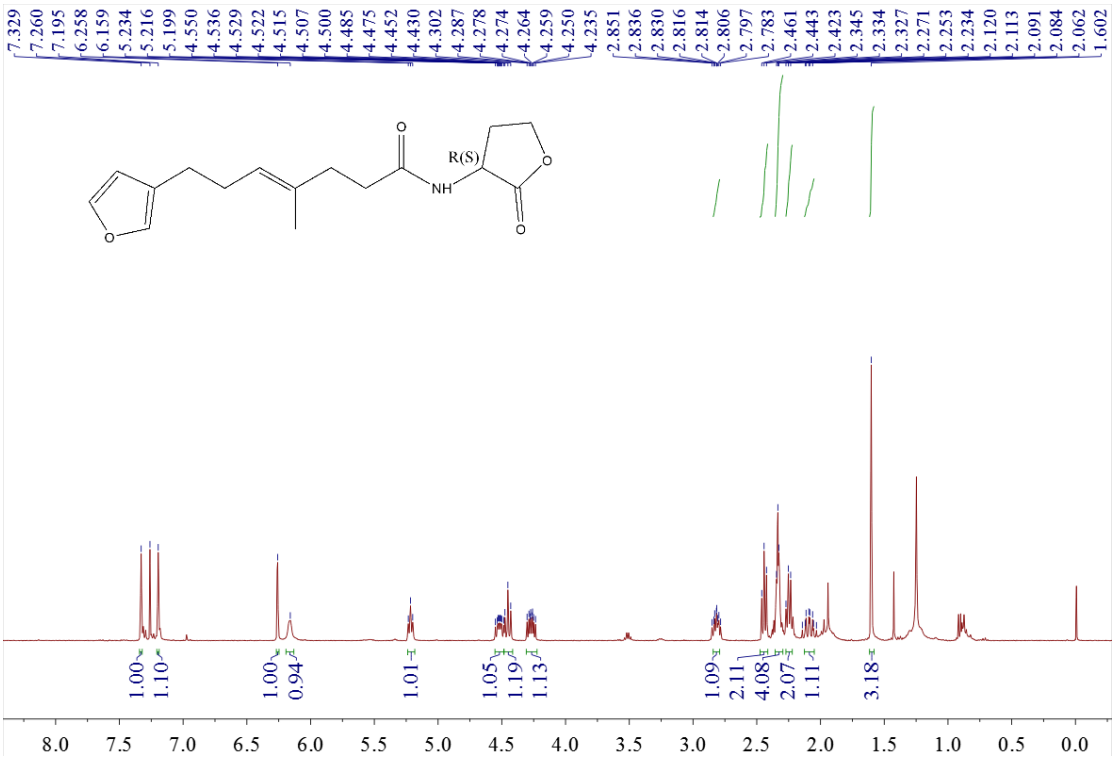


Figure 13a. ^{13}C NMR spectrum (125 MHz, $CDCl_3$) of natural products **2**

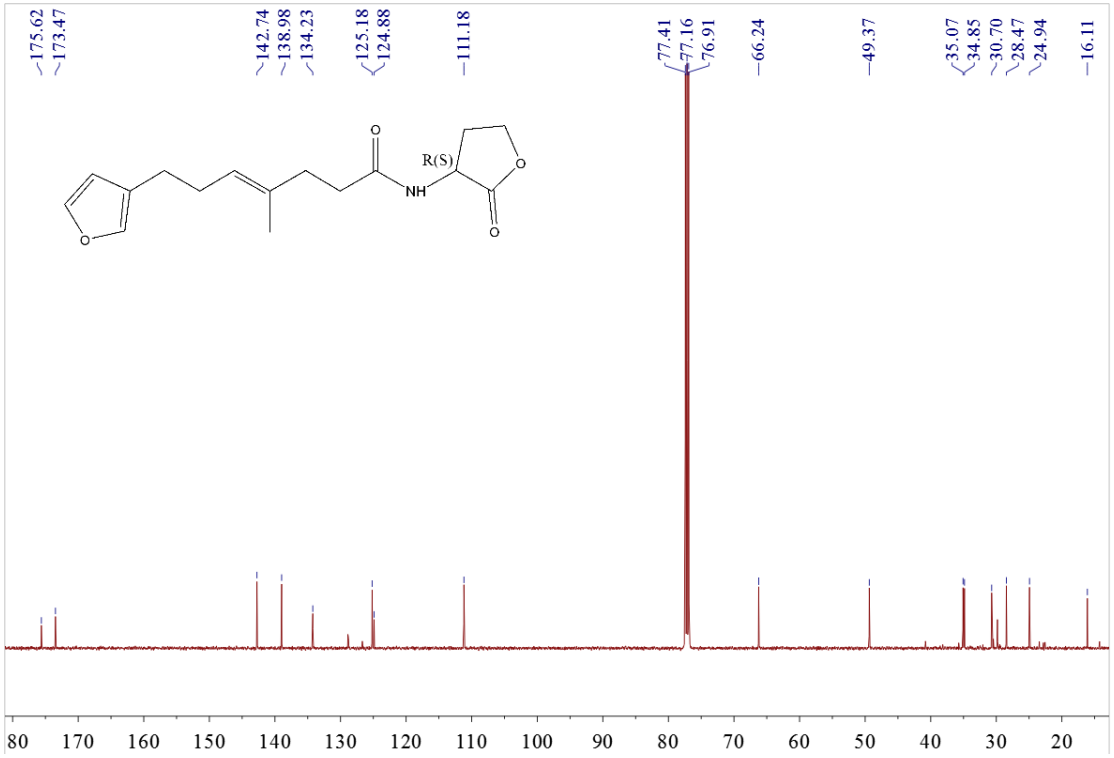


Figure 13b. ^{1}H-^{1}H COSY (400 MHz, $CDCl_3$) of natural products **2**

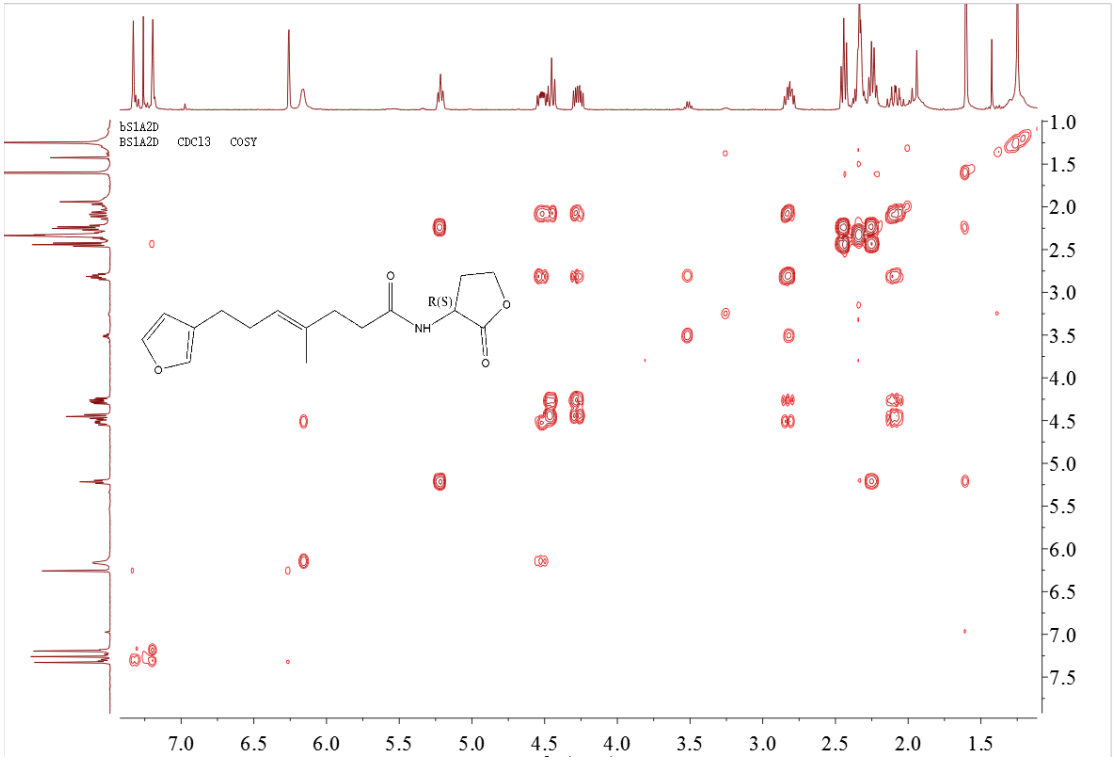


Figure 14a. HSQC (400 MHz, $CDCl_3$) of natural products **2**

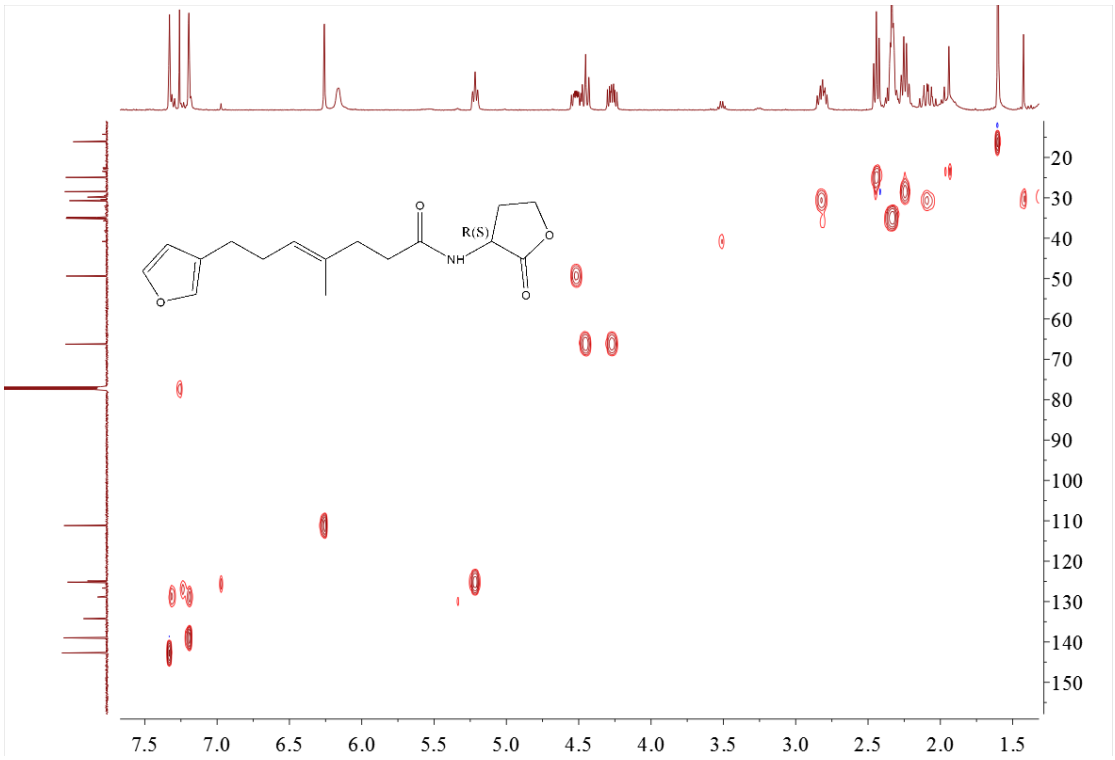


Figure 14b. HMBC (125 MHz, $CDCl_3$) of natural products **2**

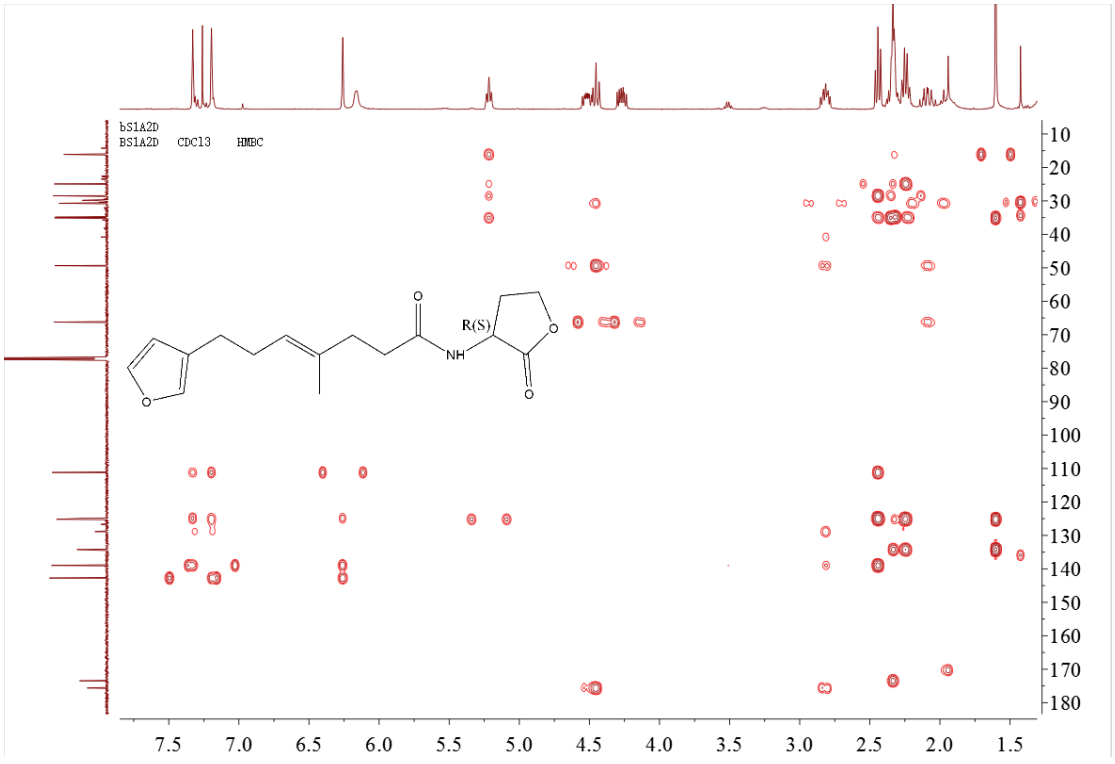


Figure 15a. NOESY (125 MHz, $CDCl_3$) of natural products **2**