Electronic Supplementary Information

Asymmetric Total Synthesis of (+)-*N*-Acetyl Norloline

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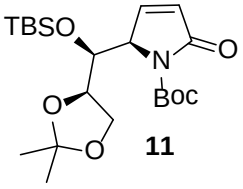
Contents (24 pages)

General Methods. Melting points were uncorrected. Infrared spectra were measured using film KBr pellet techniques. NMR spectra were recorded in $CDCl_3$ with tetramethylsilane (^1H) and $CDCl_3$ (^{13}C) as an internal standard. Chemical shifts are expressed in δ (ppm) units relative to TMS (0 ppm, ^1H) and $CDCl_3$ (77 ppm, ^{13}C). Mass Spectra were obtained using electrospray ionization and an ICR analyzer (ESI-MS) for high resolution mass spectra (HRMS). Silica gel (300-400 mesh) was used for flash column chromatography, eluting (unless otherwise stated) with ethyl acetate/ hexane. Ether and THF were distilled over sodium and benzophenone under Ar. Dichloromethane and was distilled over calcium hydride under Ar.

***tert*-Butyl (*R*)-2-((*S*)-((*tert*-butyldimethylsilyl)oxy)((*R*)-2,2-dimethyl-1,3-dioxolan -4-yl)methyl)-5-oxo-2,5-dihydro-1*H*-pyrrole-1-carboxylate (11)**

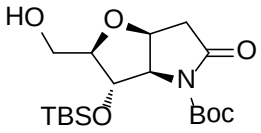


11

To a solution of the known lactam **9** (626 mg, 2.00 mmol, 1.0 equiv), prepared by the Rassu/ Casiraghi's vinylogous Mukaiyama-type aldol reaction,[1] in dry DMF (10 mL) at 0 °C under argon atmosphere were added TBSCl (3.02 g, 20.0 mmol, 10.0 equiv) and imidazole (1.36 g, 20. 0 mmol, 10.0 equiv). The mixture was allowed to warm to 5 °C. After being stirred for 12 h, two other portions of TBSC1 (2 × 755 mg, 2 × 5.00 mmol, 2.5 equiv) and imidazole (2 × 340 mg, 2 × 5.00 mmol, 2.5 equiv) were added. After being stirred at 5 °C for an additional 20 h, the mixture was quenched with 5% aqueous citric acid (20 mL). The resulting slurry was extracted with Et_2O (3 × 20 mL) and the combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: EtOAc/ Hexane = 1:10) to give the known compound **11**[2] (700 mg, yield: 82%). Mp: 140-142 °C; $[\alpha]_D^{20}$ +179.2 (*c* 1.0, $CHCl_3$); {lit.[2]: Mp: 140-142 °C; $[\alpha]_D^{20}$ +180.4 (*c* 0.92, $CHCl_3$)} IR (film) ν_{max}: 2983, 2955, 2931, 2858, 2357, 1789, 1748, 1713, 1700, 1369, 1320, 1255, 1159, 1095, 1076,

838 cm^{-1}; ^{1}H NMR (400 MHz, $CDC1_3$) δ 0.16 (s, 3H), 0.21 (s, 3H), 0.93 (s, 9H), 1.24 (s, 3H), 1.35 (s, 3H), 1.58 (s, 9H), 3.65-3.72 (m, 1H), 3.73-3.80 (m, 1H), 4.60 **(**br t, *J* = 4.7 Hz, 1H), 4.63-4.67 (m, 1H), 6.19 (dd, *J* = 6.1, 1.4 Hz, 1H), 7.28 (dd, *J* = 6.1, 1.9 Hz, 1H); ^{13}C NMR (100 MHz, $CDC1_3$) δ -4.8, -4.4, 17.8, 24.9, 25.6 (3C), 26.3, 28.2 (3C), 65.1, 66.0, 71.1, 74.7, 83.2, 108.9, 128.3, 147.3, 149.2, 168.8. HRMS calcd for $C_{15}H_{23}NO_6Na$ $[M+Na]^+$: 450.2282; found: 450.2288.

tert-Butyl (2*R*,3*S*,3a*R*,6a*S*)-3-((_tert_-butyldimethylsilyl)oxy)-2-(hydroxymethyl)-5-oxotetrahydro-2*H*-furo[3,2-*b*]pyrrole-4(5*H*)-carboxylate (13)



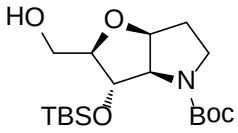
13

To a solution of compound **11** (427 mg, 1.00 mmol, 1.0 equiv) in MeOH (20 mL) at 0 °C was added 2 N HCl (0.2 mL) dropwise. After being stirred for 10 min at the same temperature, the reaction was allowed to warm to room temperature and stirred for 10 h. Then the reaction was quenched with a saturated aqueous $NaHCO_3$ (5 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure**.** The residue was used in the next step without further purification.

Then the resulting residue was dissolved in anhydrous THF (20 mL) at 0 °C and DBU (0.22 mL, 1.50 mmol, 1.5 equiv) was added dropwise. After being stirred for 20 min at the same temperature, the reaction allowed to warm to room temperature and stirred for 6 h. Then the mixture was concentrated under reduced pressure. The resulting residue was purified by flash chromatography on silica gel (eluent: EtOAc / Hexane = 1:1) to give compound **13** (271 mg, yield: 70%) as a white solid. Mp: 100-101 °C; $[\alpha]_D^{20}$ +50.7 (*c* 1.0, $CHCl_3$); IR (film) ν_{max}: 3445, 2958, 2929, 2856, 1770, 1759, 1369, 1247, 1153, 1064, 838, 773 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.11 (s, 3H), 0.18 (s, 3H), 0.90 (s, 9H) 1.55 (s, 9H), 2.22 (br s, 1H), 2.58-2.72 (m, 2H), 3.56 (dd, *J* = 11.6

Hz, 4.8 Hz, 1H), 3.71 (dd, *J* = 11.6 Hz, 2.4 Hz, 1H), 3.80-3.92 (m, 1H), 4.24 (d, *J* = 4.8 Hz, 1H), 4.34 (d, *J* = 3.8 Hz, 1H), 4.63-4.69 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.3, -4.6, 17.8, 25.7 (3C), 27.9 (3C), 39.1, 62.3, 71.2, 73.3, 77.0, 83.5, 88.3, 150.5, 171.6; HRMS calcd for $C_{18}H_{33}N_2O_6SiNa$ $[M+Na]^+$: 410.1969; found: 410.1973.

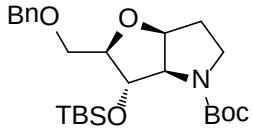
tert-Butyl (2*R*,3*S*,3a*R*,6a*S*)-3-((_tert_-butyldimethylsilyl)oxy)-2-(hydroxymethyl)-tetrahydro-2*H*-furo[3,2-*b*]pyrrole-4(5*H*)-carboxylate (14)



14

To a solution of compound **13** (120 mg, 0.31 mmol, 1.0 equiv) in anhydrous THF (15 mL) at 0 °C was added borane dimethylsulfide (2.0 M in THF, 0.47 mL, 0.93 mmol, 3.0 equiv) via syringe. The mixture was heated to reflux for 2 h. Then the reaction was cooled to room temperature and quenched with a saturated aqueous NH_4Cl (4 mL) and the aqueous layer was extracted with Et_2O (3 × 15 mL). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: EtOAc/ Hexane = 1:2) to give compound **14** (98 mg, yield: 85%) as a white solid. Mp: 91-92 °C. $[\alpha]_D^{20}$ +73.3 (*c* 1.0, $CHCl_3$); IR (film) ν_{max}: 3445, 2954, 2930, 2857, 1698, 1682, 1473, 1463, 1397, 1367, 1252, 1225, 1111, 1046, 857 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$, mixture of rotamers) δ 0.11 and 0.19 (br 2s, 6H), 0.89 (s, 9H), 1.47 (s, 9H), 1.72-1.84 (m, 1H), 1.91-2.06 (m, 2H), 3.14-3.38 (m, 1H), 3.49 (dd, *J* = 11.3, 7.4 Hz, 1H), 3.53-3.83 (m, 2H), 3.92 and 3.96 (br 2s, 2H), 4.22 (br s, 1H), 4.69-4.96 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$, mixture of rotamers) δ -5.3, -4.5, 17.8, 25.7 (3C), 28.4 (3C), 29.7, 30.3, 45.3, 63.0, 70.7, 77.4, 79.4, 80.4, 82.5, 83.7, 88.6, 154.1; HRMS calcd for $C_{18}H_{35}NO_5SiNa$ $[M+Na]^+$: 396.2177; found: 396.2177.

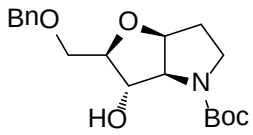
***tert*-Butyl (2*R*,3*S*,3a*R*,6a*S*)-2-((benzyloxy)methyl)-3-((tert-butyldimethylsilyl)oxy) tetrahydro-2*H*-furo[3,2-*b*] pyrrole-4(5*H*)-carboxylate (15)**



15

To a suspension of NaH (37 mg, 0.92 mmol, 3.0 equiv) and TBAI (11 mg, 0.031 mmol, 0.1 equiv) in anhydrous THF (8 mL) at 0 °C was added a solution of compound **14** (115 mg, 0.308 mmol, 1.0 equiv) in anhydrous THF (2 mL), After 10 min of stirring at 0 °C, BnBr (73 uL, 0.62 mmol, 2.0 equiv) was added, and the reaction was heated to 40 °C and stirred for 3 h. Then the reaction was quenched with H_2O (3 mL) and the aqueous layer was extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: EtOAc/ Hexane = 1:5) to give compound **15** (137 mg, yield: 96%) as a colorless oil. $[\alpha]_D^{20}$ +62.5 (*c* 1.0, $CHCl_3$); IR (film) ν_{max}: 2954, 2929, 2892, 2856, 2363, 1768, 1697, 1476, 1393, 1366, 1250, 1176, 1105, 1045, 1028, 837 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$, mixture of rotamers) δ 0.04-0.19 (m, 6H), 0.86 (s, 9H), 1.44 and 1.49 (br 2s, 9H), 1.70-1.78 (m, 1H), 1.98-2.06 (m, 1H), 3.18-3.29 (m, 1H), 3.30-3.48 (m, 2H), 3.48-3.58 (m, 0.6H), 3.70 (t, *J* = 9.3 Hz, 0.4H), 3.88 and 3.93 (br 2s, 1H), 3.98 and 4.06 (br 2s, 1H), 4.24 and 4.37 (br 2s, 1H), 4.47-4.60 (m, 2H), 4.73 and 4.79 (br 2s, 1H), 7.23-7.38 (m, 5H); ^{13}C NMR (125 MHz, $CDCl_3$, mixture of rotamers) δ -5.3, -4.5, 17.8, 25.6 (3C), 25.8 (3C), 28.4 (3C), 28.7 (3C), 29.7, 30.3, 45.2, 45.5, 70.3, 70.4, 70.5, 73.2, 78.1, 78.4, 79.1, 80.1, 82.6, 83.7, 87.0, 87.2, 127.5, 127.6, 128.1, 128.3, 138.1, 154.1, 154.3; HRMS calcd for $C_{25}H_{41}NO_5SiNa$ $[M+Na]^+$: 486.2646; found: 486.2650.

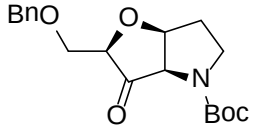
***tert*-Butyl (2*R*,3*S*,3a*S*,6a*S*)-2-((benzyloxy)methyl)-3-hydroxytetrahydro-2*H*-furo [3,2-*b*]pyrrole-4(5*H*)-carboxylate (16)**



16

To a solution of compound **15** (137 mg, 0.296 mmol, 1.0 equiv) in anhydrous THF (8 mL) at 0 °C was added TBAF (1.0 M in THF, 0.45 mL, 0.45 mmol, 1.5 equiv) dropwise. After being stirred for 30 min at the same temperature, the reaction was allowed to warm to room temperature and stirred for 4 h. Then the reaction was quenched with a saturated aqueous NH_4Cl (3 mL) and the aqueous layer was extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: EtOAc/ Hexane = 3:2) to give compound **16** (97 mg, yield: 94%) as a colorless oil. $[\alpha]_D^{20}$ +86.2 (*c* 1.0, $CHCl_3$); IR (film) ν_{max}: 3418, 2995, 1770, 1384, 1241, 1058 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$, mixture of rotamers) δ 1.46 and 1.50 (br 2s, 9H), 1.79-1.95 (m, 1H), 2.00-2.11 (m, 1H), 2.32 (d, *J* = 2.3 Hz, 0.33H), 3.21 (br s, 0.63H), 3.29-3.39 (m, 1H), 3.47-3.72 (m, 3H), 3.84-3.97 (m, 2H), 3.98-4.10 (m, 1H), 4.54-4.64 (m, 2H), 4.66-4.74 (m, 1H), 7.24-7.38 (m, 5H); ^{13}C NMR (125 MHz, $CDCl_3$, mixture of rotamers) δ 28.4 (3C), 28.5 (3C), 29.8, 30.5, 44.5, 45.0, 70.2, 70.3, 70.8, 71.1, 73.3, 73.4, 79.1, 78.0, 80.0, 80.2, 81.6, 82.9, 84.5, 84.8, 127.5, 127.6, 127.7, 128.2, 128.3, 137.8, 138.0, 153.7, 155.0; HRMS calcd for $C_{19}H_{27}NO_5Na$ $[M+Na]^+$: 372.1781; found: 372.1779.

tert-Butyl (2*R*,3a*R*,6a*S*)-2-((benzyloxy)methyl)-3-oxotetrahydro-2*H*-furo[3,2-*b*] pyrrole-4(5*H*)-carboxylate (17)

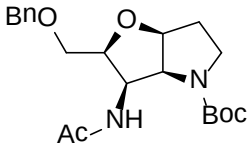


17

To a solution of oxalyl chloride (0.09 mL, 1.0 mmol, 2.0 equiv) in anhydrous CH_2Cl_2 (5 mL) at –78 °C was added DMSO (0.14 mL, 2.0 mmol, 4.0 equiv) dropwise. After

30 min of stirring at –78 °C, a solution of compound **16** (175 mg, 0.501 mmol, 1.0 equiv) in CH_2Cl_2 (1 mL) was added dropwise. After being stirred for 1h at –78 °C was added Et_3N (0.55 mL, 4.01 mmol, 8.0 equiv), then the reaction was warmed to 0 °C and stirred for 1 h. The reaction was quenched with H_2O (2 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 5 mL). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: EtOAc/ Hexane = 1:1) to give compound **17** (156 mg, yield: 90%) as a colorless oil. $[\alpha]_D^{20}$ +278.1 (*c* 1.0, $CHCl_3$); IR (film) ν_{max}: 2976, 2929, 2853, 1770, 1697, 1453, 1366, 1168, 1120, 1042, cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$, mixture of rotamers) δ 1.45 and 1.48 (br 2s, 9H), 1.89-2.00 (m, 1H), 2.22 (dd, *J* = 13.0, 5.4 Hz, 1H), 3.42 (ddd, *J* = 17.1, 11.1, 6.0 Hz, 1H), 3.56-3.88 (m, 3H), 4.00-4.36 (m, 2H), 4.51 (d, *J* = 12.2 Hz, 1H), 4.55 (d, *J* = 12.2 Hz, 1H), 4.81-4.88 (m, 1H), 7.23-7.36 (m, 5H); ^{13}C NMR(125 MHz, $CDCl_3$, mixture of rotamers) δ 28.3, 29.7, 31.3, 32.1, 44.8, 45.5, 60.4, 62.3, 69.1, 73.4, 73.7, 80.4, 81.2, 81.3, 127.5, 127.6, 127.7, 128.4, 173.6, 153.9, 154.2, 176.7, 208.0, 208.5; HRMS calcd for $C_{19}H_{25}NO_5Na$ $[M+Na]^+$: 370.1625; found: 370.1624.

***tert*-Butyl (2*S*,3*R*,3a*S*,6a*S*)-3-acetamido-2-((benzyloxy)methyl)tetrahydro-2*H*-furo[3,2-*b*]pyrrole-4(5*H*)-carboxylate (19)**



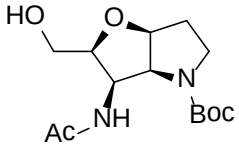
19

To a solution of compound **17** (173 mg, 0.499 mmol, 1.0 equiv) in anhydrous MeOH (5 mL) was added NH_3 (7 N in MeOH, 0.70 mL, 5.0 mmol, 10.0 equiv) and Ti(OPr-*i*)$_4$ (0.44 mL, 1.50 mmol, 3.0 equiv) dropwise. After being stirred for 10 h at the room temperature, the reaction was cooled to –20 °C and $NaBH_4$ (57 mg, 1.50 mmol, 3.0 equiv) was added. After being stirred for 30 min at –20 °C, the reaction was warmed to 0 °C and stirred for 2 h. Then the reaction was quenched with H_2O (3

mL) and the aqueous layer was extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The resulting product was used in the next step without further purification.

The above-mentioned product was dissolved in anhydrous CH_2Cl_2 (10 mL) at 0 °C was added Et_3N (0.21 mL, 1.50 mmol, 3.0 equiv) and Ac_2O (0.10 mL, 1.00 mmol, 2.0 equiv) dropwise. After being stirred for 10 min at 0 °C, the reaction mixture was heated to 38 °C and stirred for 10 h. Then the reaction was quenched with a saturated aqueous $NaHCO_3$ (3 mL) and the aqueous layer was extracted with CH_2Cl_2 (3 × 10 mL). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: EtOAc/ Hexane = 3:1) to give compound **19** (146 mg, yield: 75%) as a colorless oil. $[\alpha]_D^{20}$ +90.7 (*c* 1.0, $CHCl_3$); IR (film) ν_{max}: 3323, 2976, 2929, 1697, 1539, 1297, 1478, 1454, 1404, 1366, 1334, 1238, 1168, 1112, 993, 738 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$, mixture of rotamers) δ 1.42 (s, 9H), 1.85-2.13 (m, 5H), 3.16-3.38 (m, 1H), 3.39-3.80 (m, 2.42H), 3.80-3.99 (m, 1.32H), 4.16-4.29 (m, 0.27H), 4.43-4.57 (m, 4H), 4.67-4.95 (m, 1H), 5.47 (br s, 0.62H), 6.65 (br s, 0.27H), 7.26-7.37 (m, 5H); ^{13}C NMR (125 MHz, $CDCl_3$, mixture of rotamers) δ 23.4, 28.2, 30.3, 30.6, 45.7, 46.3, 52.8, 54.7, 64.1, 65.6, 68.7, 73.7, 79.6, 80.4, 80.8, 81.3, 81.9, 83.1, 127.8, 128.4, 130.9, 137.8, 154.2, 155.7, 169.2, 170.1; HRMS calcd for $C_{21}H_{30}N_2O_5Na$ $[M+Na]^+$: 413.2047; found: 413.2051.

tert-Butyl (2*S*,3*R*,3a*S*,6a*S*)-3-acetamido-2-(hydroxymethyl)tetrahydro-2*H*-furo [3,2-*b*]pyrrole-4(5*H*)-carboxylate (20)

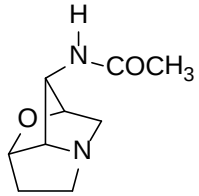


20

To a mixture of the 20% $Pd(OH)_2/C$ (29 mg, 20% wt) in MeOH (3 mL) was added **19** (146 mg, 0.374 mmol, 1.0 equiv) in MeOH (2 mL) dropwise. The reaction vessel was

degassed under vacuum and thoroughly purged with hydrogen. The mixture was stirred under hydrogen atmosphere for 8 h, the catalyst was filtered off. The filter was washed with MeOH (2× 10 mL), dried with Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: EtOAc/ MeOH = 10:1) to give the **20** (110 mg, yield: 98%) as a white solid. Mp: 166-168 °C; $[\alpha]_D^{20}$ +103.1 (*c* 1.0, $CHCl_3$); IR (film) ν_{max}: 3339, 2966, 2929, 2855, 1697, 1678, 1550, 1408, 1367, 1258, 1167, 1117, 1095, 1041, 800 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$, mixture of rotamers) δ 1.34-1.50 (m, 9H), 1.89-2.10 (m, 5H), 2.57-3.37 (m, 2H), 3.50-3.98 (m, 4H), 4.43-4.70 (m, 3H), 5.72 and 6.01 (br 2s, 0.7H), 6.54 and 6.79 (br 2s, 0.3H); ^{13}C NMR (125 MHz, $CDCl_3$, mixture of rotamers) δ 23.2, 28.2, 29.7, 30.2, 31.9, 46.1, 52.9, 54.4, 60.0, 61.9, 64.1, 80.7, 82.0, 82.8, 154.3, 171.4, 174.9; HRMS calcd for $C_{14}H_{24}N_2O_5Na$ $[M+Na]^+$: 323.1577; found: 323.1580.

(+)-*N*-acetyl norloline (3)



(+)-*N*-acetyl norloline

3

To a solution of compound **20** (30 mg, 0.10 mmol, 1.0 equiv) in anhydrous CH_2Cl_2 (3 mL) at –20 °C were added Et_3N (15 uL, 0.11 mmol, 1.1 equiv), after 5 min at the same temperature was added MsCl (8 uL, 0.10 mmol, 1.0 equiv) in anhydrous CH_2Cl_2 (0.2 mL). The reaction mixture was stirred at the same temperature until TLC indicated complete consumption of starting material, then was added TFA (0.3 mL) dropwise at –20 °C. After being stirred for 10 min at the same temperature, the reaction was allowed to warm to room temperature and stirred for 2 h which the starting material has been exhausted as monitored by TLC. The reaction mixture was concentrated under stream of argon gas over 1 h. The resulting residue was dissolved in MeCN (4 mL) and K_2CO_3 (83 mg, 0.60 mmol, 6.0 equiv) was added, the mixture was stirred at room temperature for 10 h under argon atmosphere. The K_2CO_3 was

filtered off, and the organic phase was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: $CHCl_3$ / MeOH = 10:1) to give (+)-*N*-acetyl norloline (**3**) (14 mg, yield: 80%) as a colorless oil. $[\alpha]_D^{20}$ +48.7 (*c* 0.5, $CHCl_3$) {lit.[3] $[\alpha]_D^{20}$ +49.8 (*c* 2.23, $CHCl_3$)}; IR (film) ν_{max}: 3430, 2962, 2847, 1642, 1386, 1260, 1094, 1021 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 4.43 (dd, *J* = 4.6,1.7 Hz, 1H), 4.41 (dd, *J* = 5.6, 1.4 Hz, 1H), 4.17 (d, *J* = 1.1 Hz, 1H), 3.31 (d, *J* = 11.9 Hz, 1H), 3.15 (m, 1H), 3.09 (ddd, *J* = 12.5, 8.5, 3.2 Hz, 1H), 2.93 (ddd, *J* = 12.5, 9.2, 7.3 Hz, 1H), 2.43 (d, *J* = 11.9 Hz, 1H), 1.98 (dddd, *J* = 14.4, 9.4, 4.3, 3.4 Hz, 1H), 1.95 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.5, 80.8, 73.8, 69.7, 61.0, 57.6, 54.5, 33.6, 23.1; HRMS calcd for $C_9H_{15}N_2O_2$ $[M+H]^+$: 183.1128; found: 183.1126.

Table 1. Comparison of ^{1}H NMR data of synthetic and natural samples of (+)-*N*-acetyl norloline

^{1}H NMR (400 MHz, $CDCl_3$)		^{1}H NMR (600 MHz, $CDCl_3$)
synthetic (±)-*N*-acetyl norloline reported by Scheerer[4]	semi-synthetic (+)-*N*-acetyl norloline reported by Powell[5]	this work
4.46-4.48 (dd, *J* = 4.4, 1.9 Hz, 1H)	4.44 (dd, *J* = 4.3, 1.3 Hz, 1H)	4.43 (dd, *J* = 4.6, 1.7 Hz, 1H)
4.44 (m, 1H)	4.41 (dd, *J* = 2.5, 1.6 Hz, 1H)	4.41 (dd, *J* = 5.6, 1.4 Hz, 1H)
4.18 (m, 1H)	4.17 (dd, *J* = 2.5, 1.0 Hz, 1H)	4.17 (d, *J* = 1.1 Hz, 1H)
3.30-3.33 (d, *J* = 11.9 Hz, 1H)	3.29 (dd, *J* = 11.8, 1.0 Hz, 1H)	3.31 (d, *J* = 11.9 Hz, 1H)
3.12 (m, 1H)	3.10 (ddd, *J* = 12.8, 8.3, 3.6 Hz, 1H)	3.09 (ddd, *J* = 12.5, 8.3, 3.4 Hz, 1H)
3.10-3.15 (m, *J* = 3.5 Hz, 1H)	3.09 (dd, *J* = 1.9, 1.6 Hz, 1H)	3.15 (m, 1H)
2.89 (m, *J* = 12.8, 9.4 Hz, 1H)	2.90 (ddd, *J* = 12.8, 9.3, 7.4 Hz, 1H)	2.93 (ddd, *J* = 12.5, 9.2, 7.3 Hz, 1H)
2.43-2.46 (d, *J* = 12.1 Hz, 1H)	2.42 (d, *J* = 11.8 Hz, 1H)	2.43 (d, *J* = 11.9 Hz, 1H)
2.02-2.14 (m, 2H)	2.08 (ddd, *J* = 14.4, 8.3, 7.4 Hz, 1H)	2.07 (ddd, *J* = 14.4, 8.3Hz, 7.3 Hz, 1H)
	1.98 (dddd, *J* = 14.4, 9.3, 4.3, 3.6 Hz, 1H)	1.98 (dddd, *J* = 14.4, 9.4, 4.3, 3.4 Hz, 1H)
1.99 (s, 3H)	1.97 (s, 3H)	1.95 (s, 3H)

Table 2. Comparison of ^{13}C NMR data of synthetic and natural samples of (+)-*N*-acetyl norloline

^{13}C NMR (100 MHz, $CDCl_3$)		^{13}C NMR (150 MHz, $CDCl_3$)
synthetic (±)-*N*-acetyl norloline reported by Scheerer[4]	semi-synthetic (+)-*N*-acetyl norloline reported by Powell[5]	this work
170.29	170.2	170.5
80.96	80.9	80.8
73.75	73.8	73.8
69.67	69.6	69.7
60.94	60.9	61.0
57.56	57.6	57.6
54.61	54.6	54.5
33.87	33.9	33.6
23.21	23.1	23.1

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1. G. Rassu, G. Casiraghi, P. Spanu, L. Pinna, G. G. Fava, M. B. Ferrari and G. Pelosi, *Tetrahedron: Asymmetry*, 1992, **3**, 1035-1048.
2. F. Zanardi, L. Battistini, M. Nespi, G. Rassu, P. Spanu, M. Cornia and G. Casiraghi, *Tetrahedron: Asymmetry*, 1996, **7**, 1167-1180.
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4. M. T. Hovey, E. J. Eklund, R. D. Pike, A. A. Mainkar and J. R. Scheerer, *Org. Lett.*, 2011, **13**, 1246-1249.
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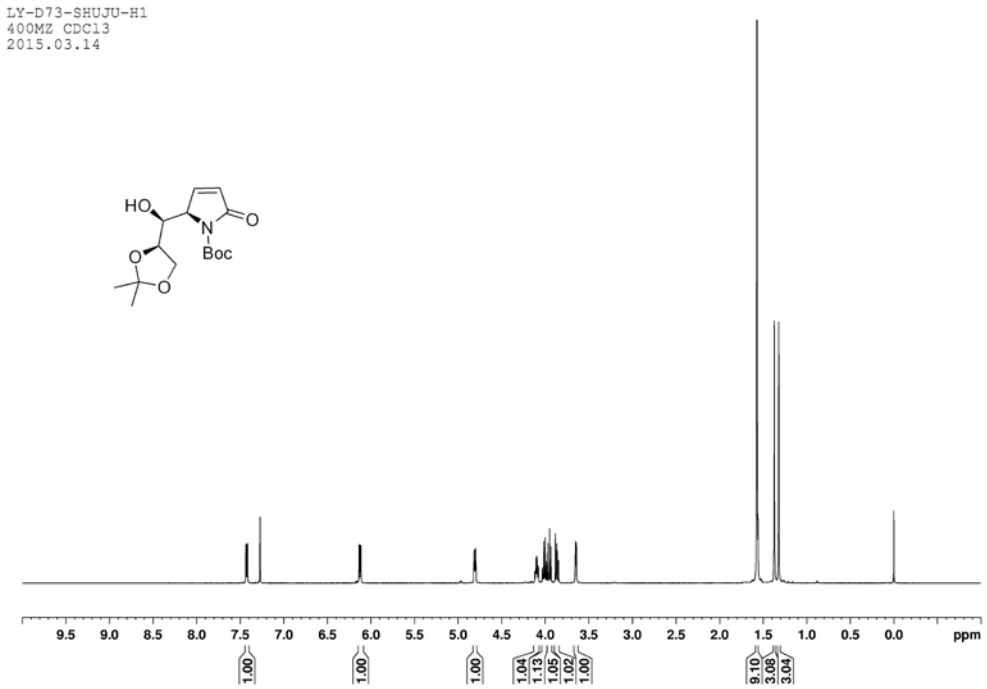
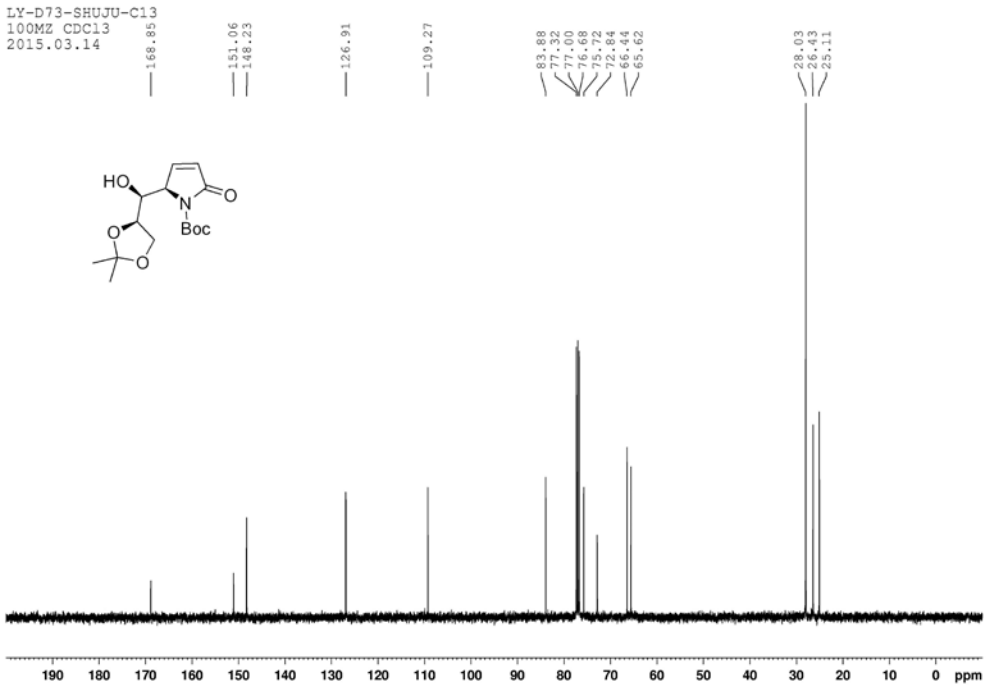
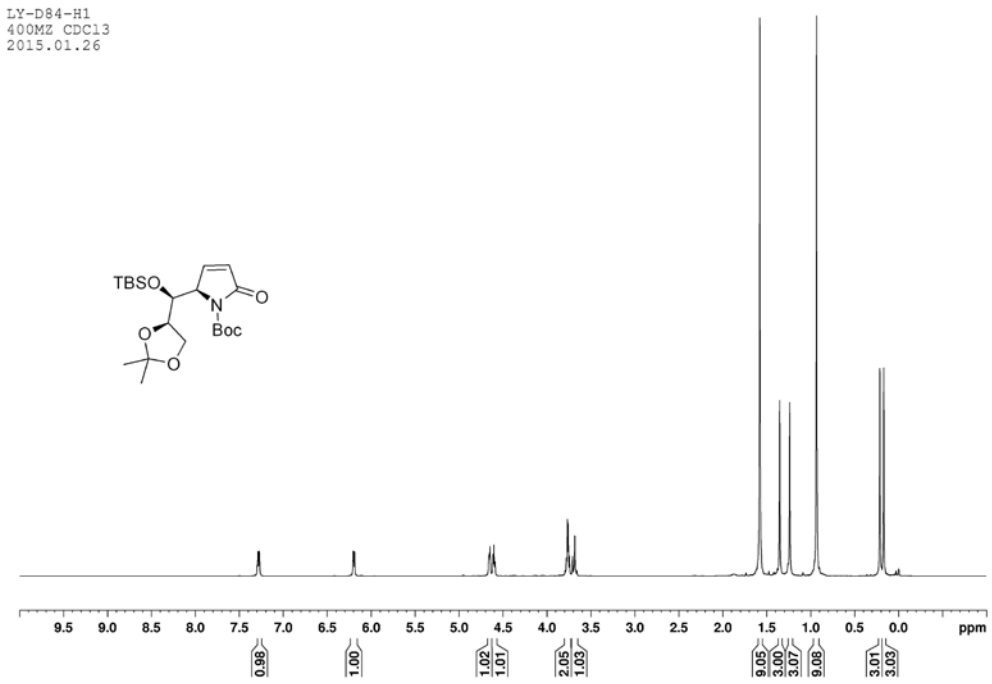
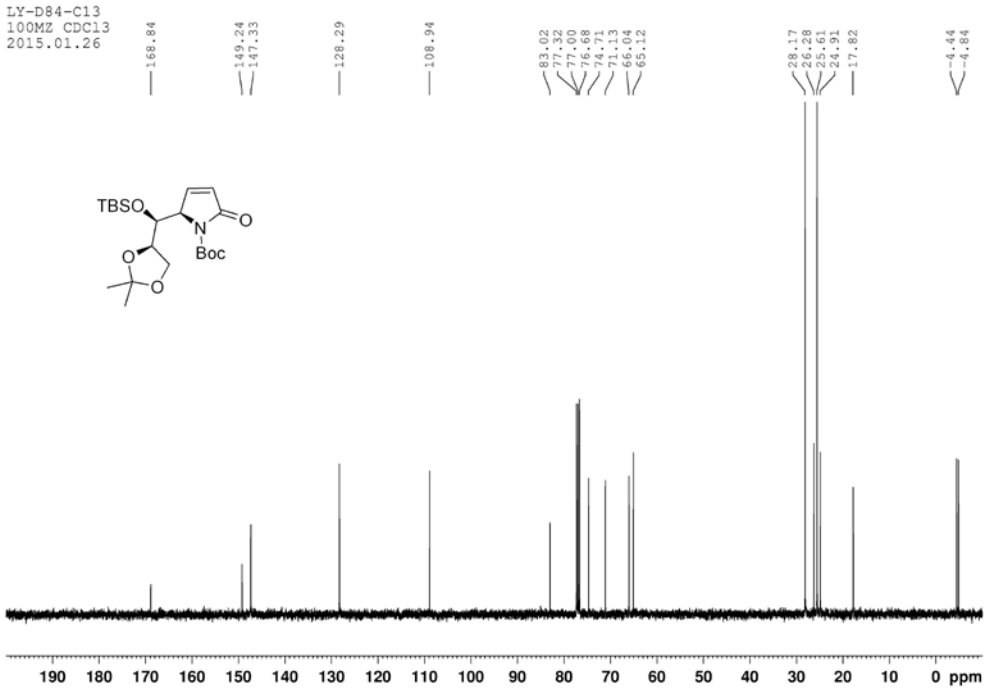
^{1}H and ^{13}C NMR spectra of compound 9



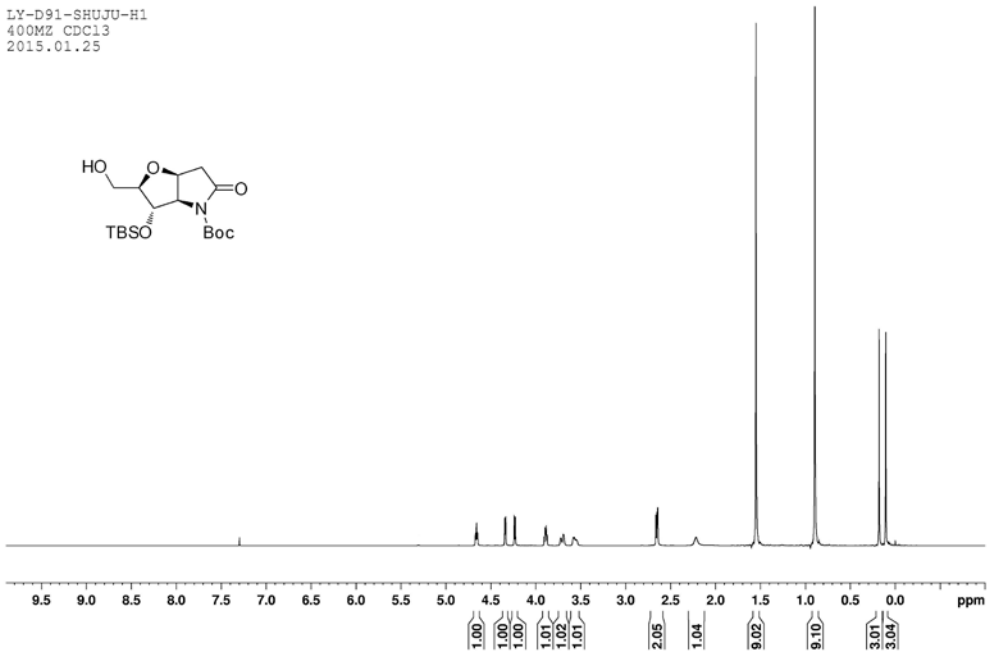


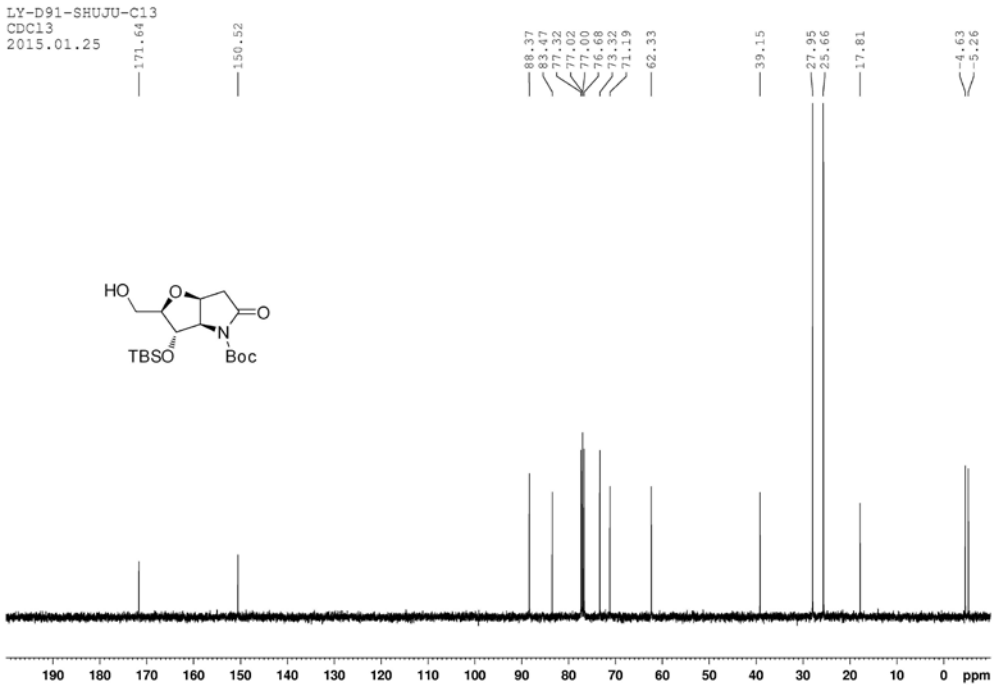
^{1}H and ^{13}C NMR spectra of compound 11



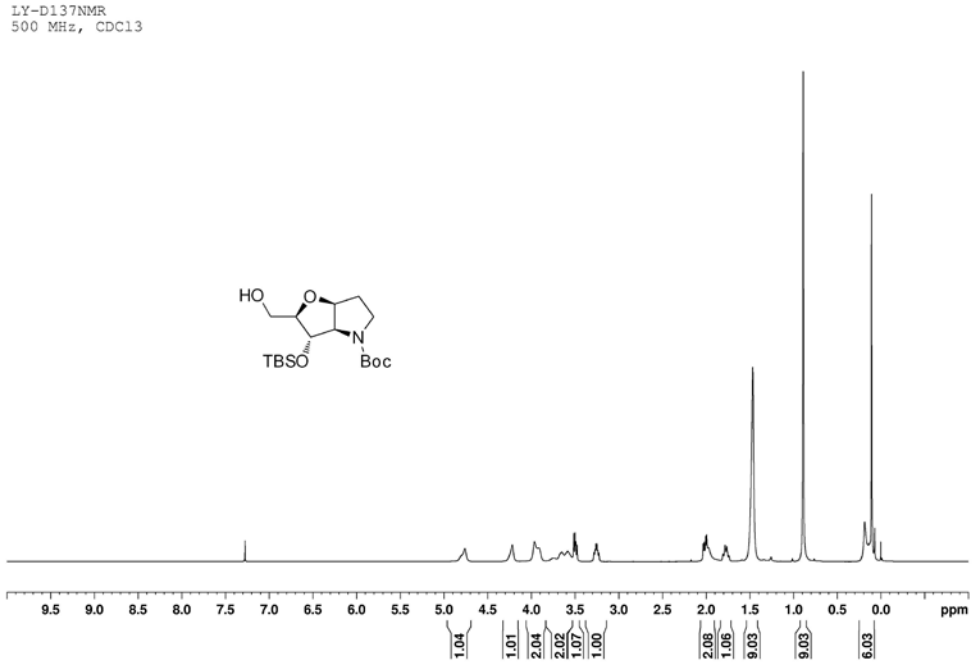


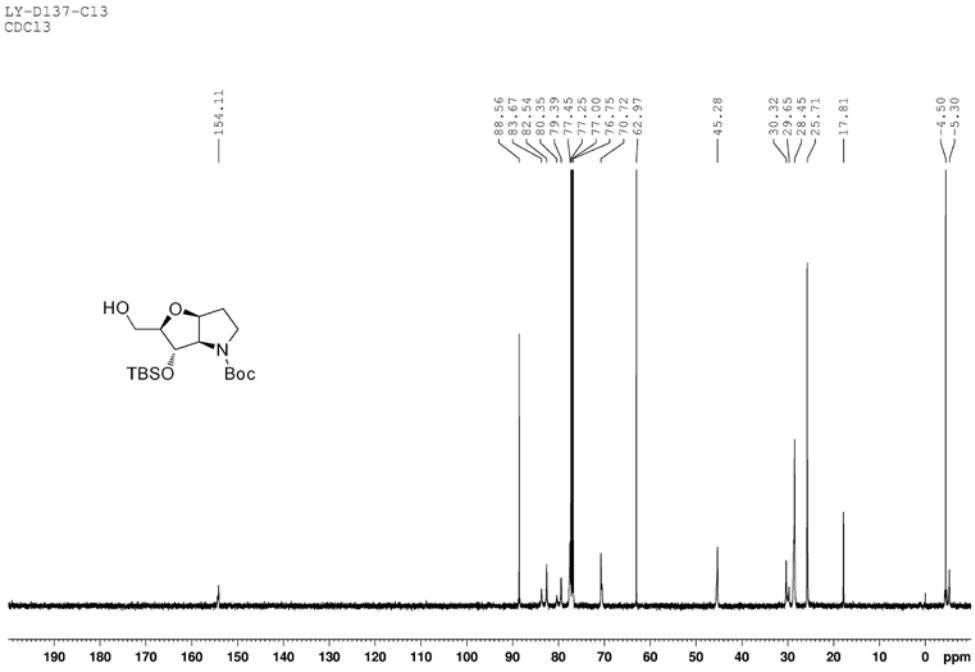
^{1}H and ^{13}C NMR spectra of compound 13



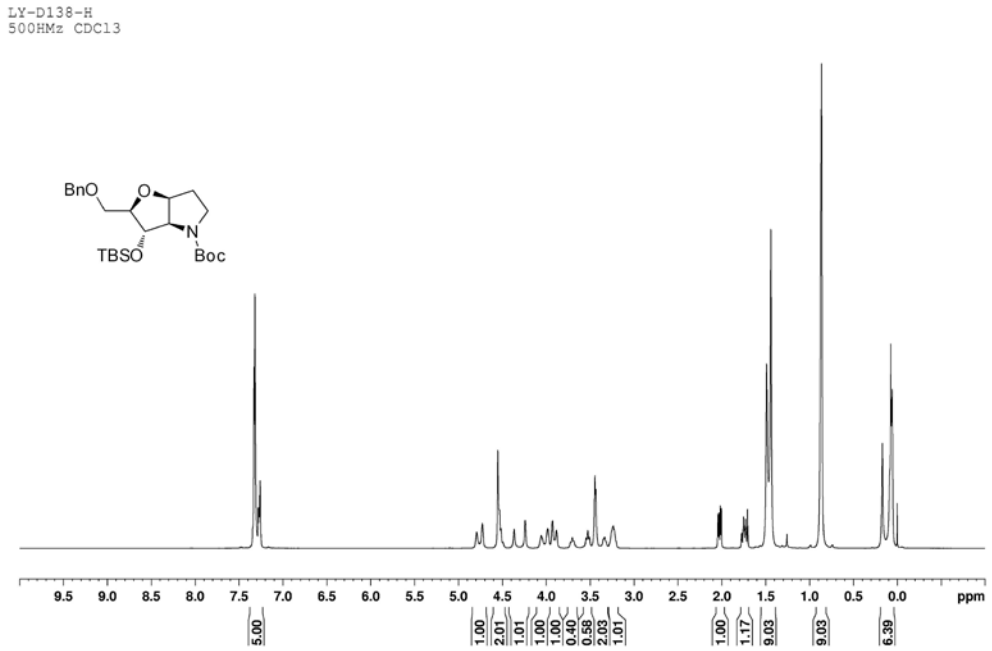


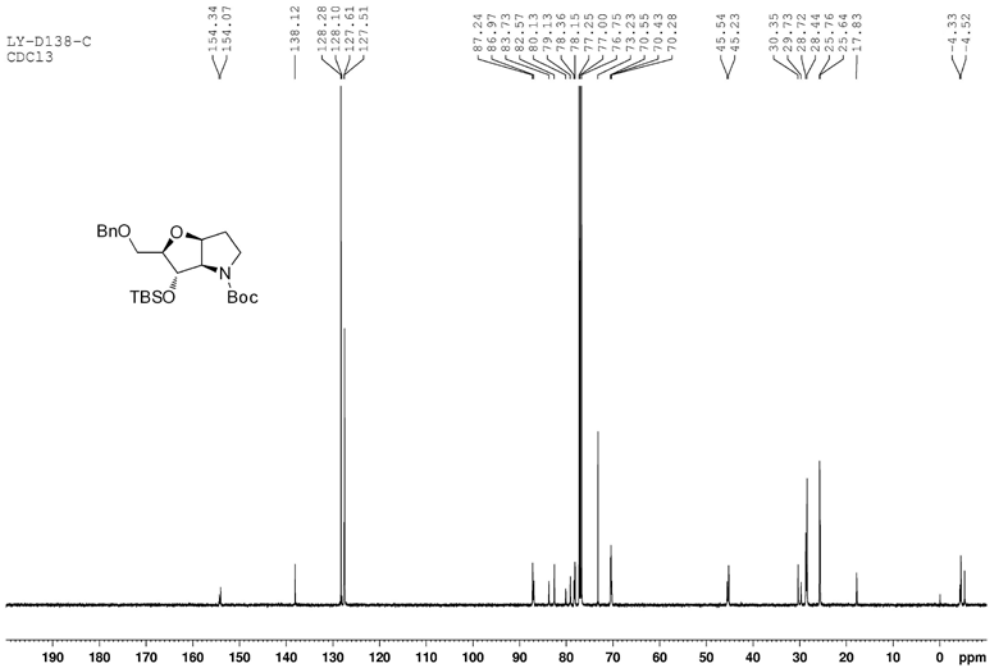
^{1}H and ^{13}C NMR spectra of compound 14



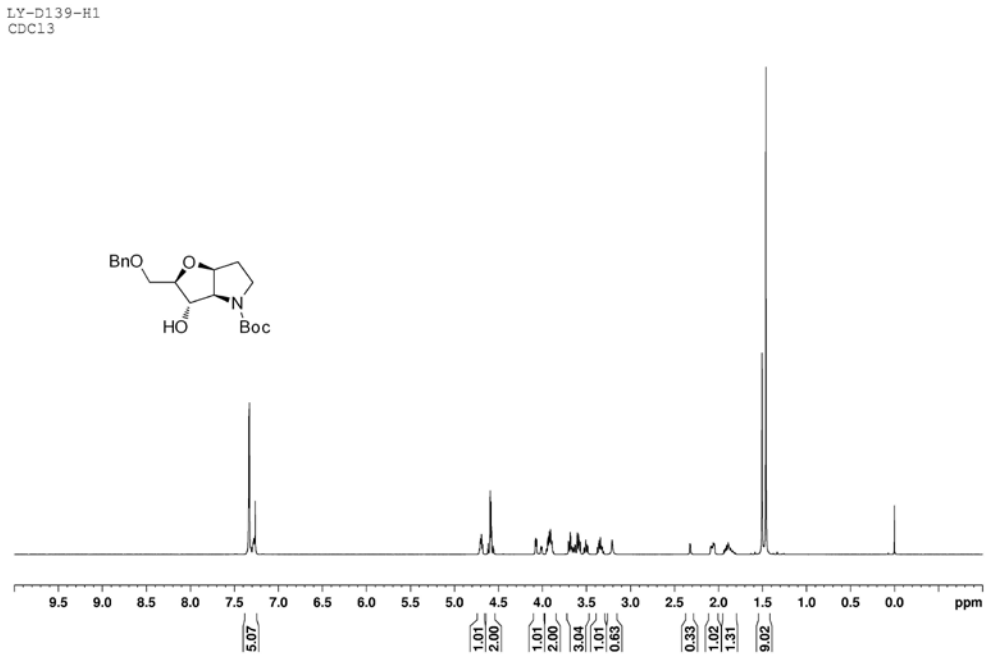


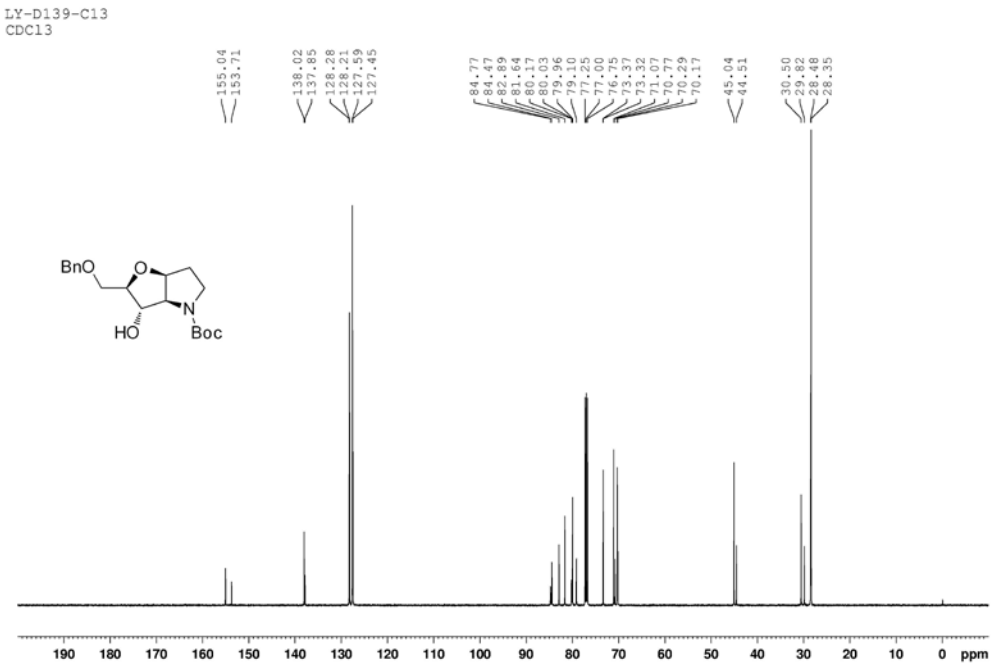
^{1}H and ^{13}C NMR spectra of compound 15



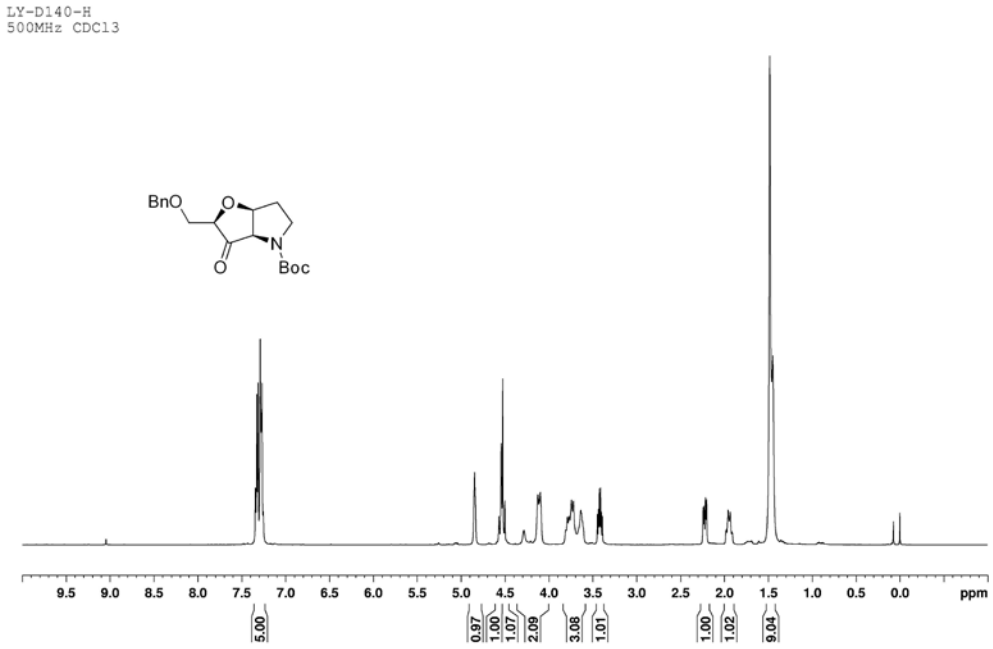


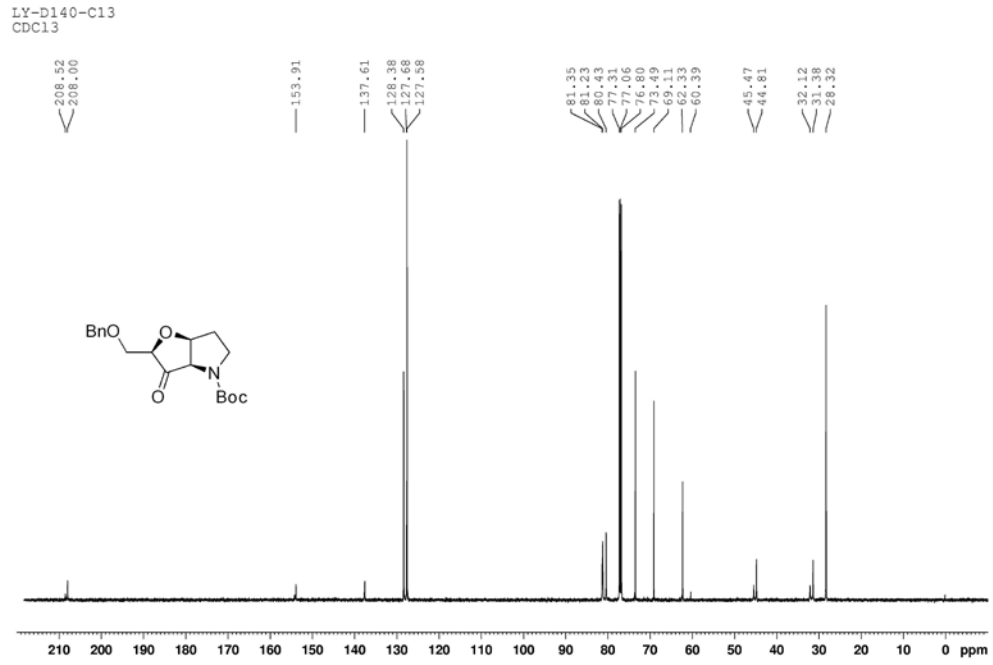
^{1}H and ^{13}C NMR spectra of compound 16



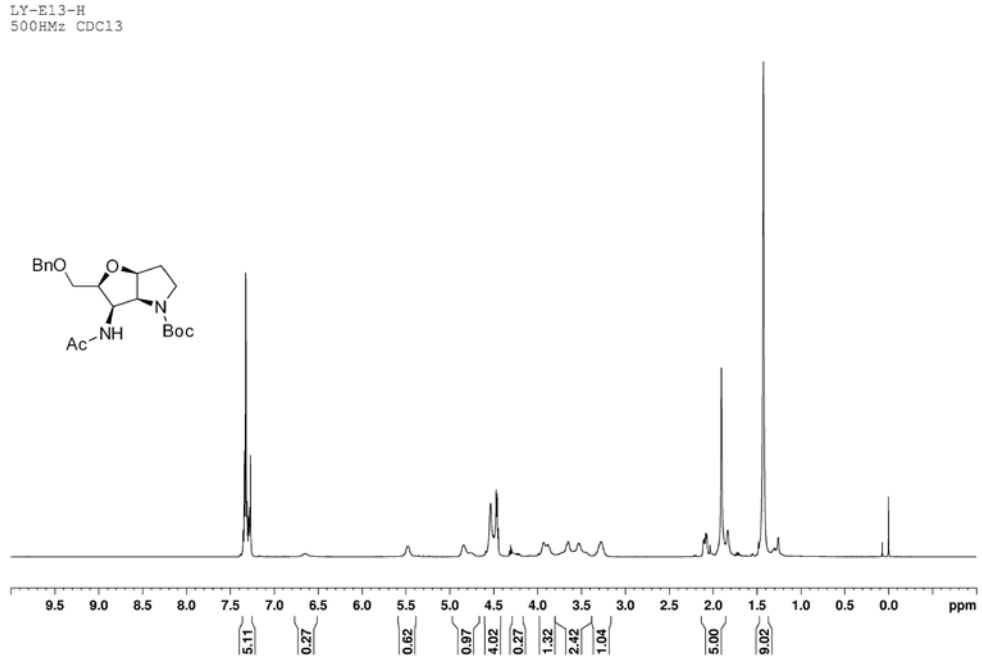


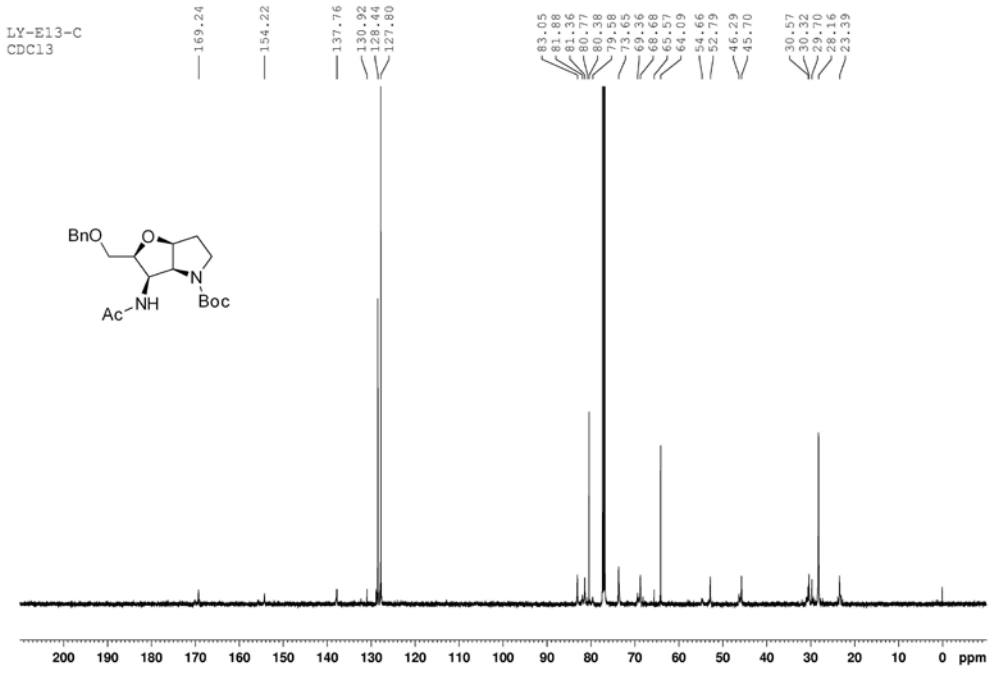
^{1}H and ^{13}C NMR spectra of compound 17



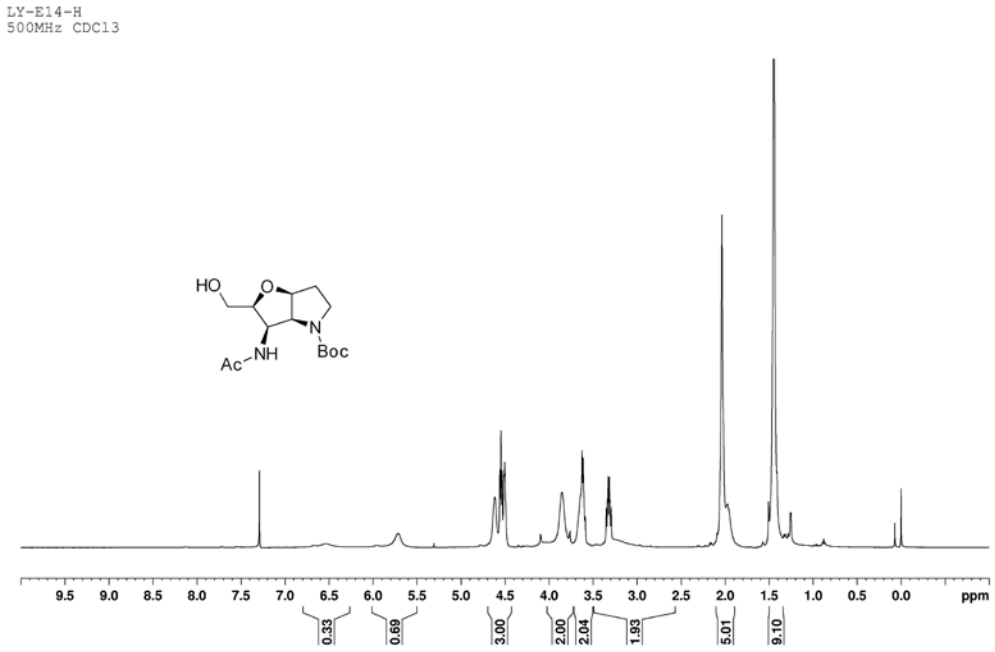


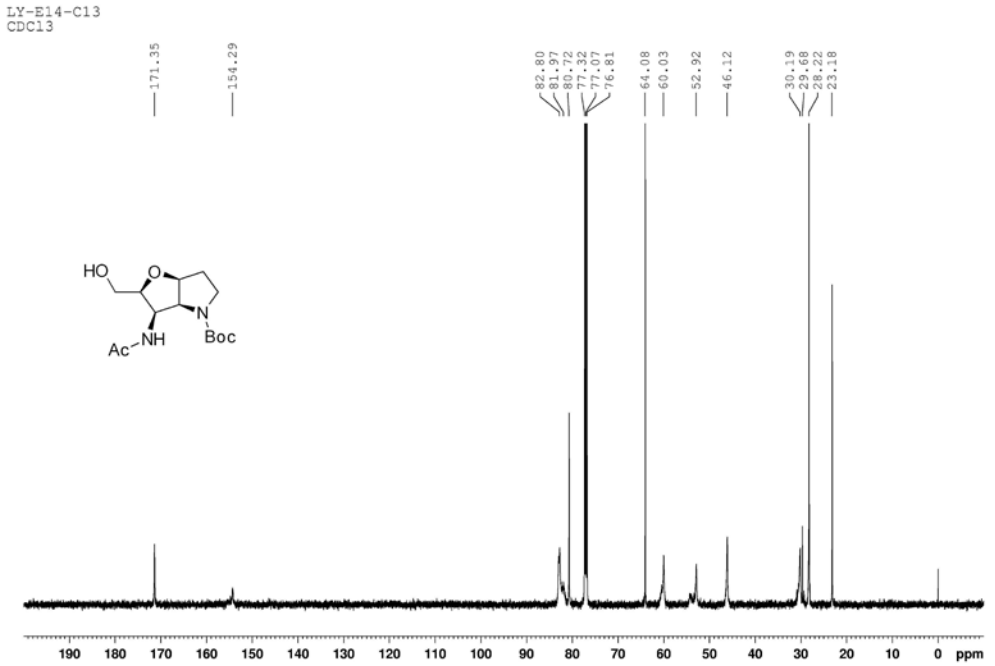
^{1}H and ^{13}C NMR spectra of compound 19



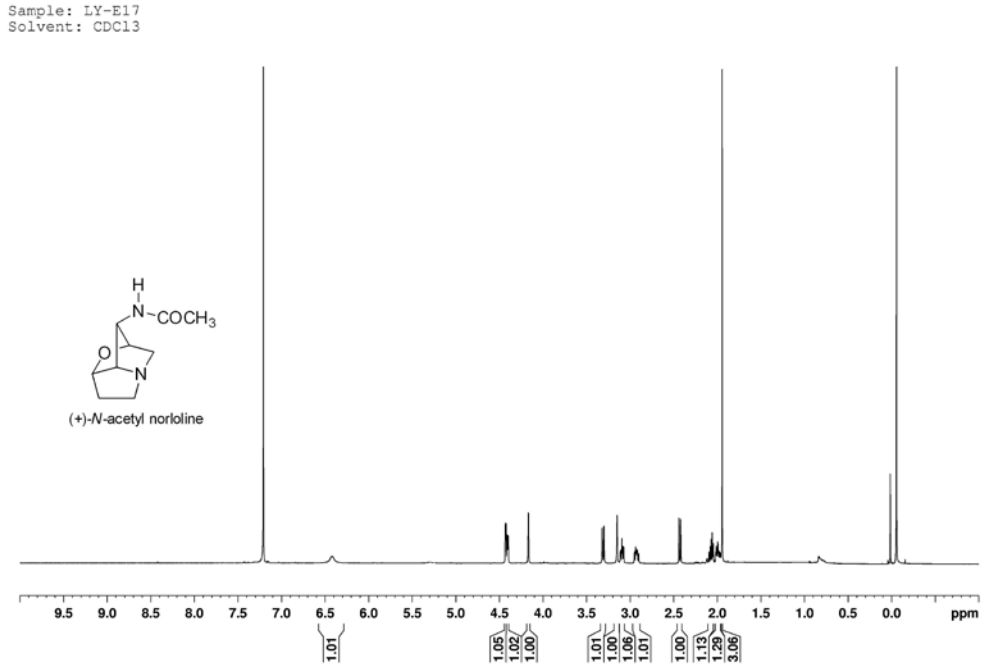


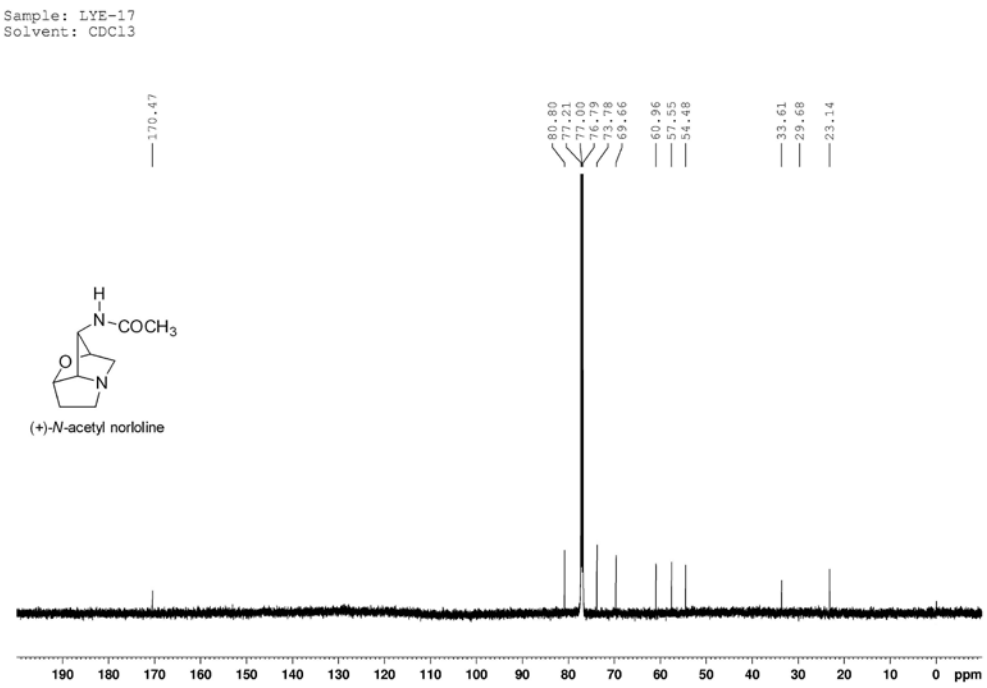
^{1}H and ^{13}C NMR spectra of compound 20



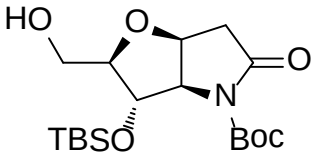


^{1}H and ^{13}C NMR spectra of compound (+)-*N*-acetyl norloline (3)





X-ray structure of compound **13**



13