Diastreoselective Construction of *syn*-α-Oxyamines *via* Copper(I)-Catalyzed Three-Component α-Oxyaldehyde-Dibenzylamine-Alkynes Coupling Reaction: Application in the Synthesis of (+)-β-Conhydrine and Its Analogues

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Supporting Information

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I. Physical Measurements.

^{1}H NMR spectra were recorded at 400 or 500 MHz using TMS as an internal standard and ^{13}C NMR spectra at 100 or 125 MHz using $CDCl_3$ as an internal standard. The following abbreviations are used to describe peak patterns where appropriate: b, broad; s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet. Coupling constants are reported in hertz (Hz). High resolution mass spectra (HRMS) were performed either on an electron spray ionization time-of-flight (ESI-TOF) or on a Matrix-assisted laser desorption/ionization (MALDI-TOF-TOF) mass spectrometer. Melting points were measured with a micro melting point apparatus. HPLC analyses were performed on a HPLC system equipped with C18 columns, detected at 273 nm. Flow phase was acetonitrile/water (95/5 to 90/10), and flow rate was 1.0 mL/min.

II. Experimental

Synthesis of (*R*)-*N*,*N*-dibenzyl-3-(cyclohex-1-en-1-yl)-1-((*S*)-2,2-dimethyl-1,3-dioxolan-4-yl)prop-2-yn-1-amine 15b ($C_{28}H_{33}NO_2$). Following the Method A, reaction of **12** (245 mg, 1.88

mmol) with **13** (374 mg, 1.90 mmol) and alkyne **14b** (200 mg, 1.88 mmol) in dry toluene (5 mL) in the presence of CuBr (14 mg, 0.10 mmol), 4 Å molecular sieves (1.12 g) was carried out. The crude product was subjected to column chromatography over silica gel (*Eluent*: 2% EtOAc in petroleum ether) to furnish **15b** (508 mg, 65%) as colorless oil. IR (KBr) ν (cm^{-1}): 2925,1605, 1494, 1456, 1372, 1257, 1209, 1134, 1070, 1029, 1002 ; $[\alpha]_D^{25}$ = - 158.2 (*c* = 1.0, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.46 (d, *J* = 7.3 Hz, 4H), 7.31 (t, *J* = 7.4 Hz, 4H), 7.23 (t, *J* = 7.3 Hz, 2H), 6.18 - 6.15 (m, 1H), 4.30 (q, *J* = 6.4 Hz, 1H), 4.03 (dd, *J* = 8.2, 6.4 Hz, 1H), 3.91-3.85 (m, 3H), 3.70 (d, *J* = 7.4 Hz, 1H), 3.48 (d, *J* = 13.8 Hz, 2H), 2.21 - 2.17 (m, 2H), 2.16 – 2.12 (m, 2H) 1.72-1.60 (m, 4H), 1.35 (s, 3H), 1.28 (s, 3H) ; ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 139.7(2C), 135.0, 129.0 (4C), 128.3 (4C), 127.0 (2C), 120.4, 109.7, 88.7, 81.2, 76.5, 67.5, 56.1, 55.5 (2C), 29.8, 29.7, 26.7, 25.7, 22.4, 21.6 ; HRMS (ESI) Calcd. for $C_{28}H_{34}NO_2$ 416.2590 $[M + H]^+$, found 416.2583.

Synthesis of (*R*)-*N*,*N*-dibenzyl-1-((*S*)-2,2-dimethyl-1,3-dioxolan-4-yl)-4,4-dimethylpent-2-yn-1-amine 15c ($C_{26}H_{33}NO_2$). Following the Method **A**, reaction of **12** (174 mg, 1.34 mmol) with **13** (213 mg, 1.12 mmol) and alkyne **14a** (100 mg, 1.12 mmol) in dry toluene (5.0 mL) in the presence of CuBr (9 mg, 0.06 mmol), 4 Å molecular sieves (2.00 g) was carried out. The crude product was subjected to column chromatography over silica gel (*Eluent*: 1 % EtOAc in petroleum ether) to furnish **15c** (348 mg, 73%) as colorless solid. Mp.76–78 ^oC, IR (KBr) ν (cm^{-1}): 2958, 2873, 1609, 1585, 1456, 1285, 1121, 1078; $[\alpha]_D^{25}$ = - 133.67 (*c* = 0.3, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.42 (d, *J* = 7.2 Hz, 4H), 7.28 (t, *J* = 7.3 Hz, 4H), 7.20 (t, *J* = 7.1 Hz, 2H), 4.21 (q, *J* = 6.5 Hz, 1H), 3.98 (dd, *J* = 8.2, 6.6 Hz, 1H), 3.82 (dd, *J* = 8.1, 6.6 Hz, 1H), 3.78 (d, *J* = 14.0 Hz, 2H), 3.56 (d, *J* = 7.5 Hz, 1H), 3.43 (d, *J* = 14.0 Hz, 2H), 1.32 (s, 3H), 1.26 (s, 12H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 139.8 (2C), 129.0 (4C), 128.2 (4C), 127.0 (2C), 109.5, 96.0, 76.5, 72.6, 67.6, 55.8, 55.4 (2C), 31.5 (3C), 27.7, 26.7, 25.9; HRMS (ESI) Calcd. for $C_{26}H_{34}NO_2$ 392.2590 $[M + H]^+$, found 392.2589.

Synthesis of (*R*)-*N*,*N*-dibenzyl-1-((*S*)-2,2-dimethyl-1,3-dioxolan-4-yl)-4-methoxybut-2-yn-1-amine 15d ($C_{24}H_{29}NO_3$). Following the Method **A**, reaction of **12** (204 mg, 1.57 mmol) with **13** (272 mg, 1.43 mmol) and alkyne **14d** (100 mg, 1.43 mmol) in dry toluene (8.0 mL) in the presence of CuBr (12 mg, 0.08 mmol), 4 Å molecular sieves (2.00 g) was carried out. The crude product was subjected to column chromatography over silica gel (*Eluent*: 2% EtOAc in petroleum ether) to furnish **15d** (480 g, 88%) as light yellow oil. IR (neat) ν (cm^{-1}): 2928, 1508, 1495, 1371, 1252, 1210, 1187, 1146, 1098, 1028; $[\alpha]_D^{25}$ = - 135.20 (*c* = 1.0, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.43 (d, *J* = 7.2 Hz, 4H), 7.29 (t, *J* = 7.2 Hz, 4H), 7.21 (t, *J* = 7.2 Hz, 2H), 4.29 (q, *J* = 6.3 Hz, 1H), 4.20 (d, *J* = 1.8 Hz, 2H), 4.00 (dd, *J* = 8.2, 6.4 Hz, 1H), 3.89 - 3.85 (m, 3H), 3.62 (d, *J* = 7.2 Hz, 1H), 3.46 (d, *J* = 14.0 Hz, 2H), 3.60 (s, 3H), 1.32 (s, 3H), 1.26 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 139.4 (2C), 129.0 (4C), 128.3 (4C), 127.1 (2C), 109.8, 82.3, 81.4, 76.3, 67.4, 60.1, 57.6, 55.5 (2C), 55.4, 26.6, 25.5; HRMS (ESI) Calcd. for $C_{24}H_{30}NO_3$ $[M + H]^+$ 380.2226, found 380.2224.

Synthesis of (*R*)-*N*,*N*-dibenzyl-4-((tert-butyldiphenylsilyl)oxy)-1-((*S*)-2,2-dimethyl-1,3-dioxolan-4-yl)but-2-yn-1-amine 15e ($C_{39}H_{45}NO_3Si$). Following the Method A, reaction of **12** (500 mg, 3.84 mmol) with **13** (760 g, 3.84 mmol) and alkyne **14e** (1.13 g, 3.84 mmol) in dry toluene (8.0 mL) in the presence of CuBr (27 mg, 0.19 mmol), 4 Å molecular sieves (2.00 g) was carried out. The crude product was subjected to column chromatography over silica gel (*Eluent*: 2% EtOAc in petroleum ether) to furnish **15e** (1.62 g, 70%) as colorless oil. IR (Neat) ν (cm^{-1}): 2983, 2889, 2361, 1508, 1492, 1455, 1370, 1209, 1029, 1088, 967, 838; $[\alpha]_D^{25}$ = - 64.60 (*c* = 1.0, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.76 (dd, *J* = 7.8, 1.5 Hz, 4H), 7.46 - 7.38 (m, 10H), 7.30 (t, *J* = 7.1 Hz, 4H), 7.23 (t, *J* = 7.3 Hz, 2H), 4.34 (d, *J* = 1.8 Hz, 2H), 4.21 (q, *J* = 6.2 Hz, 1H), 3.92 (dd, *J* = 8.4, 6.4 Hz, 1H), 3.82 (d, *J* = 13.9 Hz, 2H), 3.77 (dd, *J* = 8.4, 6.2 Hz, 1H), 3.54 (dt, *J* = 7.8, 1.8 Hz, 1H), 3.40 (d, *J* = 14.0 Hz, 2H), 1.34 (s, 3H), 1.26 (s, 3H), 1.15 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 139.6 (2C), 135.8 (4C), 133.4 (2C), 130.0 (2C), 129.0 (4C), 128.3 (4C), 127.9 (4C), 127.0 (2C), 109.7, 85.0, 80.0, 76.2, 67.4, 55.5, 55.4 (2C), 52.9, 26.8 (3C), 26.6, 25.7, 19.4; HRMS (ESI) Calcd. For $C_{39}H_{46}NO_3Si$ 604.3247 $[M + H]^+$, found 604.3245.

Synthesis of *tert*-butyl ((*R*)-4-(dibenzylamino)-4-((*S*)-2,2-dimethyl-1,3-dioxolan-4-yl)but-2-yn-1-yl)carbamate 15f ($C_{28}H_{36}N_2O_4$). Following the Method A, reaction of **12** (456 mg, 3.50 mmol) with **13** (691 mg, 3.50 mmol) and alkyne **14f** (0.60 g, 3.50 mmol) in dry toluene (8.0 mL) in the presence of CuBr (25 mg, 0.19 mmol), 4 Å molecular sieves (1.75 g) was carried out. The crude product was subjected to column chromatography over silica gel (*Eluent*: 5% EtOAc in petroleum ether) to furnish **15f** (1.20 g, 76%) as colorless oil. IR (Neat) ν (cm^{-1}): 3566, 2980, 1699, 1495, 1455, 1367, 1245, 1160, 1069; $[\alpha]_D^{25}$ = - 104.0 (*c* = 1.0, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.42 (br d, *J* = 5.0 Hz, 4H), 7.29 (d, *J* = 7.4 Hz, 4H), 7.21 (d, *J* = 7.1 Hz, 2H), 4.70 (br s, 1H), 4.22 – 4.27 (m, 1H), 4.00 – 3.97 (m, 3H), 3.83 (dd, *J* = 8.2, 6.0 Hz, 3H), 3.56 (d, *J* = 4.8 Hz, 1H), 3.43 (d, *J* = 13.3 Hz, 2H), 1.46 (s, 9H), 1.31 (s, 3H), 1.25 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 155.4, 139.4 (2C), 129.0 (4C), 128.3 (4C), 127.1 (2C), 109.7, 82.8, 80.1, 78.0, 76.3, 67.3, 55.5 (2C), 55.4, 30.8, 28.5(3C), 26.6, 25.5; HRMS (ESI) Calcd. for $C_{28}H_{37}N_2O_4$ 465.2753 $[M + H]^+$, found 465.2757.

(*R*)-5-((*S*)-1-hydroxy-2-iodoethyl)pyrrolidin-2-one 22a ($C_6H_{10}INO_2$). To the solution of the epoxide **21a** (252 mg, 1.97 mmol) in THF (8 mL) was added to CuI (74 mg, 0.39 mmol) and methylmagnesium iodide (655 mg in 8 mL in Et_2O, 3.94 mmol) at -30 °C during 15 min. The reaction mixture was allowed to warm to 0 °C, stirred for 2.5 h. After completion, the reaction mixture was quenched by addition of NH_4Cl (20 mL). Compound was extracted in CH_2Cl_2 (2 × 20 mL), dried over Na_2SO_4 and concentrated *in vacuo*. The dried mass was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish the pure **22a** (268 mg, 53%) as white solid. Mp. 124–126 °C; IR (KBr) ν (cm^{-1}): 3862, 3300, 3161, 1660, 1411, 1188, 1041; $[\alpha]_D^{25}$ = - 19.25 (*c* = 0.4, $CHCl_3$); ^{1}H NMR (400 MHz, DMSO-D_6) δ (ppm): 7.6 (br s, 1H), 5.41 (d, *J* = 5.5 Hz, 1H), 3.61 (dt, *J* = 8.2, 4.5 Hz, 1H), 3.36 (dt, *J* = 11.4, 5.1 Hz, 1H), 3.30 (dd, *J* = 10.1, 4.8 Hz, 1H), 3.17 (dd, *J* = 9.6, 6.8 Hz, 1H), 2.15 - 1.97 (m, 3H), 1.80 - 1.72 (m, 1H) ;

^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 177.0, 73.6, 57.5, 30.3, 23.6, 12.0 ; HRMS (ESI) Calcd. for $C_6H_{10}INO_2Na$ 277.9653 $[M + Na]^+$, found 277.9653.

(*R*)-5-((*S*)-2-bromo-1-hydroxyethyl)pyrrolidin-2-one 22b ($C_6H_{10}BrNO_2$). To the solution of the epoxide **21a** (50mg, 0.394 mmol) in THF (6 mL) was added to CuI (15 mg, 0.08 mmol) and methylmagnesium bromide [3.0 M in Et_2O] (0.26 mL, 0.79 mmol) at -30 ^oC during 15 min. The reaction mixture allowed to warm to 0 ^oC, stirred for 2.5 h. After completion, the reaction mixture was quenched by addition of NH_4Cl (10 mL). Compound was extracted in CH_2Cl_2 (2 × 10 mL), dried over Na_2SO_4 and concentrated *in vacuo*. The dried mass was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish the pure **22b** (43 mg, 53%) as white solid. Mp. 135 – 136 ^oC; IR (KBr) ν (cm^{-1}): 3315, 3212, 2924, 1666, 1459, 1382, 1286, 1181, 1060, 950; $[\alpha]_D^{25}$ = - 16.4 (*c* = 0.5, MeOH); ^{1}H NMR (400 MHz, CD_3OD) δ (ppm): 3.85- 3.80 (m, 1H), 3.65 – 3.60 (m, 1H), 3.47 (dd, *J* = 14.6, 8.9, 1H), 3.38 (dd, *J* = 10.7, 6.7, 1H), 2.41 – 2.32 (m, 1H), 2.29 – 2.18 (m, 2H), 1.93 – 1.88 (m, 1H); ^{13}C NMR (100 MHz, CD_3OD) δ (ppm): 180.2, 73.8, 57.2, 33.9, 29.9, 23.3; HRMS (ESI) Calcd. for $C_6H_{11}BrNO_2$ 207.9973 $[M + H]^+$, found 207.9973.

(*R*)-6-((*S*)-1-hydroxy-2-iodoethyl)piperidin-2-one 22c ($C_7H_{12}INO_2$). To the solution of the epoxide **21b** (100 mg, 0.71 mmol) in THF (8 mL) was added to CuI (27 mg, 0.14 mmol) and methylmagnesium iodide (236 mg in 8 mL in Et_2O, 1.42 mmol) at -30 ^oC during 15 min. The reaction mixture was allowed to warm to 0 ^oC, stirred for 2.5 h. After completion, the reaction mixture was quenched by addition of NH_4Cl (20 mL). Compound was extracted in CH_2Cl_2 (2 × 20 mL), dried over Na_2SO_4 and concentrated *in vacuo*. The dried mass was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish the pure **22c** (107 mg, 56%) as white solid. Mp. 117–119 ^oC; IR (KBr) ν (cm^{-1}): 3402, 3198, 2945, 1636, 1541, 1339, 1263, 1168, 1036; $[\alpha]_D^{25}$ = + 9.25 (*c* = 0.4, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 6.93 (br s, 1H), 3.48 – 3.26 (m, 3H), 3.25 – 3.14 (m, 2H), 2.48 – 2.38 (m, 1H), 2.33 – 2.18 (m, 1H), 2.00 – 1.88 (m, 2H), 1.36 – 1.18 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 173.1, 73.2, 57.6, 31.1, 24.8, 19.7, 11.1; HRMS (ESI) Calcd. for $C_7H_{12}INO_2Na$ 291.9810 $[M + Na]^+$, found 291.9811.

(*R*)-5-((*R*)-1-hydroxypropyl)pyrrolidin-2-one 23a ($C_7H_{13}NO_2$). Following the Method B, the Gilman reagent was prepared by adding MeLi (1.6 M) in pentane (11 mL, 17.30 mmol) to a suspension of CuI (1.64 g, 8.66 mmol) in dry Et_2O (40 mL) at -35 ^oC. Opening of the epoxide was carried out by adding a solution of **21a** (220 mg, 1.73 mmol) in dry THF (6 mL) to the freshly prepared Gilman reagent and stirring for 2 h at the same temperature. The crude product was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish **23a** (191 mg, 77%) as colorless oil. IR (KBr) ν (cm^{-1}): 3266, 2930, 1670, 1459, 1417, 1270, 1122, 1078, 1042; $[\alpha]_D^{25}$ = - 30.0 (*c* = 0.4, $CHCl_3$); ^{1}H NMR (500 MHz, DMSO) δ (ppm): 7.44 (br s, 1H), 4.59 (d, *J* = 5.6 Hz, 1H), 3.34 (dt, *J* = 7.4, 5.1 Hz, 1H), 3.08 (dt, *J* = 9.0, 5.3 Hz, 1H), 2.04 – 1.89 (m, 3H), 1.70 – 1.62 (m, 1H), 1.35 – 1.28 (m, 1H), 1.25 – 1.16 (m, 1H), 0.82 (t, *J* =

7.4 Hz, 3H); ^{13}C NMR (100 MHz, DMSO) δ (ppm): 179.3, 76.6, 59.6, 30.7, 26.3, 23.8, 10.0; HRMS (ESI) Calcd. For $C_7H_{13}NO_2Na$ 166.0844 $[M + H]^+$, found 166.0844.

(*R*)-5-((*R*)-1-hydroxyhexyl)pyrrolidin-2-one 23b ($C_{10}H_{19}NO_2$). Following the Method B, the Gilman reagent was prepared by adding BuLi (1.6 M) in hexane (15.0 mL, 23.6 mmol) to a suspension of CuI (2.24 g,11.8 mmol) in dry Et_2O (40 mL) at -35 ^oC. Opening of the epoxide was carried out by adding a solution of **21a** (300 mg, 2.36 mmol) in dry THF (5 mL) to the freshly prepared Gilman reagent and stirring for 2 h at the same temperature. The crude product was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish **23b** (332 mg, 76%) as white solid. Mp. 60–62 ^oC; IR (KBr) ν (cm^{-1}): 3417, 3221, 2931, 1685, 1457, 1363, 1270, 1133, 1072, 1057; $[\alpha]_D^{25}$ = - 9.75 (*c* = 0.4, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 6.54 (br s, 1H), 3.52 (q, *J* = 7.1 Hz, 1H), 3.42 – 3.33 (m, 1H), 2.70 – 2.58 (m, 1H), 2.39 – 2.28 (m, 2H), 2.21 – 2.09 (m, 1H), 1.82 – 1.74 (m, 1H), 1.56 – 1.41 (m, 2H), 1.41 – 1.20 (m, 6H), 0.89 (t, *J* = 6.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 179.1, 75.3, 59.9, 33.4, 31.9, 30.7, 25.2, 23.9, 22.7, 14.1; HRMS (ESI) Calcd. for $C_{10}H_{20}NO_2$ 186.1415 $[M + H]^+$, found 186.1415.

(*R*)-5-((*R*)-1-hydroxy-3,3-dimethylbutyl)pyrrolidin-2-one 23c ($C_{10}H_{19}NO_2$). Following the Method B, the Gilman reagent was prepared by adding ^{t}BuLi (1.6 M) in pentane (14.8 mL, 23.6 mmol) to a suspension of CuI (2.24 g,11.8 mmol) in dry Et_2O (40 mL) at -35 ^oC. Opening of the epoxide was carried out by adding a solution of **21a** (300 mg, 2.36 mmol) in dry THF (8 mL) to the freshly prepared Gilman reagent and stirring for 2 h at the same temperature. The crude product was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish **23c** (315 mg, 72%) as white solid. Mp. 100–102 ^oC; IR (KBr) ν (cm^{-1}): 3364, 3274, 2950, 1683, 1633, 1363, 1283, 1094, 1070, 102; $[\alpha]_D^{25}$ = - 0.80 (*c* = 0.5, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.15 (br s, 1H), 3.47 – 3.44 (m, 2H), 3.41 – 3.17 (m, 1H), 2.36 – 2.31 (m, 2H), 2.16 – 2.07 (m, 1H), 1.72 – 1.66 (m, 1H), 1.34 – 1.23 (m, 2H), 0.95 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 179.3, 73.1, 60.8, 46.9, 30.7, 30.2, 30.1 (3C), 23.9; HRMS (ESI) Calcd. $C_{10}H_{20}NO_2$ 186.1415 $[M + H]^+$, found 186.1415.

(*R*)-5-((*R*)-1-hydroxy-2-phenylethyl)pyrrolidin-2-one 23d ($C_{12}H_{15}NO_2$). Following the Method B, the Gilman reagent was prepared by adding PhLi (1.6 M) in pentane (14.8 mL, 23.6 mmol) to a suspension of CuI (2.24 g,11.8 mmol) in dry Et_2O (40 mL) at -35 ^oC. Opening of the epoxide was carried out by adding a solution of **21a** (300 mg, 2.36 mmol) in dry THF (8 mL) to the freshly prepared Gilman reagent and stirring for 2 h at the same temperature. The crude product was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish **23d** (329 mg, 68%) as white solid. Mp. 138–140 ^oC; IR (KBr) ν (cm^{-1}): 3377, 3258, 2917, 2852, 1631, 1636, 1494, 1311, 1266, 1101, 1067. $[\alpha]_D^{20}$ = - 30.30 (*c* = 0.4, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.36 – 7.31 (m, 2H), 7.28 – 7.26 (m, 1H), 7.24 - 7.21 (m, 2H), 6.54 (br s, 1H), 3.64 – 3.59 (m, 2H), 2.88 – 2.84 (m, 1H), 2.62 (dd, *J* = 13.8, 8.2 Hz, 1H), 2.55 (br d, *J* = 4.1 Hz, 1H), 2.41 – 2.36 (m, 2H), 2.27 – 2.20 (m, 1H), 1.92 – 1.83 (m, 1H); ^{13}C NMR

(100 MHz, $CDCl_3$) δ (ppm): 178.9, 137.5, 129.5 (2C), 128.8 (2C), 126.8, 76.1, 58.8, 40.1, 30.5, 23.9; HRMS (ESI) Calcd. for $C_{12}H_{15}NO_2Na$ 228.1000 $[M + Na]^+$, found 228.1009.

(*R*)-6-((*R*)-1-hydroxyhexyl)piperidin-2-one 25b ($C_{11}H_{21}NO_2$). Following the Method B, the Gilman reagent was prepared by adding BuLi (1.6 M) in hexane (9 mL, 14.2 mmol) to a suspension of CuI (1.36 g, 7.10 mmol) in dry Et_2O (30 mL) at -35 °C. Opening of the epoxide was carried out by adding a solution of **21b** (200 mg, 1.42 mmol) in dry THF (6 mL) to the freshly prepared Gilman reagent and stirring for 2 h at the same temperature. The crude product was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish **25b** (206 mg, 73%) as colorless solid. Mp. 70–72 °C; IR (KBr) ν (cm^{-1}): 3422, 2950, 1660, 1479, 1348, 1272, 1154, 1077, 1030; $[\alpha]_D^{25}$ = + 11.5 (*c* = 0.5, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ (ppm): 6.84 (br s, 1H), 3.62 – 3.58 (m, 1H), 3.32 (br s, 1H), 3.22 - 3.18 (m, 1H), 2.45 - 2.37 (m, 1H), 2.24 (ddd, *J* = 17.7, 12.0, 6.0 Hz, 1H), 1.93 - 1.87 (m, 2H), 1.77 (br s, 1H), 1.72 - 1.62 (m, 1H), 1.34 - 1.20 (m, 7H), 0.87 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 172.7, 74.9, 57.7, 33.5, 31.9, 31.2, 25.1, 24.7, 22.6, 20.0, 14.1; ; HRMS (ESI) Calcd. for $C_{11}H_{21}NO_2$ $[M + Na]^+$ 222.1470, found 222.1475.

(*R*)-6-((*R*)-1-hydroxy-3,3-dimethylbutyl)piperidin-2-one 25c ($C_{11}H_{21}NO_2$). Following the Method B, the Gilman reagent was prepared by adding tert-BuLi (1.6 M) in pentane (4.5 mL, 7.10 mmol) to a suspension of CuI (0.68 g, 3.55 mmol) in dry Et_2O (20 mL) at -35 °C. Opening of the epoxide was carried out by adding a solution of **21b** (100 mg, 0.71 mmol) in dry THF (5 mL) to the freshly prepared Gilman reagent and stirring for 2 h at the same temperature. The crude product was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish **25c** (106 mg, 75%) as white solid. Mp. 101–103 °C; IR (KBr) ν (cm^{-1}): 3270, 2950, 1669, 1623, 1363, 1374, 1230, 1166, 1072, 1021; $[\alpha]_D^{20}$ = + 26.50 (*c* = 0.4, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ (ppm): 6.81 (br s, 1H), 3.47 – 3.34 (m, 2H), 3.15 – 3.09 (m, 1H), 2.36 – 2.31 (m, 1H), 2.25 – 2.17 (m, 1H), 1.95 – 1.89 (m, 2H), 1.70 – 1.61 (m, 1H), 1.42 – 1.37 (m, 1H), 1.32 – 1.21 (m, 2H), 0.96 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 172.8, 72.7, 58.2, 47.5, 31.3, 30.3, 30.2 (3C), 25.4, 20.0; HRMS (ESI) Calcd. for $C_{11}H_{21}NO_2$ 222.1470 $[M + Na]^+$, found 222.1470.

(*R*)-6-((*R*)-1-hydroxy-2-phenylethyl)piperidin-2-one 25d ($C_{13}H_{17}NO_2$). Following the Method B, the Gilman reagent was prepared by adding PhLi (1.6 M) in dibutyl ether (4.4 mL, 7.10 mmol) to a suspension of CuI (0.68 g, 3.55 mmol) in dry Et_2O (20 mL) at -35 °C. Opening of the epoxide was carried out by adding a solution of **21b** (100 mg, 0.71 mmol) in dry THF (5 mL) to the freshly prepared Gilman reagent and stirring for 2 h at the same temperature. The crude product was subjected to column chromatography over silica gel (*Eluent*: 4% MeOH in $CHCl_3$) to furnish **25d** (120 mg, 77%) as white solid. Mp. 105–106 °C; IR (KBr) ν (cm^{-1}): 3518, 2964, 2873, 1654, 1600, 1501, 1579, 1448, 1285, 1123, 1073; $[\alpha]_D^{25}$ = + 7.20 (*c* = 0.25, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.32 (t, *J* = 7.3 Hz, 2H), 7.28 – 7.22 (m, 1H), 7.22 - 7.18 (m, 2H), 6.62 (br s, 1H), 3.60 – 3.53 (m, 1H), 3.33 – 3.27 (m, 1H), 2.94 (dd, *J* = 13.2, 3.2 Hz, 1H),

2.55 (dd, *J* = 13.8, 9.6 Hz, 1H), 2.48 (d, *J* = 4.6 Hz, 1H), 2.43 – 2.35 (m, 1H), 2.24 (ddd, *J* = 17.8, 11.9, 6.2 Hz, 1H), 2.02 -1.92 (m, 2H), 1.76 – 1.64 (m, 1H), 1.44 – 1.35 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 172.2, 137.1, 129.6 (2C), 129.0 (2C), 127.0, 75.8, 57.4, 40.0, 31.3, 25.2, 20.0; HRMS (ESI) Calcd. for $C_{13}H_{17}NO_2Na$ 242.1157 $[M + Na]^+$, found 242.1152.

(*R*)-1-((*R*)-pyrrolidin-2-yl)propan-1-ol 24a ($C_7H_{15}NO$). Following the Method C, reaction of **23a** (160 mg, 1.12 mmol) with $LiAlH_4$ (127 mg, 3.36 mmol) followed by purification by column chromatography over silica gel (*Eluent:* 30% MeOH in $CHCl_3$) provided **24a** (117 mg, 81%) as yellow oil. IR (KBr) ν (cm^{-1}): 3447, 2962, 2923, 1460, 1370, 1267, 1052, 1027; $[\alpha]_D^{25}$ = + 4.0 (*c* = 0.25, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 5.35 (br s, 1H), 3.83 (br s, 1H), 3.62 – 3.55 (m, 1H), 3.39 – 3.35 (m, 2H), 2.14 – 1.93 (m, 3H), 1.75 – 1.63 (m, 1H), 1.62- 1.49 (m, 2H), 1.02 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 72.6, 65.3, 45.0, 27.6, 27.5, 24.4, 9.8; HRMS (ESI) Calcd. for $C_7H_{15}NO$ 130.1232 $[M + H]^+$, found 130.1230.

(*R*)-1-((*R*)-pyrrolidin-2-yl)hexan-1-ol 24b ($C_{10}H_{21}NO$). Following the Method C, reaction of **23b** (150 mg, 0.810 mmol) with $LiAlH_4$ (92 mg, 2.43 mmol) followed by purification by column chromatography over silica gel (*Eluent:* 30% MeOH in $CHCl_3$) provided **24b** (119 mg, 86%) as yellow oil. IR (KBr) ν (cm^{-1}): 3586, 3372, 2933, 1470, 1381, 1139, 1071, 1021. $[\alpha]_D^{25}$ = + 4.1 (*c* = 1.0, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 3.86 (td, *J* = 9.2, 3.6 Hz, 1H), 3.54 (q, *J* = 9.2 Hz, 1H), 3.26 (t, *J* = 7.8 Hz, 2H), 2.12 – 1.91 (m, 3H), 1.73 – 1.63 (m, 4H), 1.53- 1.35 (m, 4H), 1.39 – 1.23 (m, 4H), 0.86 (t, *J* = 6.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 71.4, 65.7, 45.0, 34.5, 31.8, 27.7, 25.0, 24.4, 22.7, 14.2; HRMS (ESI) Calcd. for $C_{10}H_{21}NO$ 172.1701 $[M + H]^+$, found 172.1706.

(*R*)-3,3-dimethyl-1-((*R*)-pyrrolidin-2-yl)butan-1-ol 24c ($C_{10}H_{21}NO$). Following the Method C, reaction of **23c** (150 mg, 0.81 mmol) with $LiAlH_4$ (92 mg, 2.43 mmol) followed by purification by column chromatography over silica gel (*Eluent:* 30% MeOH in $CHCl_3$) provided **24c** (116 mg, 84%) as pale yellow oil. IR (KBr) ν (cm^{-1}): 3301, 2951, 2858, 1478, 1370, 1181, 1081, 1021; $[\alpha]_D^{25}$ = + 5.4 (*c* = 0.5, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 3.95 (t, *J* = 9.0 Hz, 1H), 3.59 - 3.50 (m, 1H), 3.40 - 3.36 (m, 2H), 2.10 – 1.98 (m, 3H), 1.71 – 1.62 (m, 1H), 1.51 (dd, *J* = 14.4, 9.2 Hz, 1H), 1.31 - 1.20 (m, 1H), 1.02 (s, 9H); ; ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 69.5, 66.2, 48.0, 45.2, 30.5, 30.2 (3C), 28.0, 24.4; HRMS (ESI) Calcd. for $C_{10}H_{21}NO$ 172.1701 $[M + H]^+$, found 172.1703.

(*R*)-2-phenyl-1-((*R*)-pyrrolidin-2-yl)ethanol 24d ($C_{12}H_{17}NO$). Following the Method C, reaction of **23d** (120 mg, 0.58 mmol) with $LiAlH_4$ (102 mg, 1.74 mmol) followed by purification by column chromatography over silica gel (*Eluent:* 30% MeOH in $CHCl_3$) provided **24d** (81 mg, 72%) as colorless oil. IR (KBr) ν (cm^{-1}): 3410, 3238, 2921, 1605, 1498, 1370, 1280, 1132, 1042; $[\alpha]_D^{25}$ = + 3.3 (*c* = 0.2, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.23 – 7.15 (m, 5H), 3.87 (td, *J* = 8.2, 3.6 Hz, 1H), 3.35 (q, *J* = 9.2 Hz, 1H), 3.09- 3.04 (m, 2H), 2.74 (dd, *J* = 13.7, 3.2 Hz, 1H), 2.68 – 2.62 (m, 1H), 1.89- 1.82 (m, 2H), 1.81 – 1.73 (m, 1H), 1.59 – 1.50 (m, 1H), 1.27 – 1.23 (m, 1H): ^{13}C NMR (75 MHz, $CDCl_3$) δ (ppm): 138.1, 129.7 (2C), 128.4 (2C), 126.4, 72.8,

64.1, 45.4, 41.1, 28.0, 25.0; HRMS (ESI) Calcd. for $C_{12}H_{18}NO$ 192.1388 $[M + H]^+$, found 192.1384.

(*R*)-1-((*R*)-piperidin-2-yl)hexan-1-ol 26b ($C_{11}H_{23}NO$). Following the Method C, reaction of **25b** (180 mg, 0.90 mmol) with $LiAlH_4$ (102 mg, 2.71 mmol) followed by purification by column chromatography over silica gel (*Eluent:* 30% MeOH in $CHCl_3$) provided **26b** (122 mg, 73%) as colorless oil. IR (KBr) ν (cm^{-1}): 3404, 2932, 2856, 1458, 1331, 1306, 1130, 1115, 1054; $[\alpha]_D^{25}$ = + 12.9 (*c* = 1.0, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ (ppm): 3.28 (td, *J* = 7.8, 1.8 Hz, 1H), 3.10 - 3.05 (m, 1H), 2.81 - 2.56 (br s, 1H), 2.57 (dt, *J* = 11.7, 2.7 Hz, 1H), 2.34 (ddd, *J* = 10.6, 7.7, 2.7 Hz, 1H), 1.81 - 1.73 (m, 1H), 1.67 - 1.56 (m, 2H), 1.50 - 1.43 (m, 2H), 1.34 - 1.26 (m, 8H), 1.17 – 1.08 (m, 1H), 0.87 (t, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 74.0, 61.4, 46.4, 33.7, 32.0, 29.1, 26.2, 25.5, 24.4, 22.7, 14.2; HRMS (ESI) Calcd. For $C_{11}H_{23}NO$ 186.1858 $[M + H]^+$, found 186.1858.

(*R*)-3,3-dimethyl-1-((*R*)-piperidin-2-yl)butan-1-ol 26c ($C_{11}H_{23}NO$). Following the Method C, reaction of **25c** (50 mg, 0.25 mmol) with $LiAlH_4$ (57 mg, 1.50 mmol) followed by purification by column chromatography over silica gel (*Eluent:* 30% MeOH in $CHCl_3$) provided **26c** (36 mg, 77%) as colorless oil. IR (KBr) ν (cm^{-1}): 3439, 3161, 2954, 1480, 1448, 1363, 1223, 1117, 1052; $[\alpha]_D^{25}$ = + 14.8 (*c* = 0.75, $CHCl_3$); ^1H NMR (200 MHz, $CDCl_3$) δ (ppm): 3.43 (td, *J* = 7.7, 2.5 Hz, 1H), 3.14 - 3.07 (m, 2H), 2.57 (dt, *J* = 11.5, 3.0 Hz, 1H), 2.26 (ddd, *J* = 10.6, 7.9, 2.7 Hz, 1H), 1.81 - 1.42 (m, 4H), 1.41 - 1.19 (m, 4H), 1.19 - 1.08 (m, 1H), 0.97 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 72.0, 62.8, 48.4, 47.0, 31.0 (3C), 30.9, 29.7, 26.4, 25.0; HRMS (ESI) Calcd. for $C_{11}H_{24}NO$ 186.1858 $[M + H]^+$, found 186.1853.

(*R*)-2-phenyl-1-((*R*)-piperidin-2-yl)ethanol 8c ($C_{13}H_{19}NO$). Following the Method C, reaction of **25d** (120 mg, 0.55 mmol) with $LiAlH_4$ (104 mg, 2.74 mmol) followed by purification by column chromatography over silica gel (*Eluent:* 30% MeOH in $CHCl_3$) provided **8c** (88 mg, 78%) as oil. IR (KBr) ν (cm^{-1}): 3415, 3290, 2933, 2851, 1599, 1495, 1424, 1306, 1298, 1120, 1042; $[\alpha]_D^{25}$ = + 16.4 (*c* = 0.5, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ (ppm): 7.29 – 7.26 (m, 2H), 7.22 – 7.17 (m, 3H), 3.58 – 3.47 (m, 2H), 3.07 – 3.01 (m, 1H), 2.86 (dd, *J* = 13.7, 3.6 Hz, 1H), 2.60 – 2.42 (m, 3H), 1.78 – 1.69 (m, 2H), 1.55- 1.53 (m, 1H), 1.38 – 1.18 (m, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 139.4, 130.3 (2C), 129.1 (2C), 127.0, 75.5, 61.4, 46.8, 40.8, 29.2, 26.3, 24.7; HRMS (ESI) Calcd. for $C_{13}H_{20}NO$ 206.1545 $[M + H]^+$, found 206.1541.

III. Theoretical Calculations.

The molecular geometries of **16** were fully optimized at a level of density functional theory employing the hybrid functional B3LYP[S1] with Pople's basis set 6-311G(d,p) where polarization

functions were added to all the atoms and diffuse functions to the heavy atoms. All the calculations were performed with the development version of Gaussian 03.[S2]

Table S1. Atomic coordinates calculated for **16** from DFT B3LYP/6-311G(d,p) geometry optimization.

Atom #	Atom Type	x	y	z
1	C	2.198	-1.977	-1.666
2	C	0.766	-1.685	-1.171
3	C	0.546	-0.209	-0.991
4	O	0.750	-2.203	0.154
5	C	2.126	-2.577	0.537
6	O	2.935	-1.968	-0.460
7	C	2.228	-4.097	0.521
8	C	2.455	-1.961	1.880
9	N	-0.530	0.462	-1.188
10	C	0.585	2.531	-0.207
11	C	1.603	3.127	-0.960
12	C	2.711	3.685	-0.328
13	C	2.809	3.651	1.062
14	C	1.797	3.065	1.820
15	C	0.688	2.508	1.190
16	C	-0.618	1.943	-0.883
17	C	-2.857	-0.205	-0.589
18	C	-2.648	-1.019	0.530
19	C	-3.628	-1.114	1.513
20	C	-4.822	-0.405	1.385
21	C	-5.036	0.403	0.272
22	C	-4.054	0.506	-0.712
23	C	-1.815	-0.120	-1.684
24	H	2.230	-2.947	-2.172
25	H	2.611	-1.216	-2.330
26	H	0.005	-2.176	-1.776
27	H	1.387	0.342	-0.577
28	H	1.525	-4.527	1.235
29	H	2.001	-4.504	-0.466
30	H	3.240	-4.399	0.798
31	H	1.788	-2.355	2.648
32	H	3.483	-2.203	2.154
33	H	2.351	-0.876	1.837
34	H	1.522	3.172	-2.042
35	H	3.490	4.154	-0.917
36	H	3.668	4.092	1.554
37	H	1.865	3.054	2.902
38	H	-0.106	2.066	1.783
39	H	-0.809	2.420	-1.848

40	H	-1.515	2.051	-0.272
41	H	-1.726	-1.582	0.639
42	H	-3.463	-1.749	2.376
43	H	-5.585	-0.486	2.150
44	H	-5.964	0.951	0.165
45	H	-4.229	1.131	-1.582
46	H	-1.603	-1.096	-2.113
47	H	-2.155	0.530	-2.491

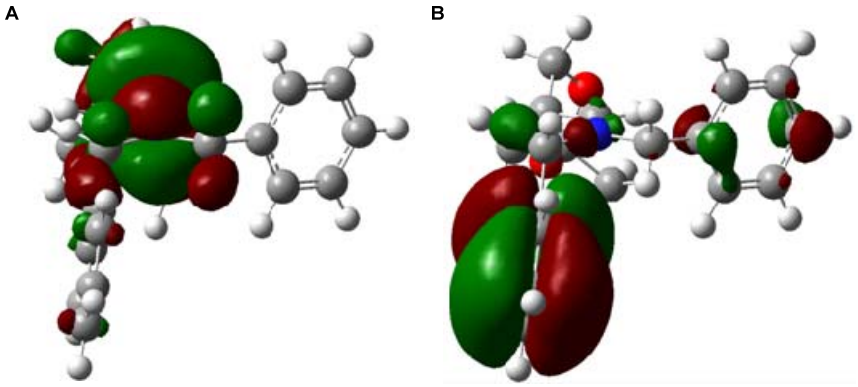

Fig. S1 View of the frontier molecular orbitals (MOs), HOMO (**A**) and LUMO (**B**) of the iminium cation **16** generated from DFT B3LYP/6-311G(d,p) geometry optimization.

IV. Crystal Structures

Single-crystal X-ray diffraction analysis. Single crystals of **15c**, **22a**, **23d** and **25b** suitable for X-ray diffraction study were grown as mentioned below. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif, by emailing data_request@ccdc.cam.ac.uk, or by contacting The Cambridge Crystallographic Data Centre, 12, Union Road, Cambridge CB2 1EZ, U.K. (fax +44 1223 336033).

Crystal structure of compound 15c (CCDC 861123): Compound **15a** was crystallized from ethyl acetate / chloroform (1:1) at 25 ^{o}C. A colorless rectangular shaped crystal with approximate dimensions 0.09 x 0.07 x 0.08 mm gave an Monoclinic with space group $P4_3$; a = 13.877 (5) b =

13.877 (5) *c* = 12.453 (5) Å, α = 90° β = 90° γ = 90°; *V* = 2398.09 ; *T* = 296 (2) K; *Z* = 4; ρ_{calc} = 1.084 Mgm^{-3}; $2\theta_{max}$ = 56.74°; *MoKαλ* = 0.71073 Å. Fine-focus sealed tube source with graphite monochromator. *R* = 0.0368 (for 2459 reflection *I>2σ(I)*), *wR* = 0.1046 which was refined against |*F2*| and S = 0.855 for 268 parameters and 4900 unique reflections. The structure was obtained by direct methods using SHELXS-97.[S3] All non-hydrogen atoms were refined isotropically. The hydrogen atoms were fixed geometrically in the idealized position and refined in the final cycle of refinement as riding over the atoms to which they are bonded. μ = 0.067 mm^{-1}; Minimum/maximum residual electron density 0.171 / -0.157 eÅ^{-3}.

Crystal structure of compound 22a (CCDC 856727): Compound **22a** was crystallized from chloroform at 25 °C. A colorless needle shaped crystal with approximate dimensions 0.09 x 0.08 x 0.07 mm gave an monoclinic with space group C2; *a* = 24.717 (2) *b* = 4.8349 (4) *c* = 15.6744 (13) Å, α = 90° β = 113.833° γ = 90°; *V* = 1713.4 (2); *T* = 296 (2) K; *Z* = 2; ρ_{calc} = 2.009 Mgm^{-3}; $2\theta_{max}$ = 56.74°; *MoKαλ* = 0.71073 Å. Fine-focus sealed tube source with graphite monochromator. *R* = 0.0300 (for 2729 reflection *I>2σ(I)*), *wR* = 0.0716 which was refined against |*F2*| and S = 0.904 for 188 parameters and 3078 unique reflections. The structure was obtained by direct methods using SHELXS-97.[S3] All non-hydrogen atoms were refined isotropically. The hydrogen atoms were fixed geometrically in the idealized position and refined in the final cycle of refinement as riding over the atoms to which they are bonded. μ = 3.688 mm^{-1}; Minimum/maximum residual electron density 0.659 / -0.853 eÅ^{-3}.

Crystal structure of compound 23d (CCDC 859884): $C_{12}H_{15}NO_2$; Compound **23d** was crystallized from ethyl acetate and chloroform (1:1) at 25 °C. A colorless rectangular shaped

crystal with approximate dimensions 0.14 x 0.13 x 0.12 mm gave an Triclinic with space group $P2_12_12_1$; a = 5.4457 (9) b = 8.3138 (13) c = 23.660 (4) Å, α = 90° β = 90° γ = 90°; V = 1071.2 (3); T = 296 (2) K; Z = 4; ρ_{calc} = 1.273 Mgm^{-3}; $2\theta_{max}$ = 57.04°; $MoK\alpha\lambda$ = 0.71073 Å. Fine-focus sealed tube source with graphite monochromator. R = 0.0396 (for 2361 reflection $I>2\sigma(I)$), wR = 0.1059 which was refined against $|F2|$ and S = 1.064 for 138 parameters and 2731 unique reflections. The structure was obtained by direct methods using SHELXS-97.[S3] All non-hydrogen atoms were refined isotropically. The hydrogen atoms were fixed geometrically in the idealized position and refined in the final cycle of refinement as riding over the atoms to which they are bonded. μ = 0.087 mm^{-1}; Minimum/maximum residual electron density 0.168 / -0.221 $eÅ^{-3}$.

Crystal structure of compound 25b (CCDC 865442): Compound **25b** was crystallized from chloroform at 25 °C. A colorless needle shaped crystal with approximate dimensions 0.8 x 0.7 x 0.7 mm gave an Monoclinic with space group $P2_1$; a = 5.1574 (8) b = 7.2509 (11) c = 15.552 (3) Å, α = 90° β = 94.590 (3) ° γ = 90°; V = 579.714 (3); T = 296 (2) K; Z = 2; ρ_{calc} = 1.142 Mgm^{-3}; $2\theta_{max}$ = 56.82°; $MoK\alpha\lambda$ = 0.71073 Å. Fine-focus sealed tube source with graphite monochromator. R = 0.0361 (for 2329 reflection $I>2\sigma(I)$), wR = 0.0892 which was refined against $|F2|$ and S = 1.082 for 130 parameters and 2657 unique reflections. The structure was obtained by direct methods using SHELXS-97.[S3] All non-hydrogen atoms were refined isotropically. The hydrogen atoms were fixed geometrically in the idealized position and refined in the final cycle of refinement as riding over the atoms to which they are bonded. μ = 0.077 mm^{-1}; Minimum/maximum residual electron density 0.112 / -0.097 $eÅ^{-3}$.

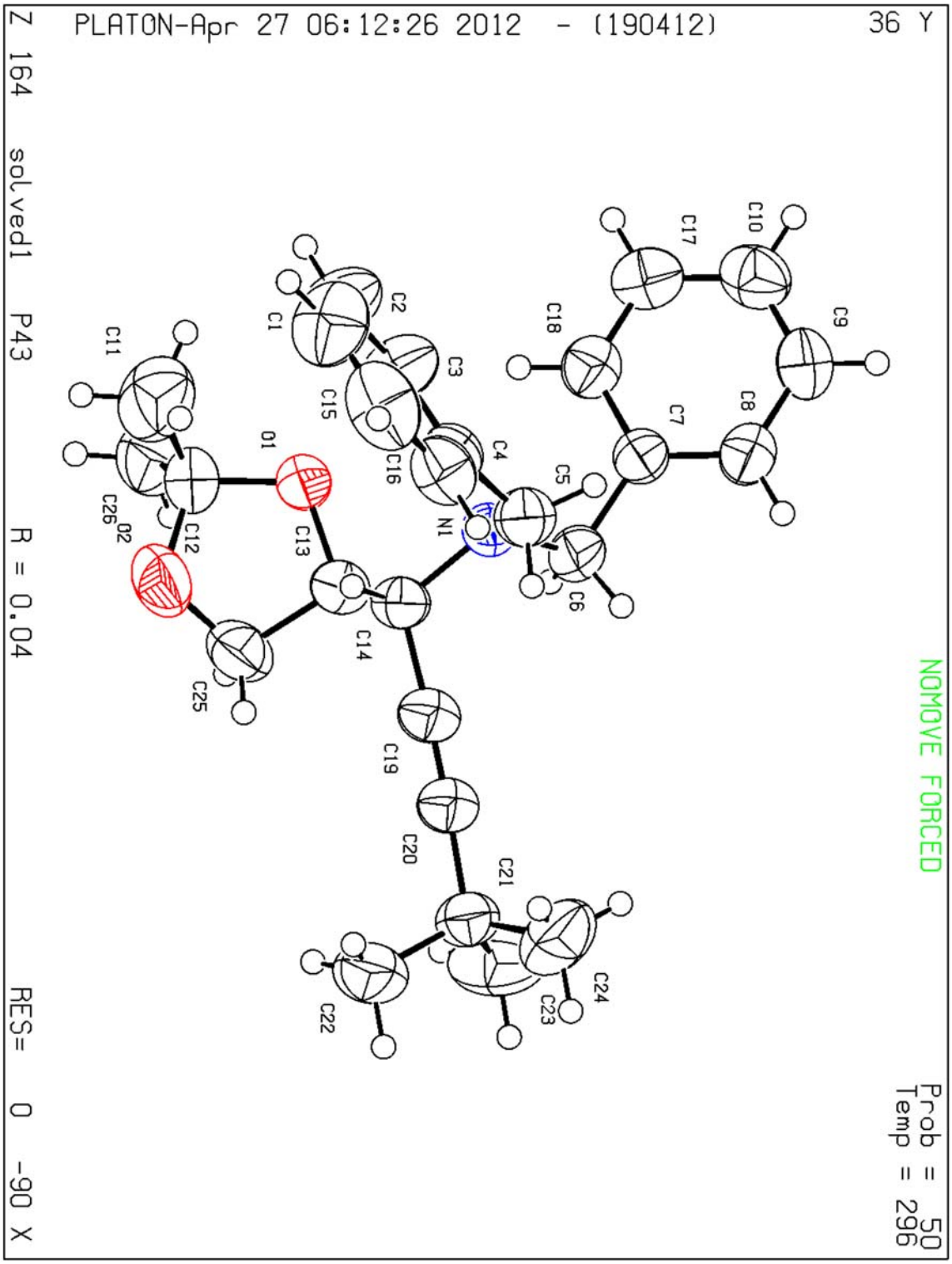

Fig. S2 ORTEP diagram of **15c.**

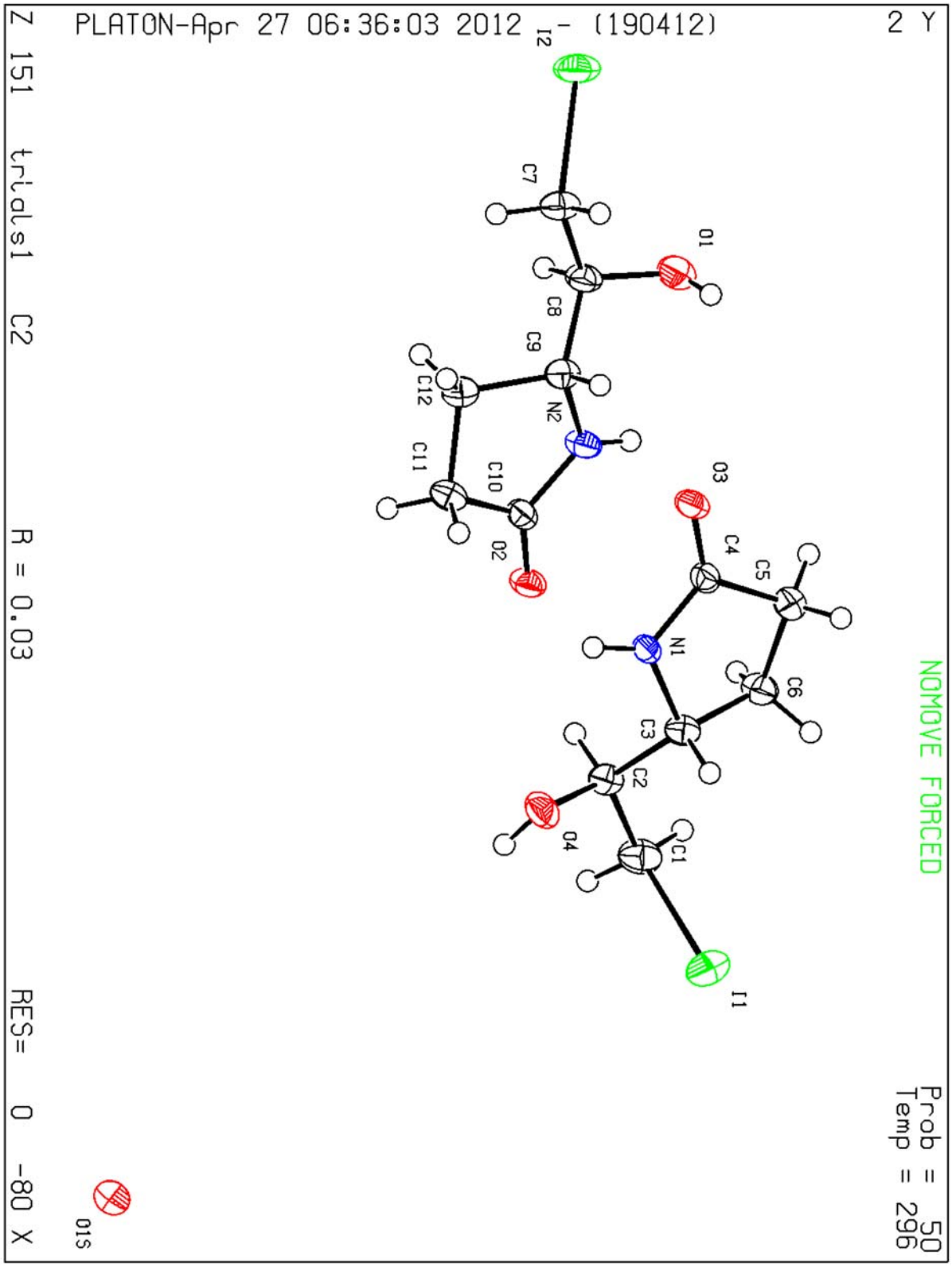

Fig. S3 ORTEP diagram of **22a.**

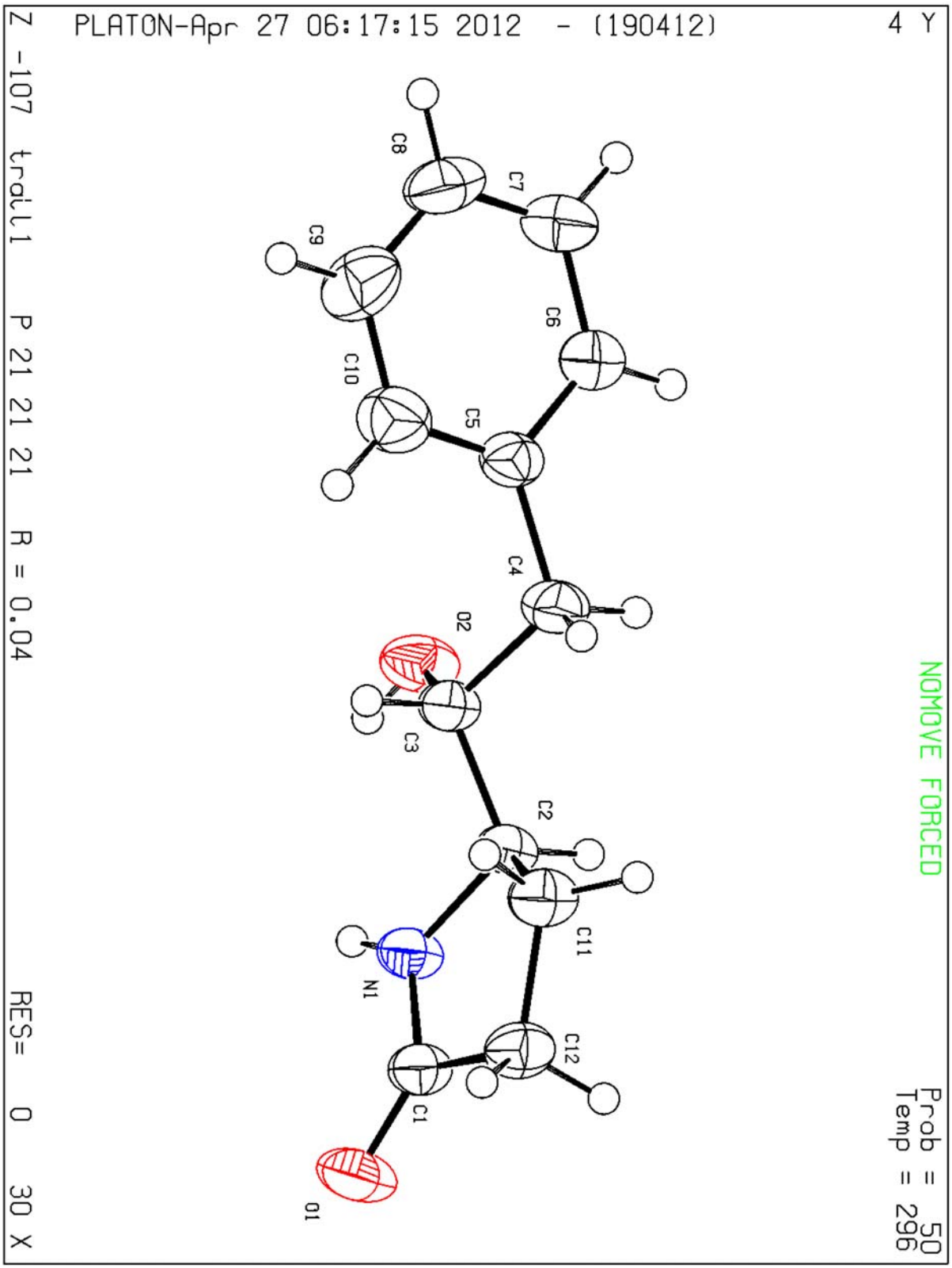

Fig. S4 ORTEP diagram of **23d.**

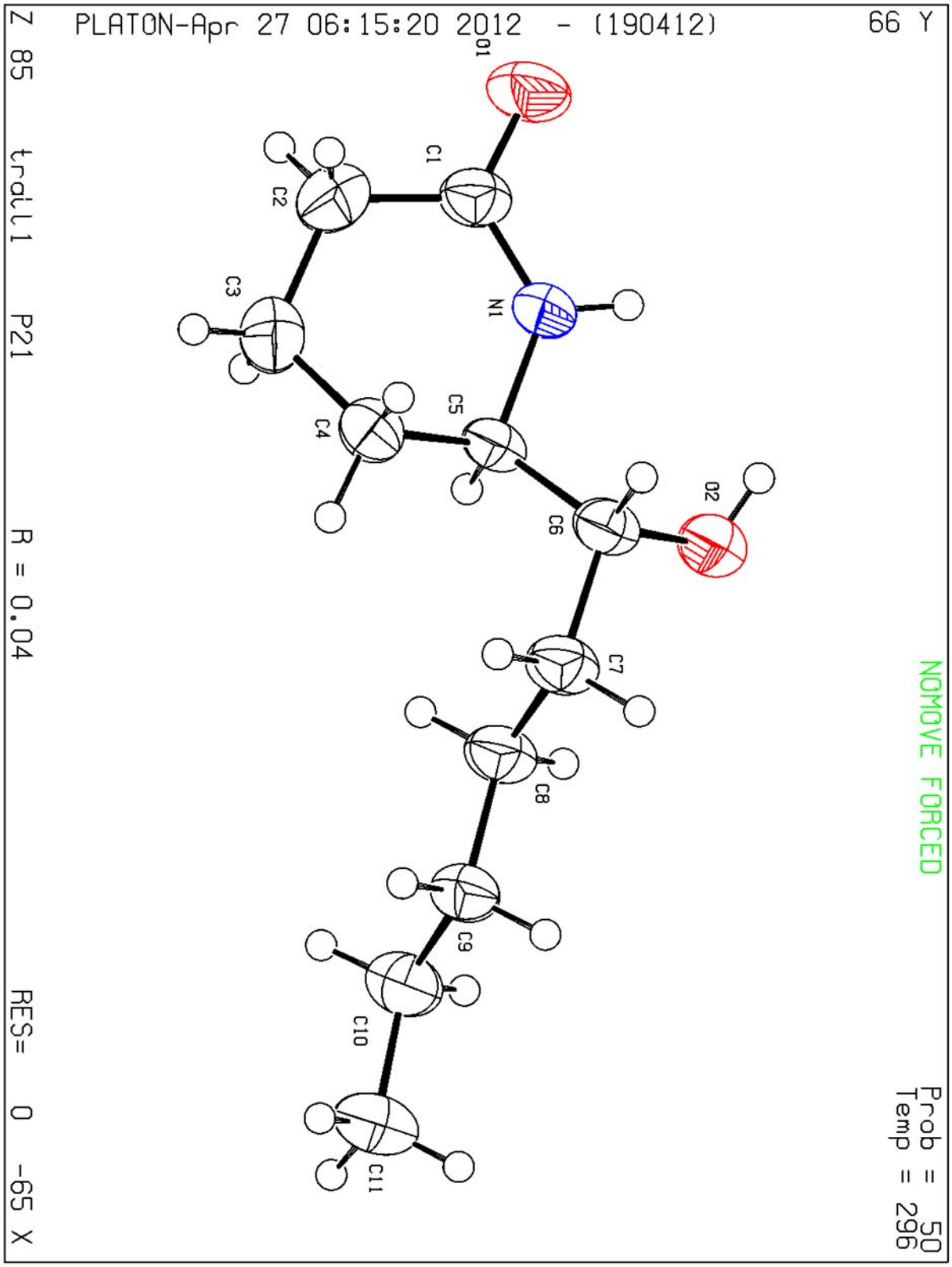

Fig. S5 ORTEP diagram of **25b.**

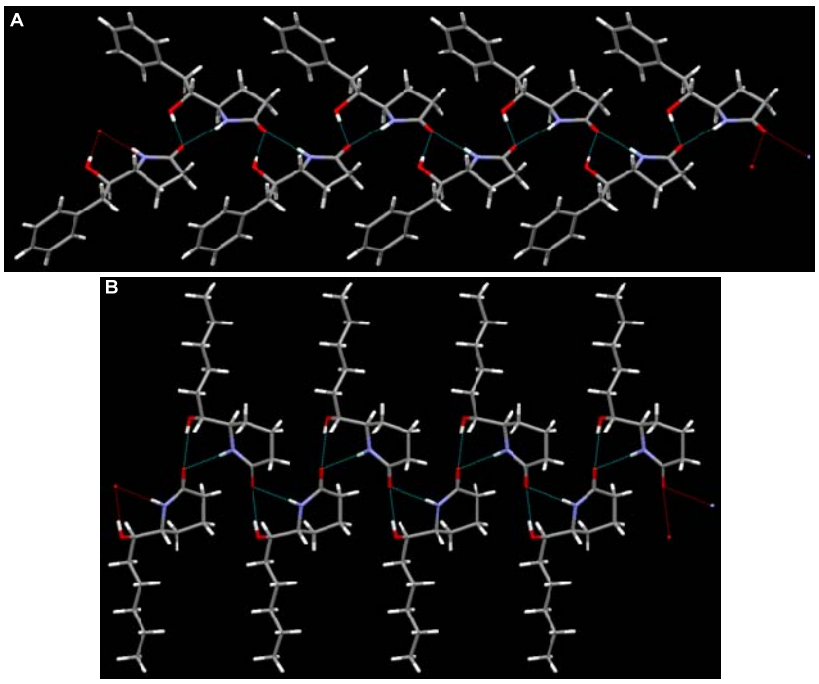

Fig. S6 The extended sheet type assembly of **23d** (**A**) and that of **25b** (**B**) represented in the Capped sticks models.

Table S2. Non-covalent interactions in the crystal structures of **23d** and **25b**.

Compound		D-H---A [Å]	D---A [Å]	D-H---A [deg]	Type of H-bonding
23d	N1---O1	2.036	2.855	159	NH---CO
	O2H---O1	1.984	2.797	171	OH---CO
25b	N1---O1	2.218	3.049	162	NH---CO
	O2H---O1	1.966	2.782	173	OH---CO

V. NMR Spectra.

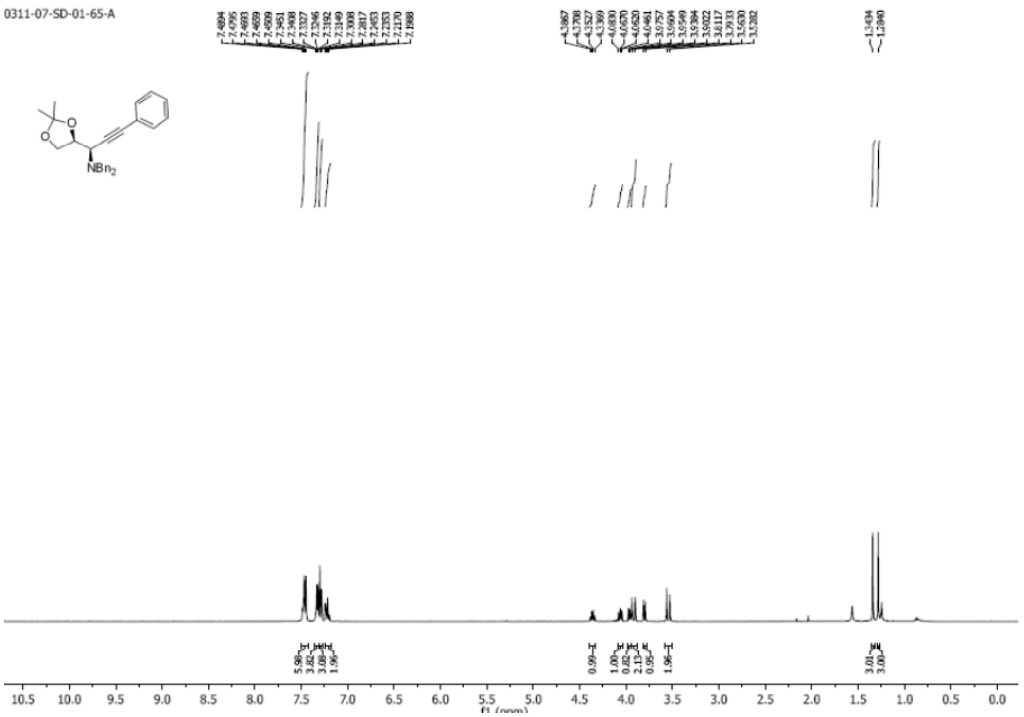

Fig. S7 ^{1}H-NMR of **15a**.

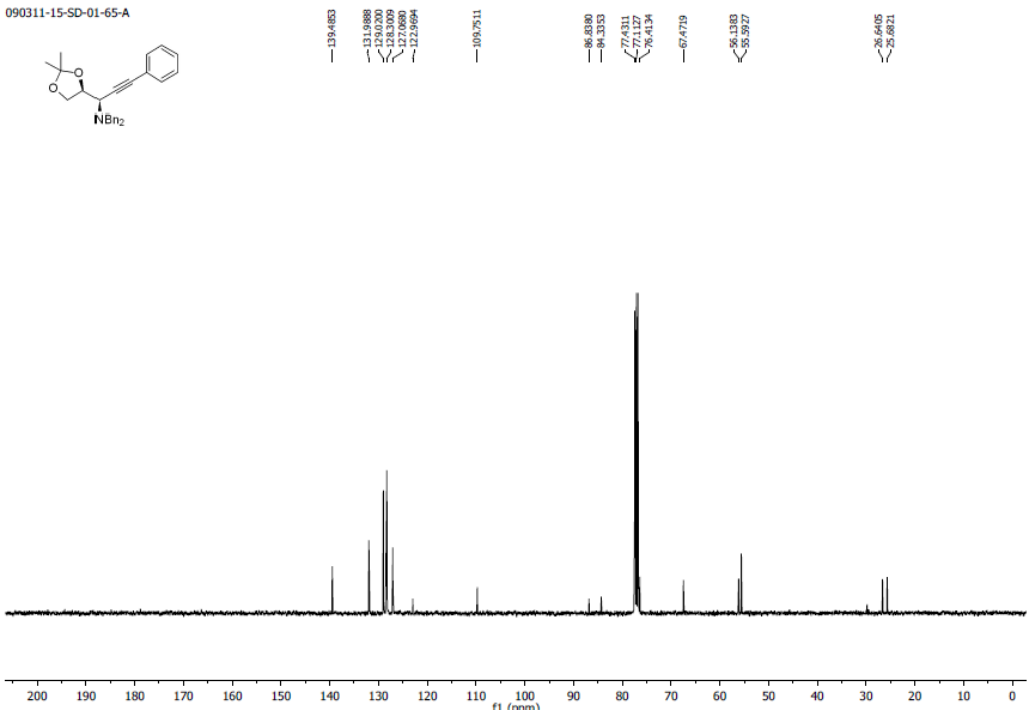

Fig. S8 ^{1}H-NMR of **15a**.

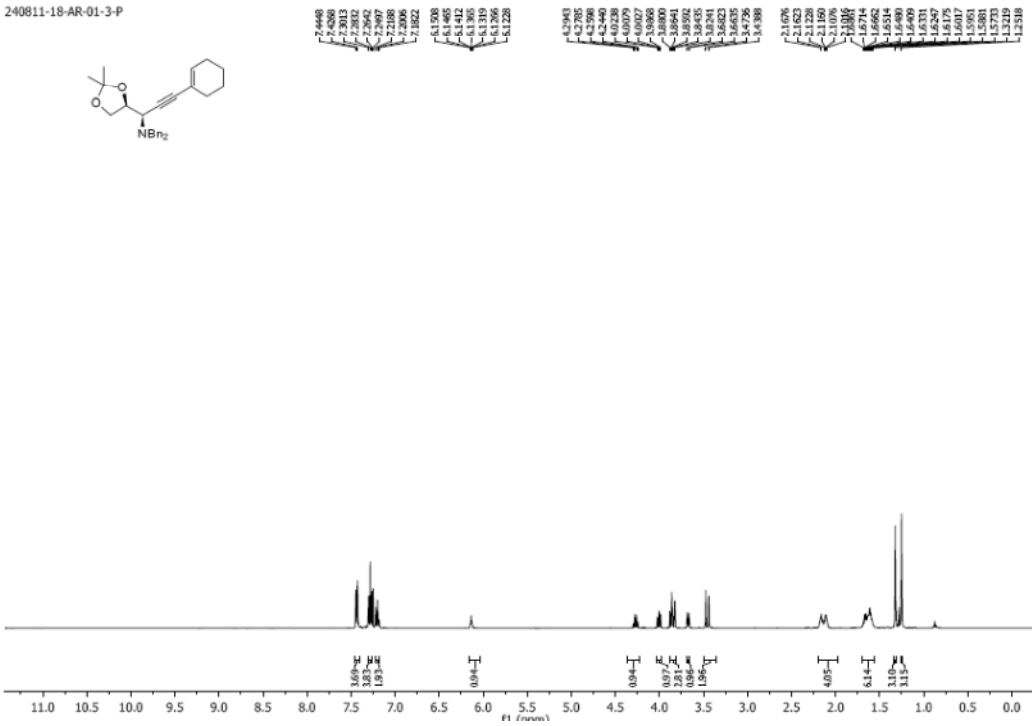

Fig. S9 ^{1}H-NMR of **15b**.

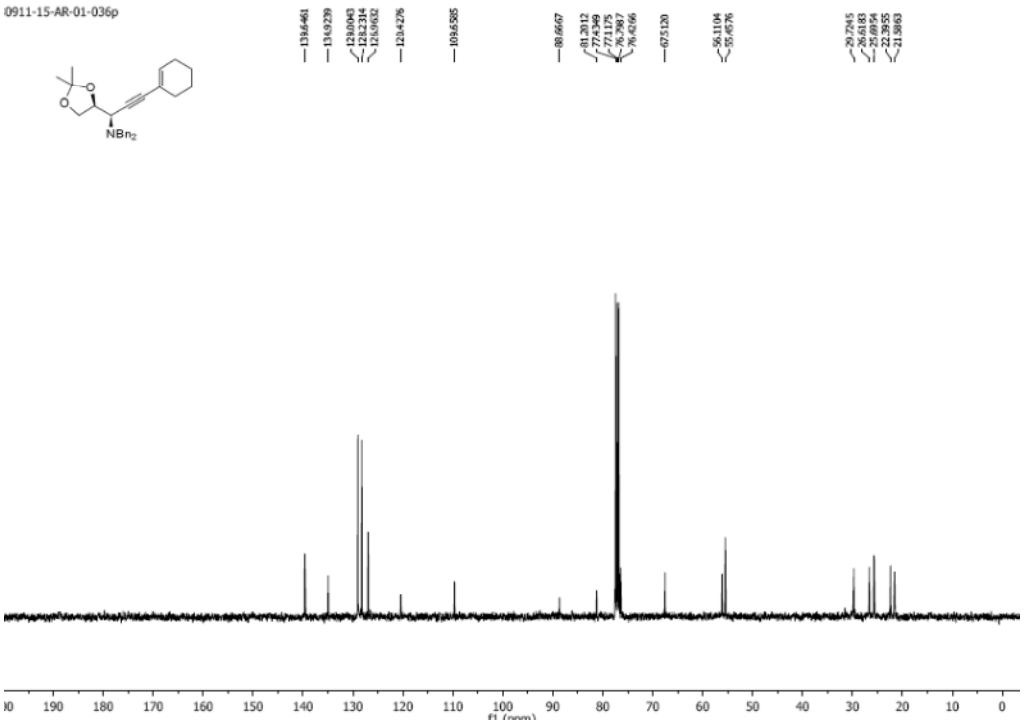

Fig. S10 ^{1}H-NMR of **15b**

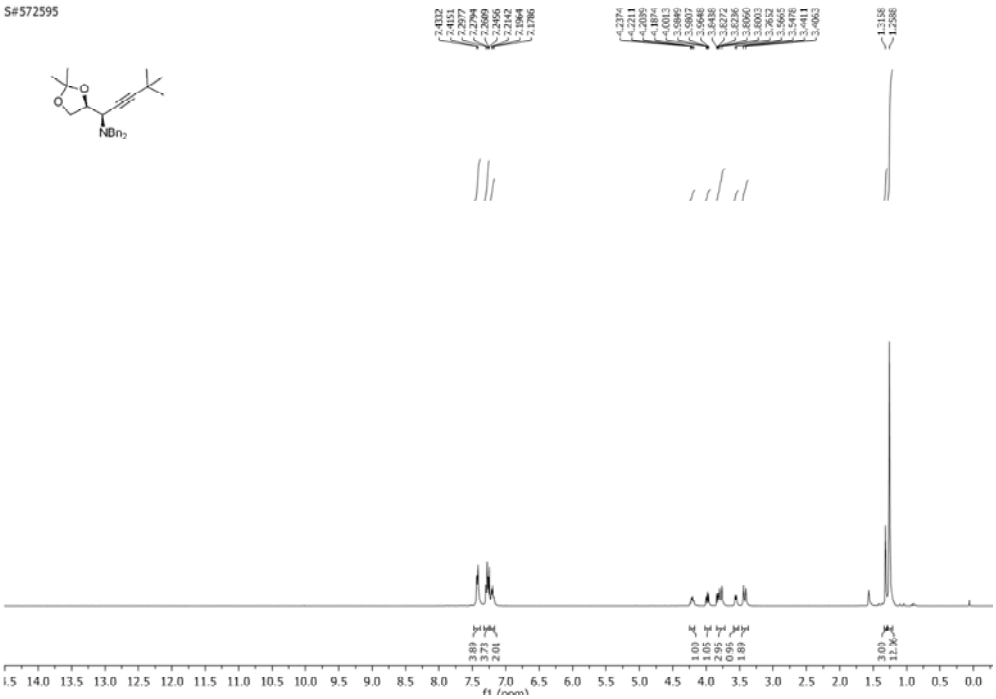

Fig. S11 ^{1}H-NMR of **15c**.

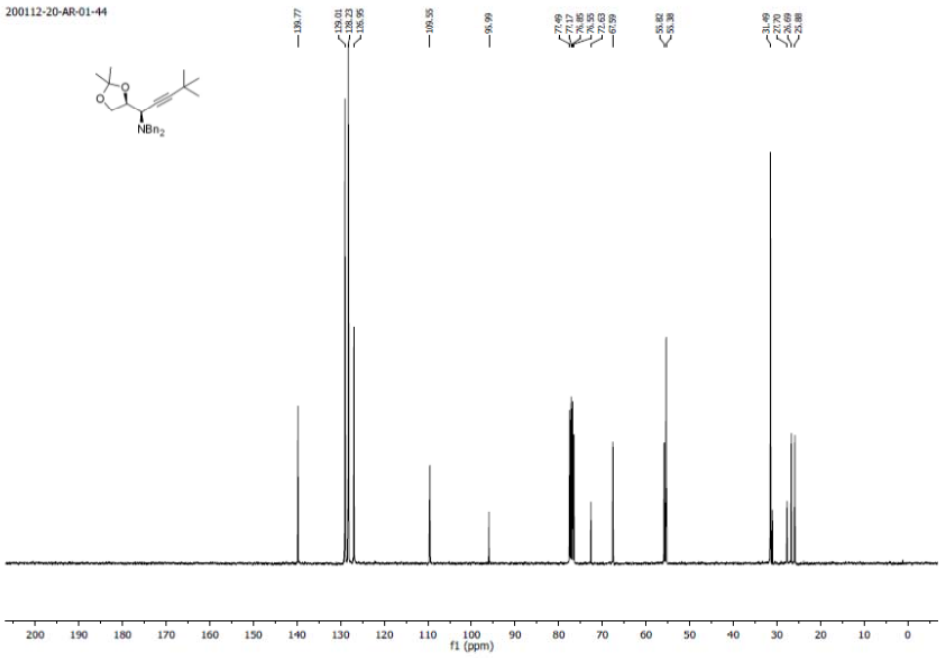

Fig. S12 ^{13}C-NMR of **15c**.

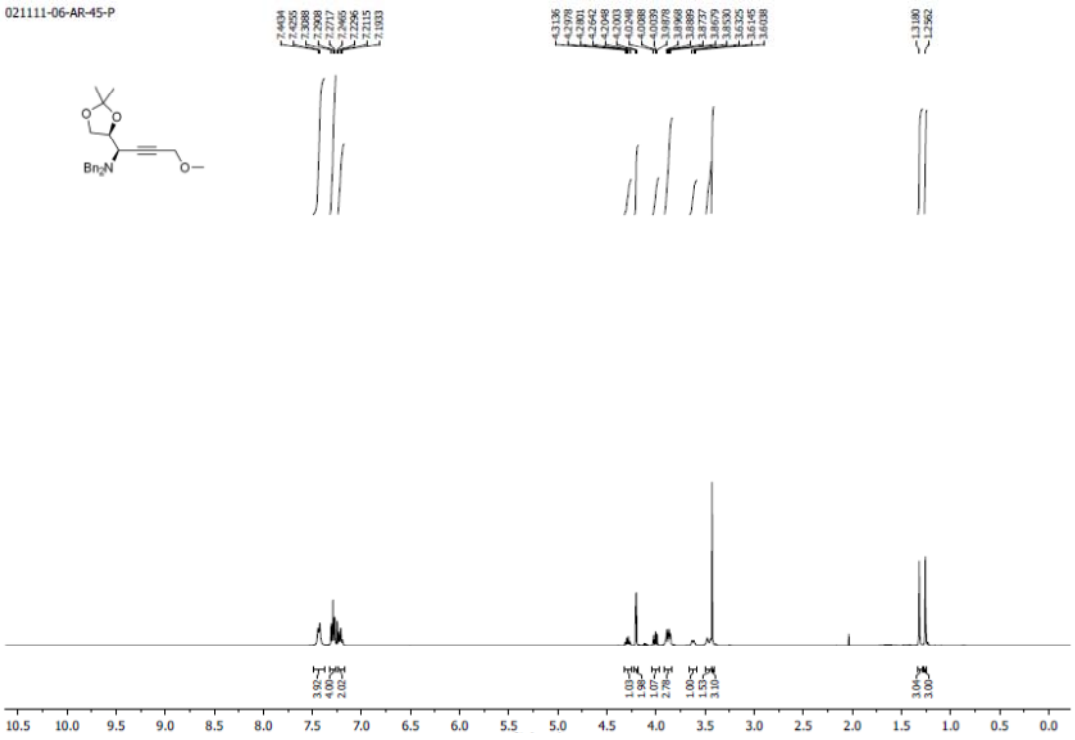

Fig. S13 ^{1}H-NMR of 1**5d**.

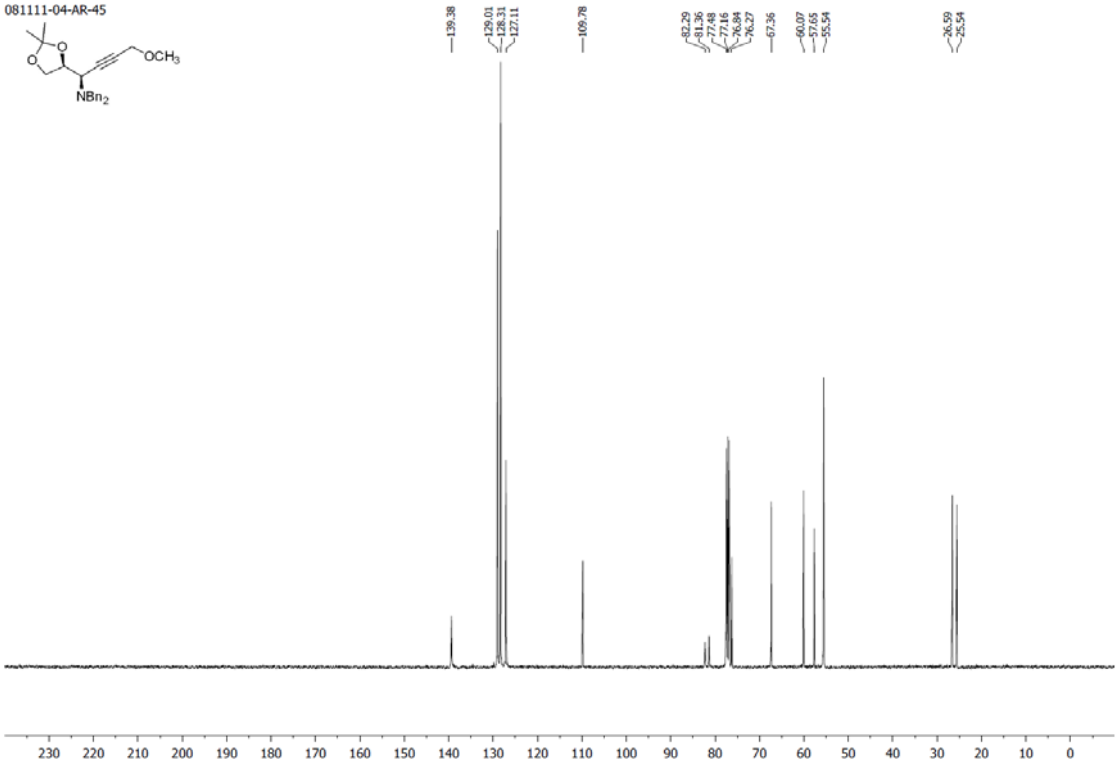

Fig. S14 ^{13}C-NMR of 1**5d**.

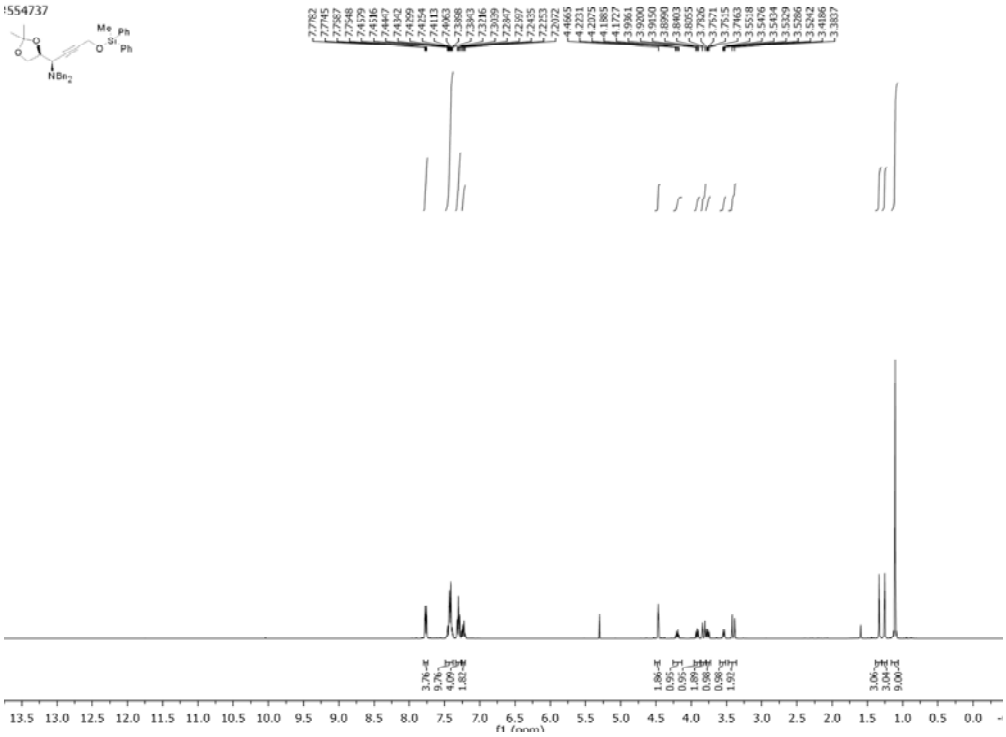

Fig. S15 ^{1}H-NMR of 1**5e**.

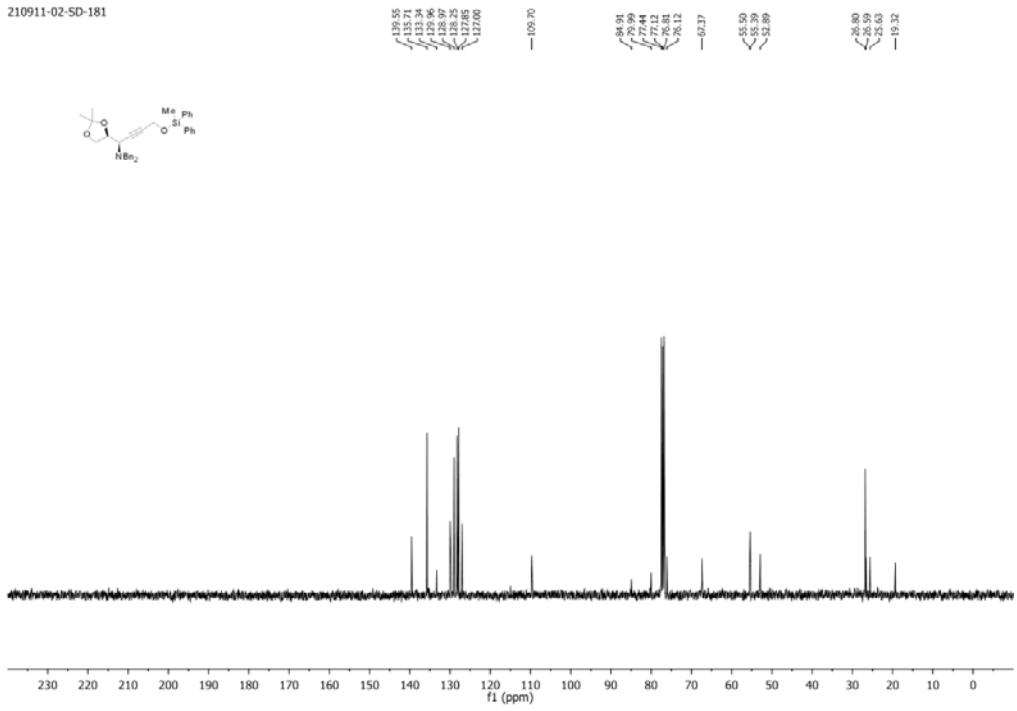

Fig. S16 ^{13}C-NMR of 1**5e**.

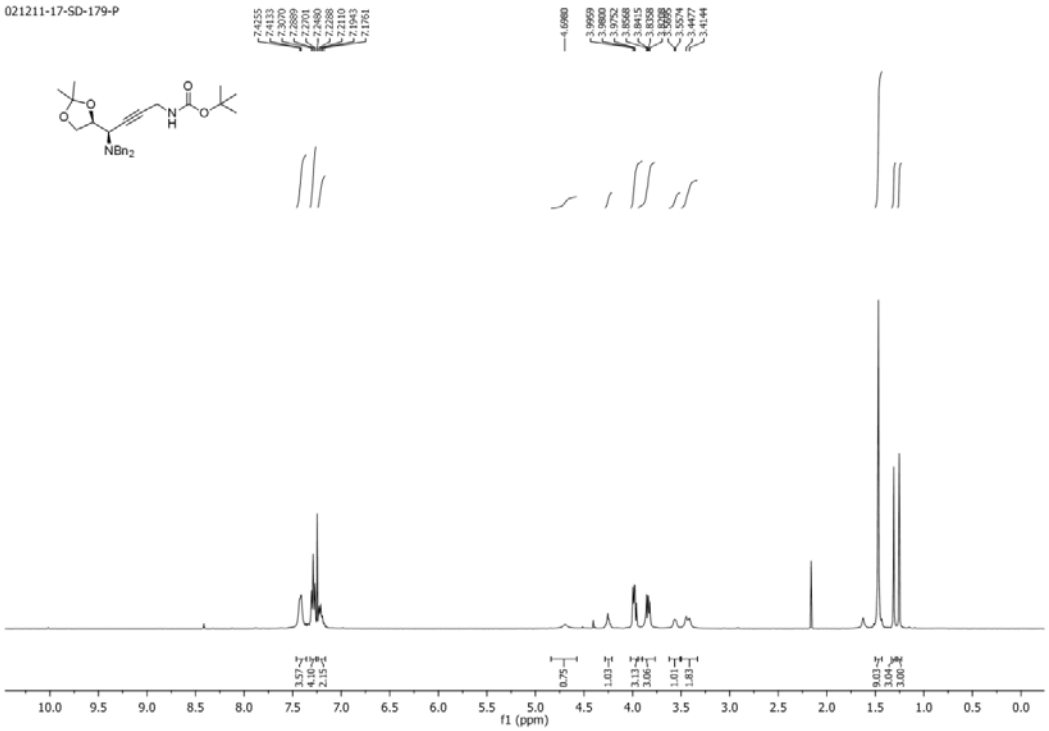

Fig. S17 ^{1}H-NMR of 1**5f**.

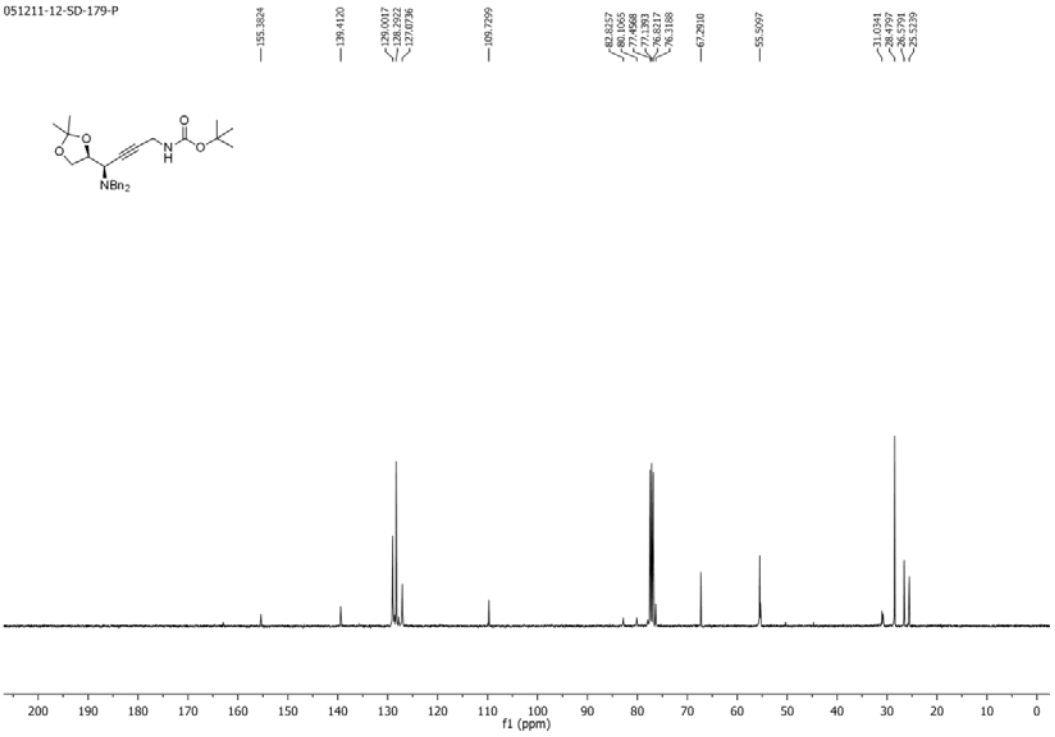

Fig. S18 ^{13}C-NMR of 1**5f**.

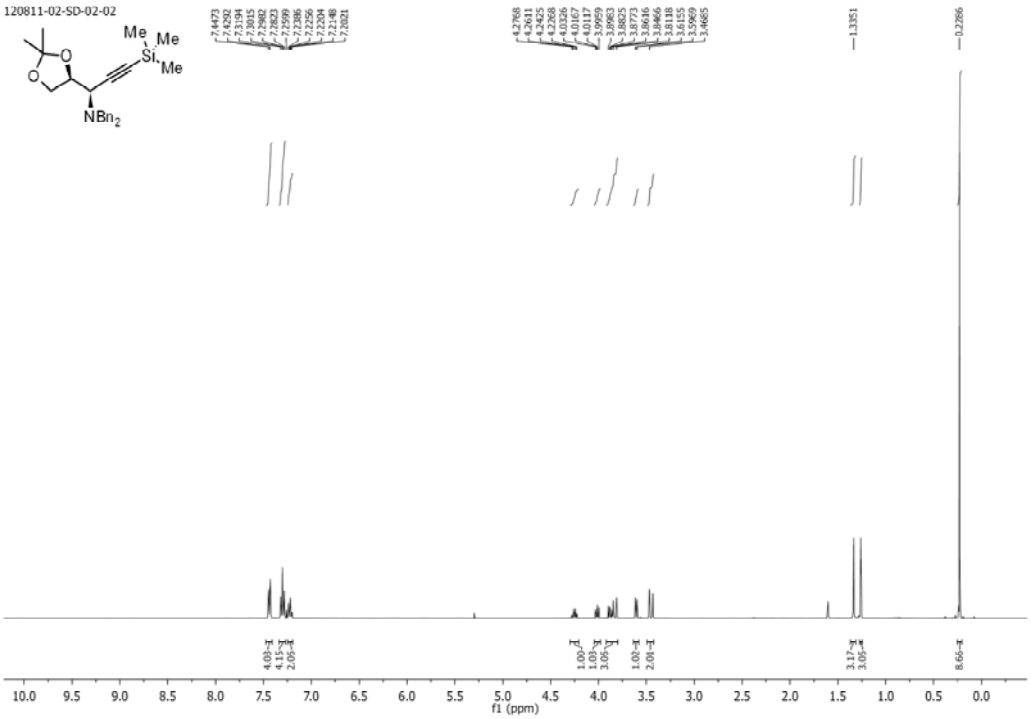

Fig. S19 ^{1}H-NMR of 1**5g**.

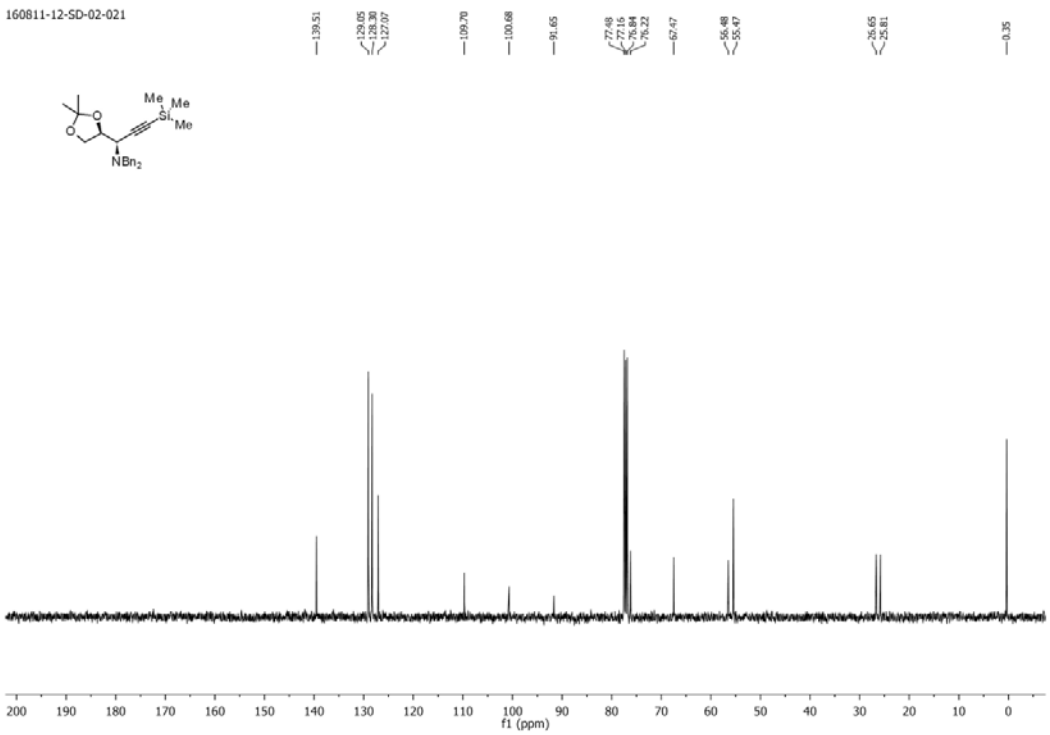

Fig. S20 ^{13}C-NMR of 1**5g**.

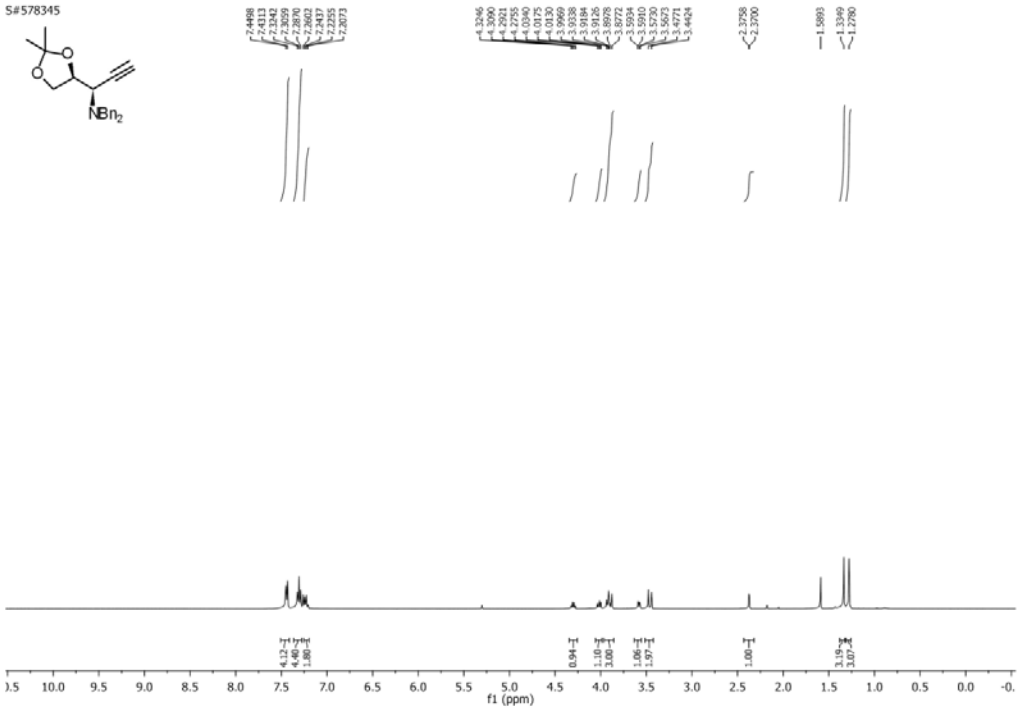

Fig. S21 ^{1}H-NMR of **17**.

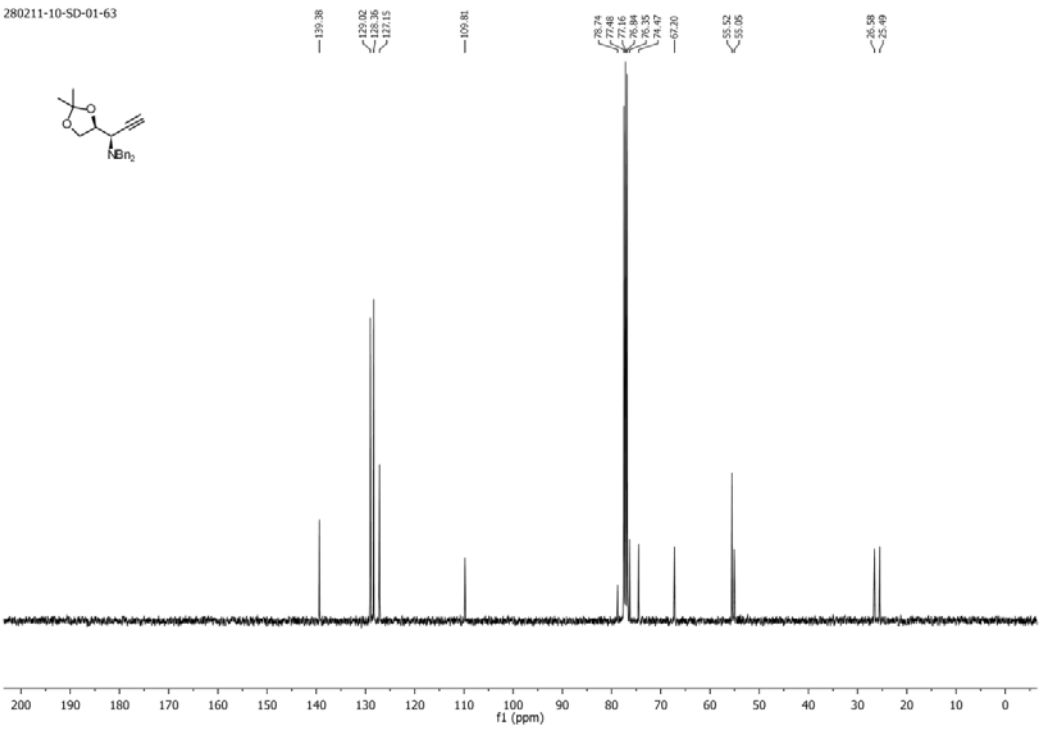

Fig. S22 ^{13}C-NMR of **17**.

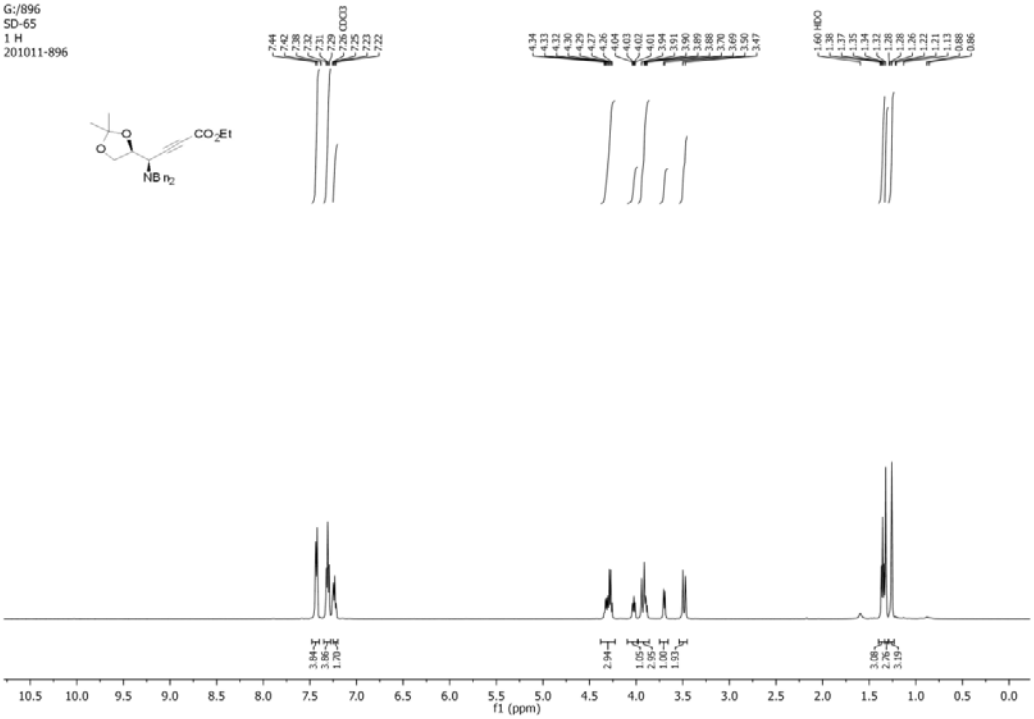

Fig. S23 ^{1}H-NMR of 1**8a**.

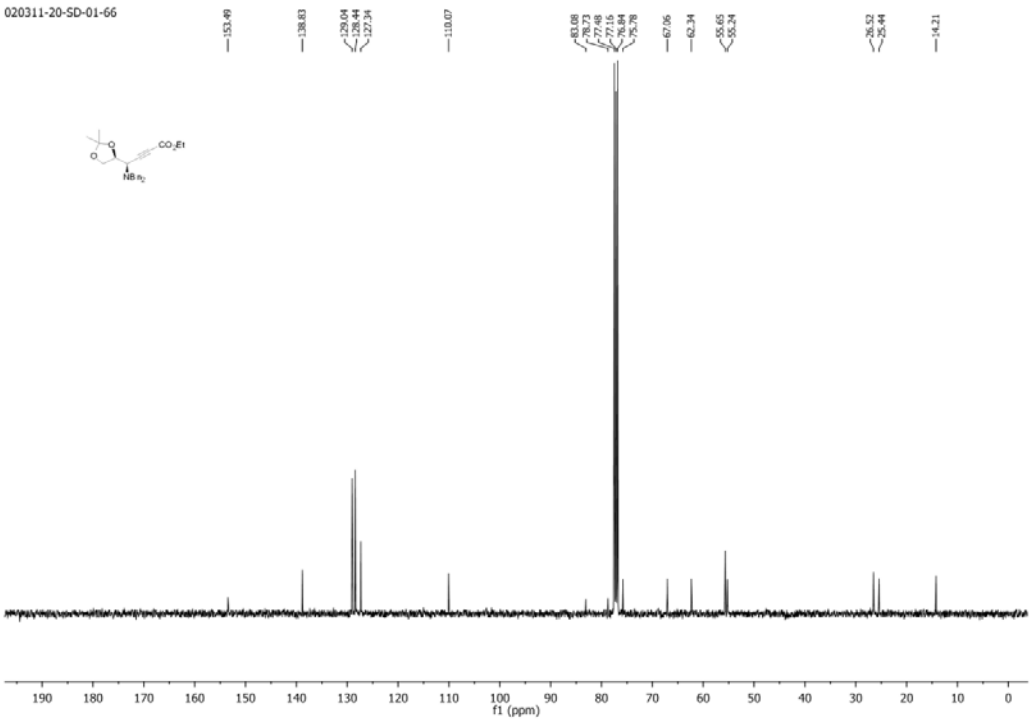

Fig. S24 ^{13}C-NMR of 1**8a**.

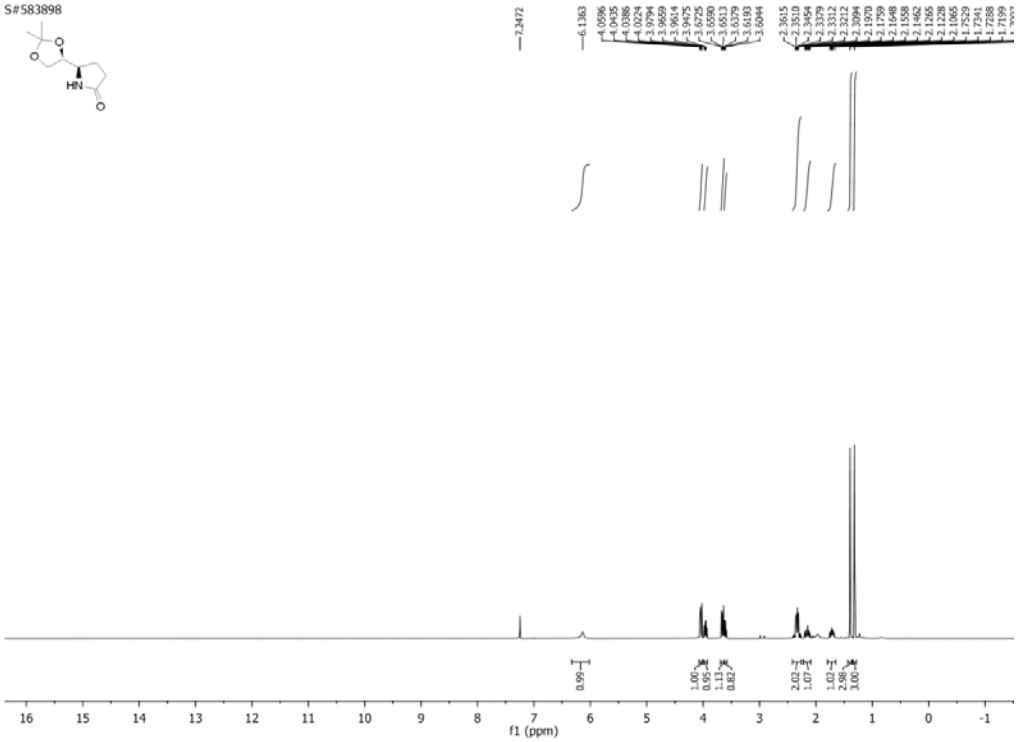

Fig. S25 ^{1}H-NMR of 1**9a**.

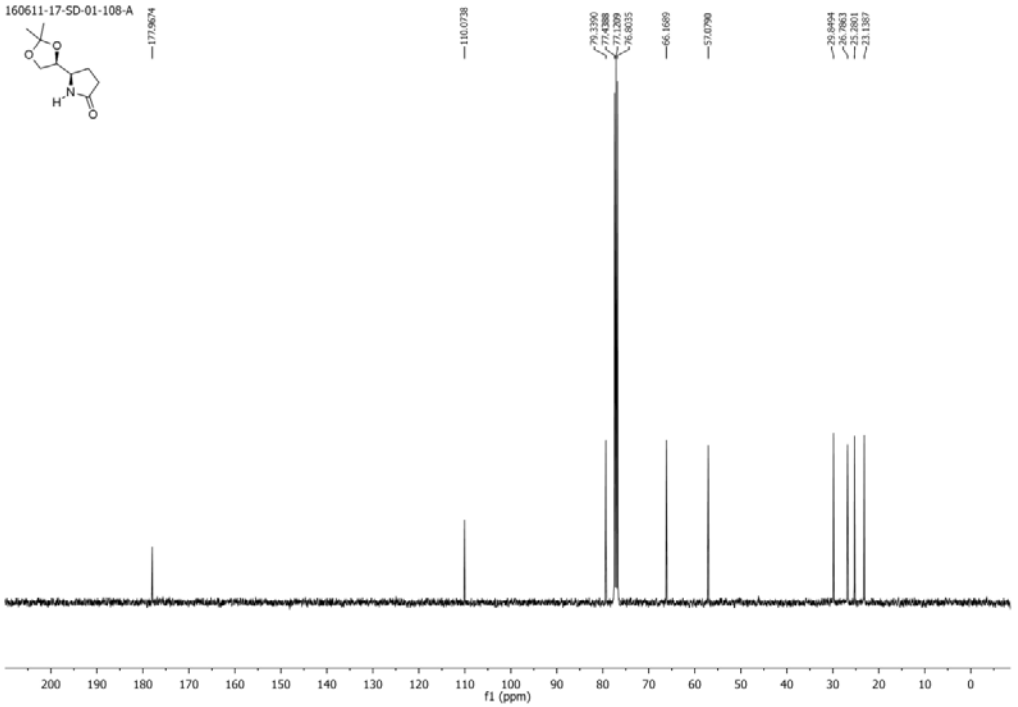

Fig. S26 ^{13}C-NMR of 1**9a**.

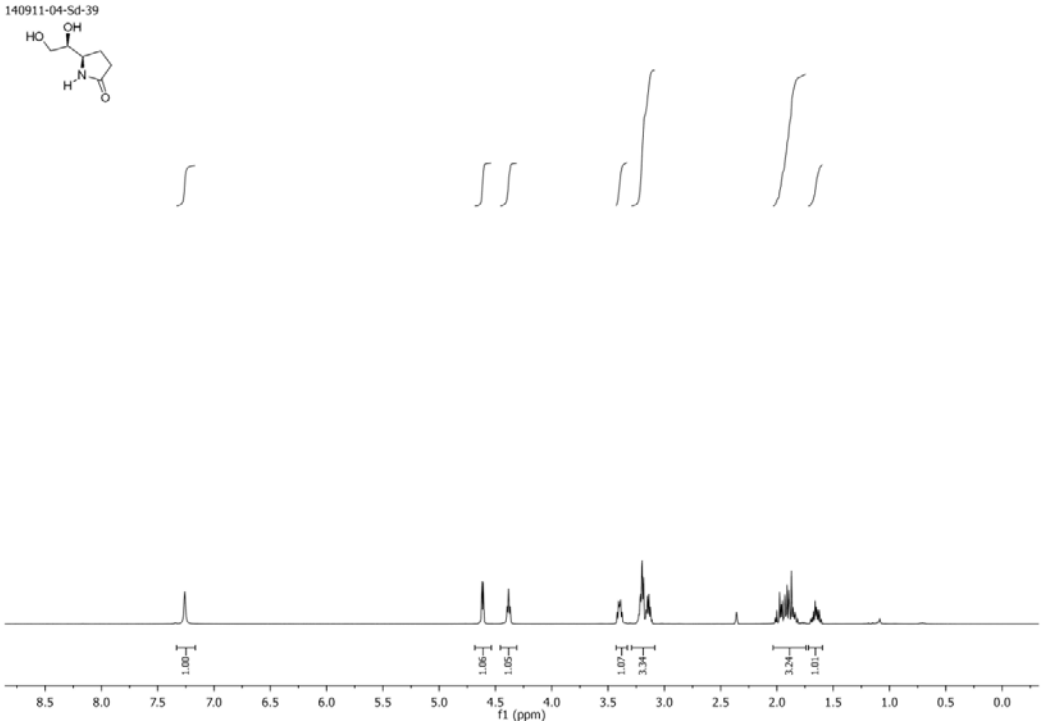

Fig. S27 ^{1}H-NMR of **20a**.

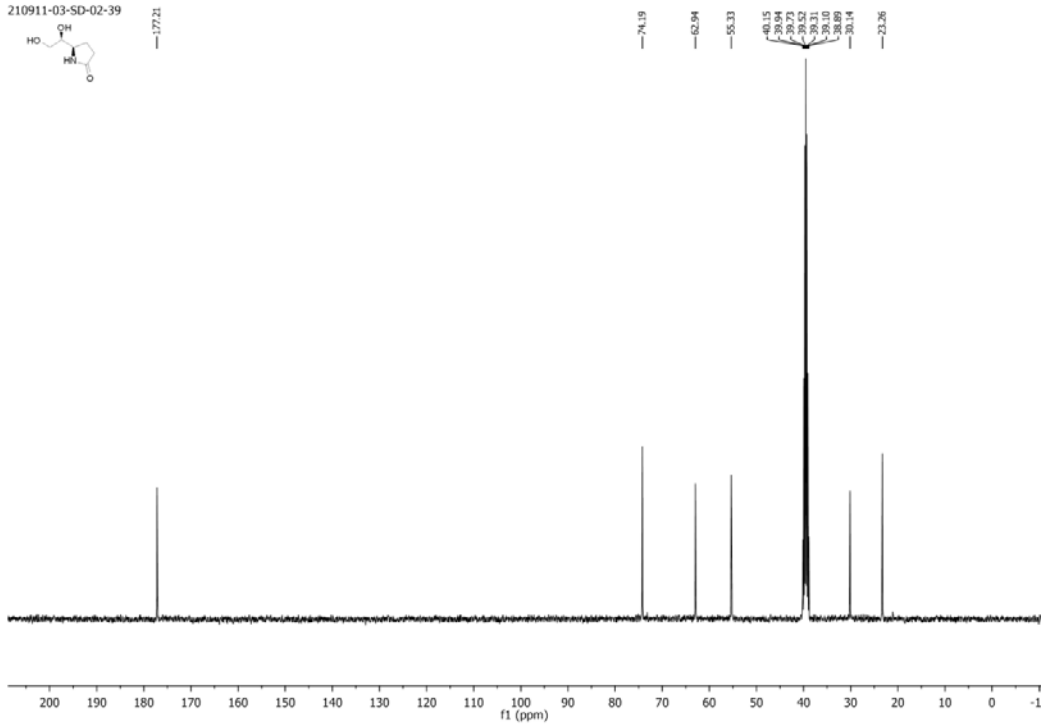

Fig. S28 ^{13}C-NMR of **20a**.

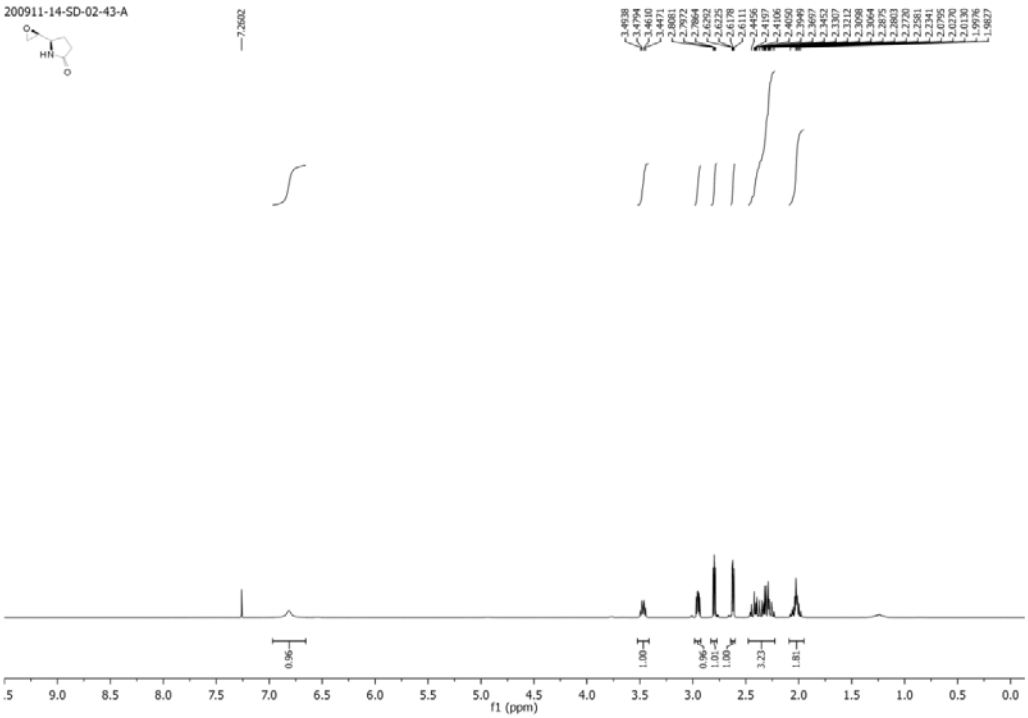

Fig. S29 ^{1}H-NMR of **21a**.

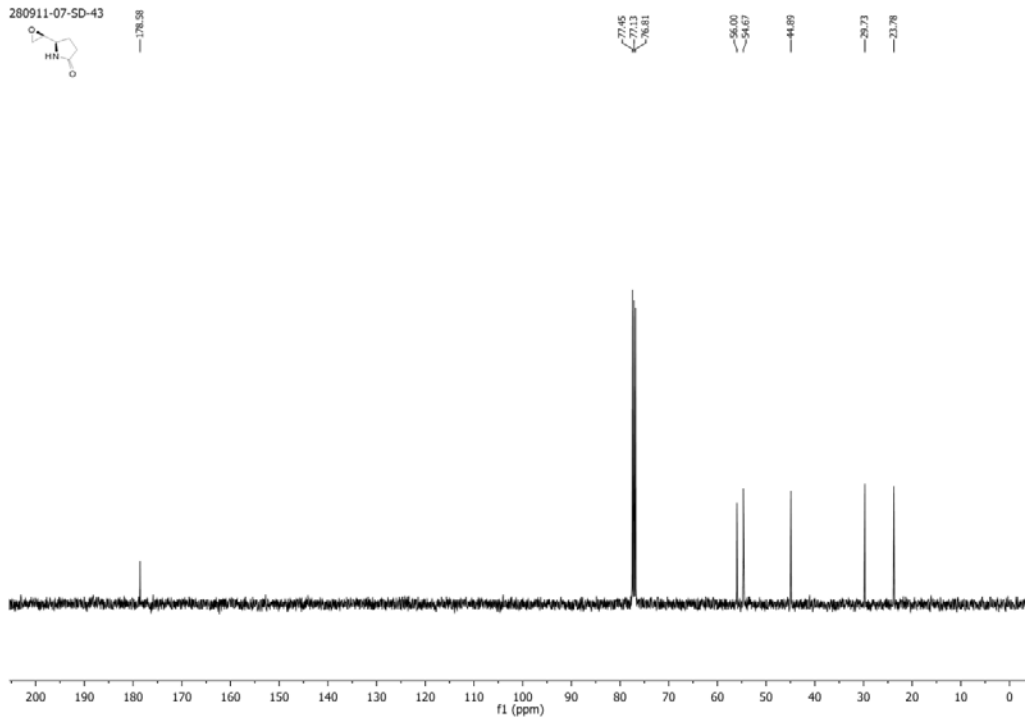

Fig. S30 ^{13}C-NMR of **21a**.

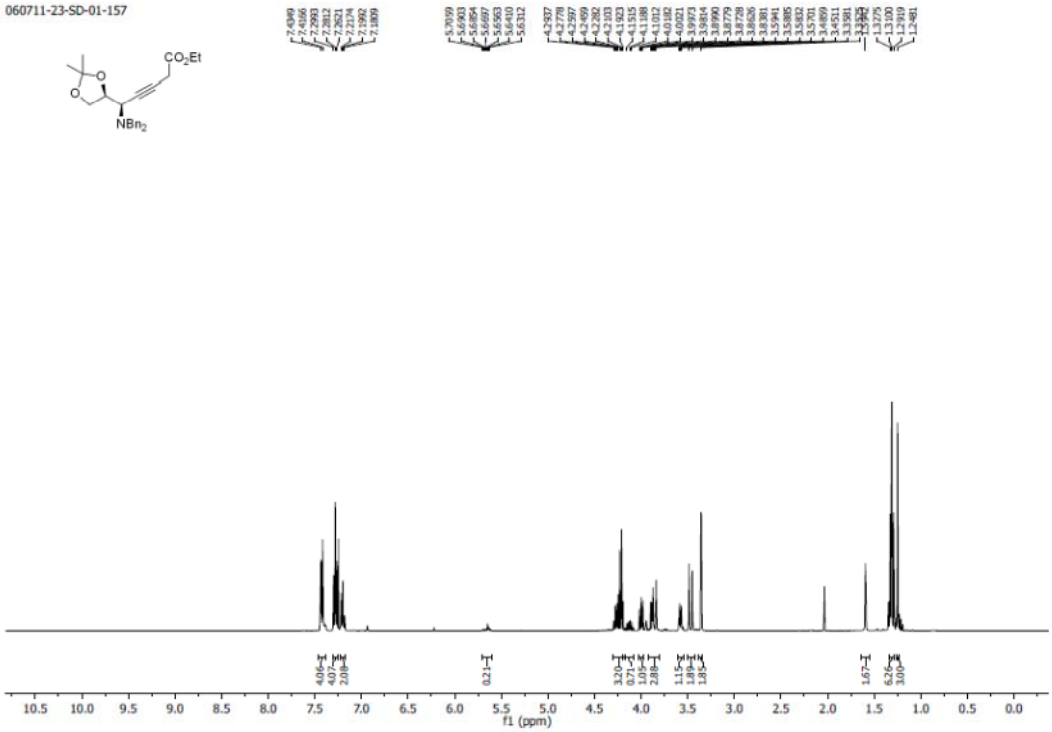

Fig. S31 ^{1}H-NMR of **18b**.

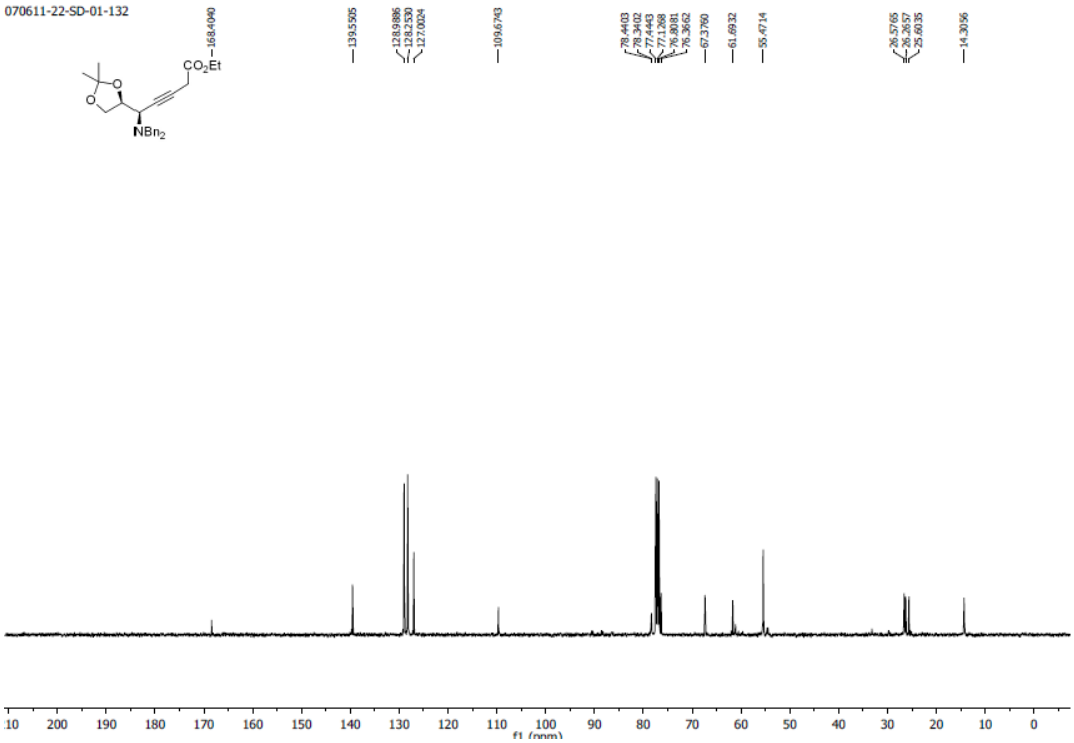

Fig. S32 ^{13}C-NMR of **18b**.

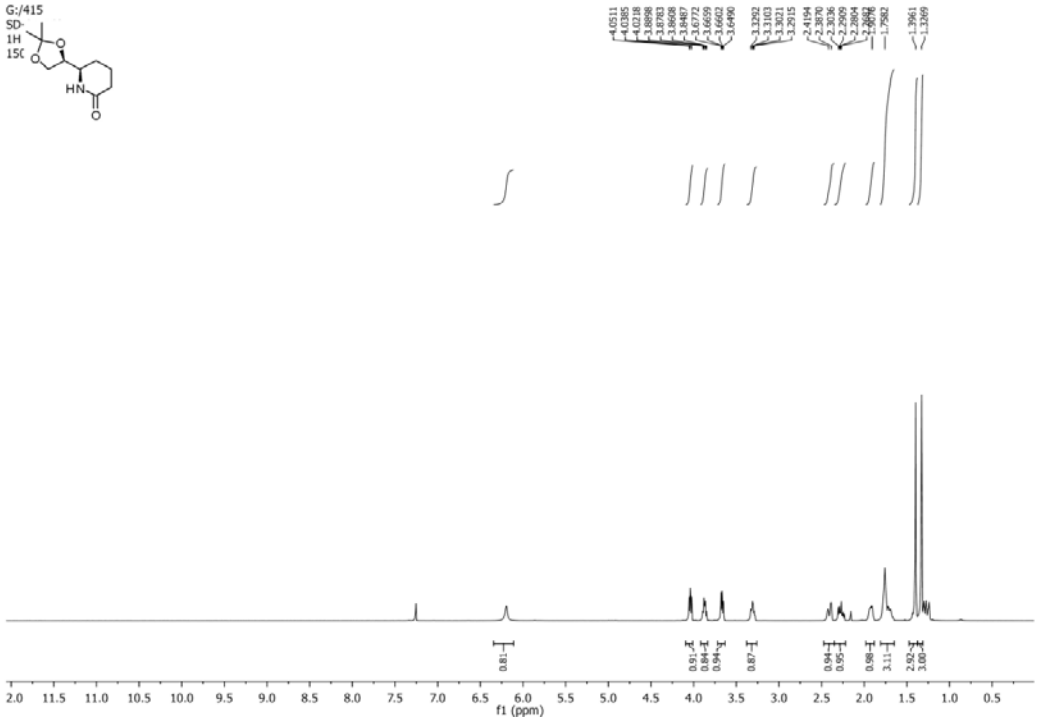

Fig. S33 ^{1}H-NMR of **19b**.

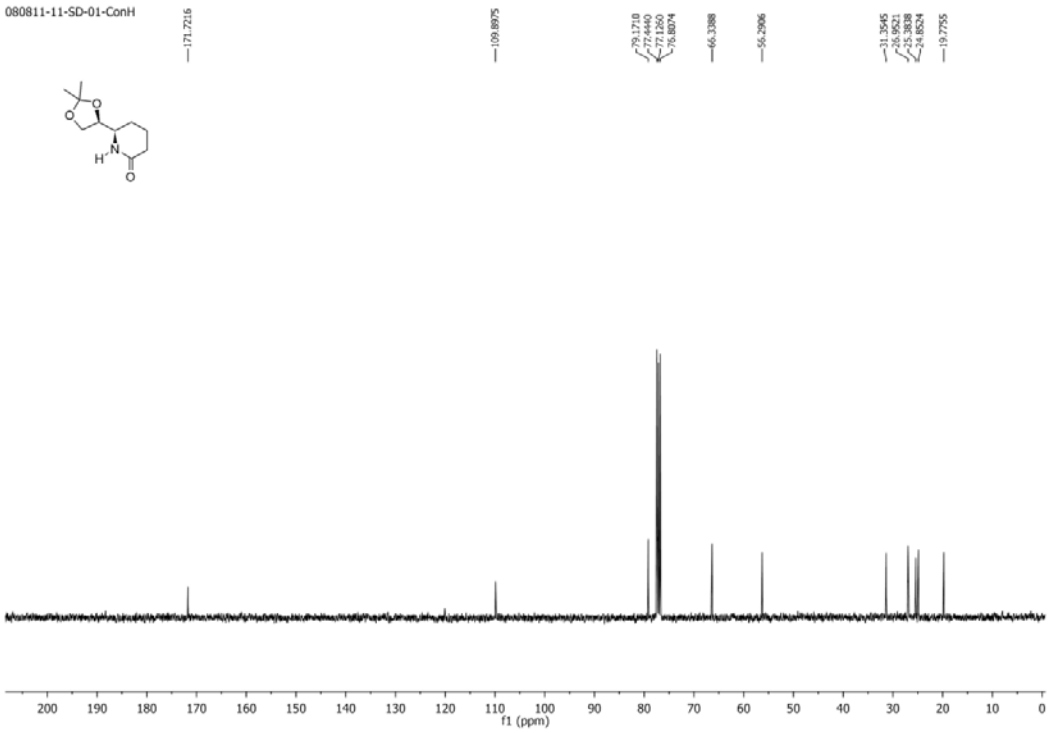

Fig. S34 ^{13}C-NMR of **19b**.

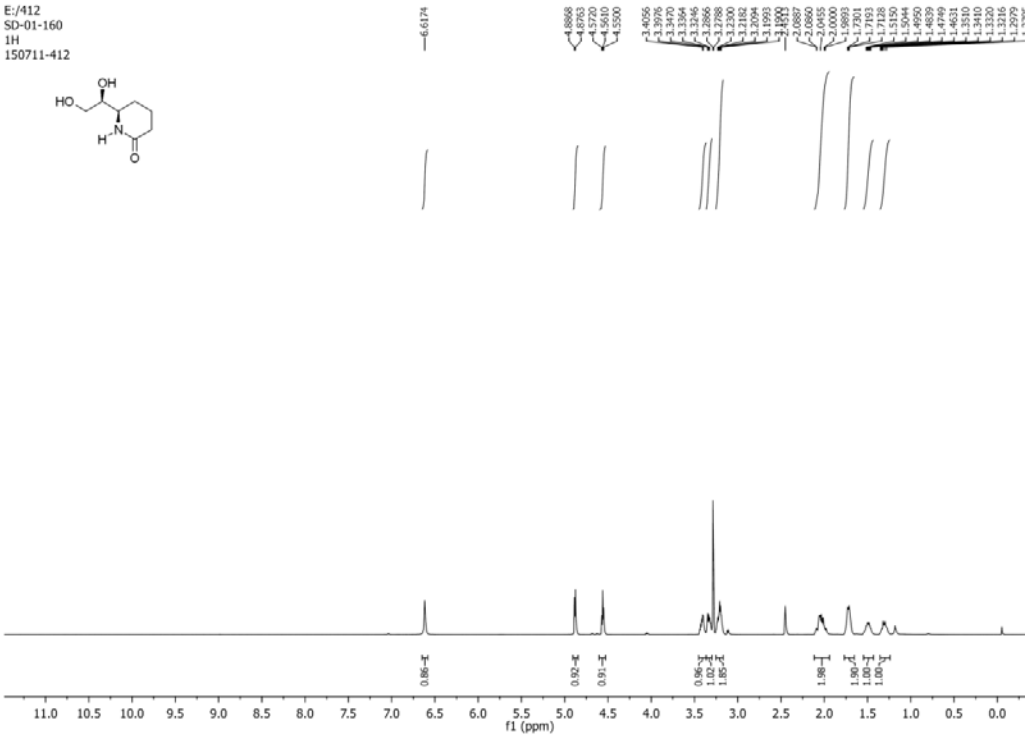

Fig. S35 ^{1}H-NMR of **20b**.

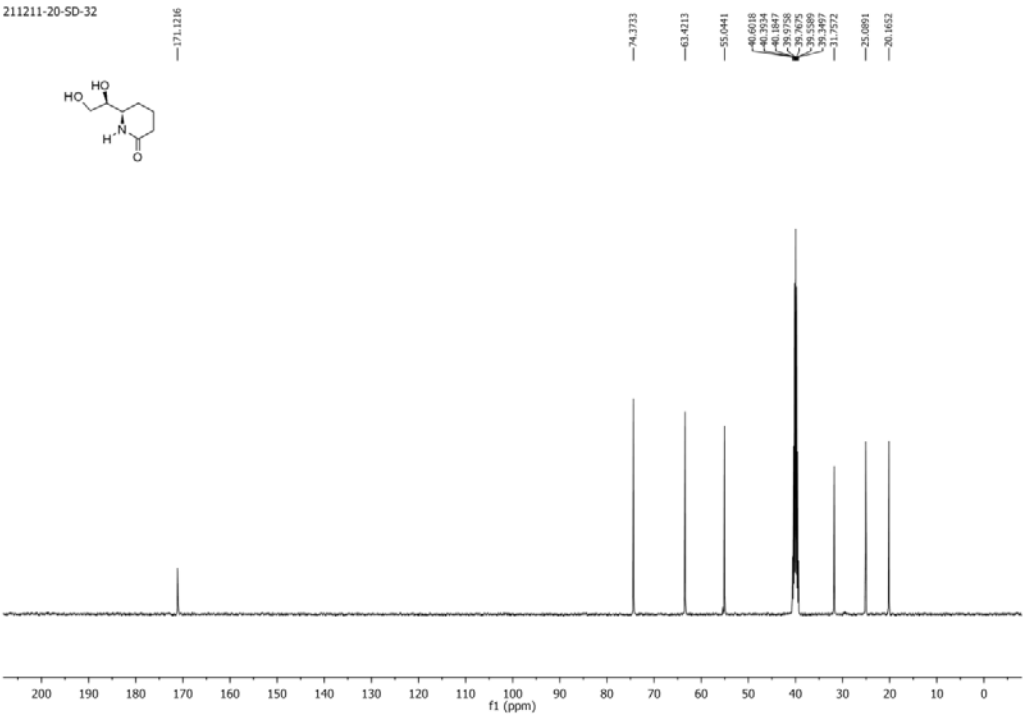

Fig. S36 ^{13}C-NMR of **20b**.

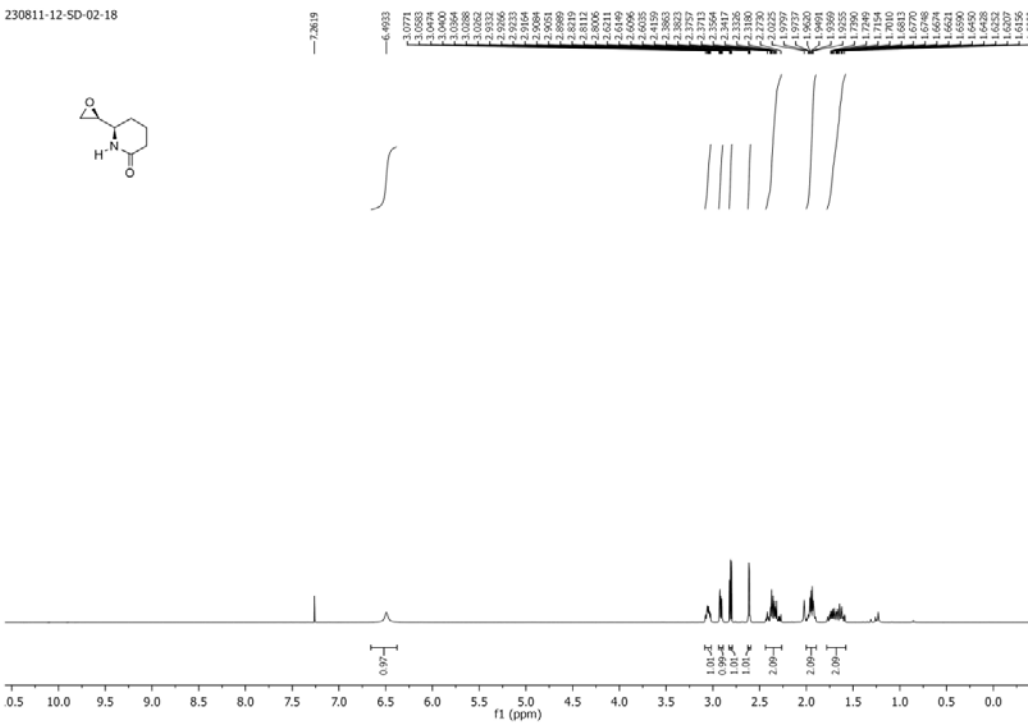

Fig. S37 ^{1}H-NMR of **21b**.

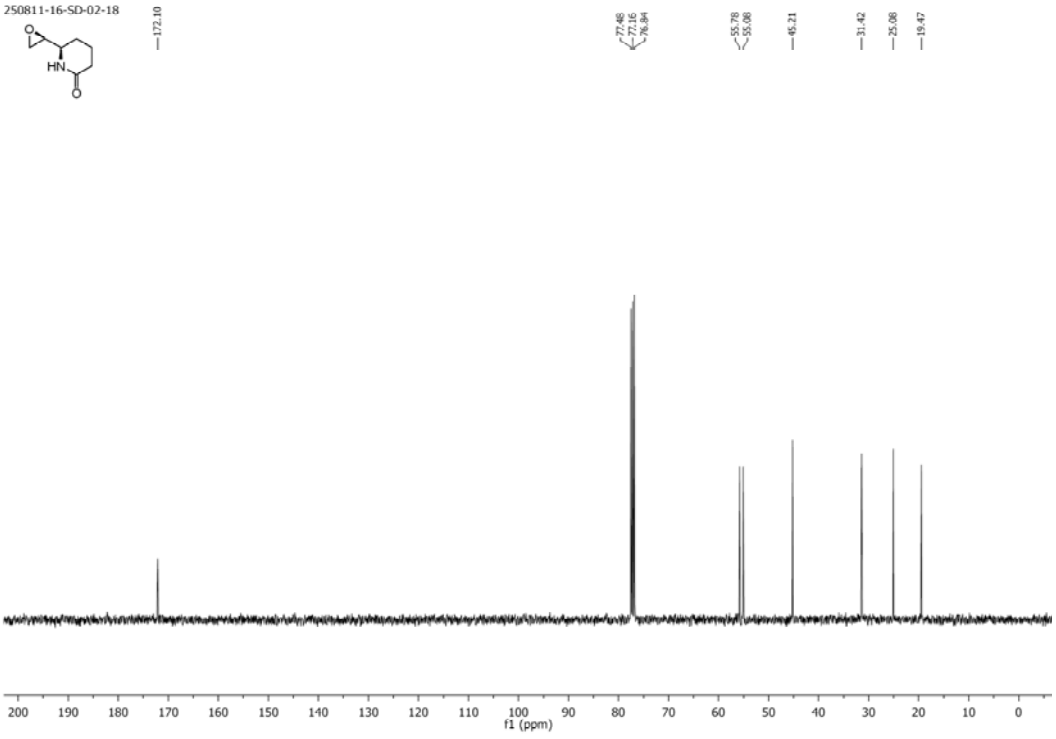

Fig. S38 ^{13}C-NMR of **21b**.

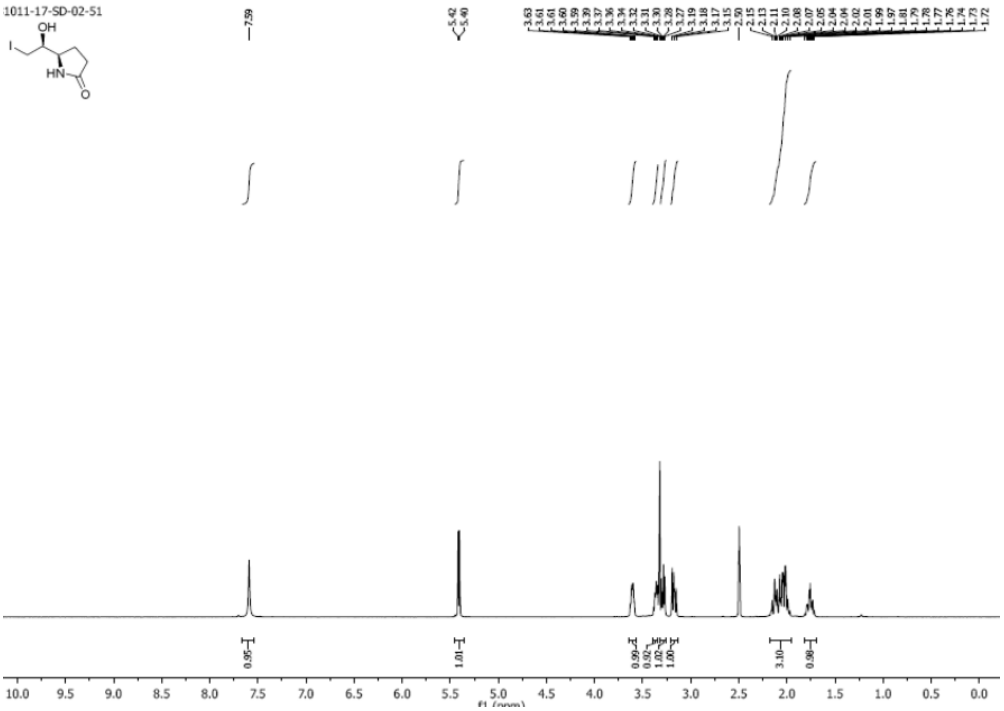

Fig. S39 ^{1}H-NMR of **22a**.

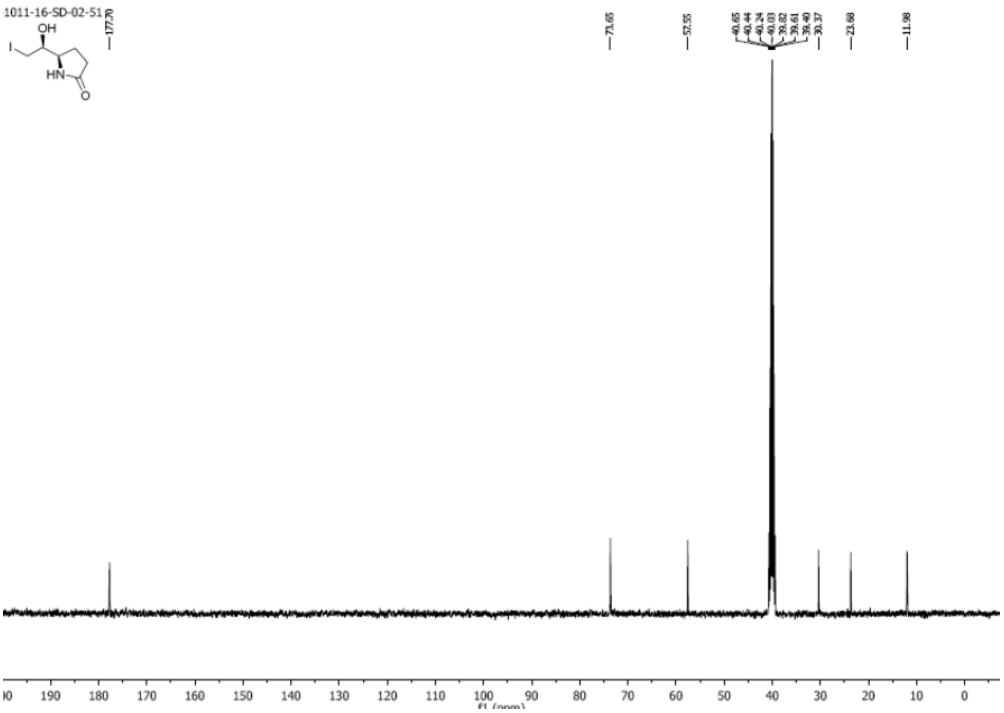

Fig. S40 ^{13}C-NMR of **22a**.

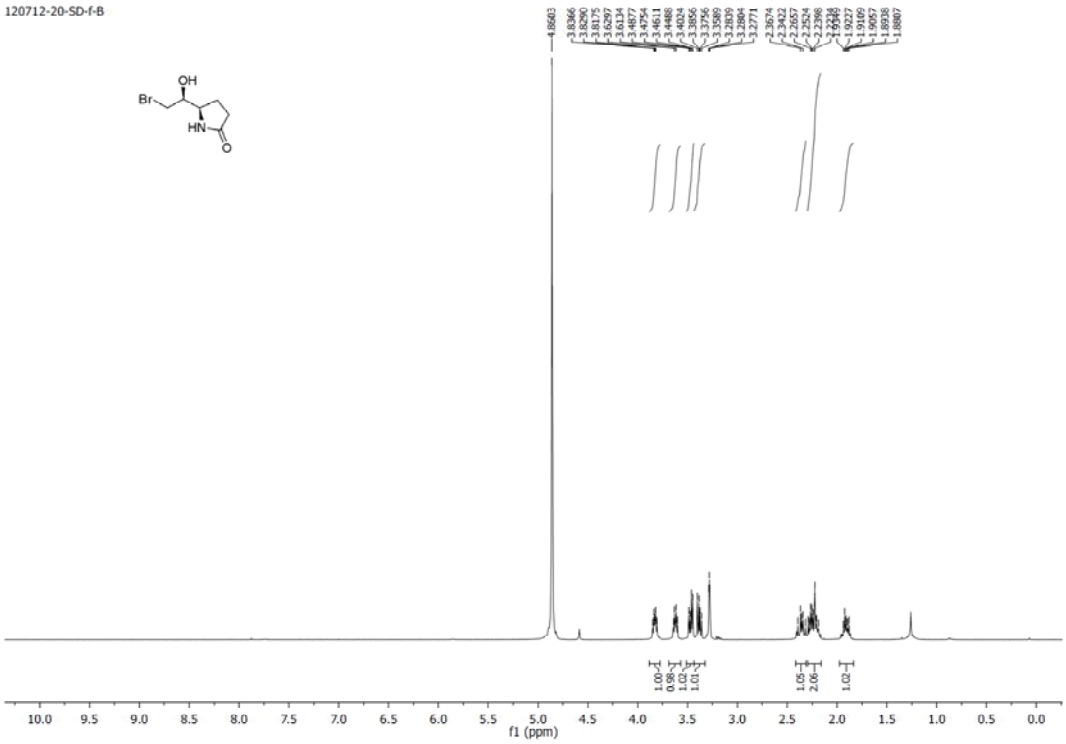

Fig. S41 ^{1}H-NMR of **22b**.

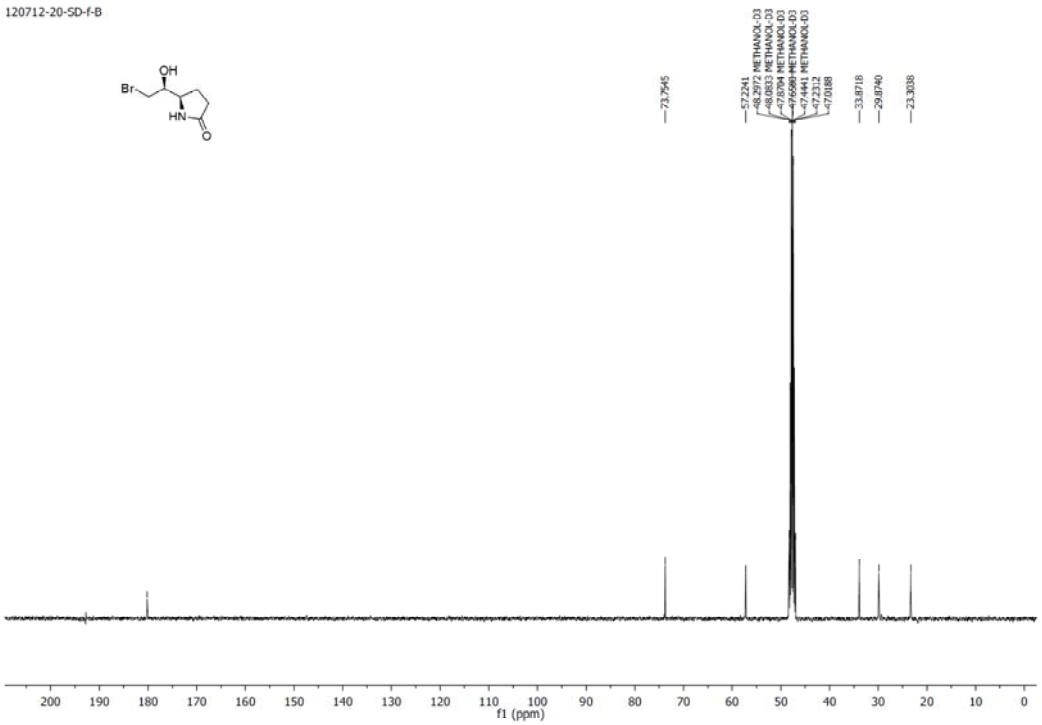

Fig. S42 ^{13}C-NMR of **22b**.

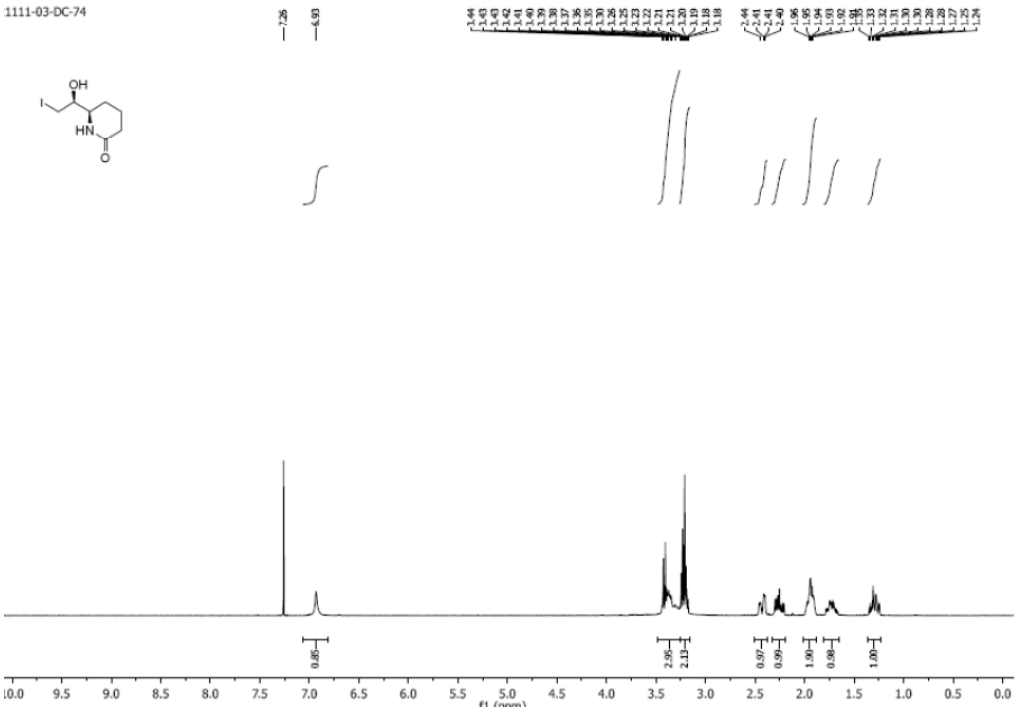

Fig. S43 ^{1}H-NMR of **22c**.

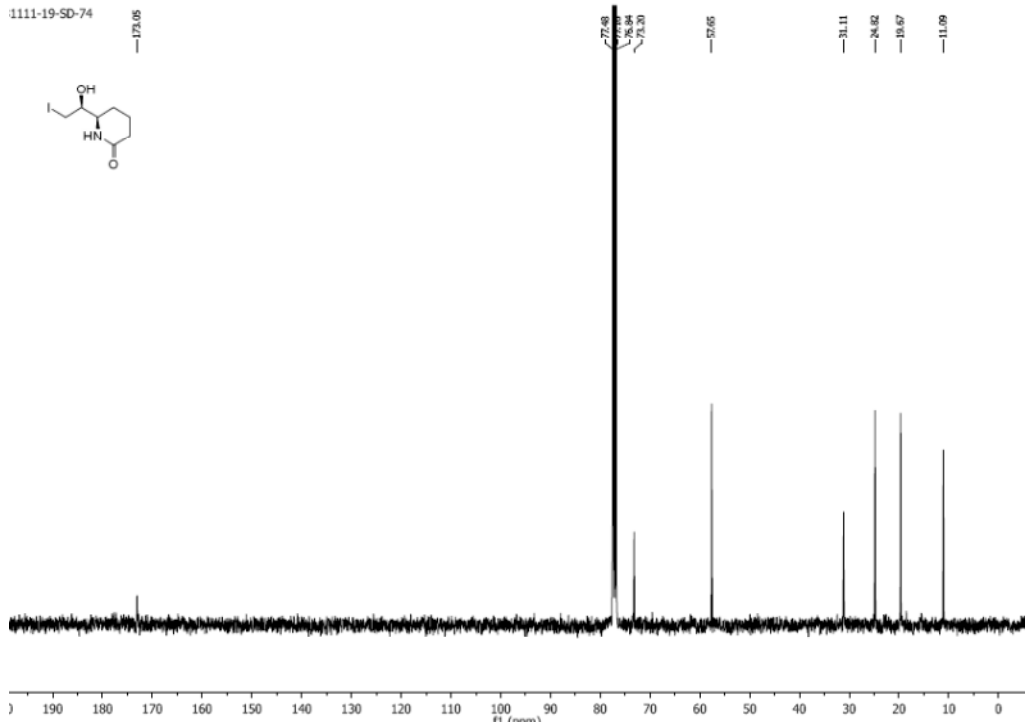

Fig. S44 ^{13}C-NMR of **22c**.

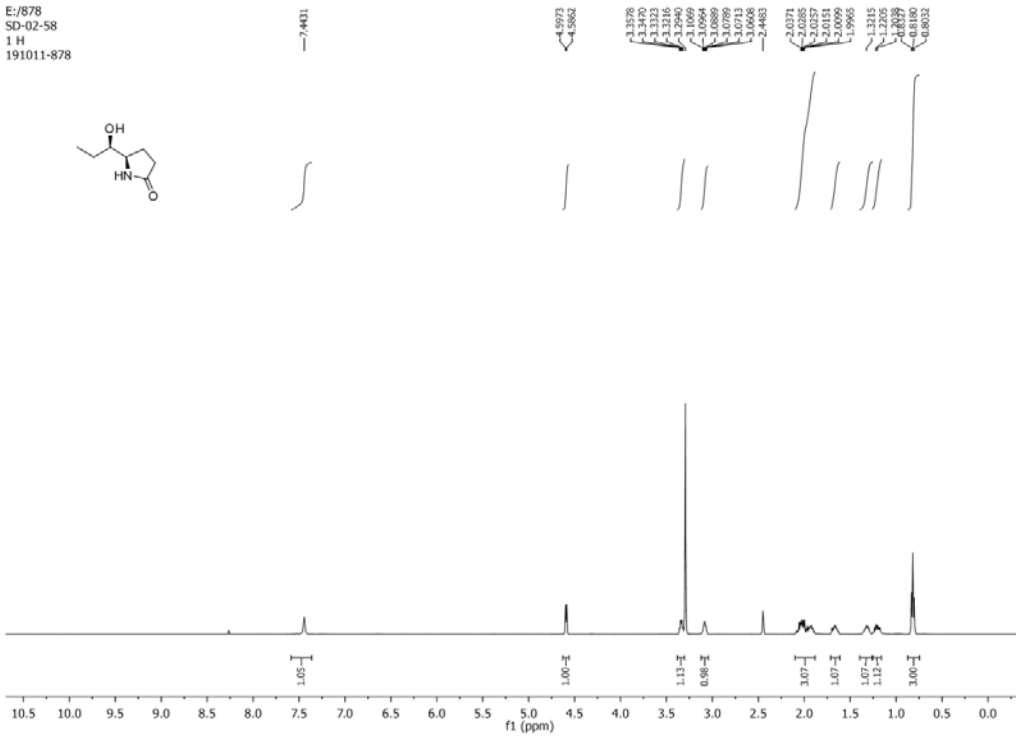

Fig. S45 ^{1}H-NMR of **23a**.

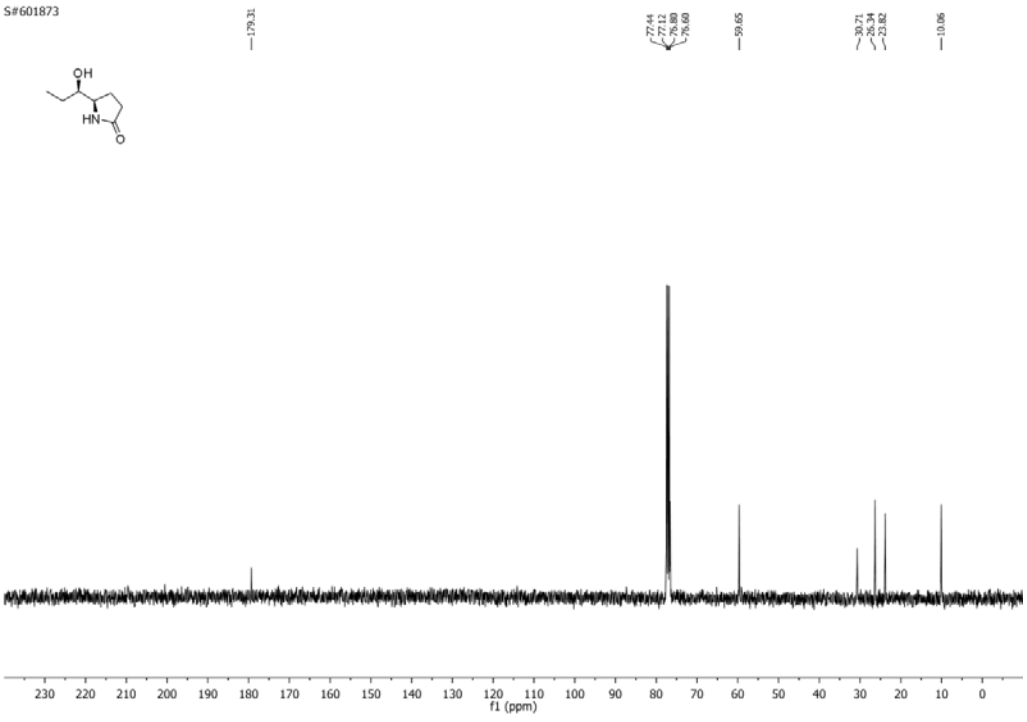

Fig. S46 ^{13}C-NMR of **23a**.

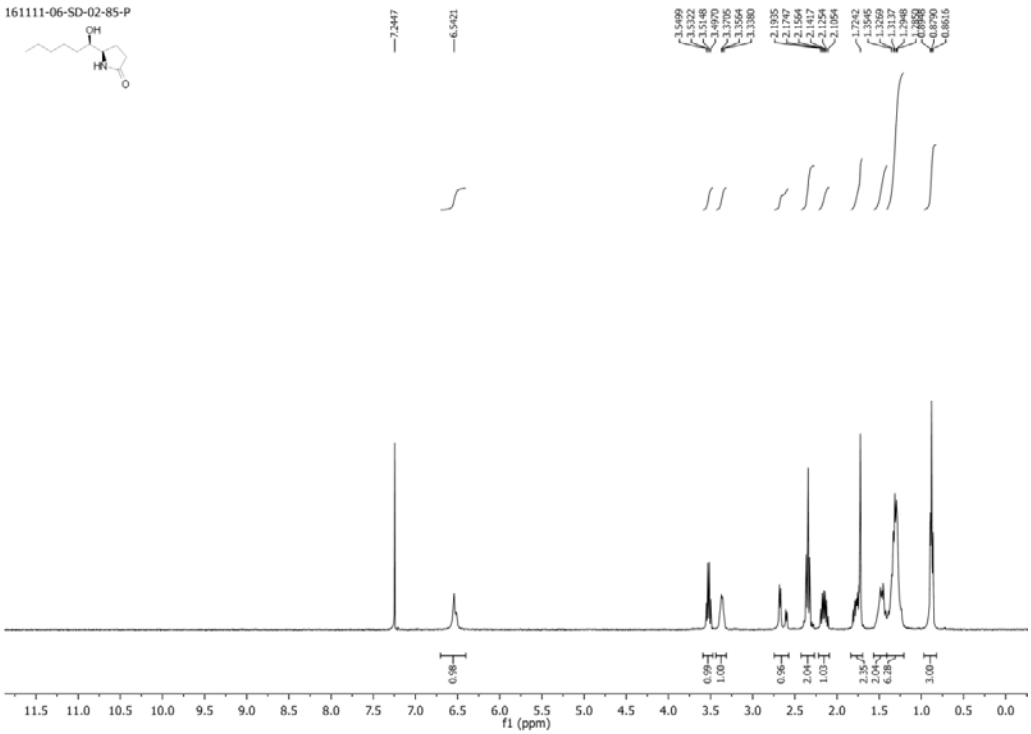

Fig. S47 ^{1}H-NMR of **23b**.

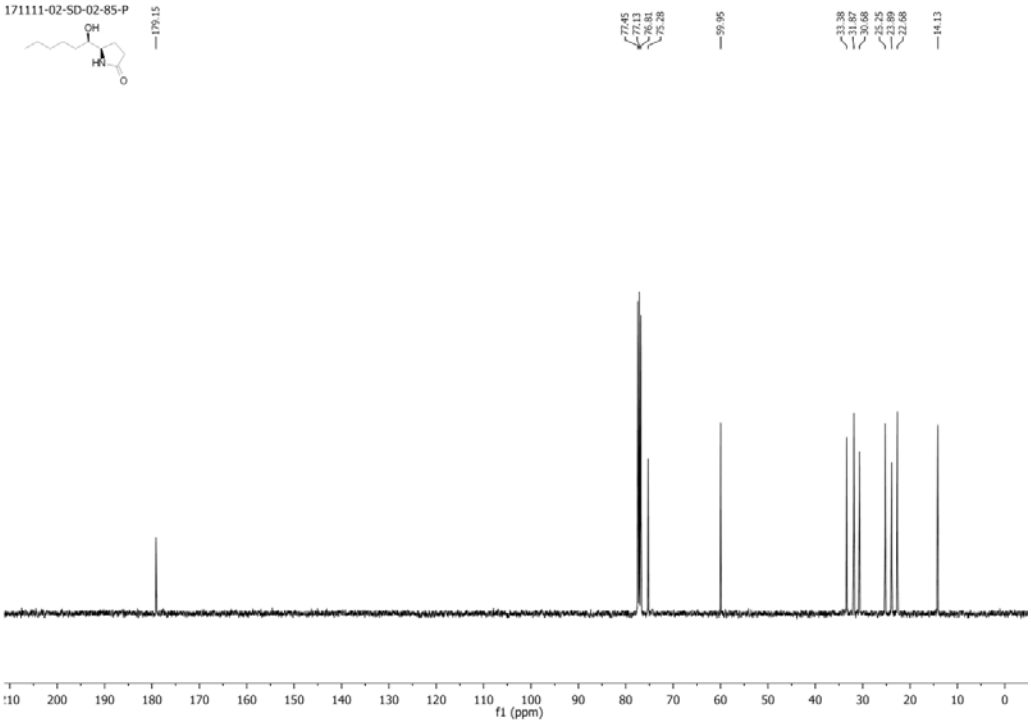

Fig. S48 ^{13}C-NMR of **23b**.

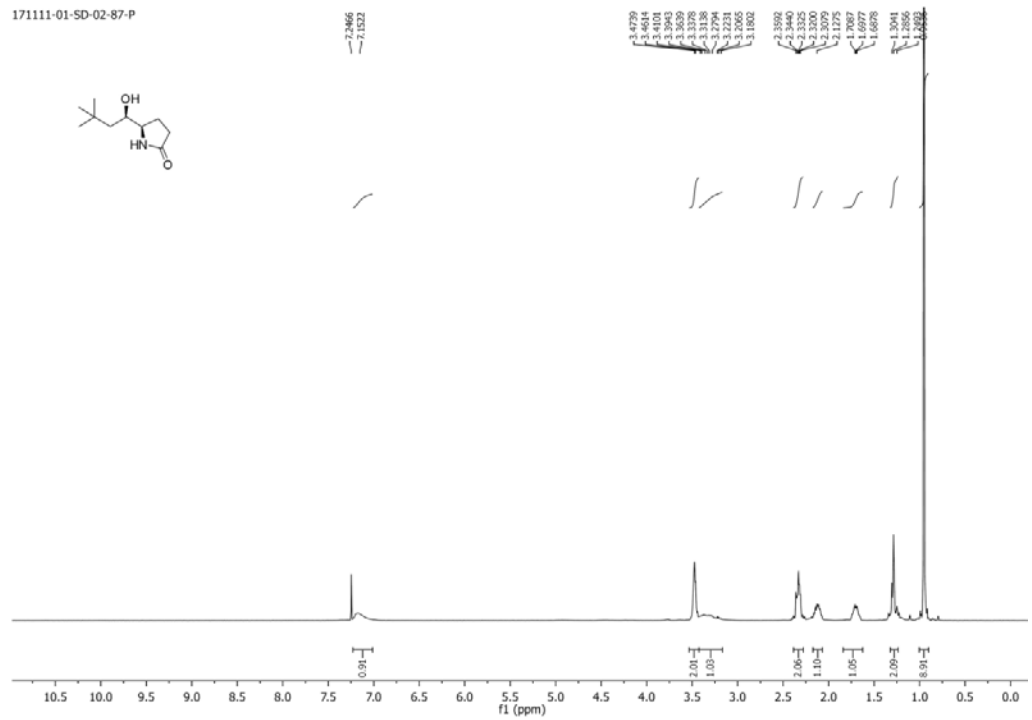

Fig. S49 ^{1}H-NMR of **23c**.

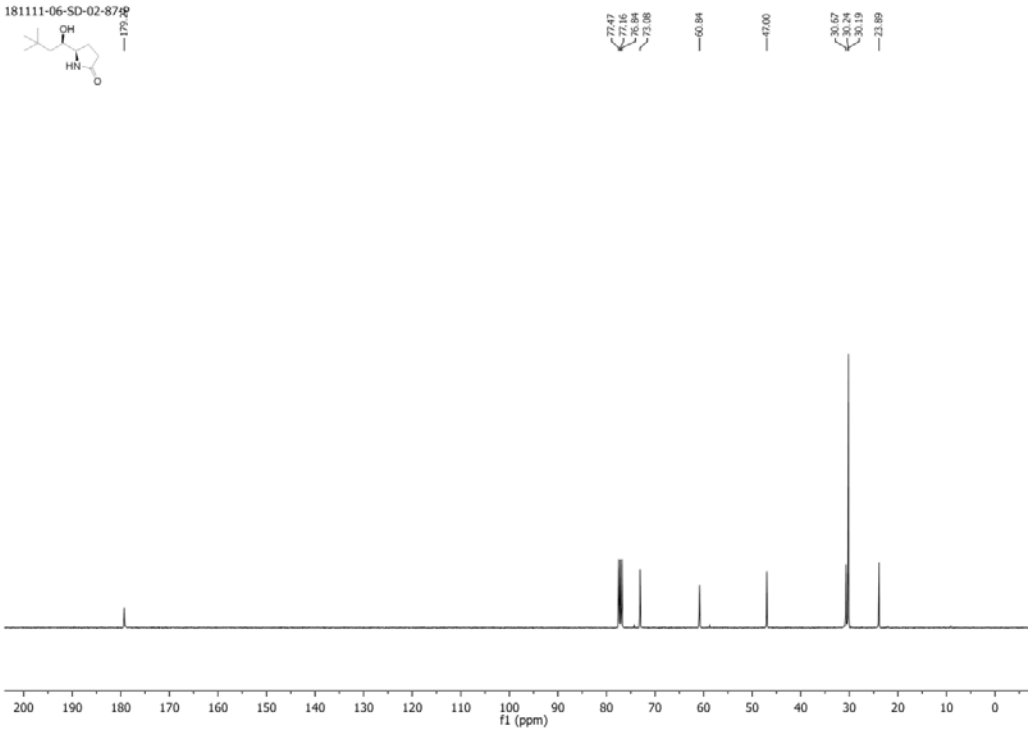

Fig. S50 ^{13}C-NMR of **23c**.

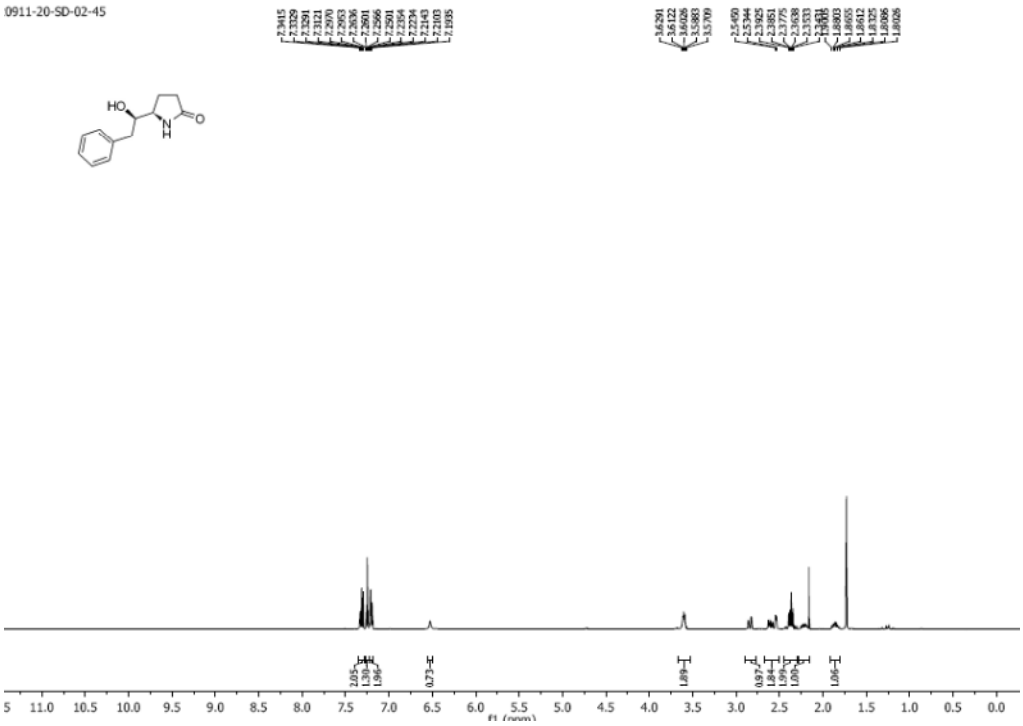

Fig. S51 ^{1}H-NMR of **23d**.

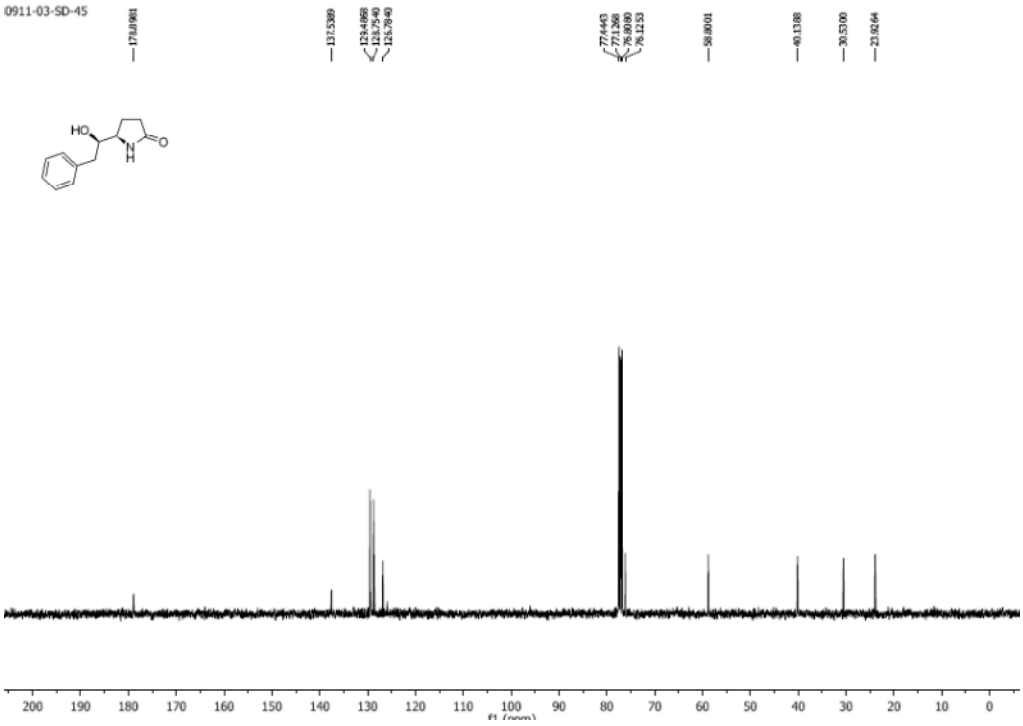

Fig. S52 ^{13}C-NMR of **23d**.

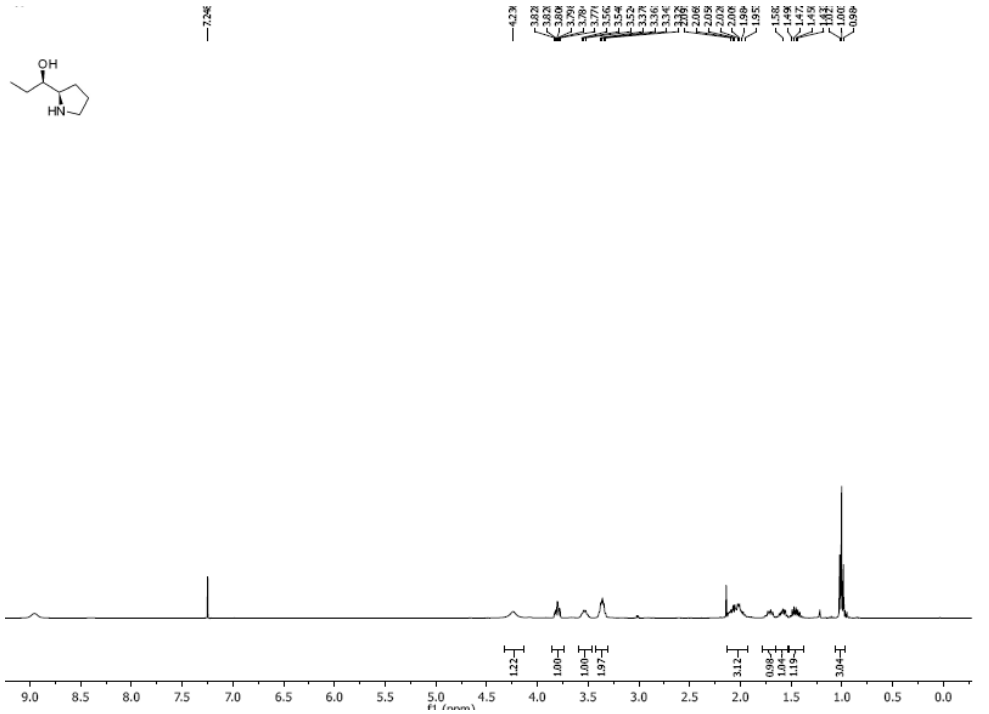

Fig. S53 ^{1}H-NMR of **24a**.

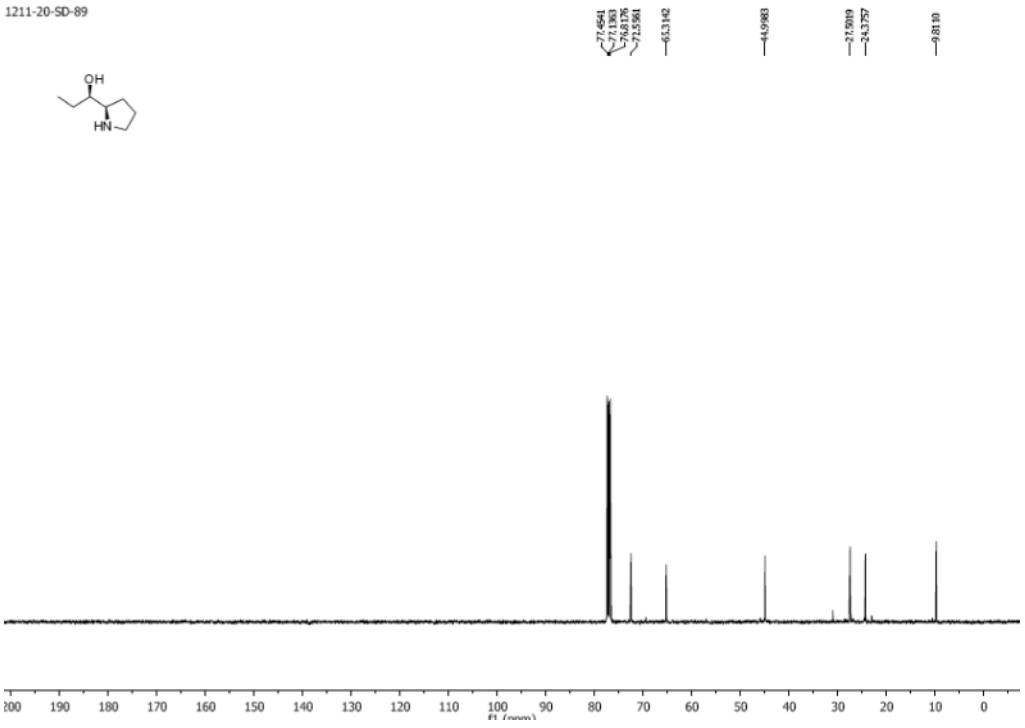

Fig. S54 ^{13}C-NMR of **24a**.

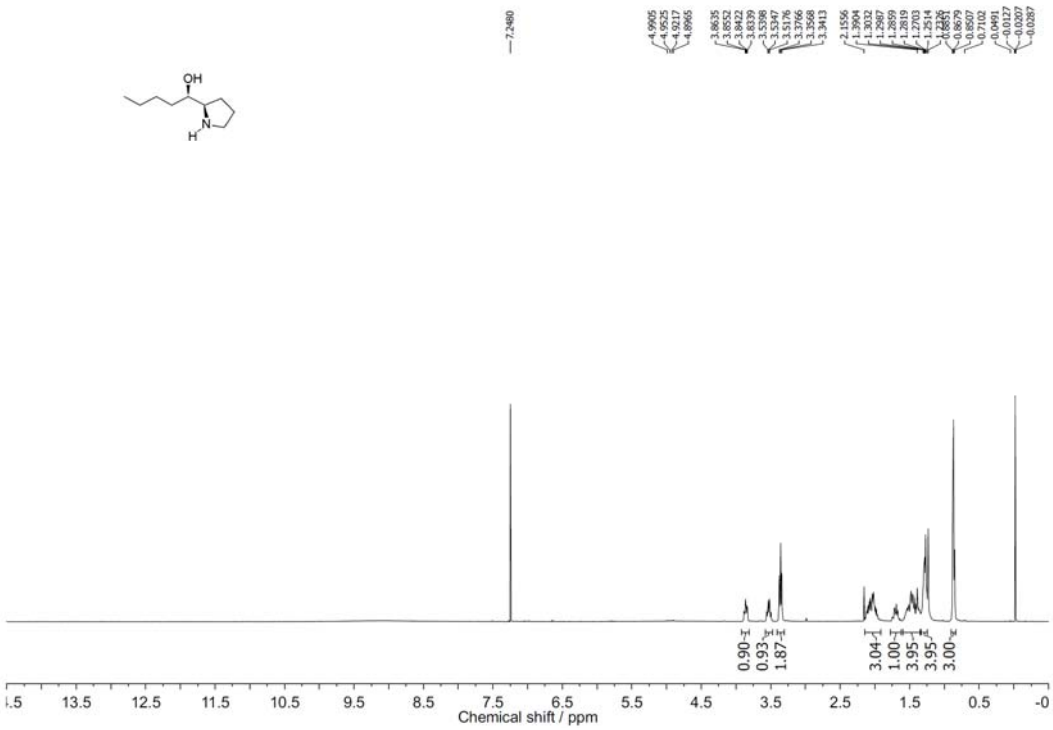

Fig. S55 ^{1}H-NMR of **24b**.

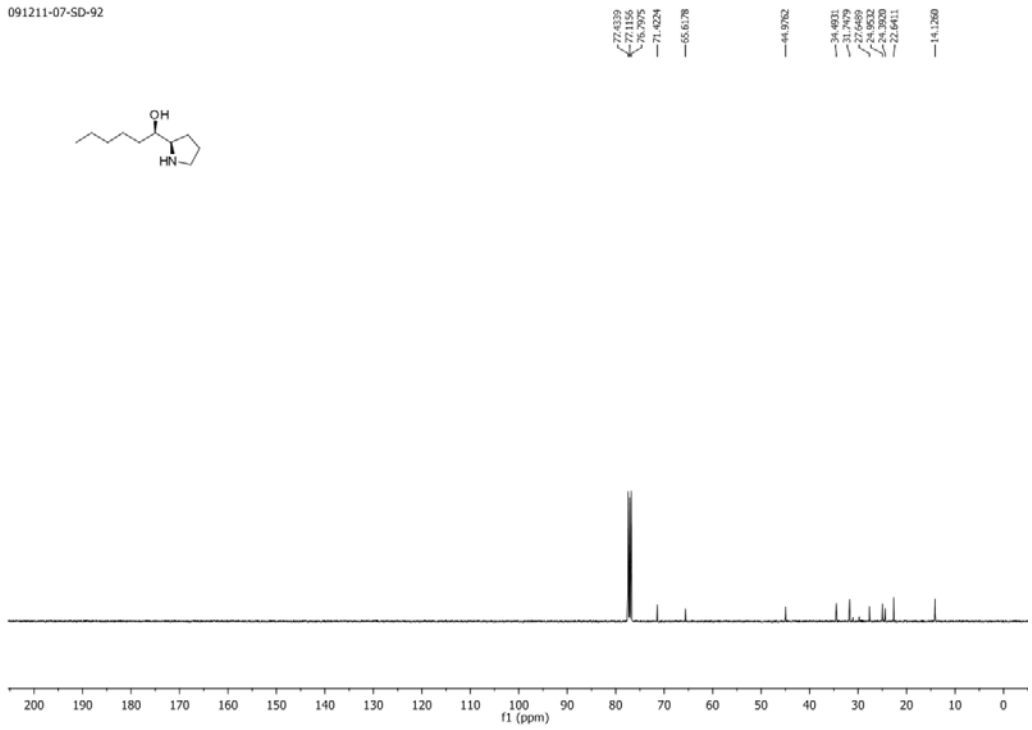

Fig. S56 ^{13}C-NMR of **24b**.

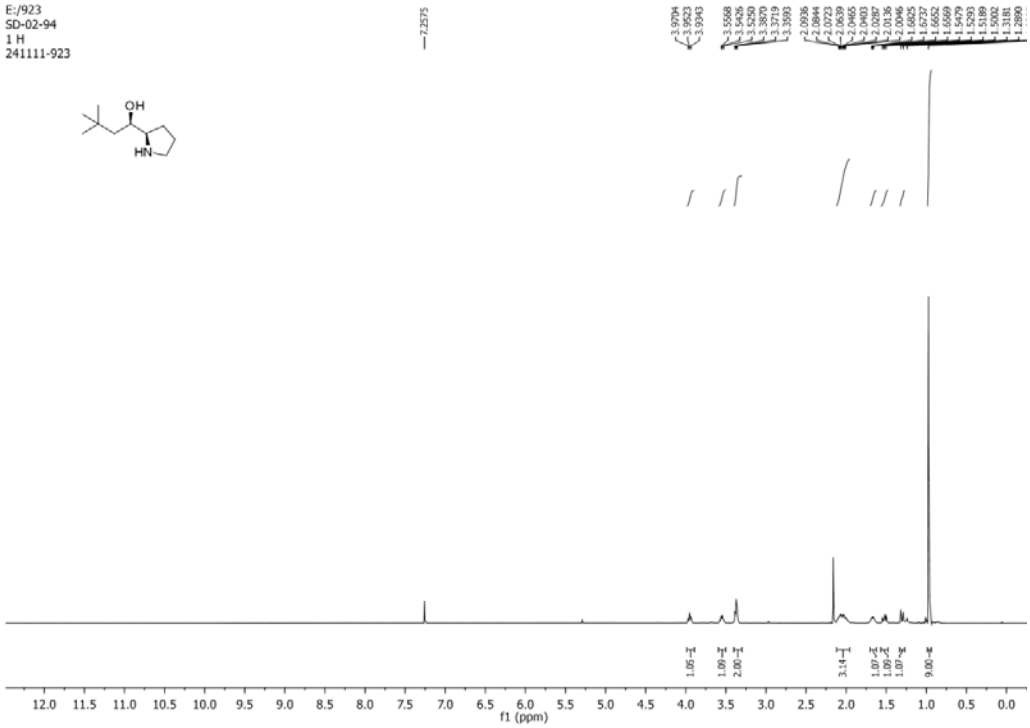

Fig. S57 ^{1}H-NMR of **24c**.

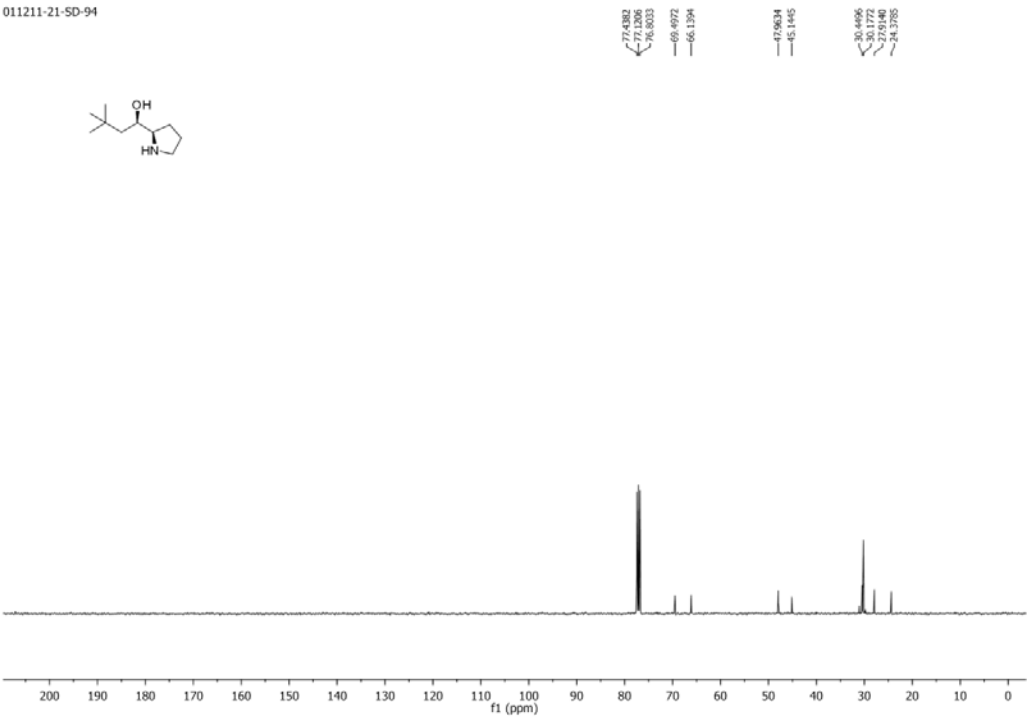

Fig. S58 ^{13}C-NMR of **24c**.

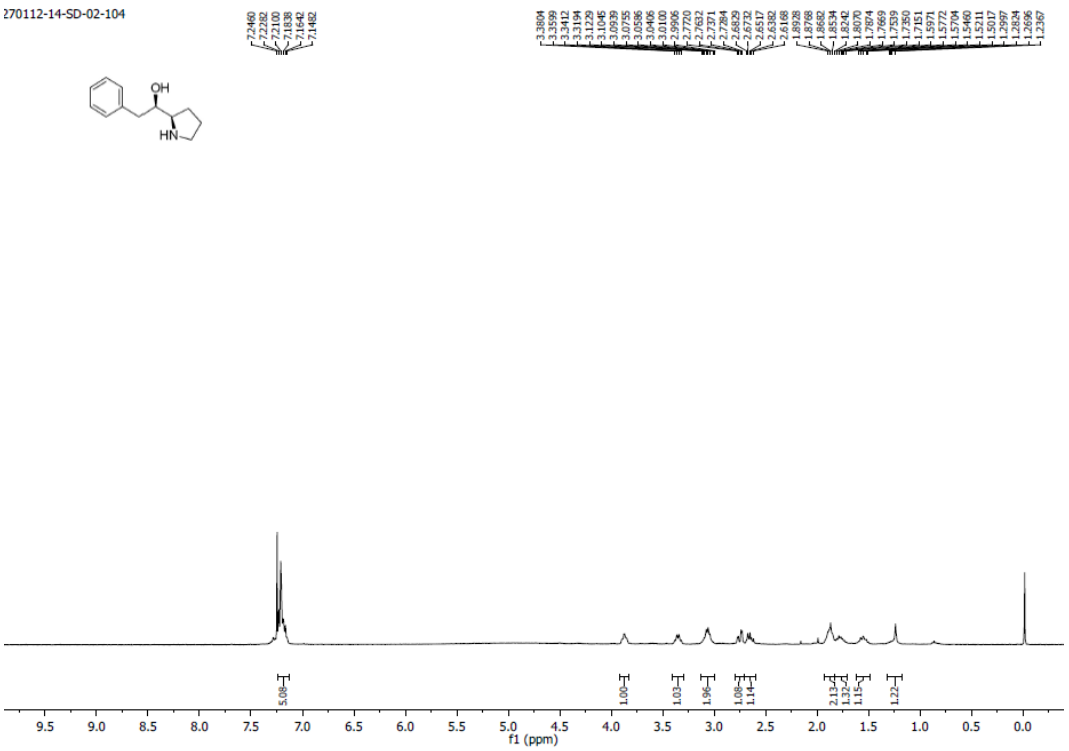

Fig. S59 ^{1}H-NMR of **24d**.

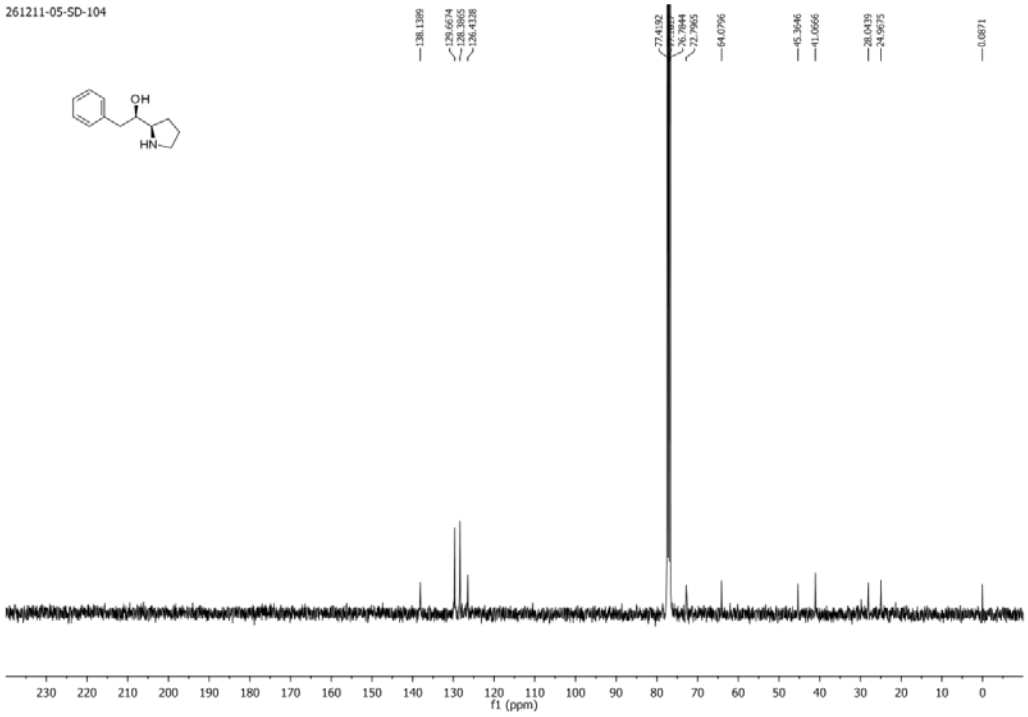

Fig. S60 ^{13}C-NMR of **24d**.

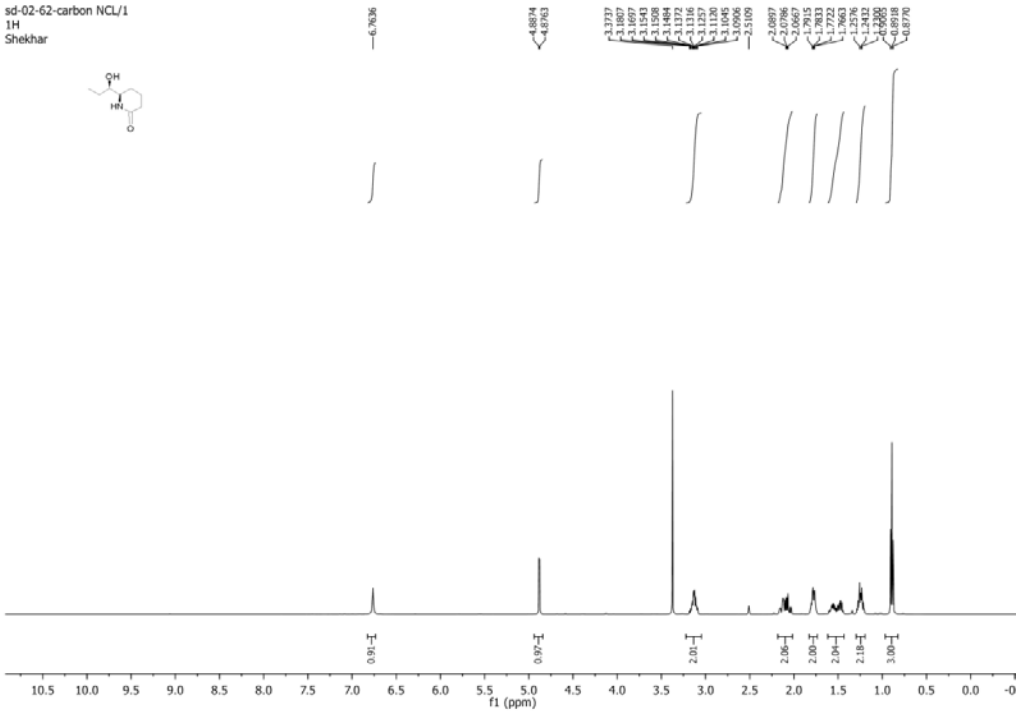

Fig. S61 ^{1}H-NMR of **25a**.

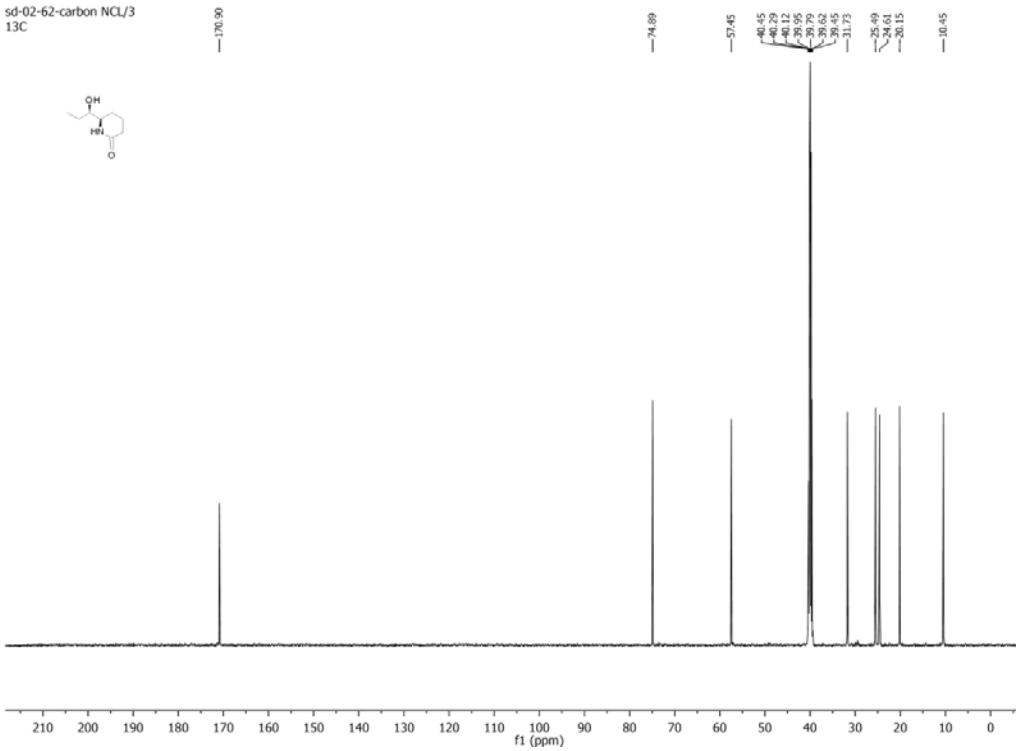

Fig. S62 ^{13}C-NMR of **25a**.

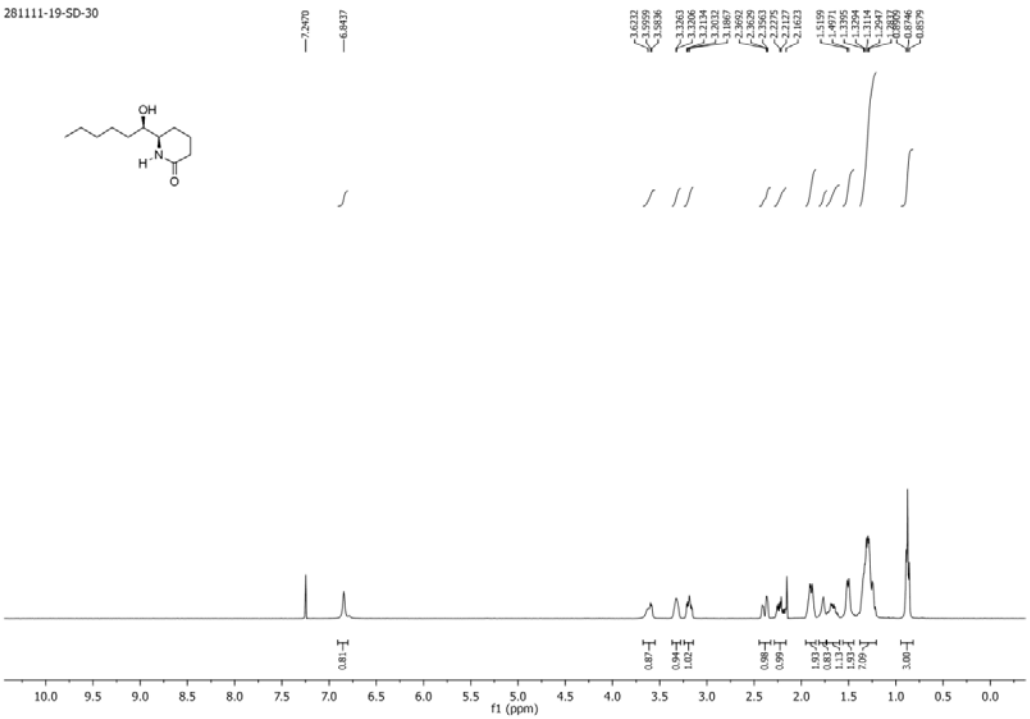

Fig. S63 ^{1}H-NMR of **25b**.

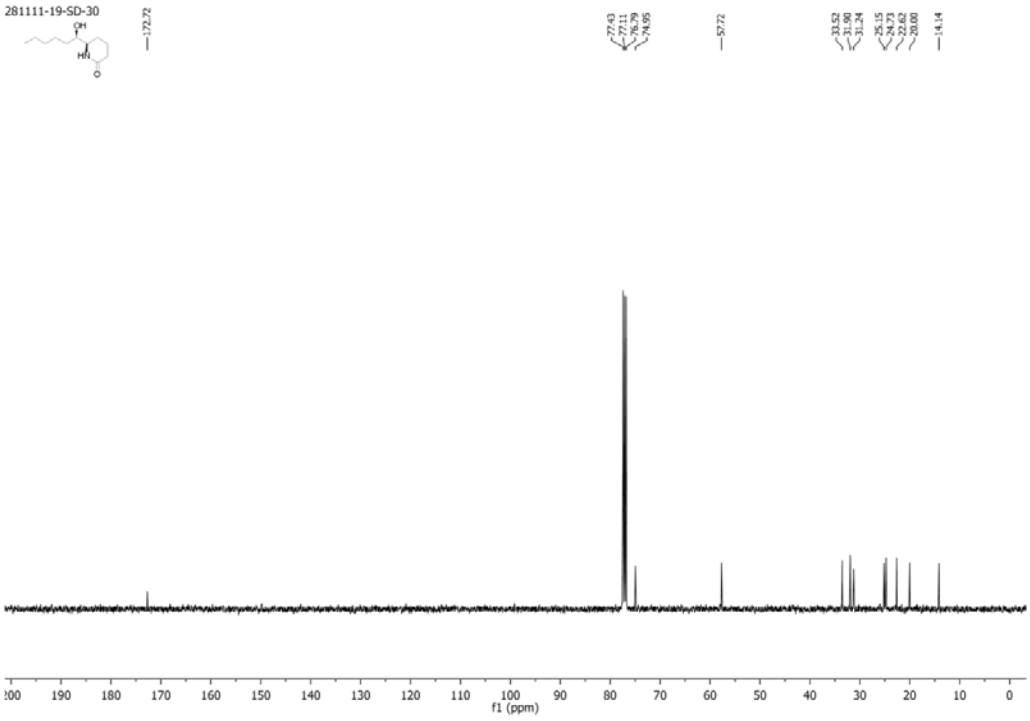

Fig. S64 ^{13}C-NMR of **25b**.

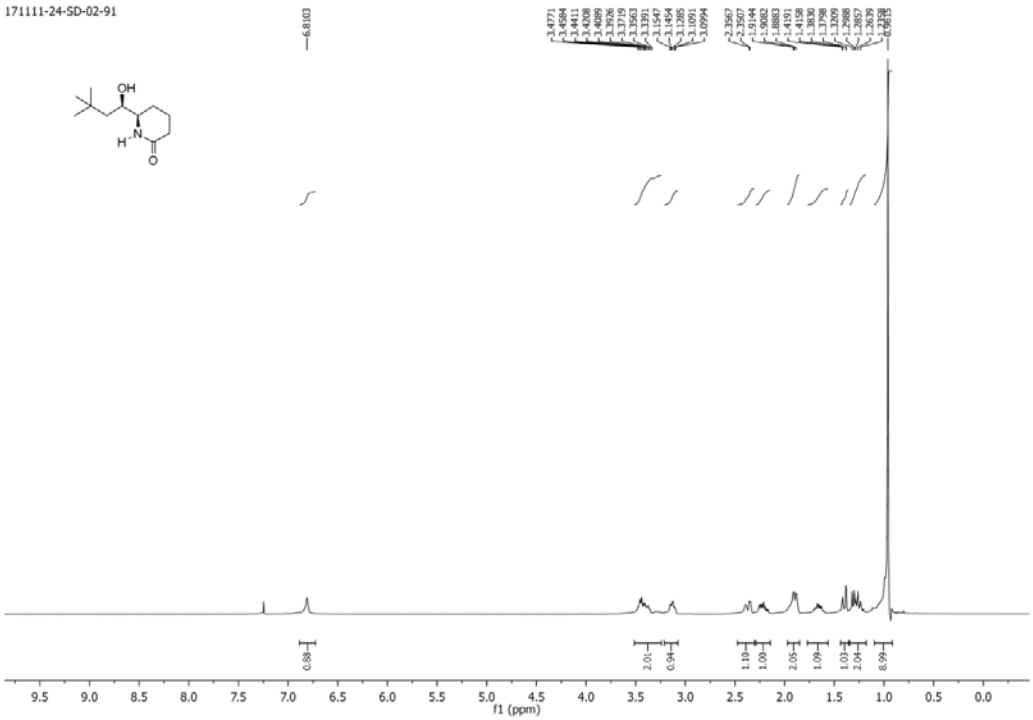

Fig. S65 ^{1}H-NMR of **25c**.

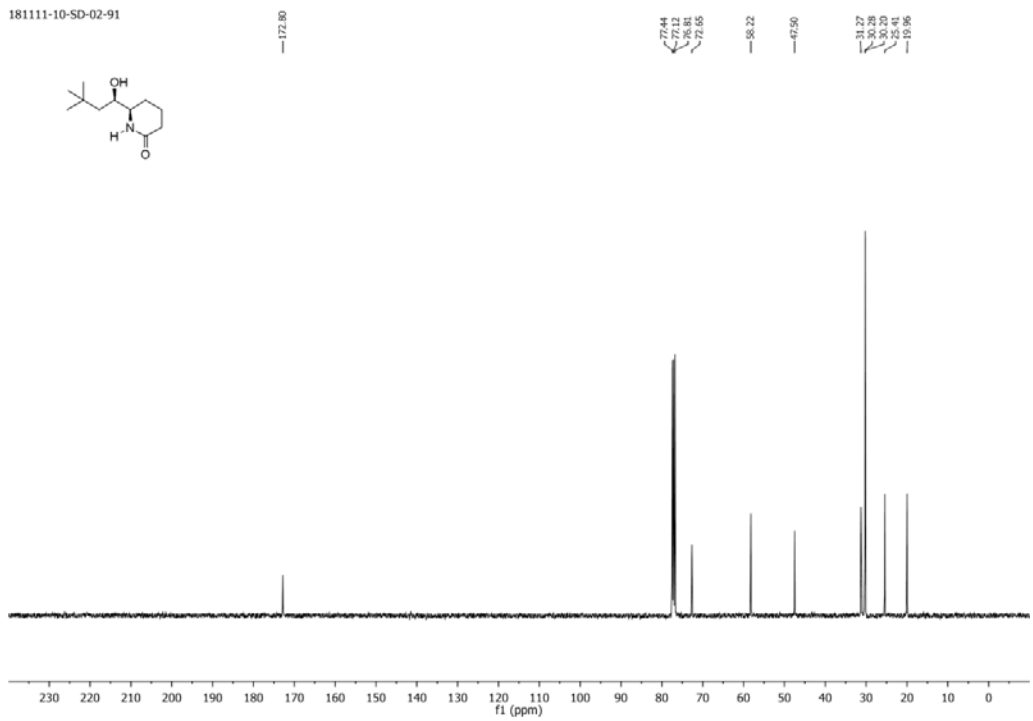

Fig. S66 ^{13}C-NMR of **25c**.

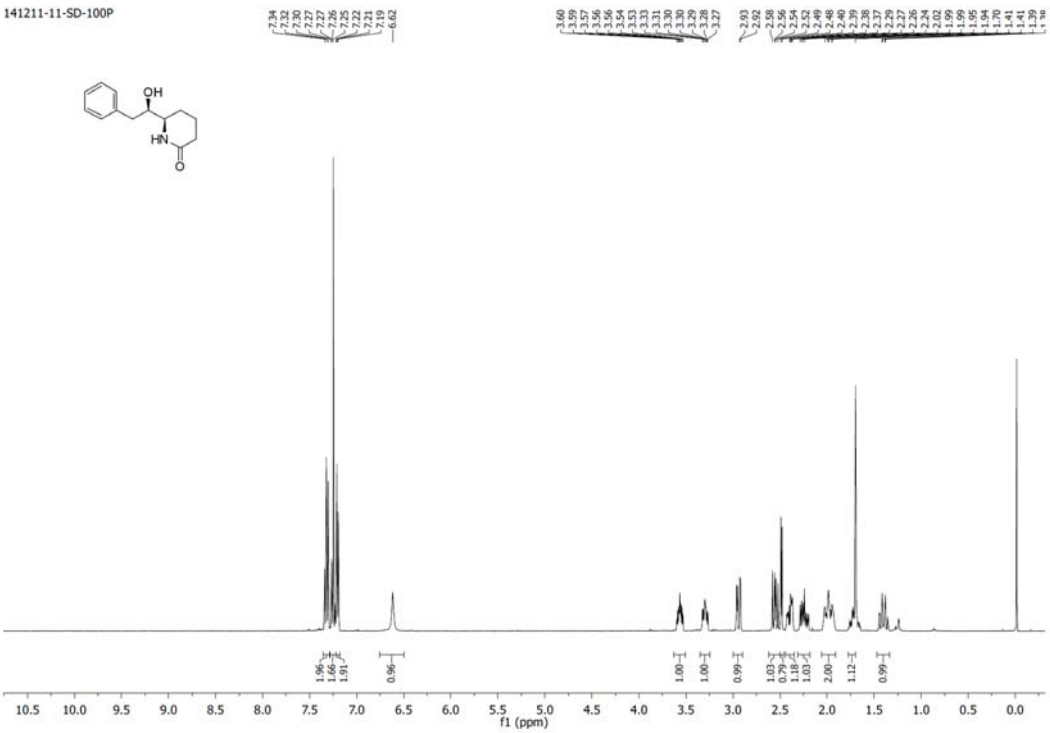

Fig. S67 ^{1}H-NMR of **25d**.

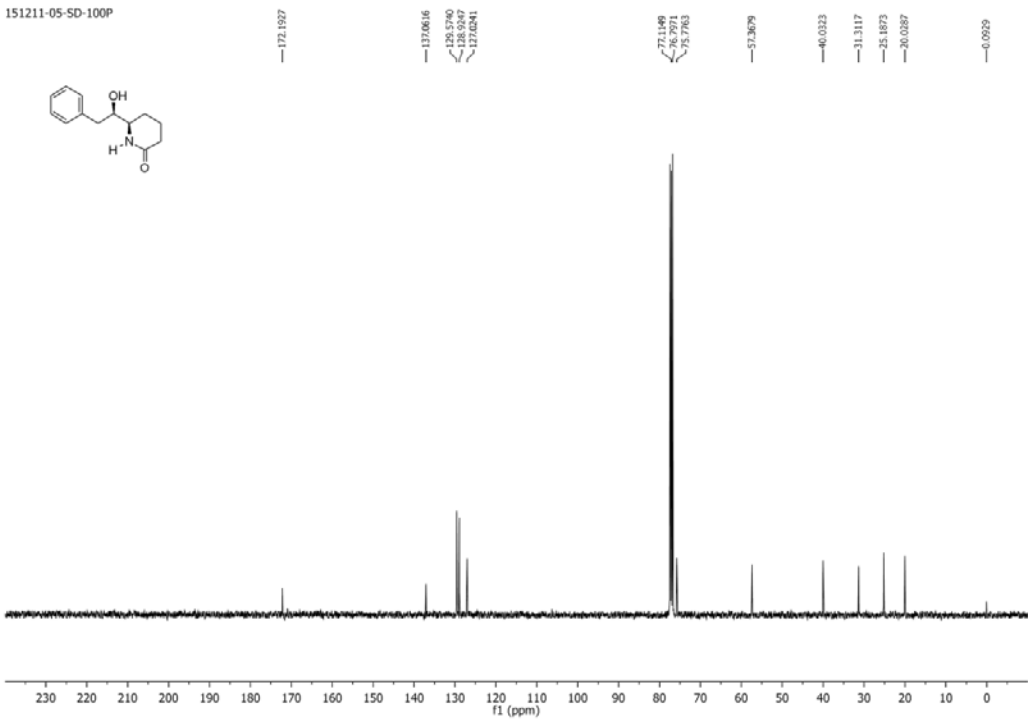

Fig. S68 ^{13}C-NMR of **25d**.

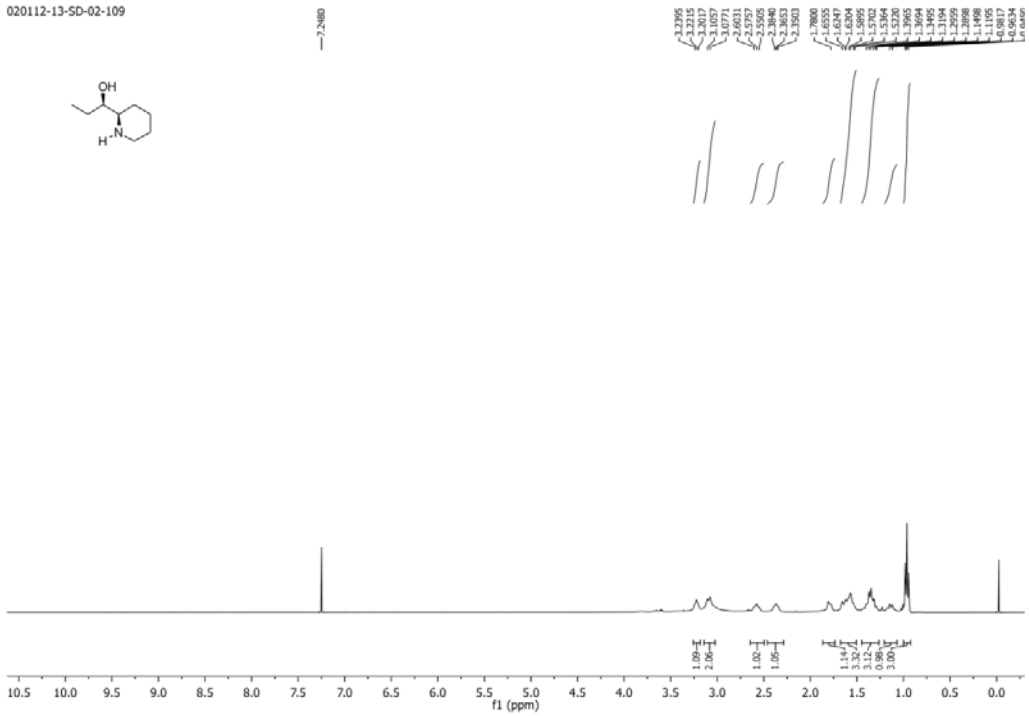

Fig. S69 ^{1}H-NMR of **8a**.

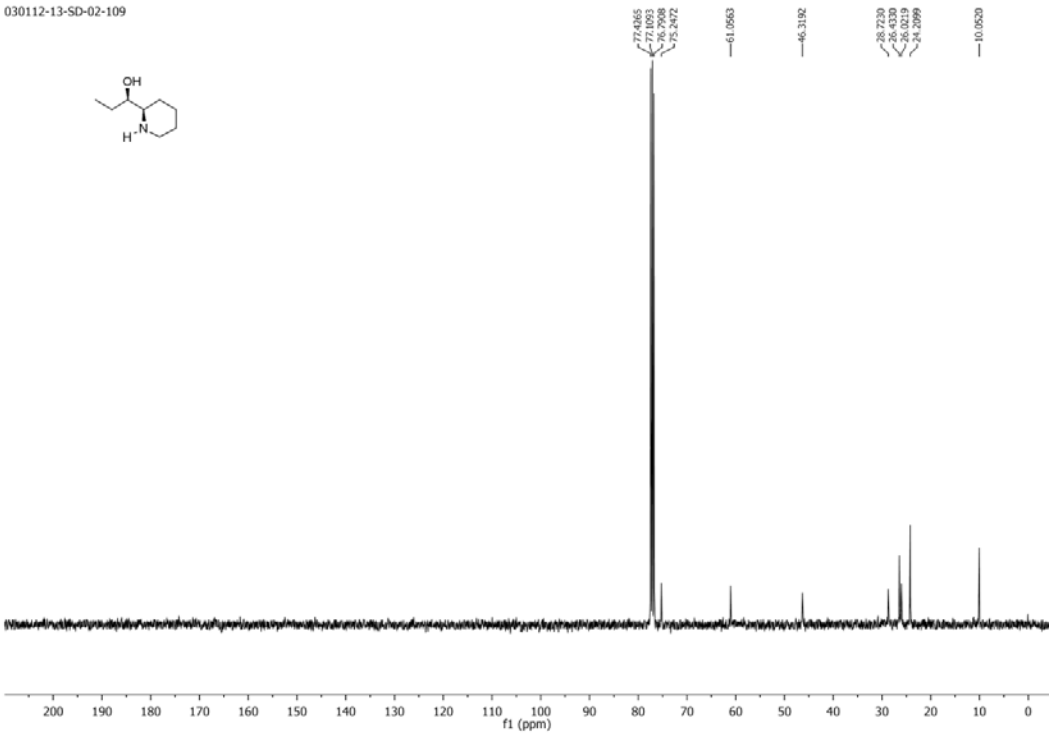

Fig. S70 ^{13}C-NMR of **8a**.

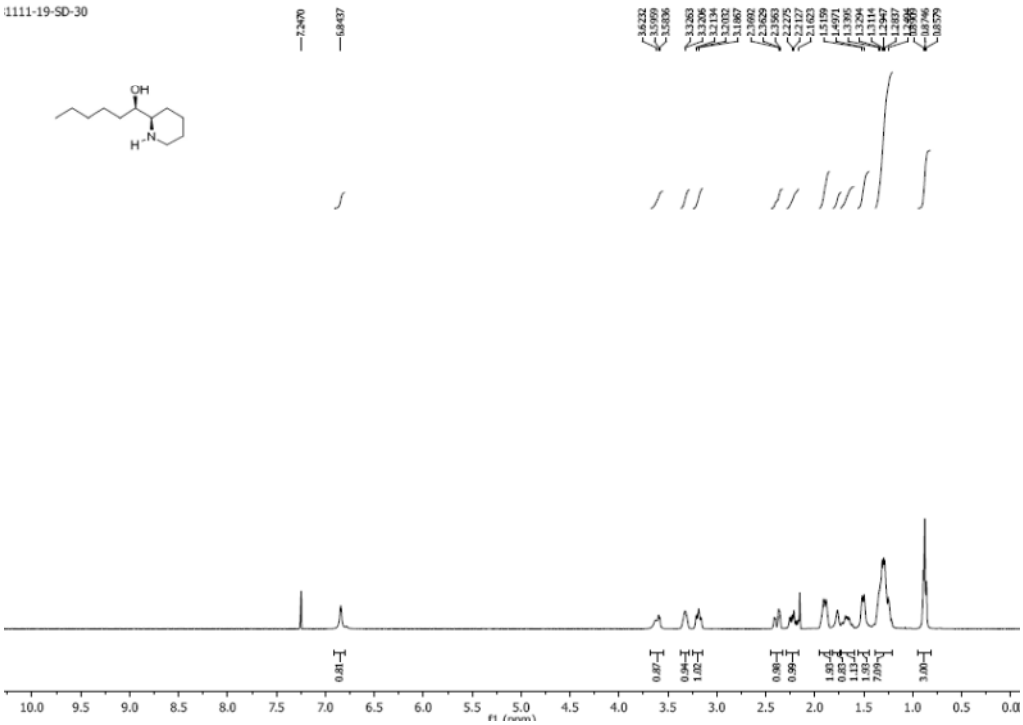

Fig. S71 ^{1}H-NMR of **26b**.

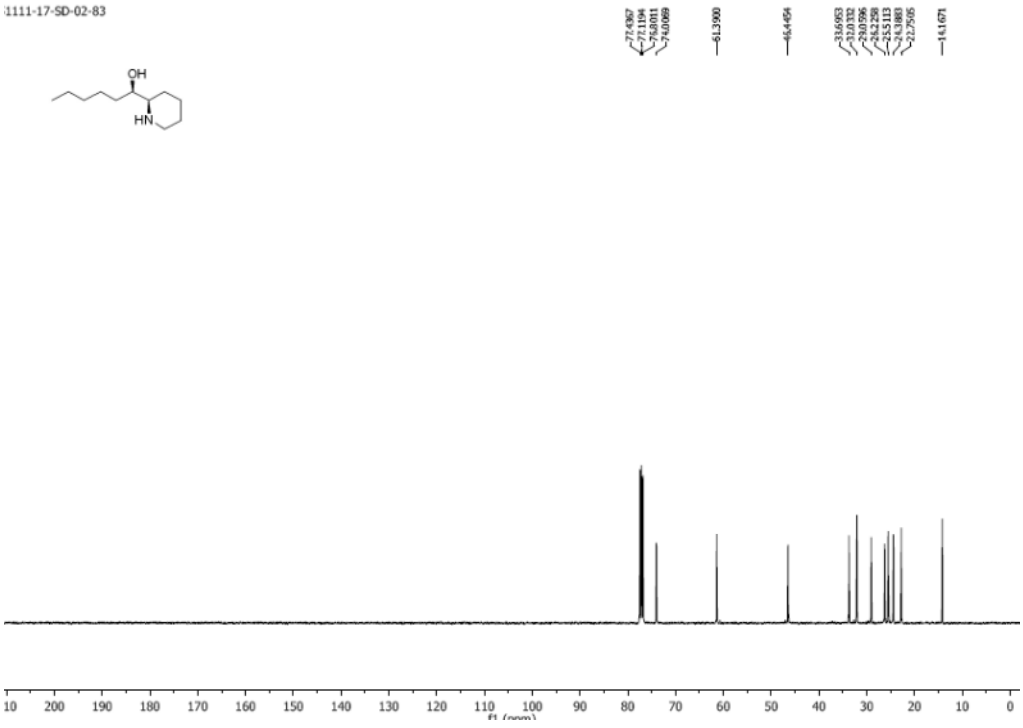

Fig. S72 ^{13}C-NMR of **26b**.

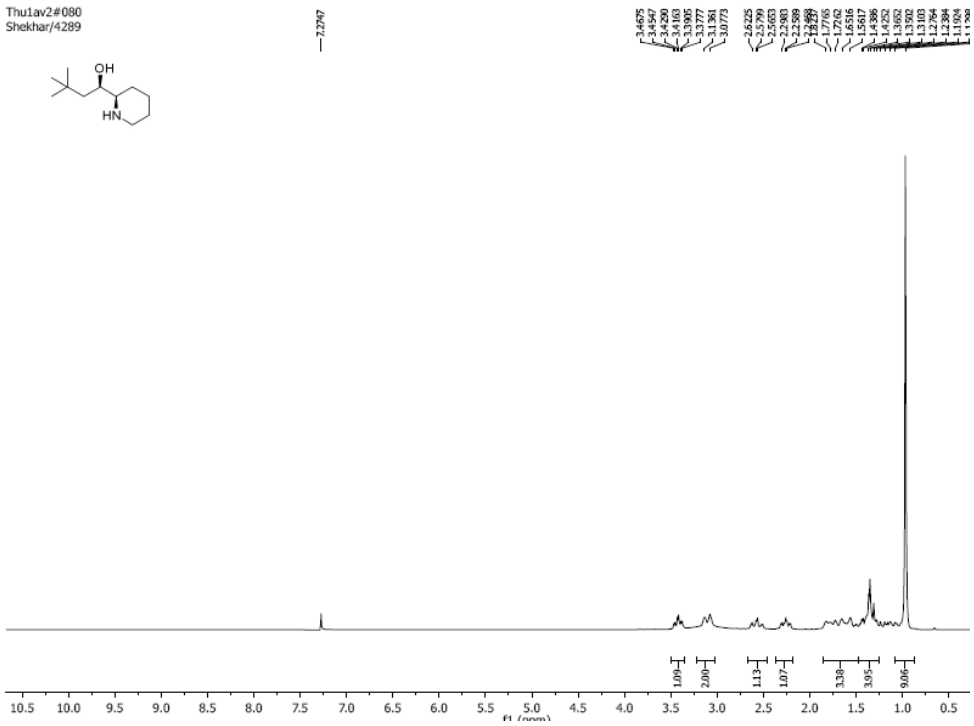

Fig. S73 ^{1}H-NMR of **26c**.

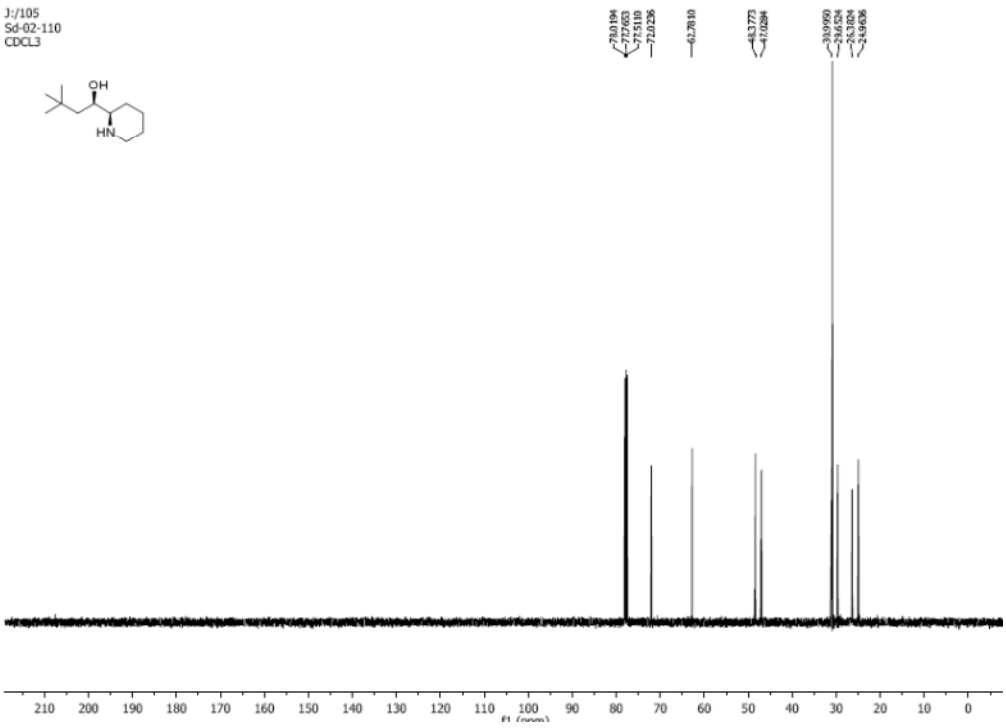

Fig. S74 ^{13}C-NMR of **26c**.

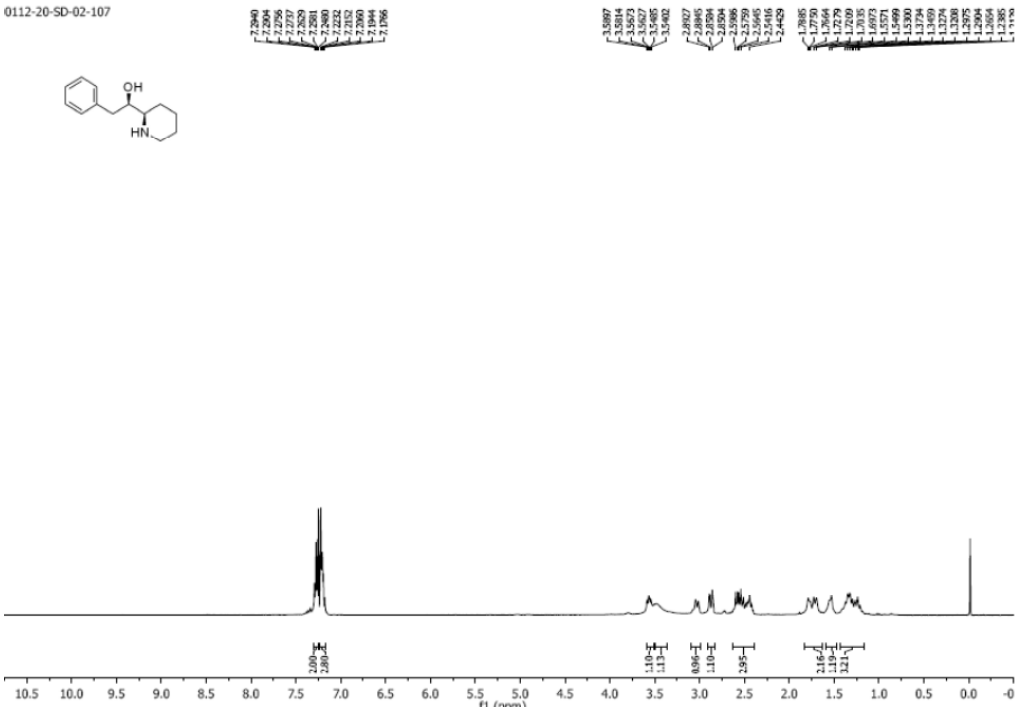

Fig. S75 ^{1}H-NMR of **26d**.

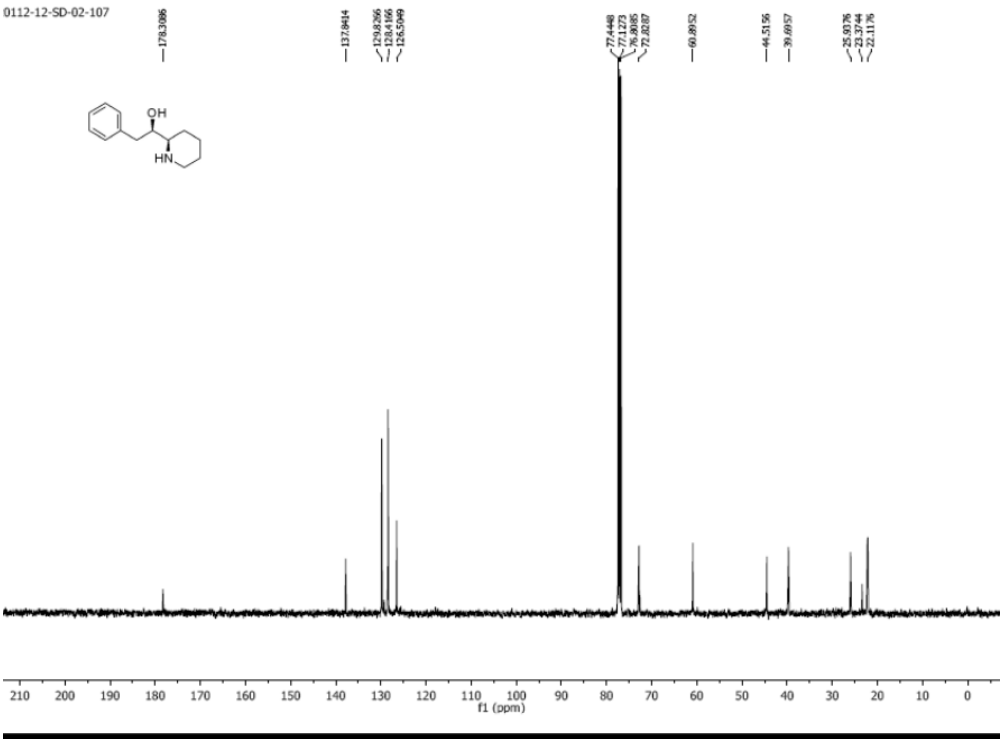

Fig. S76 ^{13}C-NMR of **26d**.

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