Supporting Information

Synthesis of Weinreb amides using diboronic acid anhydride-catalyzed dehydrative amidation of carboxylic acids

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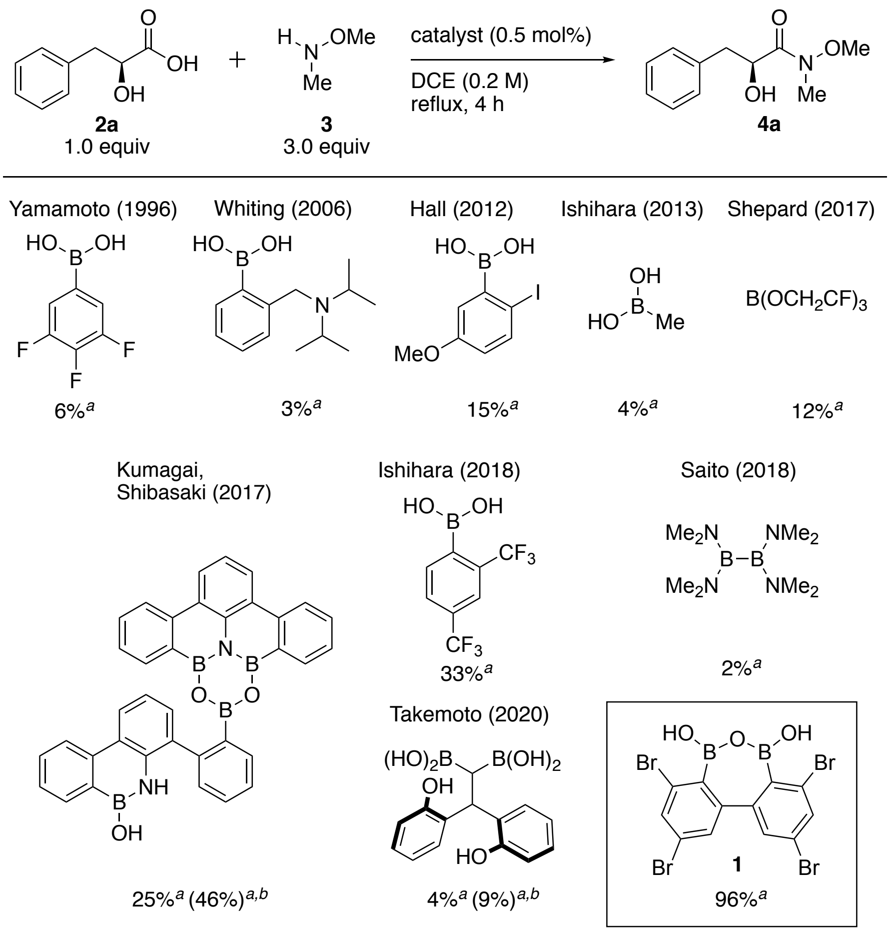
1. General information

Melting points (mp) were obtained on Stanford Research Systems MPA100 melting point apparatus. IR spectra were recorded on an FT/IR460-plus IR spectrometer and absorbance bands are reported in wavenumber (cm^{-1}). Optical rotation was recorded on a JASCO DIP-1000 polarimeter and reported as follows: $[\alpha]_D$, concentration (g/100 mL), and solvent. NMR spectra were recorded on Agilent Technologies 400-MR DD2 (400 MHz for ^1H, 100 MHz for ^{13}C, 377 MHz for ^{19}F), 400-MR (400 MHz for ^1H, 100 MHz for ^{13}C, 377 MHz for ^{19}F), ^1H NMR data are reported as follows; chemical shift in parts per million (ppm) downfield or upfield from $CDCl_3$ (δ 7.26), CD_3OD (δ 3.31), DMSO-d_6 (δ 2.50) integration, multiplicity (br = broad, s = singlet, d = doublet, t = triplet, q = quartet, dd = double doublet, ddd = double double doublet, dt = double triplet, and m = multiplet), and coupling constants (Hz). ^{13}C NMR chemical shifts are reported in ppm downfield or upfield from $CDCl_3$ (δ 77.0) or CD_3OD (δ 49.0), DMSO-d_6 (δ 39.52). ^{19}F NMR chemical shifts are reported in ppm downfield or upfield from C_6H_5F (δ –113.15). Mass spectra were measured with JEOL JMS-AX505HA, JMS-700 MStation, and JEOL JMS-T100LP spectrometers. Thin-layer chromatography (TLC) was carried out on Merck 60F-254 precoated silica gel plates and were visualized by fluorescence quenching under UV light and anisaldehyde phosphomolybdic acid stain, followed by heating. Column chromatography was performed using Silica Gel 60N (spherical, neutral, 63-210 μm) (Kanto Chemical Co., Inc.). Analytical high performance liquid chromatography (HPLC) was performed on a JASCO PU-2089 intelligent HPLC pump with JASCO UV-2075 intelligent UV/VIS detector. Detection was performed at 254 nm. CHIRALPAK® IA (ϕ0.46 cm × 25 cm), CHIRALPAK® IB (ϕ0.46 cm × 25 cm) and CHIRALPAK® IC (ϕ0.46 cm × 25 cm) from Daicel were used. Retention times (t_R) and peak ratios were determined with ChromNAV. Air- and/or moisture-sensitive reactions were carried out under nitrogen atmosphere using oven-dried glassware. DATB[1], *gem*-DBA[2], diboronic acid anhydride **1**[3] and carboxylic acid **7b**[3], **7c**[3], **7d**[3] were synthesized according to the literatures.

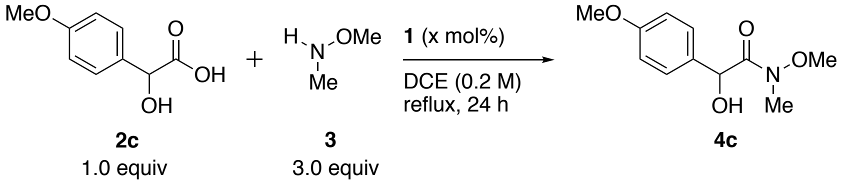
2. Supplemental data for the catalytic amidation of α-hydroxycarboxylic acids

SI-Table 1. Comparision of catalytic efficiency between 1 and the other known catalysts for amidation of α-hydroxycarboxylic acid.



[a] Determined by ^{1}H NMR of a crude mixture of products.
[b] Performed in toluene (0.2 M).

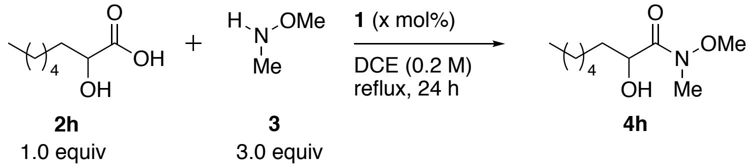
SI-Table 2. Optimization of the reaction conditions for 4c



entry	**1** (mol%)	yield (%)
1	0.5	60[a]
2	**2.0**	**96**[b]

[a] Determined by ^{1}H NMR of a crude mixture of products. [b] Isolated yield.

SI-Table 3. Optimization of the reaction conditions for 4h

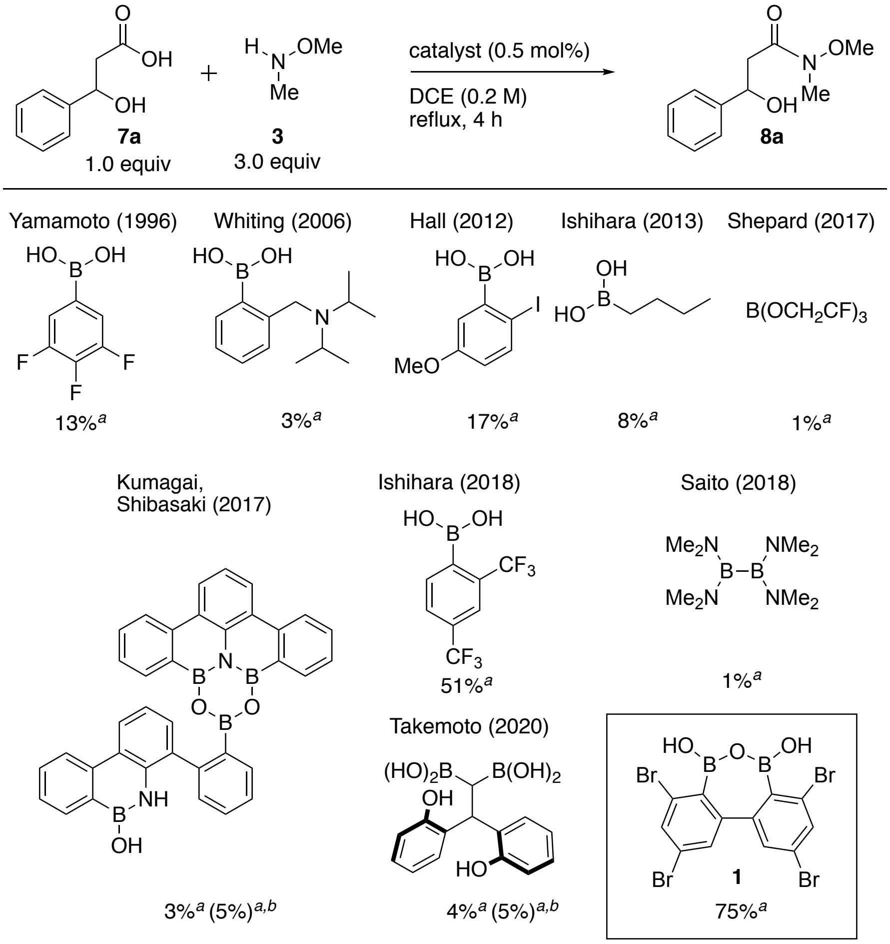


entry	**1** (mol%)	yield (%)
1	0.5	59[a]
2	**2.0**	**98**[b]

[a] Determined by ^{1}H NMR of a crude mixture of products. [b] Isolated yield.

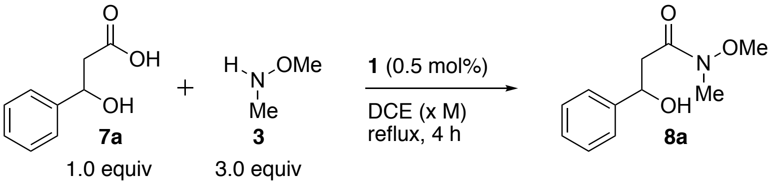
3. Supplemental data for the catalytic amidation of *β*-hydroxycarboxylic acids

SI-Table 4. Comparision of catalytic efficiency between 1 and the other known catalysts for amidation of *β*-hydroxycarboxylic acid.



[a] Determined by ^{1}H NMR of a crude mixture of products.
[b] Performed in toluene (0.2 M).

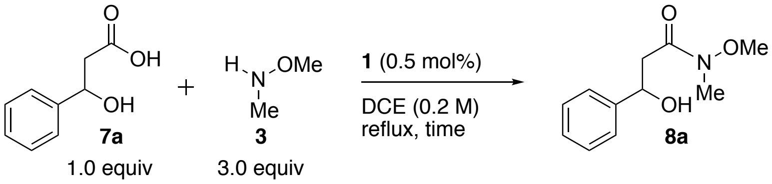
SI-Table 5. Optimization of concentration for the diboronic acid anhydride-catalyzed amidation of *β*-hydroxycarboxylic acid.



entry	DCE (M)	yield (%)[a]
1	0.05	55
2	0.1	66
3	**0.2**	**75**
4	0.3	70
5	0.4	57

[a] Determined by ^{1}H NMR of a crude mixture of products.

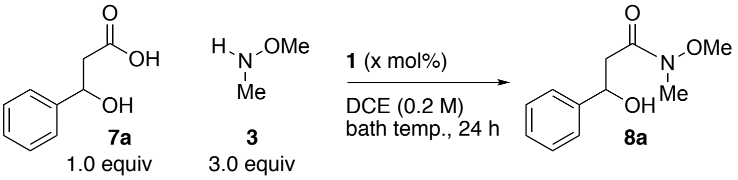
SI-Table 6. Optimization of reaction time for the diboronic acid anhydride-catalyzed amidation of *β*-hydroxycarboxylic acid.



entry	time (h)	yield (%)[a]
1	0.5	27
2	1	39
3	2	57
4	4	75
5	8	83
6	16	92
7	**24**	**96 [94][b]**

[a] Determined by ^{1}H NMR of a crude mixture of products. [b] Isolated yield.

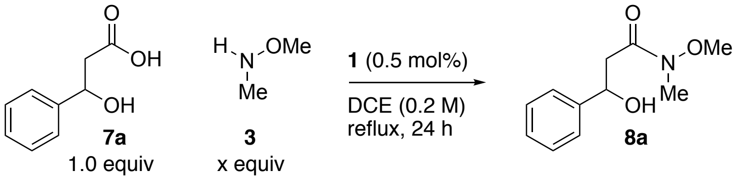
SI-Table 7. Temperature effect on the diboronic acid anhydride-catalyzed-amidation of *β*-hydroxycarboxylic acid.



entry	bath temp. (°C)	**1** (mol%)	yield (%)[a]
1	**90**	**0.5**	**96 [94][b]**
2	70	0.5	87
3	60	0.5	80
4	**60**	**5.0**	**>99**

[a] Determined by ^{1}H NMR of a crude mixture of products. [b] Isolated yield.

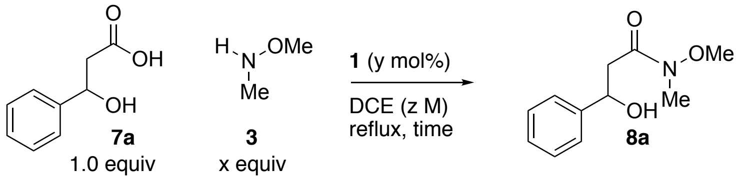
SI-Table 8. Optimization of equivalent of amine for the diboronic acid anhydride-catalyzed amidation of *β*-hydroxycarboxylic acid.



entry	**3** (equiv)	yield (%)[a]
1	**3.0**	**96[94][b]**
2	2.0	91
3	1.0	80

[a] Determined by ^{1}H NMR of a crude mixture of products. [b] Isolated yield.

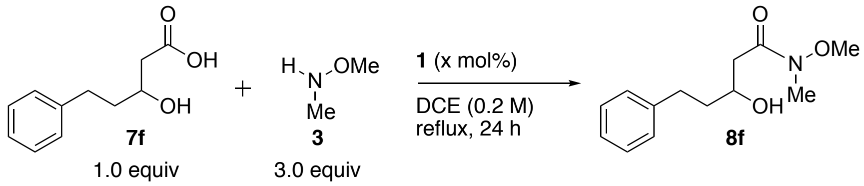
SI-Table 9. Survey of the reaction conditions for the diboronic acid anhydride-catalyzed amidation of *β*-hydroxycarboxylic acid.



entry	**1** (mol%)	**3** (equiv)	DCE (M)	time (h)	yield (%)[a]
1	1.0	3.0	0.1	4	92
2	1.0	1.0	0.1	4	71
3	0.5	3.0	0.1	4	66
4	0.5	3.0	0.2	4	75
5	**0.5**	**3.0**	**0.2**	**24**	**96 [94]**[b]

[a] Determined by ^{1}H NMR of a crude mixture of products. [b] Isolated yield.

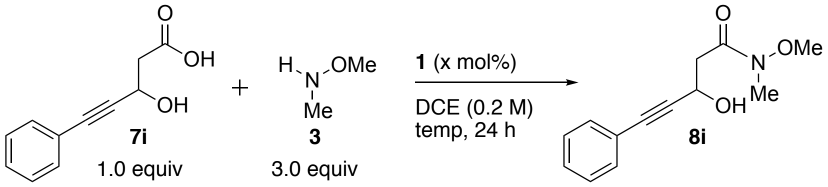
SI-Table 10. Optimization of the reaction conditions for 8f



entry	**1** (mol%)	yield (%)
1	0.5	47[a]
2	**2.0**	**98**[b]

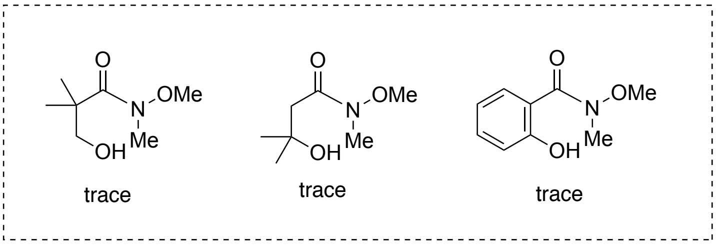
[a] Determined by ^{1}H NMR of a crude mixture of products. [b] Isolated yield.

SI-Table 11. Optimization of the reaction conditions for 8i



entry	temperature (°C)	**1** (mol%)	yield (%)
1	90	0.5	52[a]
2	**60**	**2.0**	**82**[b]

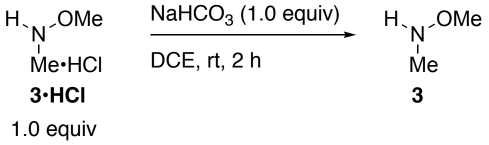
[a] Determined by ^{1}H NMR of a crude mixture of products. [b] Isolated yield.



SI-Figure 1. Unsuccessful examples for the diboronic acid anhydride-catalyzed amidation of *β*-hydroxycarboxylic acid.

4. Preparation of *N*,*O*-dimethylhydroxylamine (3)

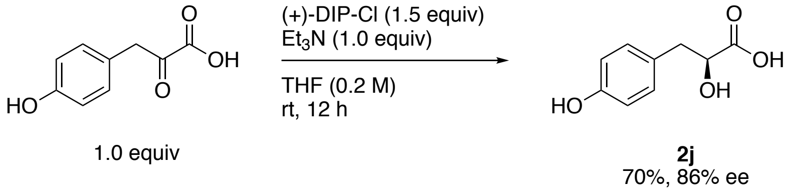
Preparation of *N*,*O*-dimethylhydroxylamine solution in 1,2-dichloroethane (DCE)



N,*O*-Dimethylhydroxylamine hydrochloride (**3•HCl**) (1.46 g, 15.0 mmol, 1.0 equiv) was added to a suspension of $NaHCO_3$ (1.26 g, 15.0 mmol, 1.0 equiv) in DCE (25.0 mL, 0.60 M) at room temperature. After stirring for 2 h, the resulting suspension was left to stand, furnishing 0.60 M solution of *N*,*O*-dimethylhydroxylamine (**3**) in DCE.

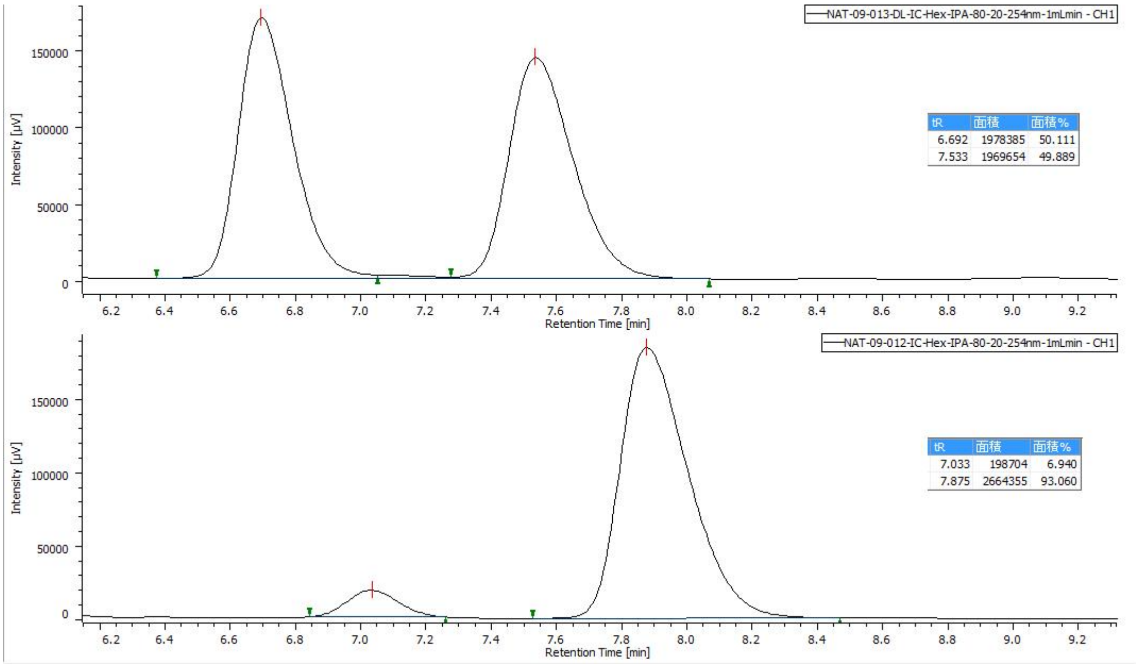
5. Preparation of *α*-hydroxycarboxylic acid 2j, 2k

(*S*)-2-hydroxy-3-(4-hydroxyphenyl)propanoic acid (2j)[4]



A solution of (+)-DIP-Cl (1.12 g, 3.50 mmol, 1.5 equiv) in THF (3.3 mL) was added to a solution of 4-hydroxyphenylpiruvic acid (420 mg, 2.33 mmol, 1.0 equiv) and Et_3N (0.33 mL, 2.33 mmol, 1.0 equiv) in THF (8.4 mL, total 0.2 M) at room temperature. After stirring for 12 h, the reaction was quenched with water (2 mL) and the resulting mixture was basified to pH 12 with 1M NaOH aq and washed by Et_2O (10 mL×2). The combined aqueous layer was acidified to pH 2 with 1M HCl aq and extracted with EtOAc (20 mL×3). The combined organic layer was washed by brine (30 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (50% MeOH in CH_2Cl_2) to give (*S*)-2-hydroxy-3-(4-hydroxyphenyl)propanoic acid (**2j**) (299 mg, 1.64 mmol, 70%, 86% ee) as a brown solid. The enantiopurity was determined by comparison of HPLC retention time with the racemic sample after conversion to a corresponding methyl ester obtained by the treatment with trimethylsilyldiazomethane.

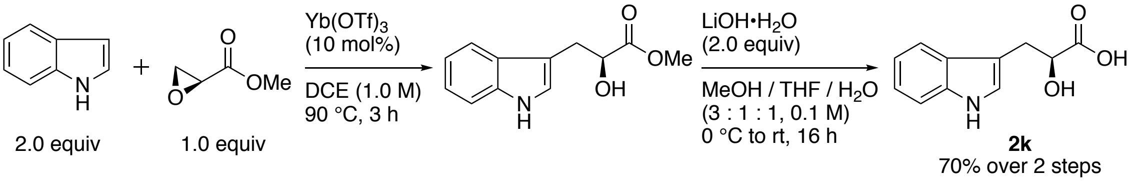
Data for **2j**: R_f = 0.28 (CH_2Cl_2/MeOH = 1:1); mp 147–157 °C; $[\alpha]_D^{23}$ –13.7° (*c* = 1.0, MeOH); IR (KBr) ν = 3245, 1738, 1598, 1510, 1367, 1237, 1083, 829, 626 cm^{-1}; ^1H NMR (400 MHz, CD_3OD) δ 7.11–7.09 (m, 2H), 6.74–6.71 (m, 2H), 4.29 (dd, *J* = 8.0, 4.4 Hz, 1H), 3.04 (dd, *J* = 14.0, 4.4 Hz, 1H), 2.84 (dd, *J* = 14.0, 8.0 Hz, 3H); ^{13}C NMR (100 MHz, CD_3OH) δ 178.9, 157.9, 132.4, 130.5, 116.9, 74.3, 41.7; HRMS (ESI) m/z calcd for $C_9H_9O_4$ $[M–H]^-$ 181.0501, found 181.0493; HPLC (CHIRALPAK® IC (ϕ 0.46 cm × 25 cm), hexane/*i*-PrOH = 80:20, 254 nm, flow rate 1.0 mL/min) t_R = 7.0 min (minor), 7.9 min (major) as a methyl ester.



tR	面積	面積%
6.692	1978385	50.111
7.533	1969654	49.889

tR	面積	面積%
7.033	198704	6.940
7.875	2664355	93.060

(*S*)-2-hydroxy-3-(1*H*-indol-3-yl)propanoic acid (2k)[5,6]

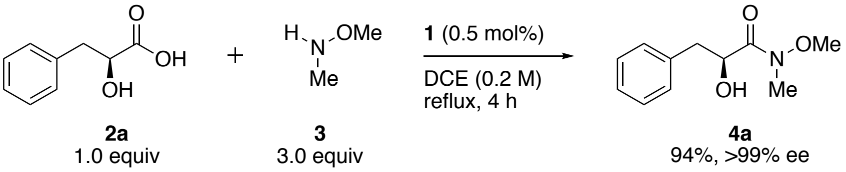


A flame-dried round bottom flask was charged with a solution of indole (1.57 g, 13.4 mmol, 2.0 equiv), $Yb(OTf)_3$ (416 mg, 0.67 mmol, 10 mol%) in DCE (6.7 mL, total 1.0 M) at 90 °C under nitrogen atmosphere. After stirring for 3 h, methyl (*S*)-oxirane-2-carboxylate (590 μL, 6.7 mmol, 1.0 equiv) was added dropwise and the reaction was quenched with Na_2CO_3 aq (6 mL). The resulting mixture was acidified to pH 2 with 1M HCl aq and extracted with $CHCl_3$ (20 mL×2). The combined organic layer was washed by brine (20 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (50% EtOAc in hexane) to give corresponding ester. LiOH•H_2O (383 mg, 9.2 mmol, 2.0 equiv) was added to a solution of methyl (*S*)-2-hydroxy-3-(1*H*-indol-3-yl)propanoate (1.00g, 4.6 mmol, 1.0 equiv) in solvent (MeOH / THF / H_2O = 3 : 1 : 1, 46 mL, total 0.1 M) at 0 °C and the mixture was warmed up to room temperature. After stirring for 16 h, the reaction was basified to pH 12 with 1M NaOH aq and washed by Et_2O (50 mL×2). The combined aqueous layer was acidified to pH 2 with 1M HCl aq and extracted with Et_2O (100 mL×3). The combined organic layer was washed by brine (100 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the (*S*)-2-hydroxy-3-(1*H*-indol-3-yl)propanoic acid (**2k**) (490 mg, 4.63 mmol, 70% over 2 steps) as a brown solid.

Data for **2k**: R_f = 0.55 (EtOAc/MeOH = 1:2); mp 96–101 °C; $[\alpha]_D^{24}$ +0.9° (*c* = 1.0, MeOH); IR (KBr) ν = 3390, 1747, 1457, 1424, 1259, 1209, 1096, 932, 744, 665 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ 10.79 (s, 1H), 7.53 (d, *J* = 8.0 Hz, 1H), 7.32 (d, *J* = 8.0 Hz, 1H), 7.13 (d, *J* = 2.4 Hz, 1H), 7.05 (td, *J* = 8.0, 1.2 Hz, 1H), 6.96 (td, *J* = 8.0, 0.8 Hz, 1H), 5.23 (br s, 1H), 4.20 (dd, *J* = 7.2, 5.2 Hz, 1H), 3.08 (dd, *J* = 14.8, 5.2 Hz, 1H), 2.93 (dd, *J* = 14.8, 7.2 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 175.6, 136.0, 127.6, 123.7, 120.8, 118.6, 118.2, 111.3, 110.3, 70.8, 30.2; HRMS (ESI) m/z calcd for $C_{11}H_{10}N_1O_3$ $[M–H]^-$ 204.0661, found 204.0654.

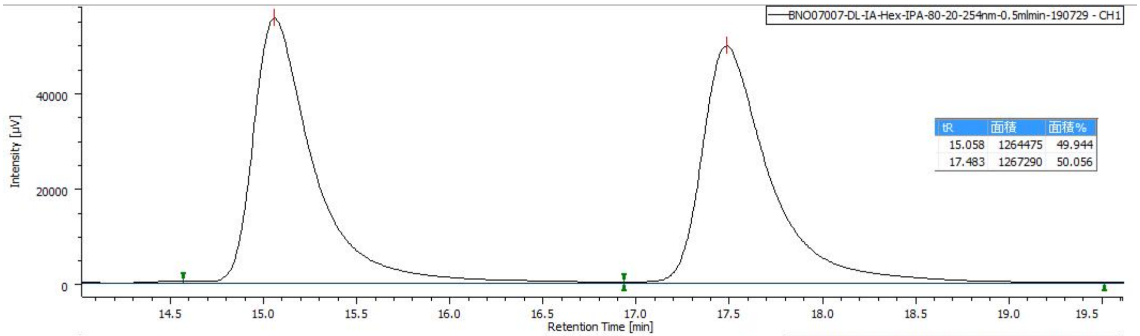
6. Procedures for the catalytic amidation of *α*-hydroxycarboxylic acids and characterization of *α*-hydroxy Weinreb amides (Table 1, Scheme 1)

(*S*)-2-Hydroxy-*N*-methoxy-*N*-methyl-3-phenylpropanamide (4a)[7]

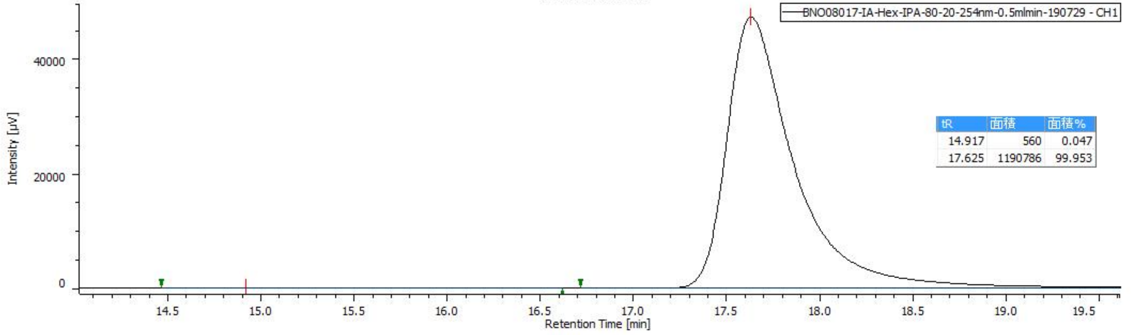


Diboronic acid anhydride **1** (1.1 mg, 2.00 µmol, 0.5 mol%) was added to a DCE solution (total 0.20 M) of (*S*)-2-hydroxy-3-phenylpropanoic acid (**2a**) (66.5 mg, 0.400 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (2.00 mL, 0.60 M in DCE, 1.20 mmol, 3.0 equiv) at room temperature. After stirring for 4 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (50% EtOAc in *n*-hexane) to give (*S*)-2-hydroxy-*N*-methoxy-*N*-methyl-3-phenylpropanamide (**4a**) (78.7 mg, 0.376 mmol, 94%, >99% ee) as a colorless oil.

Data for **4a**; colorless oil; R_f = 0.33 (*n*-hexane/EtOAc = 1:1); $[\alpha]_D^{23}$ –55.3° (*c* = 1.0, $CHCl_3$); IR (neat) ν = 3434, 1455, 1373, 1367, 1178, 1078, 985, 752, 701 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.32–7.22 (m, 5H), 4.63 (br s, 1H), 3.73 (s, 3H), 3.28–3.25 (m, 4H), 3.07 (dd, *J* = 13.6, 3.8 Hz, 1H), 2.85 (dd, *J* = 13.6 ,7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.1, 137.2, 129.4, 128.3, 126.6, 69.6, 61.3, 40.9, 32.4; HRMS (ESI) m/z calcd for $C_{11}H_{15}NNaO_3$ $[M+Na]^+$ 232.0950, found 232.0948; HPLC (CHIRALPAK® IA (*ϕ* 0.46 cm × 25 cm), hexane/*i*-PrOH = 80:20, 254 nm, flow rate 0.5 mL/min) t_R = 14.9 min (minor), 17.6 min (major).

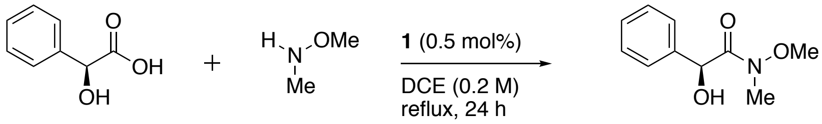


tR	面積	面積%
15.058	1264475	49.944
17.483	1267290	50.056



tR	面積	面積%
14.917	560	0.047
17.625	1190786	99.953

(*S*)-2-Hydroxy-*N*-methoxy-*N*-methyl-2-phenylacetamide (4b)[7]



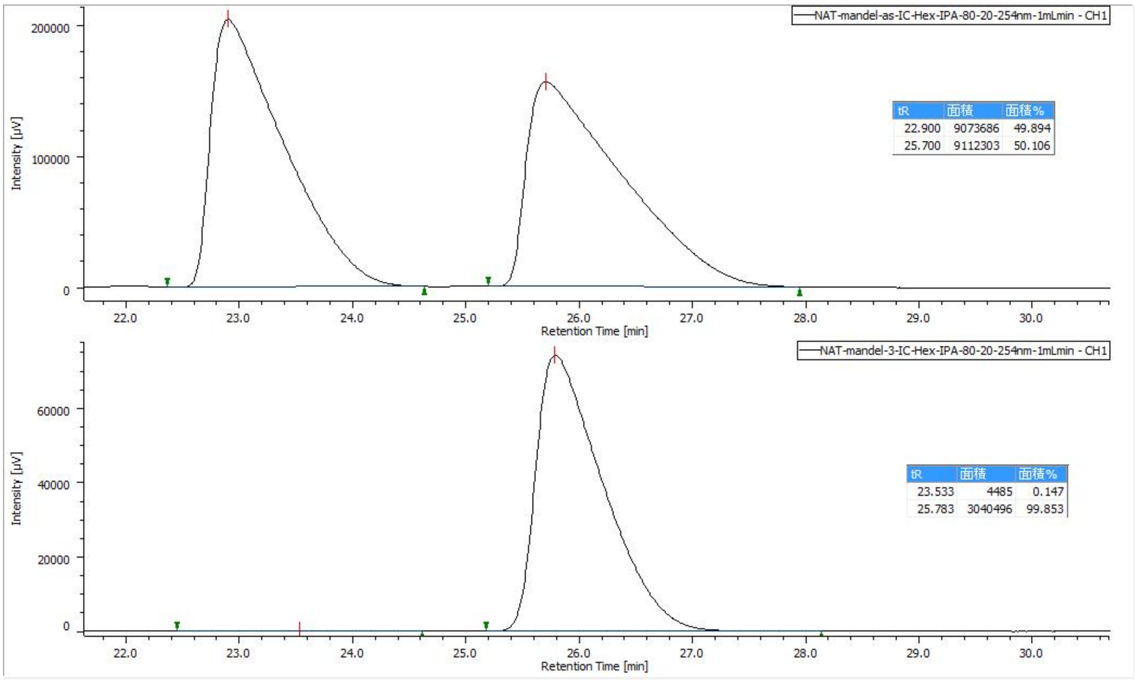
2b 1.0 equiv

3 3.0 equiv

4b 92%, >99% ee

Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 0.5 mol%) was added to a DCE solution (total 0.20 M) of (*S*)-mandelic acid (**2b**) (60.9 mg, 0.400 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (2.00 mL, 0.60 M in DCE, 1.20 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (60% EtOAc in *n*-hexane) to give (*S*)-2-hydroxy-*N*-methoxy-*N*-methyl-2-phenylacetamide (**4b**) (71.7 mg, 0.367 mmol, 92%, >99% ee) as a white solid.

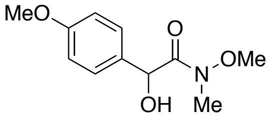
Data for **4b**; white solid; $R_f = 0.25$ (*n*-hexane/EtOAc = 1.5:1); mp 65–66 °C; $[\alpha]_D^{24}$ +117.2° ($c = 1.0$, $CHCl_3$); IR (KBr) ν = 3306, 2942, 1640, 1458, 1271, 1181, 1063, 991, 769, 709 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.37–7.31 (m, 5H), 5.35 (d, $J = 5.6$ Hz, 1H), 4.27 (d, $J = 5.6$ Hz, 1H), 3.22 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.5, 139.6, 128.6, 128.3, 127.5, 71.5, 60.6, 32.6; HRMS (ESI) m/z calcd for $C_{10}H_{13}NNaO_3$ $[M+Na]^+$ 218.0793, found 218.0785; HPLC (CHIRALPAK® IC (ϕ 0.46 cm × 25 cm), hexane/*i*-PrOH = 80:20, 254 nm, flow rate 1.0 mL/min) t_R = 23.5 min (minor), 25.8 min (major).



tR	面積	面積%
22.900	9073686	49.894
25.700	9112303	50.106

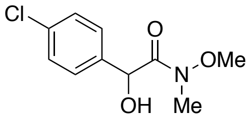
tR	面積	面積%
23.533	4485	0.147
25.783	3040496	99.853

2-Hydroxy-*N*-methoxy-2-(4-methoxyphenyl)-*N*-methylacetamide (**4c**)


4c

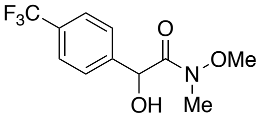
Compound **4c** was prepared according to the procedure for **4b** from 2-hydroxy-2-(4-methoxyphenyl)acetic acid (**2c**) (18.2 mg, 0.100 mmol) using 2.0 mol% of **1**. Yield 96% (21.5 mg, 0.096 mmol). Data for **4c**; white solid; R*f* = 0.26 (*n*-hexane/EtOAc = 1:1); mp 75–77 °C; IR (KBr) ν = 3427, 2979, 1656, 1515, 1463, 1380, 1263, 1183, 1072, 988, 861, 809, 734, 677, 590 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.28–7.26 (m, 2H), 6.89–6.87 (m, 2H), 5.31 (s, 1H), 4.18 (br s, 1H), 3.80 (s, 3H), 3.24–3.21 (m, 6H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 173.8, 159.5, 132.0, 128.7, 114.0, 71.0, 60.7, 55.2, 32.6; HRMS (ESI) m/z calcd for $C_{11}H_{15}NNaO_4$ [M+Na]$^+$ 248.0899, found 248.0892.

2-(4-Chlorophenyl)-2-hydroxy-*N*-methoxy-*N*-methylacetamide (**4d**)[8]


4d

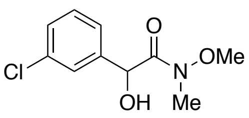
Compound **4d** was prepared according to the procedure for **4b** from 2-(4-chlorophenyl)-2-hydroxyacetic acid (**2d**) (74.6 mg, 0.400 mmol). Yield 84% (76.9 mg, 0.335 mmol). Data for **4d**; white solid; R*f* = 0.30 (*n*-hexane/EtOAc = 1:1); mp 71–74 °C; IR (KBr) ν = 3443, 2946, 1646, 1174, 1075, 981, 801, 739, 636 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.35–7.28 (m, 4H), 5.32 (s, 1H), 3.30 (s, 3H), 3.22 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 173.0, 138.2, 134.1, 128.84, 128.77, 70.8, 60.7, 32.7 ; HRMS (ESI) m/z calcd for $C_{10}H_{12}ClNNaO_3$ [M+Na]$^+$ 252.0403, found 252.0396.

2-Hydroxy-*N*-methoxy-*N*-methyl-2-(4-(trifluoromethyl)phenyl)acetamide (**4e**)


4e

Compound **4e** was prepared according to the procedure for **4b** from 2-hydroxy-2-(4-(trifluoromethyl)phenyl)acetic acid (**2e**) (88.1 mg, 0.400 mmol). Yield 89% (94.1 mg, 0.357 mmol). Data for **4e**; white solid; R*f* = 0.31 (*n*-hexane/EtOAc = 1:1); mp 48–50 °C; IR (KBr) ν = 3400, 1650, 1422, 1335, 1163, 1120, 1069, 995, 814, 631 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.62 (d, J = 8.0 Hz, 2H), 7.48 (d, J = 8.0 Hz, 2H), 5.39 (s, 1H), 4.32 (br s, 1H), 3.33 (s, 3H), 3.23 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 172.6, 143.5, 130.4 (q, $^2J_{C\text{-}F}$ = 32.3 Hz), 127.8, 125.5 (q, $^3J_{C\text{-}F}$ = 3.9 Hz), 123.9 (q, $^1J_{C\text{-}F}$ = 270.2 Hz), 70.9, 60.7, 32.7; ^{19}F NMR (377 MHz, CDCl$_3$) δ –62.67; HRMS (ESI) m/z calcd for $C_{11}H_{12}F_3NNaO_3$ [M+Na]$^+$ 286.0667, found 286.0654.

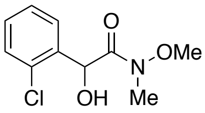
2-(3-Chlorophenyl)-2-hydroxy-*N*-methoxy-*N*-methylacetamide (4f)



4f

Compound **4f** was prepared according to the procedure for **4b** from 2-(3-chlorophenyl)-2-hydroxyacetic acid (**2f**) (74.6 mg, 0.400 mmol). Yield 91% (83.7 mg, 0.364 mmol). Data for **4f**; white solid; R*f* = 0.35 (*n*-hexane/EtOAc = 1:1); mp 80–82 °C; IR (KBr) ν = 3319, 2942, 1649, 1459, 1281, 1191, 1067, 982, 868, 786, 678 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.353–7.347 (m, 1H), 7.32–7.28 (m, 2H), 7.25–7.23 (m, 1H), 5.31 (s, 1H), 4.28 (br s, 1H), 3.31 (s, 3H), 3.23 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.7, 141.5, 134.4, 129.8, 128.4, 127.6, 125.6, 70.8, 60.7, 32.7; HRMS (ESI) m/z calcd for $C_{10}H_{12}ClNNaO_3$ $[M+Na]^+$ 252.0403, found 252.0391.

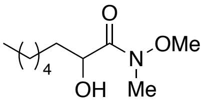
2-(2-Chlorophenyl)-2-hydroxy-*N*-methoxy-*N*-methylacetamide (4g)



4g

Compound **4g** was prepared according to the procedure for **4b** from 2-(2-chlorophenyl)-2-hydroxyacetic acid (**2g**) (74.6 mg, 0.400 mmol). Yield 80% (73.9 mg, 0.322 mmol). Data for **4g**; white solid; R*f* = 0.33 (*n*-hexane/EtOAc = 1:1); mp 77–79 °C; IR (KBr) ν = 3442, 1655, 1474, 1367, 1262, 1177, 1067, 981, 759, 607 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.42–7.39 (m, 1H), 7.28–7.23 (m, 3H), 5.80 (s, 1H), 4.29 (br s, 1H), 3.28 (s, 3H), 3.23 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1, 137.2, 133.8, 129.7, 129.4, 128.6, 127.3, 68.2, 60.6, 32.8; HRMS (ESI) m/z calcd for $C_{10}H_{12}ClNNaO_3$ $[M+Na]^+$ 252.0403, found 252.0391.

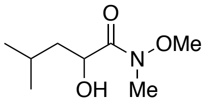
2-Hydroxy-*N*-methoxy-*N*-methyloctanamide (4h)



4h

Compound **4h** was prepared according to the procedure for **4b** from 2-hydroxyoctanoic acid (**2h**) (16.0 mg, 0.100 mmol) using 2.0 mol% of **1**. Yield 98% (19.8 mg, 0.098 mmol). Data for **4h**; colorless oil; R*f* = 0.40 (*n*-hexane/EtOAc = 1:1); IR (neat) ν = 3455, 2928, 2858, 1659, 1465, 1374, 1178, 1136, 1077, 994 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 4.37 (dd, *J* = 5.8, 3.0 Hz, 1H), 3.71 (s, 3H), 3.24 (s, 3H), 1.73–1.68 (m, 1H), 1.56–1.39 (m, 9H), 0.89–0.85 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 175.2, 68.6, 61.2, 34.6, 32.4, 31.6, 28.9, 24.9, 22.5, 14.0; HRMS (ESI) m/z calcd for $C_{10}H_{21}NNaO_3$ $[M+Na]^+$ 226.1419, found 226.1408.

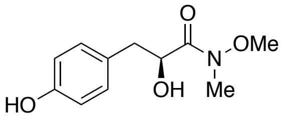
2-Hydroxy-*N*-methoxy-*N*,4-dimethylpentanamide (**4i**)



4i

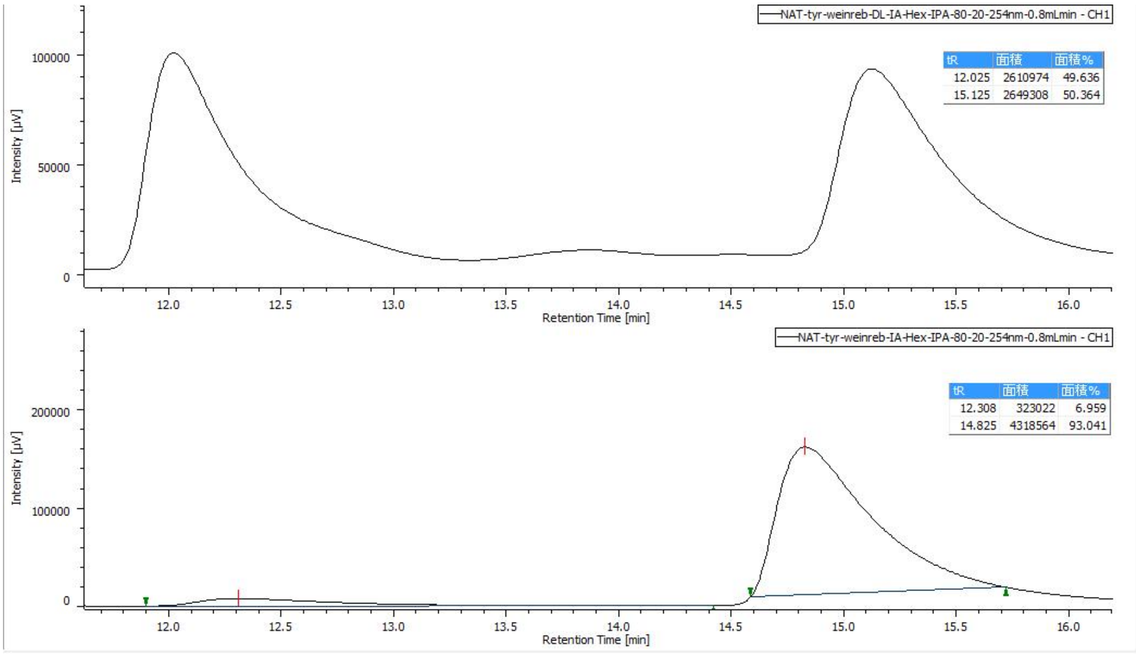
Compound **4i** was prepared according to the procedure for **4b** from 2-hydroxy-4-methylpentanoic acid (**2i**) (52.9 mg, 0.400 mmol). Yield 83% (58.5 mg, 0.334 mmol). Data for **4i**; colorless oil; R*f* = 0.38 (*n*-hexane/EtOAc = 1:1); IR (neat) ν = 3445, 2956, 1659, 1468, 1369, 1177, 1146, 1074, 982 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 4.41 (dd, *J* = 8.8, 2.8 Hz, 1H), 3.71 (s, 3H), 3.23 (s, 3H), 2.54 (br s, 1H), 1.99–1.89 (m, 1H), 1.50–1.38 (m, 2H), 0.96 (d, *J* = 8.8 Hz, 3H), 0.95 (d, *J* = 8.8 Hz, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 175.8, 67.3, 61.2, 44.0, 32.5, 24.6, 23.6, 21.3; HRMS (ESI) m/z calcd for $C_8H_{17}NNaO_3$ [M+Na]$^+$ 198.1106, found 198.1099.

(*S*)-2-Hydroxy-3-(4-hydroxyphenyl)-*N*-methoxy-*N*-methylpropanamide (**4j**)[9]



4j

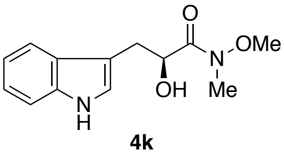
Compound **4j** was prepared according to the procedure for **4b** from (*S*)-2-hydroxy-3-(4-hydroxyphenyl)propanoic acid (**2j**) (18.2 mg, 0.100 mmol) using 2.0 mol% of **1** in DCE (0.1 M). Yield 89% (20.0 mg, 0.089 mmol). Data for **4j**; yellow oil; R*f* = 0.37 (*n*-hexane/EtOAc = 1:4); $[\alpha]_D^{24}$ +1.1° (*c* = 0.5, MeOH); IR (neat) ν = 3348, 2937, 1645, 1517, 1446, 1373, 1241, 1110, 1070, 984, 819, 756 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.09–7.06 (m, 2H), 6.75–6.71 (m, 2H), 4.58 (br s, 1H), 3.73 (s, 3H), 3.24 (s, 3H), 3.05 (dd, *J* = 14.0, 3.6 Hz, 1H), 2.81 (dd, *J* = 14.0, 7.2 Hz, 1H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 174.1, 154.9, 130.5, 128.2, 115.3, 69.8, 61.4, 39.8, 32.5; HRMS (ESI) m/z calcd for $C_{11}H_{15}NNaO_4$ [M+Na]$^+$ 248.0899, found 248.0892; HPLC (CHIRALPAK ® IC (*ϕ* 0.46 cm × 25 cm), hexane/*i*-PrOH = 80:20, 254 nm, flow rate 0.8 mL/min) t_R = 12.3 min (minor), 14.8 min (major).



tR	面積	面積%
12.025	2610974	49.636
15.125	2649308	50.364

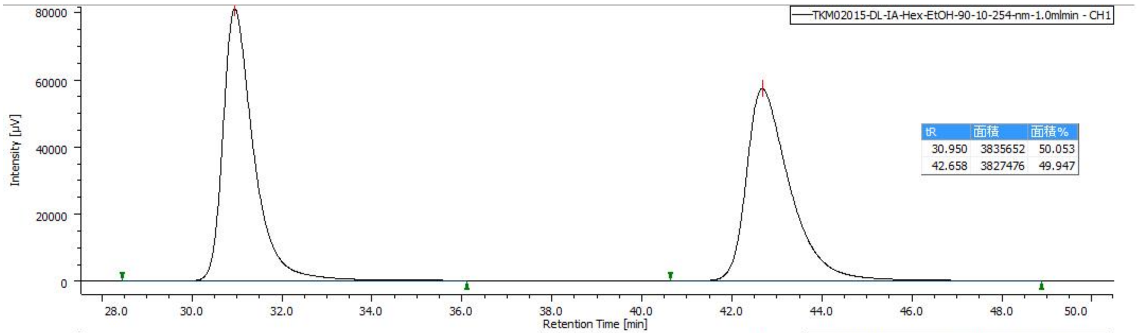
tR	面積	面積%
12.308	323022	6.959
14.825	4318564	93.041

(*S*)-2-Hydroxy-3-(1*H*-indol-3-yl)-*N*-methoxy-*N*-methylpropanamide (4k)

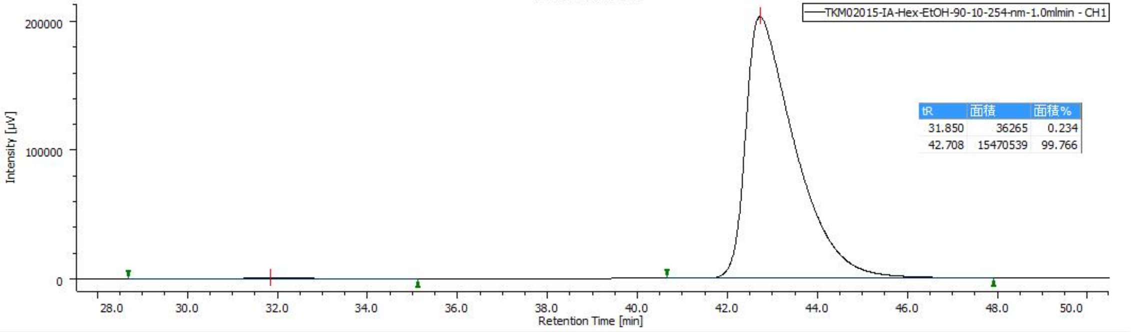


4k

Compound **4k** was prepared according to the procedure for **4b** from (*S*)-2-hydroxy-3-(1*H*-indol-3-yl)propanoic acid (**2k**) (41.0 mg, 0.200 mmol) using 2.0 mol% of **1**. Yield 97% (48.0 mg, 0.193 mmol). Data for **4k**; white solid; R_f = 0.30 (*n*-hexane/EtOAc = 1:4); mp 69–70 °C; $[\alpha]_D^{24}$ –40.4° (*c* = 1.0, $CHCl_3$); IR (KBr) ν = 3279, 2922, 1654, 1458, 1357, 1180, 1076, 988, 741, 610, 426 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (br s, 1H), 7.60 (d, *J* = 8.0 Hz, 1H), 7.35 (d, *J* = 8.0 Hz, 1H), 7.20–7.16 (m, 1H), 7.14–7.09 (m, 2H), 4.69 (dd, *J* = 7.2, 3.2 Hz, 1H), 3.74 (s, 3H), 3.27–3.21 (m, 4H), 3.06 (dd, *J* = 14.8, 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.2, 136.1, 127.6, 123.2, 121.7, 119.2, 118.4, 111.2, 110.7, 68.9, 61.4, 32.4, 30.5; HRMS (ESI) m/z calcd for $C_{13}H_{16}N_2NaO_3$ $[M+Na]^+$ 271.1059, found 271.1053; HPLC (CHIRALPAK® IA (ϕ 0.46 cm × 25 cm), hexane/EtOH = 90:10, 254 nm, flow rate 1.0 mL/min) t_R = 31.9 min (minor), 42.7 min (major).

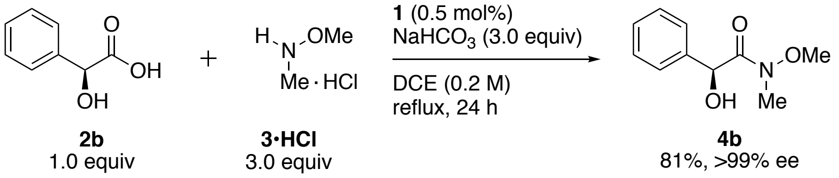


tR	面積	面積%
30.950	3835652	50.053
42.658	3827476	49.947

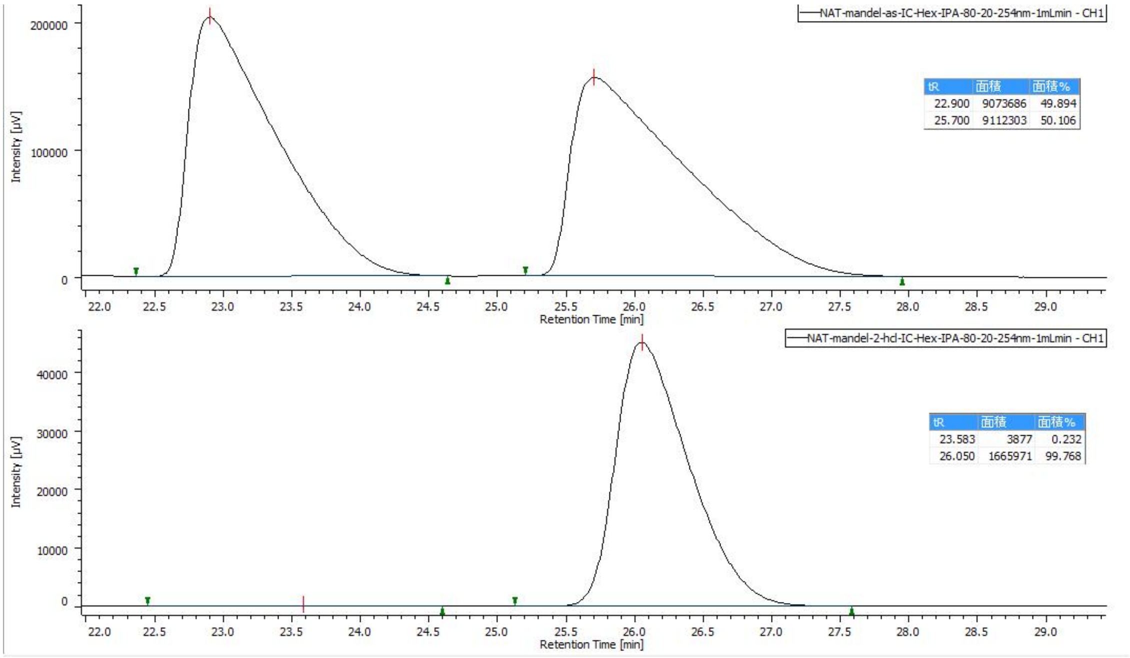


tR	面積	面積%
31.850	36265	0.234
42.708	15470539	99.766

7. Procedure for the catalytic amidation using HNMe(OMe)•HCl salt (3•HCl) (Scheme 2a)



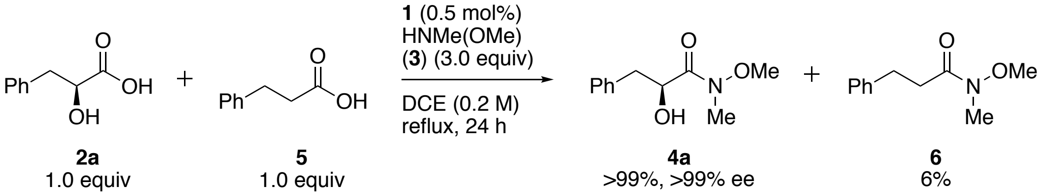
Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 0.5 mol%) was added to the suspension of (*S*)-mandelic acid (**2b**) (60.9 mg, 0.400 mmol, 1.0 equiv), *N*,*O*-dimethylhydroxylamine hydrochloride (**3•HCl**) (117 mg, 1.20 mmol, 3.0 equiv) and sodium hydrogen carbonate (101 mg, 1.20 mmol, 3.0 equiv) in DCE (2.0 mL, 0.20 M). After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature, and diluted with DCM (15 mL). The resulting solution was washed by saturated $NaHCO_3$ aq (5 mL), brine (5 mL), successively, and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (60% EtOAc in *n*-hexane) to give (*S*)-2-hydroxy-*N*-methoxy-*N*-methyl-2-phenylacetamide (**4b**) (62.9 mg, 0.322 mmol, 81%, >99% ee) as a white solid.



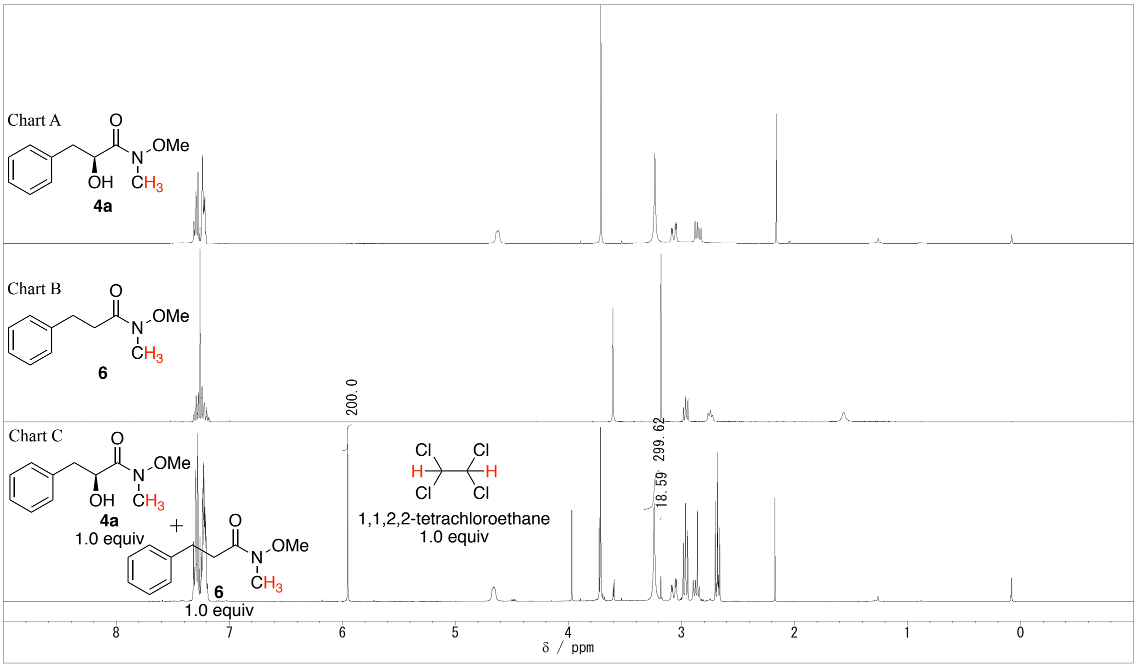
tR	面積	面積%
22.900	9073686	49.894
25.700	9112303	50.106

tR	面積	面積%
23.583	3877	0.232
26.050	1665971	99.768

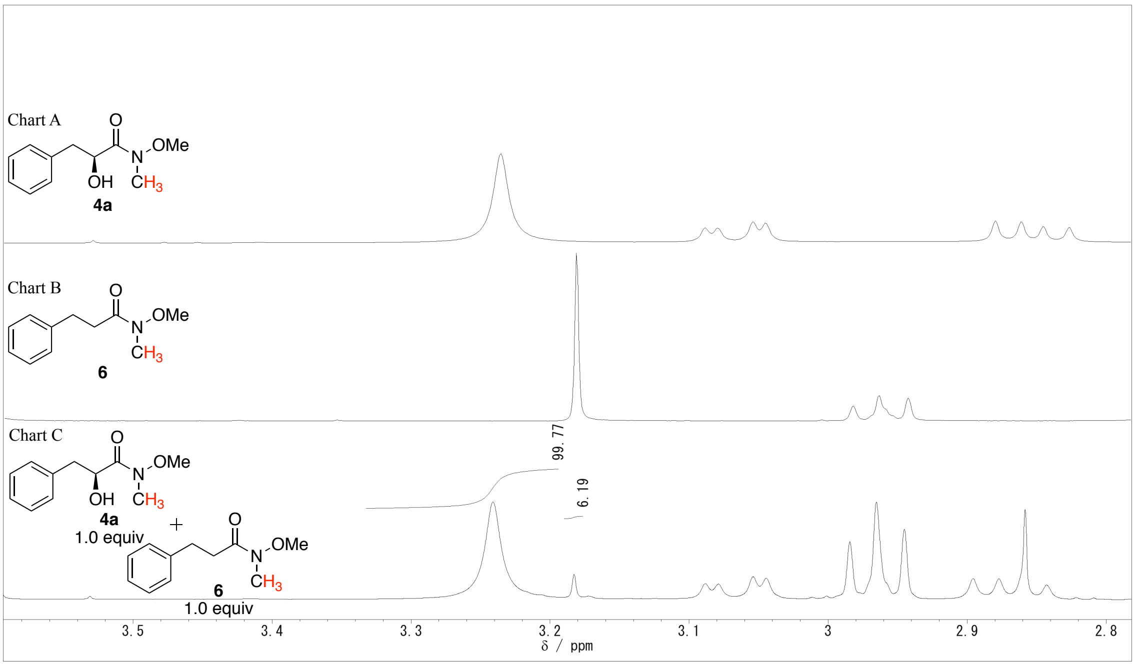
8. Procedure for the crossover experiment (Scheme 2b)



Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 0.5 mol%) was added to a DCE solution (total 0.20 M) of (*S*)-2-hydroxy-3-phenylpropanoic acid (**2a**) (66.5 mg, 0.400 mmol, 1.0 equiv), 3-phenylpropanoic acid (**5**) (60.0 mg, 0.400 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (2.00 mL, 0.60 M in DCE, 1.20 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product. The ^{1}H NMR yields of amide **4a** and **6**[10] were determined to be >99% and 6%, respectively using 1,1,2,2-tetrachloroethane (2.0 mL, 0.2 M in $CDCl_3$, 0.400 mmol, 1.0 equiv) as an internal standard.



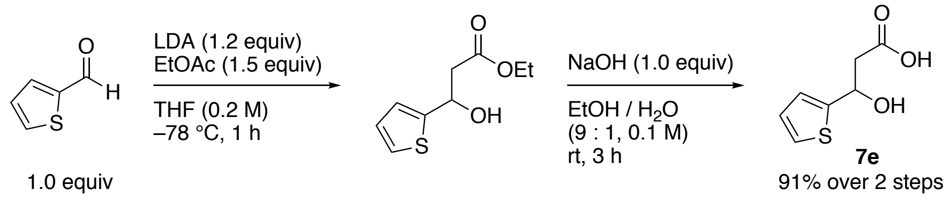
SI-Figure 2. Chart A: ^{1}H NMR spectrum of α-hydroxy Weinreb amide **4a**. Chart B: ^{1}H NMR spectrum of Weinreb amide **6**. Chart C: ^{1}H NMR spectrum of the crude mixture for the crossover experiment shown in Scheme 2b using equimolar amount of 1,1,2,2-tetrachloroethane as an internal standard (5.95 ppm).



SI-Figure 3. Enlarged view of SI-Figure 2. Showing the product yields of **4a** and **6**, respectively by the integration of each peaks.

9. Preparation of *β*-hydroxycarboxylic acids 7e, 7f, 7h and 7i

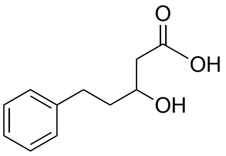
3-Hydroxy-3-(thiophen-2-yl)propanoic acid (7e)



n-BuLi (6.00 mL, 1.6 M in hexane, 9.60 mmol, 1.2 equiv) was added to a stirred solution of *N*,*N*-diisopropylamine (1.47 mL, 10.4 mmol, 1.3 equiv) in dry THF (40 mL, 0.2 M) at –78 °C under nitrogen atmosphere. After stirring for 1 h, EtOAc (1.17 mL, 12.0 mmol, 1.5 equiv) was added to the solution at –78 °C and stirred for an additional 1 h. To this solution, thiophene-2-carbaldehyde (748 μL, 8.00 mmol, 1.0 equiv) was added. After stirring for 1 h, the reaction was poured into saturated NH_4Cl aq and the mixture was extracted with EtOAc (60 mL×3). The combined organic layer was washed by brine (60 mL), dried over Na_2SO_4, filtered and concentrated under reduced pressure. The crude product was subjected to the next step without further purification. A solution of 1 M NaOH aq (8.00 mL, 8.00 mmol, 1.0 equiv) was added to a solution of the crude product in EtOH (45 mL). After stirring for 3 h at room temperature, organic solvent was removed under reduced pressure and the mixture was washed by Et_2O (5 mL×2). Aqueous layer was acidified to pH 2 with 1 M HCl aq and extracted with Et_2O (10 mL×3). The combined organic layer was washed by brine (30 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished crude product, which was purified by trituration from Et_2O/*n*-hexane to give 3-hydroxy-3-(thiophen-2-yl)propanoic acid (**7e**) (1.25 g, 7.26 mmol, 91%) as a white solid.

Data for **7e**: white solid; R_f = 0.38 ($CHCl_3$/MeOH = 19:1); mp 83–84 °C; IR (KBr) ν = 3367, 3099, 1727, 1389, 1073, 842, 704 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.39 (dd, *J* = 4.8, 2.0 Hz, 1H), 6.96–6.94 (m, 2H), 5.80 (br s, 1H), 5.17 (dd, *J* = 8.0, 5.6 Hz, 1H), 2.66 (dd, *J* = 15.2, 5.6 Hz, 1H), 2.60 (dd, *J* = 15.2, 8.0 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 171.9, 149.5, 126.7, 124.4, 123.1, 65.7, 44.8; HRMS (ESI) m/z calcd for $C_7H_7O_3S$ $[M–H]^-$ 171.0116, found 171.0113.

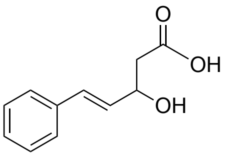
3-Hydroxy-5-phenylpentanoic acid (7f)



7f

Compound **7f** was prepared according to the procedure for the preparation of **7e** from 3-phenylpropanal (671 mg, 5.00 mmol). Yield 86% (834 mg, 4.29 mmol). Data for **7f**: white solid; R_f = 0.40 ($CHCl_3$/MeOH = 19:1); mp 129–130 °C; IR (KBr) ν = 3221, 2642, 1683, 1455, 1271, 1089, 706 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.29–7.25 (m, 2H), 7.20–7.14 (m, 3H), 3.85–3.79 (m, 1H), 2.73–2.66 (m, 1H), 2.61–2.54 (m, 1H), 2.35 (dd, *J* = 14.8, 4.8 Hz, 1H), 2.27 (dd, *J* = 14.8, 8.0 Hz, 1H), 1.73–1.57 (m, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 173.0, 142.3, 128.4, 128.3, 125.7, 66.6, 42.7, 38.9, 31.4; HRMS (ESI) m/z calcd for $C_{11}H_{13}O_3$ [M–H]$^-$ 193.0865, found 193.0859.

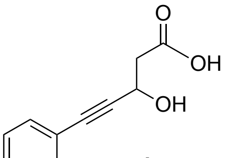
(*E*)-3-Hydroxy-5-phenylpent-4-enoic acid (7h)



7h

Compound **7h** was prepared according to the procedure for the preparation of **7e** from cinnamaldehyde (661 mg, 5.00 mmol). Yield 99% (951 mg, 4.95 mmol). Data for **7h**: white solid; R_f = 0.42 ($CHCl_3$/MeOH = 19:1); mp 96–98 °C; IR (KBr) ν = 3407, 1625, 1495, 1060, 701 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.40 (d, *J* = 7.6 Hz, 2H), 7.32 (t, *J* = 7.6 Hz, 2H), 7.23 (t, *J* = 7.6 Hz, 1H), 6.56 (d, *J* = 15.6 Hz, 1H), 6.31 (dd, *J* = 15.6, 5.6 Hz, 1H), 4.55–4.50 (m, 1H), 2.46 (ddd, *J* = 14.8, 5.6, 1.2 Hz, 1H), 2.39 (ddd, *J* = 14.8, 8.0, 1.6 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 172.3, 136.7, 133.0, 128.6, 128.4, 127.4, 126.3, 68.0, 42.8; HRMS (ESI) m/z calcd for $C_{11}H_{11}O_3$ [M–H]$^-$ 191.0708, found 191.0706.

3-Hydroxy-5-phenylpent-4-ynoic acid (7i)

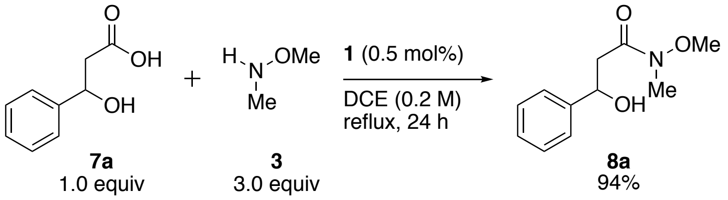


7i

Compound **7i** was prepared according to the procedure for the preparation of **7e** from 3-phenylpropiolaldehyde[11] (651 mg, 1.00 mmol). Yield 93% (880 mg, 4.63 mmol). Data for **7i**: yellow solid; R_f = 0.40 ($CHCl_3$/MeOH = 19:1); mp 116–122 °C; IR (KBr) ν = 3319, 3041, 1060, 701 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.41–7.36 (m, 5H), 4.78 (dd, *J* = 7.6, 6.4 Hz, 1H), 2.65 (d, *J* = 15.2, 6.4 Hz, 1H), 2.61 (d, *J* = 15.2, 7.6 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 171.2, 131.3, 128.7, 128.6, 122.2, 91.3, 83.0, 58.0, 43.2; HRMS (ESI) m/z calcd for $C_{11}H_9O_3$ [M–H]$^-$ 189.0552, found 189.0550.

10. Procedures for the catalytic amidation of *β*-hydroxycarboxylic acids and characterization of *β*-hydroxy Weinreb amides (Scheme 3)

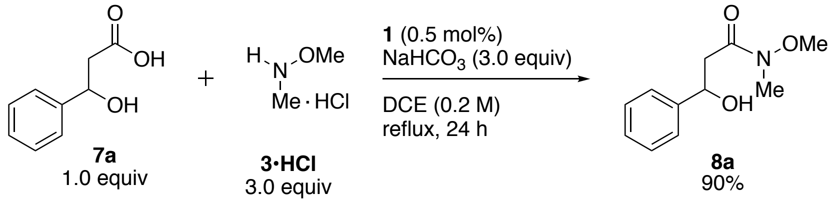
3-Hydroxy-*N*-methoxy-*N*-methyl-3-phenylpropanamide (8a)[12]



Diboronic acid anhydride **1** (2.7 mg, 5.00 μmol, 0.5 mol%) was added to a DCE solution (total 0.20 M) of 3-hydroxy-3-phenylpropanoic acid (**7a**) (166 mg, 1.00 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (5.00 mL, 0.60 M in DCE, 3.00 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (60% EtOAc in *n*-hexane) to give 3-hydroxy-*N*-methoxy-*N*-methyl-3-phenylpropanamide (**8a**) (197 mg, 0.938 mmol, 94%) as a colorless oil.

Data for **8a**: colorless oil; $R_f = 0.33$ (*n*-hexane/EtOAc = 1:1.5); IR (neat) $\nu = 3417$, 2939, 1638, 1453, 1389, 1179, 1059, 702 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43–7.34 (m, 4H), 7.31–7.27 (m, 1H), 5.16 (dd, *J* = 9.2, 2.4 Hz, 1H), 3.63 (s, 3H), 3.21 (s, 3H), 2.88 (dd, *J* = 16.8, 2.4 Hz, 1H), 2.79 (dd, *J* = 16.8, 9.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 143.0, 128.3, 127.3, 125.6, 70.0, 61.1, 40.4, 31.7; HRMS (ESI) m/z calcd for $C_{11}H_{15}NNaO_3$ $[M+Na]^+$ 232.0950, found 232.0949.

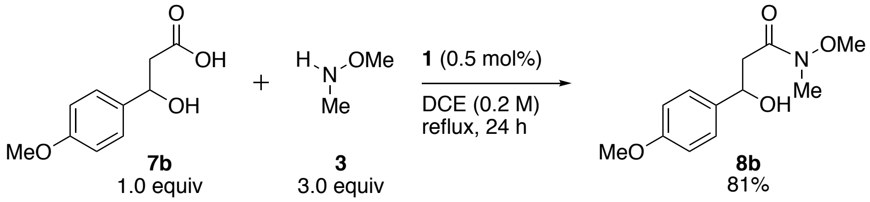
Procedure for the catalytic amidation using HNMe(OMe)•HCl salt (3•HCl)



7a 1.0 equiv + **3·HCl** 3.0 equiv → **8a** 90%

Diboronic acid anhydride **1** (2.7 mg, 5.10 μmol, 0.5 mol %) was added to the suspension of 3-hydroxy-3-phenylpropanoic acid (**7a**) (166 mg, 1.00 mmol, 1.0 equiv), *N*,*O*-dimethylhydroxylamine hydrochloride (**3•HCl**) (293 mg, 3.00 mmol, 3.0 equiv) and sodium hydrogen carbonate (252 mg, 3.00 mmol, 3.0 equiv) in DCE (5.0 mL, 0.20 M). After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature, and diluted with DCM (30 mL). The resulting solution was washed by saturated $NaHCO_3$ aq (10 mL), brine (10 mL), successively, and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (60% EtOAc in *n*-hexane) to give 3-hydroxy-*N*-methoxy-*N*-methyl-3-phenyl-propanamide (**8a**) (189 mg, 0.900 mmol, 90%) as a colorless oil.

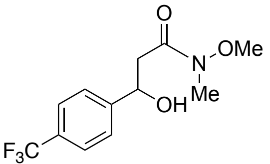
3-Hydroxy-*N*-methoxy-3-(4-methoxyphenyl)-*N*-methylpropanamide (8b)[12]



Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 0.5 mol%) was added to a DCE solution (total 0.20 M) of 3-hydroxy-3-(4-methoxyphenyl)propanoic acid (**7b**) (78.5 mg, 0.400 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (2.00 mL, 0.60 M in DCE, 1.20 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (60% EtOAc in *n*-hexane) to give 3-hydroxy-*N*-methoxy-3-(4-methoxyphenyl)-*N*-methylpropanamide (**8b**) (77.5 mg, 0.324 mmol, 81%) as a colorless oil.

Data for **8b**: colorless oil; R_f = 0.34 (*n*-hexane/EtOAc = 1:1.5); IR (neat) ν = 3445, 2938, 1644, 1248, 1033, 834 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.35–7.31 (m, 2H), 6.92–6.88 (m, 2H), 5.10 (dd, *J* = 9.2, 3.2 Hz, 1H), 3.81 (s, 3H), 3.64 (s, 3H), 3.21 (s, 3 H), 2.85 (dd, *J* = 16.8, 3.2 Hz, 1H), 2.77 (dd, *J* = 16.8, 9.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.2, 159.0, 135.2, 126.9, 113.8, 69.7, 61.2, 55.2, 40.4, 31.8; HRMS (ESI) m/z calcd for $C_{12}H_{17}NNaO_4$ $[M+Na]^+$ 262.1055, found 262.1057.

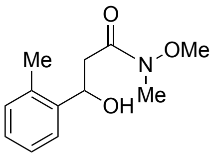
3-Hydroxy-*N*-methoxy-*N*-methyl-3-(4-(trifluoromethyl)phenyl)propanamide (8c)



8c

Compound **8c** was prepared according to the procedure for **8b** from 3-hydroxy-3-(4-(trifluoromethyl)phenyl)propanoic acid (**7c**) (93.7 mg, 0.400 mmol). Yield 84% (93.3 mg, 0.337 mmol). Data for **8c**: white solid; R$_f$ = 0.35 (*n*-hexane/EtOAc = 1:1.5); mp 73–75 °C; IR (KBr) ν = 3356, 2948, 1649, 1332, 1158, 1118, 1067, 836, 616 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.62 (d, J = 8.0 Hz, 2H), 7.53 (d, J = 8.0 Hz, 2H), 5.20 (dd, J = 9.6, 2.4 Hz, 1H), 3.65 (s, 3H), 3.22 (s, 3H), 2.89 (dd, J = 16.8, 2.4 Hz, 1H), 2.75 (dd, J = 16.8, 9.6 Hz, 1H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 172.8, 147.0, 129.6 (q, $^2J_{\text{C-F}}$ = 32.1 Hz), 126.0, 125.3 (q, $^3J_{\text{C-F}}$ = 3.8 Hz) 124.1 (q, $^1J_{\text{C-F}}$ = 270.0 Hz), 69.6, 61.2, 40.2, 31.8; ^{19}F NMR (377 MHz, CDCl$_3$) δ –62.53; HRMS (ESI) m/z calcd for $C_{12}H_{14}F_3NNaO_3$ [M+Na]$^+$ 300.0823, found 300.0818.

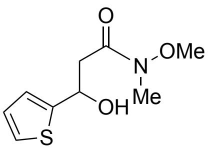
3-Hydroxy-*N*-methoxy-*N*-methyl-3-(*o*-tolyl)propanamide (8d)



8d

Compound **8d** was prepared according to the procedure for **8b** from 3-hydroxy-3-(*o*-tolyl)propanoic acid (**7d**) (72.1 mg, 0.400 mmol). Yield 94% (84.3 mg, 0.378 mmol). Data for **8d**: white solid; R$_f$ = 0.32 (*n*-hexane/EtOAc = 1:1.5); mp 51–54 °C; IR (KBr) ν = 3448, 2925, 1638, 1393, 1065, 988, 763, cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.57 (dd, J = 7.6, 1.2 Hz, 1H), 7.25 (dt, J = 7.6, 1.2 Hz, 1H), 7.19 (dt, J = 7.6, 1.6 Hz, 1H) 7.14 (dd, J = 7.6, 1.6 Hz, 1H), 5.37 (dd, J = 10.0, 2.4 Hz, 1H), 3.63 (s, 3H), 3.23 (s, 3H), 2.84 (dd, J = 16.8, 2.4 Hz, 1H), 2.71 (dd, J = 16.8, 10.0 Hz, 1H), 2.35 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 173.3, 140.9, 134.0, 130.3, 127.3, 126.3, 125.4, 66.7, 61.2, 39.1, 31.8, 19.0; HRMS (ESI) m/z calcd for $C_{12}H_{17}NNaO_3$ [M+Na]$^+$ 246.1106, found 246.1100.

3-Hydroxy-*N*-methoxy-*N*-methyl-3-(thiophen-2-yl)propenamide (8e)

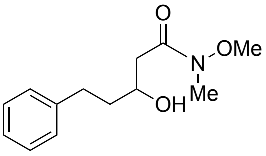


8e

Compound **8e** was prepared according to the procedure for **8b** from 3-hydroxy-3-(thiophen-2-yl)propanoic acid (**7e**) (68.9 mg, 0.400 mmol). Yield 86% (74.0 mg, 0.344 mmol). Data for **8e**: colorless oil; R$_f$ = 0.33 (*n*-hexane/EtOAc = 1:1.5); IR (neat) ν = 3409, 2937, 1644, 1441, 1389, 702 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.26 (dd, J = 4.8, 1.2 Hz, 1H), 7.01–6.97 (m, 2H) 5.40 (dd, J = 8.8, 3.2 Hz, 1H), 3.68 (s, 3H), 3.22 (s, 3H), 3.00 (dd, J = 17.2, 3.2 Hz, 1H), 2.93 (dd, J =

17.2, 8.8 Hz, 1H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 172.5, 146.8, 126.5, 124.3, 123.2, 66.4, 61.2, 40.2, 31.7; HRMS (ESI) m/z calcd for $C_9H_{13}NNaO_3S$ [M+Na]$^+$ 238.0514, found 238.0510.

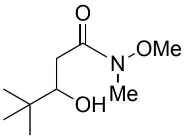
3-Hydroxy-*N*-methoxy-*N*-methyl-5-phenylpentanamide (8f)[13]



8f

Compound **8f** was prepared according to the procedure for **8b** from 3-hydroxy-5-phenylpentanoic acid (**7f**) (38.8 mg, 0.200 mmol) using 2.0 mol% of **1**. Yield 98% (46.6 mg, 0.196 mmol). Data for **8f**: colorless oil; R_f = 0.38 (*n*-hexane/EtOAc = 1:1.5); IR (neat) ν = 3435, 2936, 1644, 1454, 1388, 1179, 997, 701 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.30–7.16 (m, 5H), 4.07–4.01 (m, 1H), 3.67 (s, 3H), 3.19 (s, 3H), 2.89–2.82 (m, 1H), 2.76–2.64 (m, 2H), 2.48 (dd, *J* = 16.8, 9.6 Hz, 1H), 1.94–1.84 (m, 1H), 1.79–1.70 (m, 1H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 173.7, 141.9, 128.4, 128.3, 125.7, 67.1, 61.1, 38.1 (2C), 31.7 (2C); HRMS (ESI) m/z calcd for $C_{13}H_{19}NNaO_3$ [M+Na]$^+$ 260.1263, found 260.1260.

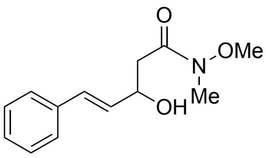
3-Hydroxy-*N*-methoxy-*N*,4,4-trimethylpentanamide (8g)



8g

Compound **8g** was prepared according to the procedure for **8b** from 3-hydroxy-4,4-dimethylpentanoic acid (**7g**) (58.5 mg, 0.400 mmol). Yield 86% (65.1 mg, 0.344 mmol). Data for **8g**: colorless oil; R_f = 0.30 (*n*-hexane/EtOAc = 1:1.5); IR (neat) ν = 3465, 2957, 1644, 1478, 1389, 1178, 1012 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 3.72–3.69 (m, 4H), 3.21 (s, 3H), 2.70 (br d, *J* = 16.4 Hz, 1H), 2.38 (dd, *J* = 16.4, 10.4 Hz, 1H), 0.95 (s, 9H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 174.6, 75.3, 61.2, 34.3, 33.2, 32.0, 25.7; HRMS (ESI) m/z calcd for $C_9H_{19}NNaO_3$ [M+Na]$^+$ 212.1263., found 212.1261.

(*E*)-3-Hydroxy-*N*-methoxy-*N*-methyl-5-phenylpent-4-enamide (8h)[12]

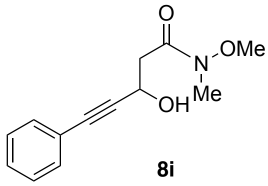


8h

Compound **8h** was prepared according to the procedure for **8b** from (*E*)-3-hydroxy-5-phenylpent-4-enoic acid (**7h**) (76.9 mg, 0.400 mmol). Yield 93% (87.8 mg, 0.373 mmol). Data for **8h**: yellow oil; R_f = 0.37 (*n*-hexane/EtOAc = 1:1.5); IR (neat) ν = 3418, 2938, 1644, 1448, 1389, 1178, 1110, 750, 695 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.41–7.38 (m, 2H), 7.33–7.29 (m, 2H), 7.26–7.21 (m, 1H), 6.68 (dd, *J* = 16.0, 1.2 Hz, 1H), 6.26 (dd, *J* = 16.0, 5.6 Hz, 1H), 4.78–4.73 (m, 1H), 3.70 (s, 3H), 3.22 (s, 3H), 2.82 (dd, *J* = 16.8, 2.8 Hz, 1H), 2.69 (dd, *J* =

16.8, 9.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 136.6, 130.4, 130.2, 128.4, 127.5, 126.4, 68.6, 61.2, 38.4, 31.8; HRMS (ESI) m/z calcd for $C_{13}H_{17}NNaO_3$ $[M+Na]^+$ 258.1106, found 258.1104.

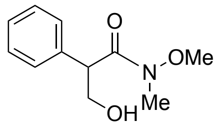
3-Hydroxy-*N*-methoxy-*N*-methyl-5-phenylpent-4-ynamide (8i)



8i

Compound **8i** was prepared according to the procedure for **8b** from 3-hydroxy-5-phenylpent-4-ynoic acid (**7i**) (38.0 mg, 0.200 mmol) using 2.0 mol% of **1** at 60 °C (bath temp.). Yield 82% (38.4 mg, 0.165 mmol). Data for **8i**: yellow oil; R_f = 0.37 (*n*-hexane/EtOAc = 1:1.5); IR (neat) ν = 3398, 2938, 1644, 1490, 1442, 1389, 1040, 758 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46–7.43 (m, 2H), 7.32–7.28 (m, 3H), 5.04 (dd, *J* = 8.4, 3.6 Hz, 1H), 3.73 (s, 3H), 3.23 (s, 3H), 3.02 (dd, *J* = 16.8, 8.4 Hz, 1H), 2.93 (dd, *J* = 16.8, 3.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.1, 131.7, 128.4, 128,2, 122.4, 88.6, 84.6, 61.3, 59.3, 38.8, 31.8; HRMS (ESI) m/z calcd for $C_{13}H_{15}NNaO_3$ $[M+Na]^+$ 256.0950, found 256.0945.

3-Hydroxy-*N*-methoxy-*N*-methyl-2-phenylpropanamide (8j)

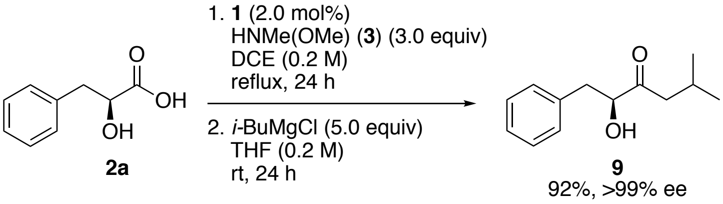


8j

Compound **8j** was prepared according to the procedure for **8b** from tropic acid (**7j**) (66.5 mg, 0.400 mmol). Yield 93% (77.8 mg, 0.372 mmol). Data for **8j**: white solid; R_f = 0.33 (*n*-hexane/EtOAc = 1:1.5); mp 59–62 °C; IR (KBr) ν = 3388, 2922, 1624, 1455, 1389, 1324, 1428, 989, 747, 703 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35–7.24 (m, 5H), 4.21 (br s, 1H) 4.09 (dd, *J* = 11.2, 4.8 Hz, 1H), 3.77 (dd, *J* = 11.2, 8.8 Hz, 1H), 3.30 (s, 3H), 3.18 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.7, 136.5, 128.7, 128.2, 127.3, 65.0, 60.9, 50.8, 32.0; HRMS (ESI) m/z calcd for $C_{11}H_{15}NNaO_3$ $[M+Na]^+$ 232.0950, found 232.0950.

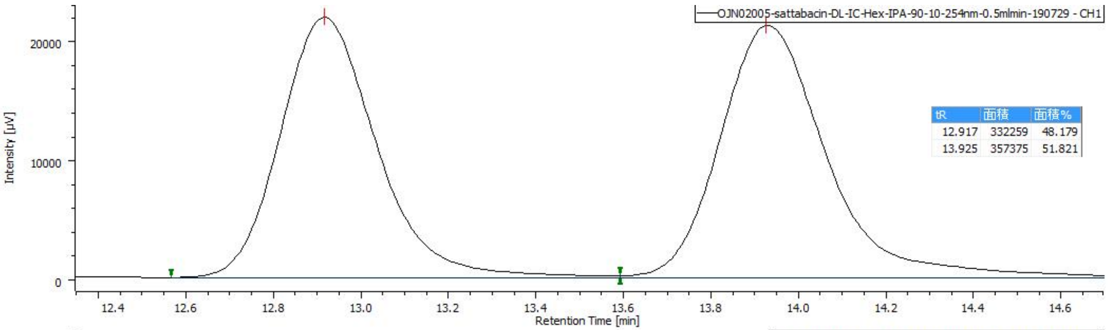
11. Procedures for the syntheses of *α*-hydroxyketone natural products and characterization of *α*-hydroxyketone natural products (Scheme 4)

sattabacin (9)[14]

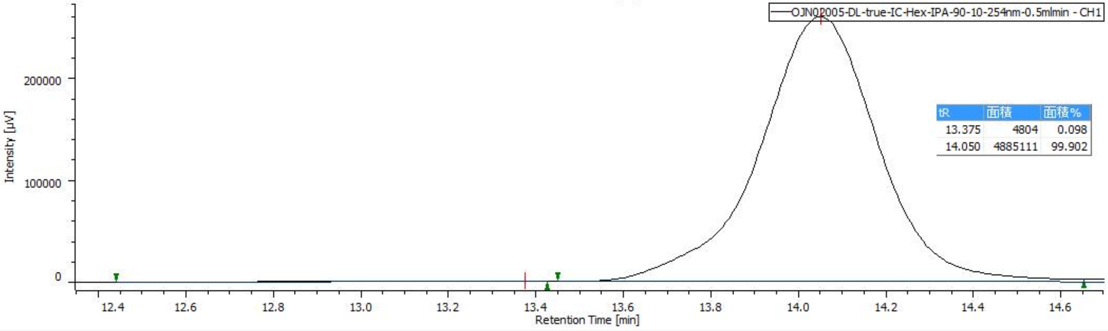


Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 2.0 mol%) was added to a DCE solution (total 0.20 M) of (*S*)-2-hydroxy-3-phenylpropanoic acid (**2a**) (16.6 mg, 0.100 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (0.5 mL, 0.60 M in DCE, 0.30 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. Isobutylmagnesium chloride (250 μL, 2.0 M in THF, 0.500 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (250 μL, total 0.2 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (2 mL) and the mixture was stirred for 30 min. The mixture was extracted with CH_2Cl_2 (10 mL×2) and washed by water (5 mL), brine (5 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (10% EtOAc in *n*-hexane) to give sattabacin (**9**) (19.0 mg, 0.092 mmol, 92%)

Data for **9**; yellow oil; R_f = 0.32 (*n*-hexane/EtOAc = 9:1); $[\alpha]_D^{24}$ +36.3° (*c* = 1.0, $CHCl_3$); IR (neat) ν = 3469, 3028, 1712, 1367, 1294, 1153, 1090, 1044, 748, 700 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.33–7.29 (m, 2H), 7.25–7.22 (m, 3H), 4.38 (dd, *J* = 7.2, 4.4 Hz, 1H), 3.13 (dd, *J* = 14.4, 4.4 Hz, 1H), 2.83 (dd, *J* = 14.4, 7.2 Hz, 1H), 2.37 (d, *J* = 7.2 Hz, 2H), 2.23–2.13 (m, 1H), 0.924 (d, *J* = 6.8 Hz, 3H), 0.922 (d, *J* = 6.8 Hz, 3H) ; ^{13}C NMR (100 MHz, $CDCl_3$) δ 211.2, 136.6, 129.3, 128.5, 126.8, 77.4, 47.4, 40.0, 24.5, 22.6, 22.5; HRMS (ESI) m/z calcd for $C_{13}H_{18}NaO_2$ $[M+Na]^+$ 229.1205, found 229.1196; HPLC (CHIRALPAK® IC (ϕ 0.46 cm × 25 cm), hexane/*i*-PrOH = 90:10, 254 nm, flow rate 1.0 mL/min) t_R = 13.4 min (minor), 14.1 min (major).

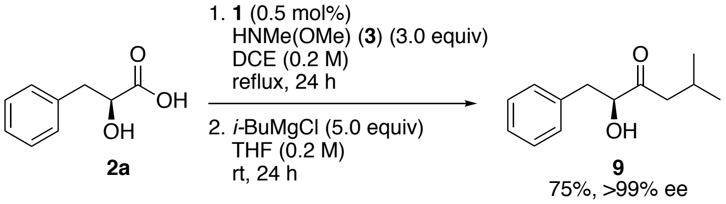


tR	面積	面積%
12.917	332259	48.179
13.925	357375	51.821



tR	面積	面積%
13.375	4804	0.098
14.050	4885111	99.902

Gram scale synthesis of Sattabacin (9)

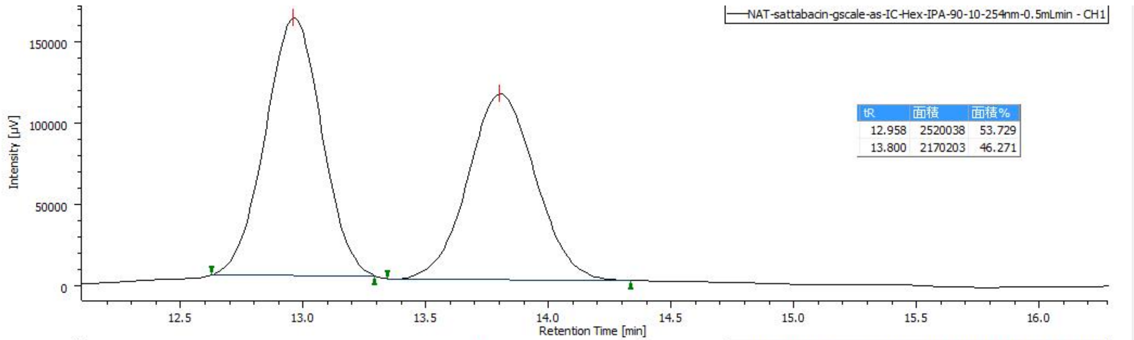


2a

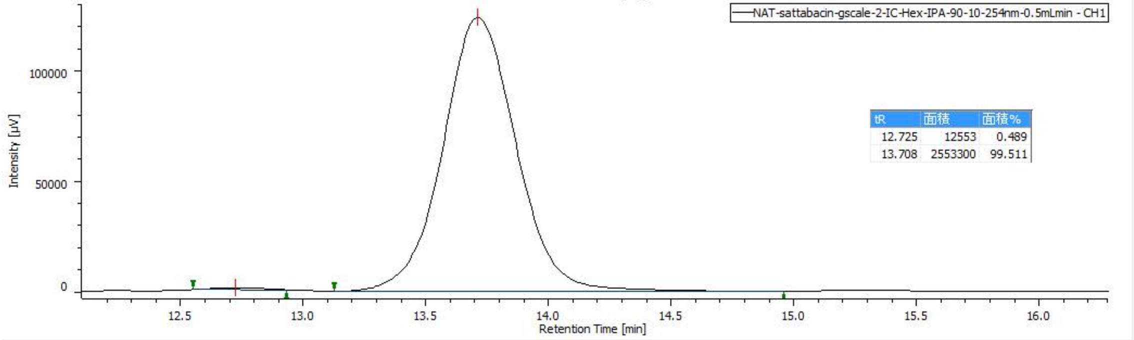
9

75%, >99% ee

N,*O*-Dimethylhydroxylamine (**3**) (30.0 mL, 0.60 M in DCE, 18.0 mmol, 3.0 equiv) was added dropwise over 1 h to a suspension of diboronic acid anhydride **1** (16.2 mg, 30.1 μmol, 0.5 mol%) and (*S*)-2-hydroxy-3-phenylpropanoic acid (**2a**) (1.00 g, 6.02 mmol, 1.0 equiv) in DCE (10.0 mL, total 0.15 M) under reflux (bath temp, 90 °C). After stirring for 24 h, the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. Isobutylmagnesium chloride (15.0 mL, 2.0 M in THF, 30.0 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (30.0 mL, total 0.2 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (20 mL) and the mixture was stirred for 30 min. The organic phase was evaporated *in vacuo* and the resulting water phase was extracted with CH_2Cl_2 (50 mL×2). The combined organic phase was washed by water (20 mL), brine (20 mL), successively, and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (10% EtOAc in *n*-hexane) to give sattabacin (**9**) (929.4 mg, 4.51 mmol, 75%, >99% ee) as a colorless oil. $[\alpha]_D^{23}$ +38.9° (c = 1.0, $CHCl_3$) for gram scale synthesis of sattabacin.

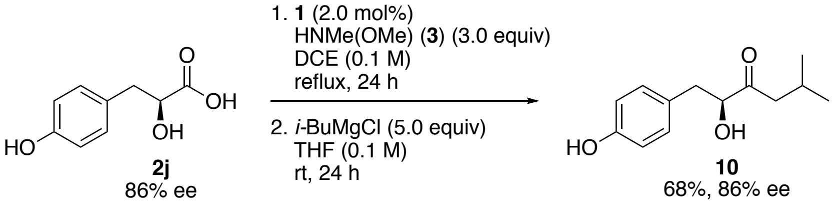


tR	面積	面積%
12.958	2520038	53.729
13.800	2170203	46.271



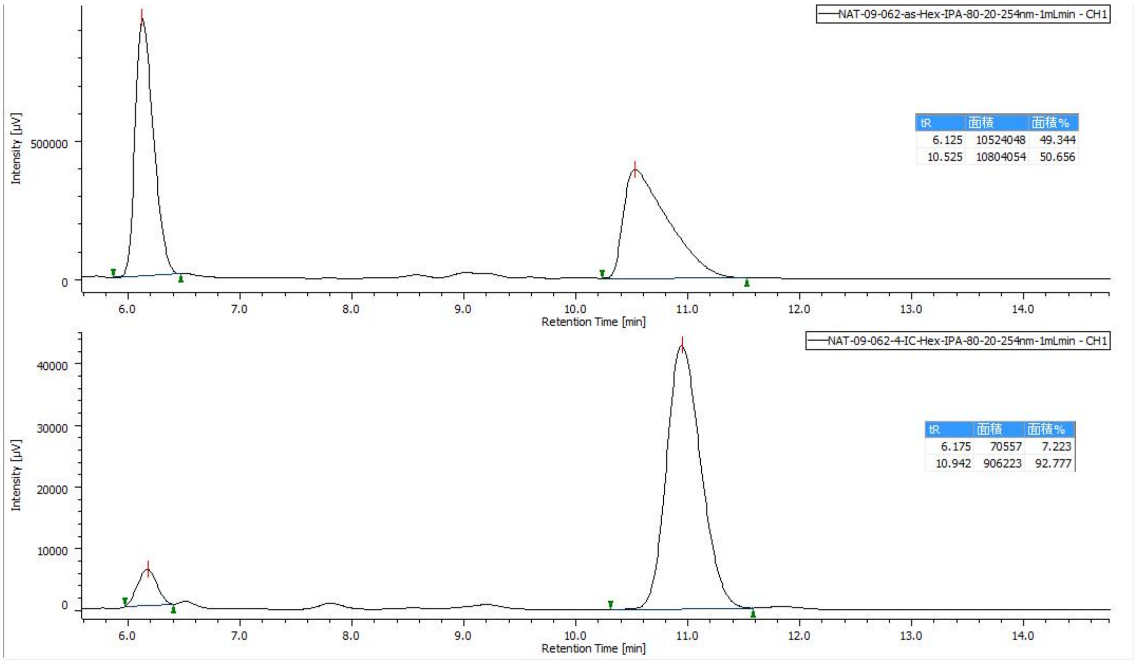
tR	面積	面積%
12.725	12553	0.489
13.708	2553300	99.511

4-hydroxy sattabacin (10)[14]



Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 2.0 mol%) was added to a DCE solution (total 0.10 M) of (*S*)-2-hydroxy-3-(4-hydroxyphenyl)propanoic acid (**2j**) (18.2 mg, 0.100 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (1.0 mL, 0.30 M in DCE, 0.30 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. Isobutylmagnesium chloride (250 μL, 2.0 M in THF, 0.500 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (750 μL, total 0.1 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (2 mL) and the mixture was stirred for 30 min. The mixture was extracted with CH_2Cl_2 (10 mL×2) and washed by water (5 mL), brine (5 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (30% EtOAc in *n*-hexane) to give 4-hydroxy sattabacin (**10**) (15.2 mg, 0.068 mmol, 68%, 86% ee) as a colorless oil.

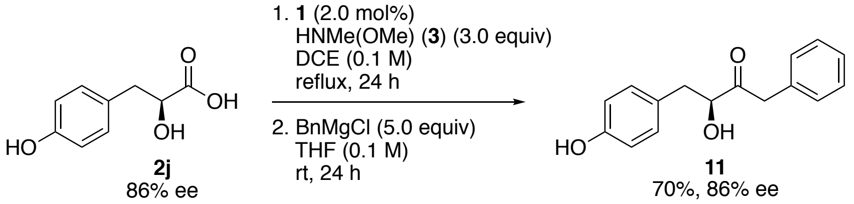
Data for **10**; colorless oil; R_f = 0.36 (*n*-hexane/EtOAc = 2:1); $[\alpha]_D^{24}$ +37.1° (*c* = 0.50, $CHCl_3$); IR (neat) ν = 3389, 2958, 1713, 1614, 1516, 1454, 1368, 1261, 1041, 950, 828 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.11–7.08 (m, 2H), 6.76–6.73 (m, 2H), 4.87 (br s, 1H), 4.33 (dd, *J* = 7.2, 4.4 Hz, 1H), 3.44 (br s, 1H), 3.07 (dd, *J* = 14.4, 4.4 Hz, 1H), 2.76 (dd, *J* = 14.4, 7.2 Hz, 1H) 2.37 (d, *J* = 6.8 Hz, 2H), 2.23–2.13 (m, 1H), 0.92 (d, *J* = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 211.3, 154.6, 130.4, 128.5, 115.4, 77.6, 47.4, 39.1, 29.7, 24.6, 22.62, 22.56; HRMS (ESI) m/z calcd for $C_{13}H_{18}NaO_3$ $[M+Na]^+$ 245.1154, found 245.1144; HPLC (CHIRALPAK® IC (ϕ 0.46 cm × 25 cm), hexane/*i*-PrOH = 80:20, 254 nm, flow rate 1.0 mL/min) t_R = 6.2 min (minor), 10.9 min (major).



tR	面積	面積%
6.125	10524048	49.344
10.525	10804054	50.656

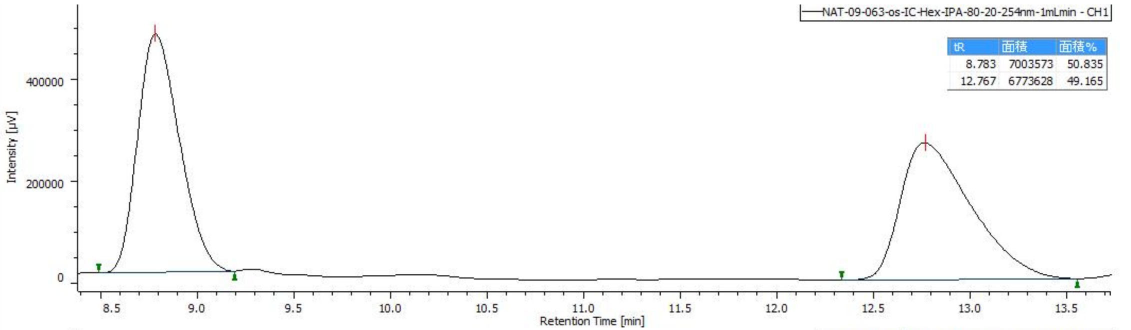
tR	面積	面積%
6.175	70557	7.223
10.942	906223	92.777

kurasoin A (11)[15]

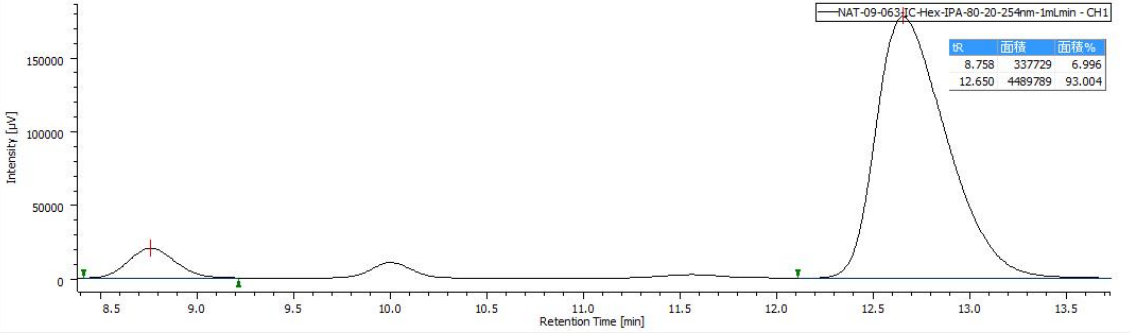


Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 2.0 mol%) was added to a DCE solution (total 0.10 M) of (*S*)-2-hydroxy-3-(4-hydroxyphenyl)propanoic acid (**2j**) (18.2 mg, 0.100 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (1.0 mL, 0.30 M in DCE, 0.30 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. Benzylmagnesium chloride (250 μL, 2.0 M in THF, 0.500 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (750 μL, total 0.1 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (2 mL) and the mixture was stirred for 30 min. The mixture was extracted with CH_2Cl_2 (10 mL×2) and washed by water (5 mL), brine (5 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (50% EtOAc in *n*-hexane) to give kurasoin A (**11**) (17.9 mg, 0.070 mmol, 70%, 86% ee) as a white solid.

Data for **11**; white solid; R_f = 0.48 (*n*-hexane/EtOAc = 1:1); mp 117–120 °C; $[\alpha]_D^{24}$ +8.2° (*c* = 0.50, MeOH); IR (KBr) ν = 3313, 3030, 2897, 1712, 1595, 1517, 1451, 1338, 1227, 1100, 1047, 993, 809, 703 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.36–7.27 (m, 3H), 7.17–7.14 (m, 2H), 7.09–7.05 (m, 2H), 6.76–6.73 (m, 2H), 4.87 (br s, 1H), 4.47 (dd, *J* = 7.2, 4.8 Hz, 1H), 3.81 (d, *J* = 16.0 Hz, 1H), 3.75 (d, *J* = 16.0 Hz, 1H), 3.09 (dd, *J* = 14.4, 4.8 Hz, 1H), 2.84 (dd, *J* = 14.4, 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.2, 154.7, 132.9, 130.4, 129.5, 128.8, 128.2, 127.3, 115.5, 76.8, 45.7, 39.2; HRMS (ESI) m/z calcd for $C_{16}H_{16}NaO_3$ $[M+Na]^+$ 279.0997, found 279.0983. ; HPLC (CHIRALPAK® IC (*ϕ* 0.46 cm × 25 cm), hexane/*i*-PrOH = 80:20, 254 nm, flow rate 1.0 mL/min) t_R = 8.8 min (minor), 12.7 min (major).

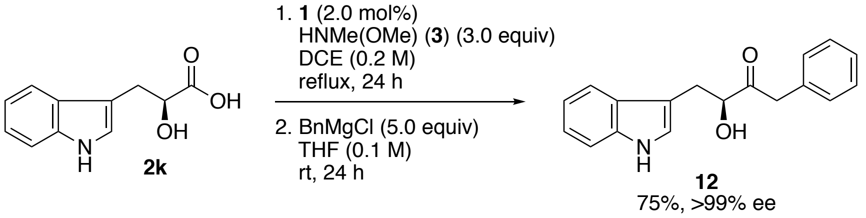


tR	面積	面積%
8.783	7003573	50.835
12.767	6773628	49.165



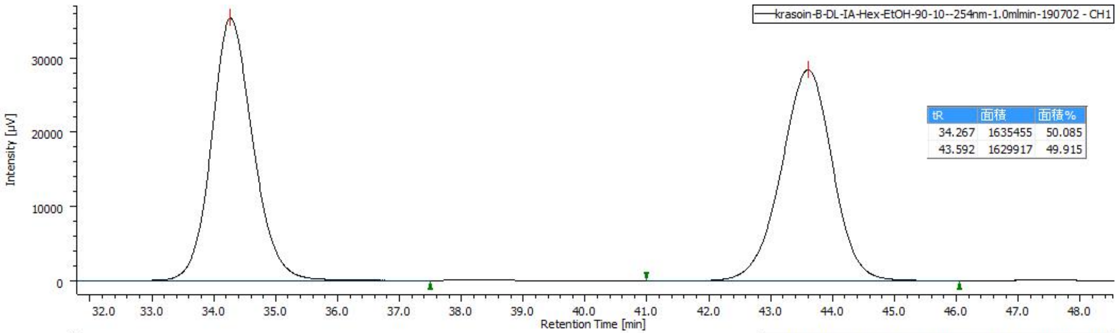
tR	面積	面積%
8.758	337729	6.996
12.650	4489789	93.004

kurasoin B (12)[15]

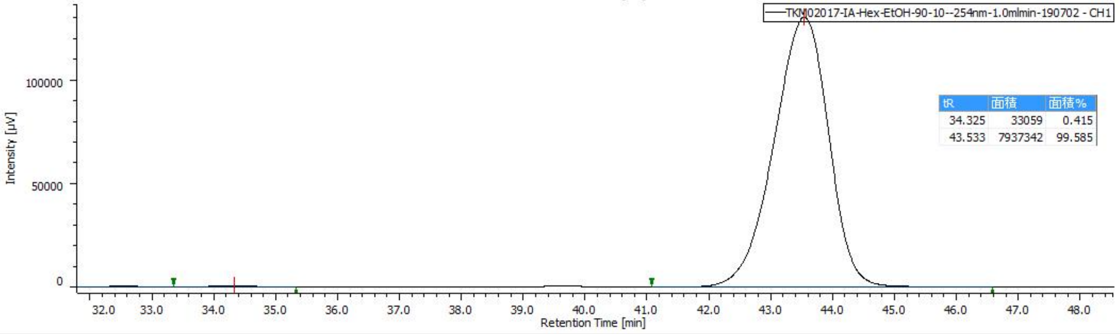


Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 2.0 mol%) was added to a DCE solution (total 0.20 M) of (*S*)-2-hydroxy-3-(1*H*-indol-3-yl)propanoic acid (**2k**) (20.5 mg, 0.100 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (0.5 mL, 0.60 M in DCE, 0.30 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. Benzylmagnesium chloride (250 μL, 2.0 M in THF, 0.500 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (750 μL, total 0.1 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (2 mL) and the mixture was stirred for 30 min. The mixture was extracted with CH_2Cl_2 (10 mL×2) and washed by water (5 mL), brine (5 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (30% EtOAc in *n*-hexane) to give kurasoin B (**12**) (20.9 mg, 0.075 mmol, 75%, >99% ee) as a yellow oil.

Data for **12**; yellow oil; R_f = 0.38 (*n*-hexane/EtOAc = 2:1); $[\alpha]_D^{26}$ +23.6° (*c* = 1.0, MeOH); IR (neat) ν = 3411, 3058, 3028, 2916, 1713, 1497, 1456, 1341, 1011, 743, 701 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.07 (br s, 1H), 7.60 (d, *J* = 8.0 Hz, 1H), 7.37 (d, *J* = 8.0 Hz, 1H) 7.32–7.20 (m, 4H), 7.16–7.12 (m, 1H), 7.10–7.07 (m, 3H) 4.61 (dd, *J* = 6.8, 4.8 Hz, 1H), 3.81 (d, *J* = 16.0 Hz, 1H), 3.75 (d, *J* = 16.0 Hz, 1H), 3.33 (dd, *J* = 14.8, 4.8 Hz, 1H), 3.16 (dd, *J* = 14.8, 6.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.6, 136.1, 133.1, 129.5, 128.7, 127.4, 127.2, 123.0, 122.3, 119.7, 118.7, 111.3, 110.3, 76.1, 45.6, 29.9; HRMS (ESI) m/z calcd for $C_{18}H_{17}NNaO_2$ $[M+Na]^+$ 302.1157, found 302.1148; HPLC (CHIRALPAK® IA (*ϕ* 0.46 cm × 25 cm), hexane/EtOH = 90:10, 254 nm, flow rate 1.0 mL/min) t_R = 34.3 min (minor), 43.5 min (major).

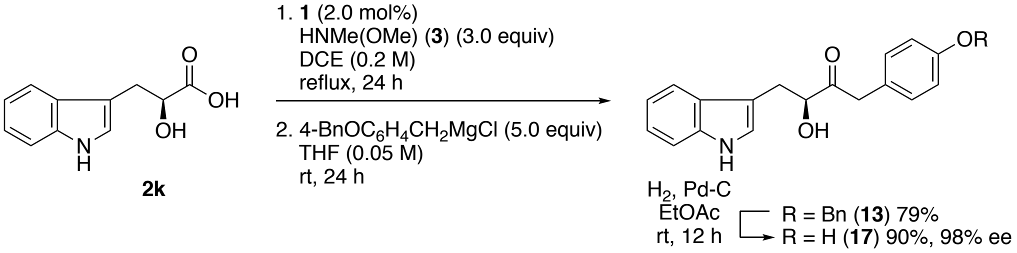


tR	面積	面積%
34.267	1635455	50.085
43.592	1629917	49.915



tR	面積	面積%
34.325	33059	0.415
43.533	7937342	99.585

soraphinol A (17)[16]

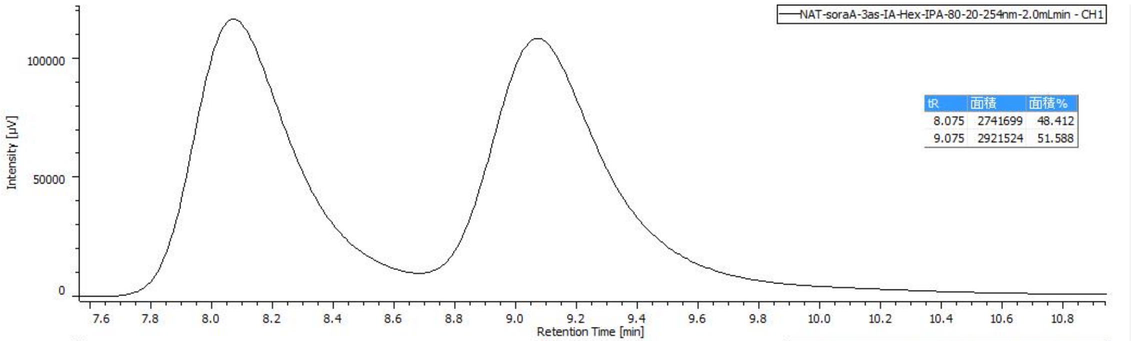


Diboronic acid anhydride **1** (1.1 mg, 2.00 µmol, 2.0 mol%) was added to a DCE solution (total 0.20 M) of (*S*)-2-hydroxy-3-(1*H*-indol-3-yl)propanoic acid (**2k**) (20.5 mg, 0.100 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (0.5 mL, 0.60 M in DCE, 0.30 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. 4-(Benzyloxy)benzylmagnesium chloride (1.67 mL, 0.3 M in THF, 0.500 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (330 µL, total 0.05 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (2 mL) and the mixture was stirred for 30 min. The mixture was extracted with CH_2Cl_2 (10 mL×2) and washed by water (5 mL), brine (5 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (5% EtOAc in CH_2Cl_2) to give (*S*)-1-(4-(benzyloxy)phenyl)-3-hydroxy-4-(1*H*-indol-3-yl)butan-2-one (**13**) (30.4 mg, 0.079 mmol, 79%) as a brown gum.

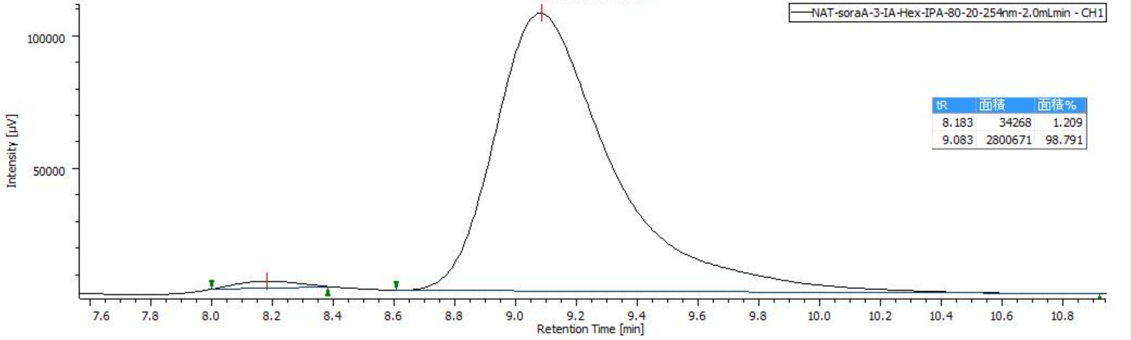
Data for **13**; amorphous; R_f = 0.35 (CH_2Cl_2/EtOAc = 20:1); $[\alpha]_D^{24}$+11.7° (*c* = 0.5, MeOH); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (br s, 1H), 7.60 (d, *J* = 8.0 Hz, 1H), 7.44–7.31 (m, 6H), 7.23–7.19 (m, 1H), 7.16–7.10 (m, 1H), 7.08–7.06 (m, 1H), 7.00–6.97 (m, 2H), 6.91–6.89 (m, 2H), 5.04 (s, 2H), 4.60 (dt, *J* = 6.8, 5.2 Hz, 1H), 3.74 (d, *J* = 16.0 Hz, 1H), 3.68 (d, *J* = 16.0 Hz, 1H), 3.34–3.23 (m, 2H), 3.15 (dd, *J* = 15.2, 6.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.9, 158.0, 136.9, 136.1, 130.5, 128.6, 128.0, 127.5, 127.4, 125.3, 122.9, 122.3, 119.7, 118.8, 115.1, 111.2, 110.4, 76.0, 70.0, 44.8, 29.9; IR (neat) ν = 3411, 2925, 1713, 1611, 1510, 1456, 1259, 1027, 800, 741 cm^{-1}; HRMS (ESI) m/z calcd for $C_{25}H_{23}NNaO_3$ $[M+Na]^+$ 408.1576, found 408.1575.

10% Pd/C (6.0 mg, 20 wt%, wet) was added to a solution of **13** (30.4 mg, 0.079 mmol) in EtOAc (2.5 mL, 0.03 M) and the mixture was stirred at room temperature under hydrogen atmosphere (balloon). After strring for 12 h, the mixture was filtered through a pad of Celite® and the resulting filtrate was concentrated under reduced pressure to furnish the crude product, which was purified by silica gel column chromatography (20% MeOH in CH_3Cl) to give soraphinol A (**17**) (21.0 mg, 0.071 mmol, 90%, 98% ee) as a colorless oil .

Data for **17**; colorless oil; R_f = 0.34 ($CHCl_3$/MeOH = 10:1); $[\alpha]_D^{23}$ +19.0° (*c* = 1.0, MeOH); IR (neat) ν = 3407, 2919, 1711, 1613, 1515, 1456, 1231, 1041, 821, 745 cm^{-1}; ^1H NMR (400 MHz, CD_3OD) δ 7.53–7.52 (m, 1H), 7.35–7.33 (m, 1H), 7.12–7.07 (m, 2H), 7.03–6.99 (m, 1H), 6.80–6.78 (m, 2H), 6.67–6.64 (m, 2H), 4.51 (dd, *J* = 6.8, 5.6 Hz, 1H), 3.62 (d, *J* = 16.4 Hz, 1H), 3.56 (d, *J* = 16.4 Hz, 1H), 3.35 (s, 1H), 3.18 (dd, *J* = 14.8, 5.6 Hz, 1H) , 3.08 (dd, *J* = 14.8, 6.8 Hz, 1H); ^{13}C NMR (100 MHz, CD_3OD) δ 213.2, 157.3, 138.0, 131.8, 128.8, 126.0, 124.7, 122.4, 119.8, 119.6, 116.2, 112.2, 111.0, 77.6, 46.1, 31.2; HRMS (ESI) m/z calcd for $C_{18}H_{17}NNaO_3$ $[M+Na]^+$ 318.1106, found 318.1103; HPLC (CHIRALPAK® IA (ϕ 0.46 cm × 25 cm), hexane/*i*-PrOH = 80:20, 254 nm, flow rate 1.0 mL/min) t_R = 16.3 min (minor), 18.1 min (major).

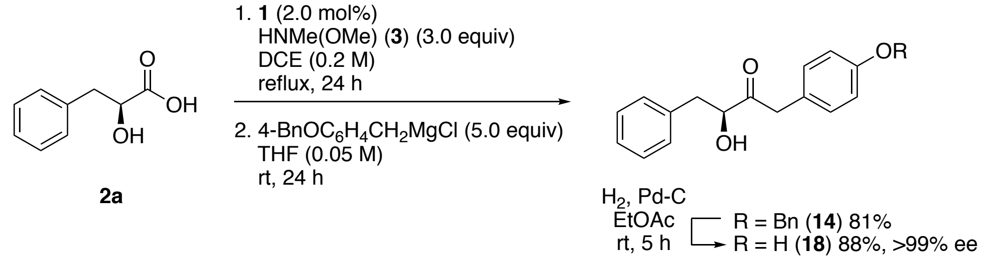


tR	面積	面積%
8.075	2741699	48.412
9.075	2921524	51.588



tR	面積	面積%
8.183	34268	1.209
9.083	2800671	98.791

soraphinol B (18)[17]

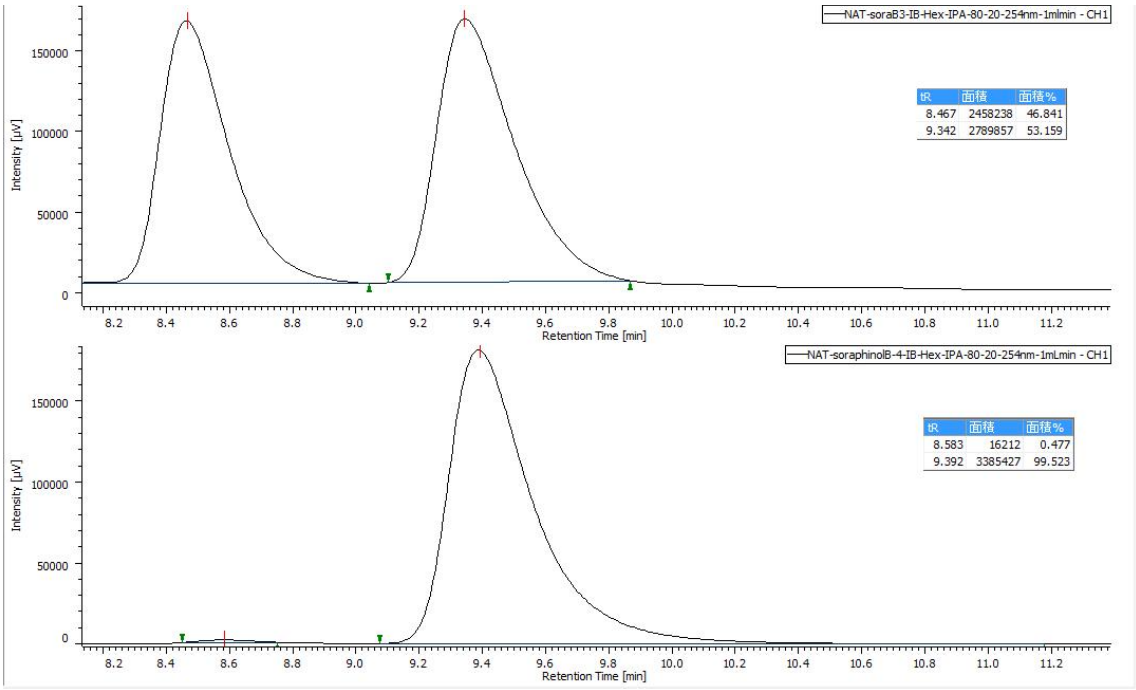


Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 2.0 mol%) was added to a DCE solution (total 0.20 M) of (*S*)-2-hydroxy-3-phenylpropanoic acid (**2a**) (16.6 mg, 0.100 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (0.5 mL, 0.60 M in DCE, 0.30 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. 4-(Benzyloxy)benzylmagnesium chloride (1.67 mL, 0.3 M in THF, 0.500 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (330 μL, total 0.05 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (2 mL) and the mixture was stirred for 30 min. The mixture was extracted with CH_2Cl_2 (10 mL×2) and washed by water (5 mL), brine (5 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (20% EtOAc in *n*-hexane) to give (*S*)-1-(4-(benzyloxy)phenyl)-3-hydroxy-4-phenylbutan-2-one (**14**) (28.1 mg, 0.081 mmol, 81%) as a white solid.

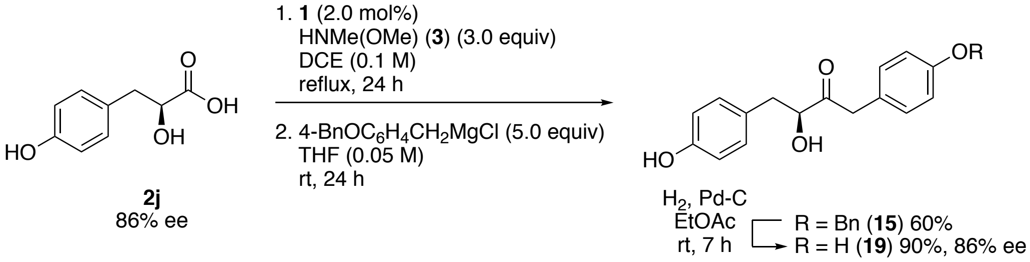
Data for **14**; white solid; $R_f = 0.46$ (*n*-hexane/EtOAc = 2:1); mp 78–81 °C; $[\alpha]_D^{24}$ +3.4° ($c = 0.5$, MeOH); IR (KBr) ν = 3422, 2905, 1695, 1515, 1382, 1249, 1094, 1013, 740, 697 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.44–7.37 (m, 4H), 7.35–7.30 (m, 3H), 7.28–7.21 (m, 3H), 7.08–7.05 (m, 2H), 6.95–6.92 (m, 2H), 5.05 (s, 2H), 4.51 (ddd, J = 7.4, 5.6, 4.8 Hz, 1H), 3.75 (d, J = 16.0 Hz, 1H), 3.69 (d, J = 16.0 Hz, 1H), 3.22 (d, J = 5.6 Hz, 1H), 3.15 (dd, J = 14.0, 4.8 Hz, 1H), 2.89 (dd, J = 14.0, 7.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.3, 158.0, 136.9, 136.4, 130.5, 129.3, 128.59, 128.57, 128.0, 127.4, 127.0, 125.2, 115.2, 76.6, 70.0, 44.8, 40.2; HRMS (ESI) m/z calcd for $C_{23}H_{22}NaO_3$ $[M+Na]^+$ 369.1467, found 369.1457.

10% Pd/C (5.6 mg, 20 wt%, wet) was added to a solution of **14** (28.1 mg, 0.081 mmol) in EtOAc (2.5 mL, 0.03 M) and the mixture was stirred at room temperature under hydrogen atmosphere (balloon). After strring for 5 h, the mixture was filtered through a pad of Celite® and the resulting filtrate was concentrated under reduced pressure to furnish the crude product, which was purified by silica gel column chromatography (20% MeOH in CH_3Cl) to give soraphinol B (**18**) (18.2 mg, 0.071 mmol, 88%, >99% ee) as a colorless oil .

Data for **18**; colorless oil; $R_f = 0.32$ (CH_2Cl_2/EtOAc = 10:1); $[\alpha]_D^{24}$ +4.2° (c = 1.0, MeOH); IR (neat) ν = 3360, 2922, 1714, 1614, 1516, 1454, 1260, 1048, 803, 750, 700 cm^{-1}; ^1H NMR (400 MHz, CD_3OD) δ 7.29–7.18 (m, 5H), 6.96–6.93 (m, 2H), 6.73–6.70 (m, 2H), 4.39 (dd, J = 8.0, 4.8 Hz, 1H), 3.73 (d, J = 16.4 Hz, 1H), 3.67 (d, J = 16.4 Hz, 1H), 3.05 (dd, J = 14.0, 4.8 Hz, 1H), 2.80 (dd, J = 14.0, 8.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 212.5, 157.4, 138.9, 131.8, 130.6, 129.3, 127.5, 126.0, 116.3, 78.4, 45.7, 41.0; HRMS (ESI) m/z calcd for $C_{16}H_{16}NaO_3$ $[M+Na]^+$ 279.0997, found 279.0991; HPLC (CHIRALPAK® IB (ϕ 0.46 cm × 25 cm), hexane/i-PrOH = 80:20, 254 nm, flow rate 1.0 mL/min) t_R = 8.6 min (minor), 9.4 min (major).



circumcin B (19)[18]

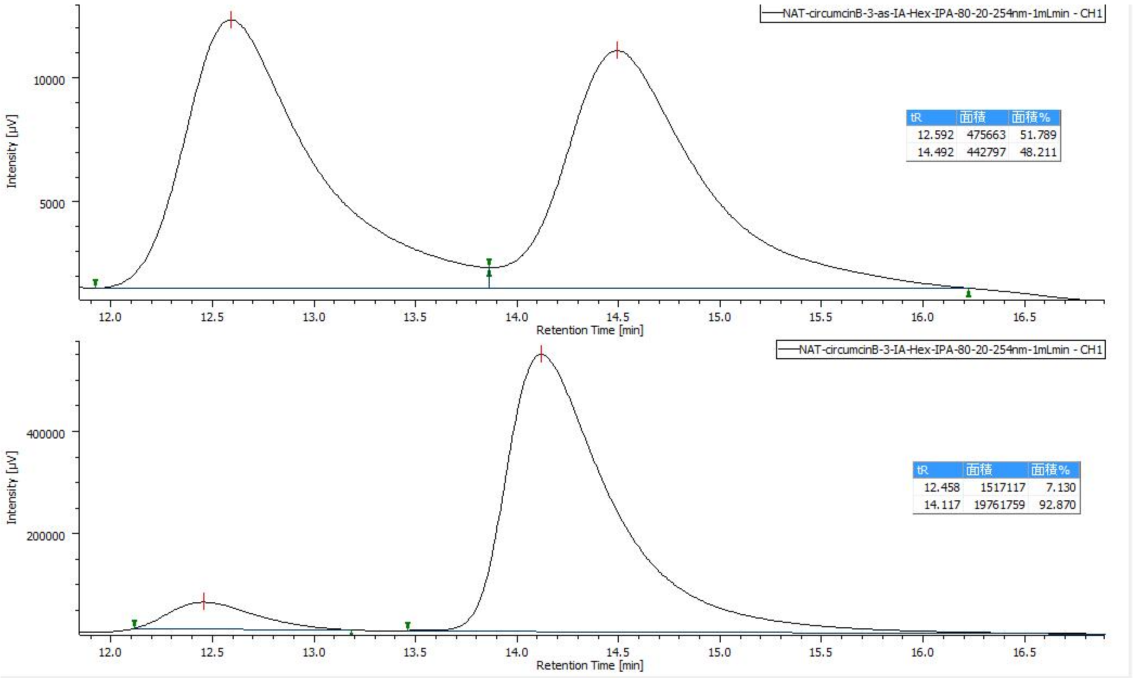


Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 2.0 mol%) was added to a DCE solution (total 0.10 M) of (*S*)-2-hydroxy-3-(4-hydroxyphenyl)propanoic acid (**2j**) (18.2 mg, 0.100 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (1.0 mL, 0.30 M in DCE, 0.30 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. 4-(Benzyloxy)benzylmagnesium chloride (1.67 mL, 0.3 M in THF, 0.500 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (330 μL, total 0.05 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (2 mL) and the mixture was stirred for 30 min. The mixture was extracted with CH_2Cl_2 (10 mL×2) and washed by water (5 mL), brine (5 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (10% EtOAc in CH_2Cl_2) to give (*S*)-1-(4-(benzyloxy)phenyl)-3-hydroxy-4-(4-hydroxyphenyl)butan-2-one (**15**) (21.7 mg, 0.060 mmol, 60%) as a white solid.

Data for **15**; white solid; R_f = 0.27 (CH_2Cl_2/EtOAc = 10:1); mp 142–152 °C; $[\alpha]_D^{24}$ +5.7° (*c* = 0.5, MeOH); IR (KBr) ν = 3450, 1712, 1638, 1515, 1388, 1255, 1100, 790, 741, 467 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.43–7.32 (m, 5H), 7.08–7.06 (m, 4H), 6.94–6.92 (m, 2H), 6.77–6.75 (m, 2H), 5.05 (s, 2H), 4.79 (s, 1H), 4.46 (ddd, *J* = 7.2, 5.6, 4.8 Hz, 1H), 3.74 (d, *J* = 16.0 Hz, 1H), 3.68 (d, *J* = 16.0 Hz, 1H), 3.21 (d, *J* = 5.6 Hz, 1H), 3.07 (dd, *J* = 14.0, 4.8 Hz, 1H), 2.83 (dd, *J* = 14.0, 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.4, 158.1, 154.6, 136.9, 130.53, 130.50, 128.6, 128.4, 128.0, 127.4, 125.2, 115.5, 115.2, 77.2, 70.0, 44.9, 39.3; HRMS (ESI) m/z calcd for $C_{23}H_{22}NaO_4$ $[M+Na]^+$ 385.1416, found 385.1405.

10% Pd/C (4.3 mg, 20 wt%, wet) was added to a solution of **15** (21.7 mg, 0.060 mmol) in EtOAc (2.5 mL, 0.02 M) and the mixture was stirred at room temperature under hydrogen atmosphere (balloon). After strring for 7 h, the mixture was filtered through a pad of Celite® and the resulting filtrate was concentrated under reduced pressure to furnish the crude product, which was purified by silica gel column chromatography (30% MeOH in CH_3Cl) to give circumcin B (**19**) (14.8 mg, 0.054 mmol, 90%, 86% ee) as a colorless oil .

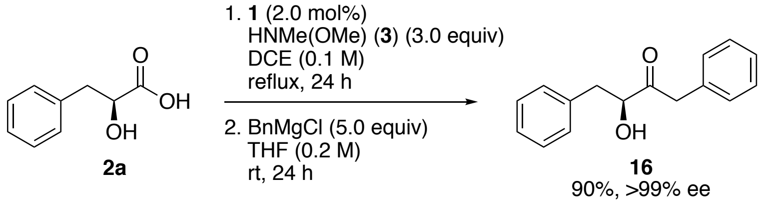
Data for **19**; amorphous; R_f = 0.23 (CH_3Cl/MeOH = 10:1); $[\alpha]_D^{23}$ +1.1° (*c* = 0.5, MeOH); IR (neat) ν = 3356, 2922, 1718, 1599, 1515, 1448, 1233, 834 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.05–7.00 (m, 2H), 6.95–6.92 (m, 2H), 6.72–6.69 (m, 4H), 4.34 (dd, *J* = 7.6, 4.8 Hz, 1H), 3.69 (d, *J* = 16.4 Hz, 1H), 3.64 (d, *J* = 16.4 Hz, 1H), 2.95 (dd, *J* = 14.0, 4.8 Hz, 1H), 2.74 (dd, *J* = 14.0, 7.6 Hz, 1H); ^{13}C NMR (100 MHz, MeOH) δ 212.7, 157.4, 157.2, 131.8, 131.5, 129.4, 126.1, 116.3, 116.1, 78.6, 45.9, 40.3; HRMS (ESI) m/z calcd for $C_{16}H_{16}NaO_4$ $[M+Na]^+$ 295.0946, found 295.0960; HPLC (CHIRALPAK® IA (ϕ 0.46 cm × 25 cm), hexane/*i*-PrOH = 80:20, 254 nm, flow rate 1.0 mL/min) t_R = 12.5 min (minor), 14.1 min (major).



tR	面積	面積%
12.592	475663	51.789
14.492	442797	48.211

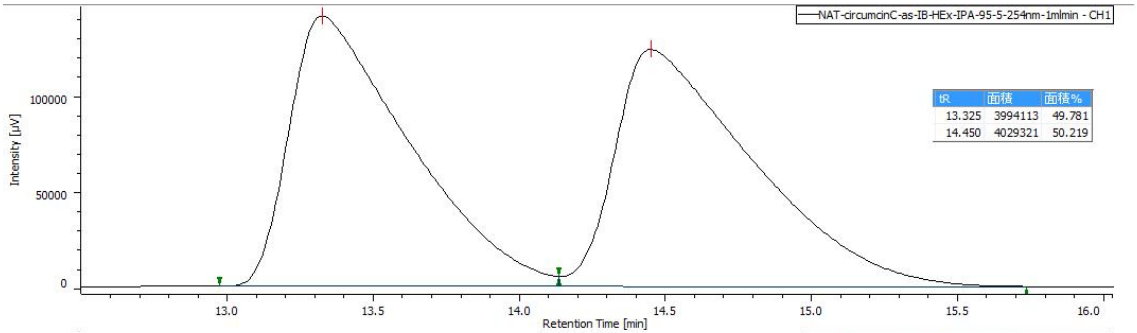
tR	面積	面積%
12.458	1517117	7.130
14.117	19761759	92.870

circumcin C (16)[18]



Diboronic acid anhydride **1** (1.1 mg, 2.00 μmol, 2.0 mol%) was added to a DCE solution (total 0.20 M) of (*S*)-2-hydroxy-3-phenylpropanoic acid (**2a**) (16.6 mg, 0.100 mmol, 1.0 equiv) and *N*,*O*-dimethylhydroxylamine (**3**) (0.5 mL, 0.60 M in DCE, 0.30 mmol, 3.0 equiv) at room temperature. After stirring for 24 h under reflux (bath temp, 90 °C), the reaction mixture was cooled to room temperature. Concentration under reduced pressure furnished the crude product, which was subjected to the next step without further purification. Benzylmagnesium chloride (250 μL, 2.0 M in THF, 0.500 mmol, 5.0 equiv) was added dropwise to a solution of the crude mixture in THF (250 μL, total 0.2 M) at rt. After stirring for 24 h, the reaction was quenched with 1M HCl (2 mL) and the mixture was stirred for 30 min. The mixture was extracted with CH_2Cl_2 (10 mL×2) and washed by water (5 mL), brine (5 mL) and dried over Na_2SO_4. Filtration and concentration under reduced pressure furnished the crude product, which was purified by silica gel column chromatography (20% EtOAc in *n*-hexane) to give circumcin C (**16**) (21.7 mg, 0.090 mmol, 90%, >99% ee) as a colorless oil.

Data for **16**; colorless oil; $R_f = 0.31$ (*n*-hexane/EtOAc = 4:1); $[\alpha]_D^{24}$ +61.2° (c = 1.0, $CHCl_3$); IR (neat) ν = 3437, 3029, 2929, 1715, 1603, 1496, 1454, 1331, 1049, 737, 699 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.35–7.27 (m, 6H), 7.24–7.21 (m, 2H), 7.17–7.15 (m, 2H), 4.51 (ddd, J = 7.2, 5.6, 4.8 Hz, 1H), 3.81 (d, J = 16.0 Hz, 1H), 3.75 (d, J = 16.0 Hz, 1H), 3.20 (d, J = 5.6 Hz, 1H), 3.16 (dd, J = 14.0, 4.8 Hz, 1H), 2.90 (dd, J = 14.0, 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.0, 136.4, 132.9, 129.5, 129.3, 128.8, 128.6, 127.3, 127.0, 76.7, 45.7, 40.2; HRMS (ESI) m/z calcd for $C_{16}H_{16}NaO_2$ $[M+Na]^+$ 263.1048, found 263.1037; HPLC (CHIRALPAK® IB (ϕ 0.46 cm × 25 cm), hexane/*i*-PrOH = 95:5, 254 nm, flow rate 1.0 mL/min) t_R = 13.6 min (minor), 14.2 min (major).



tR	面積	面積%
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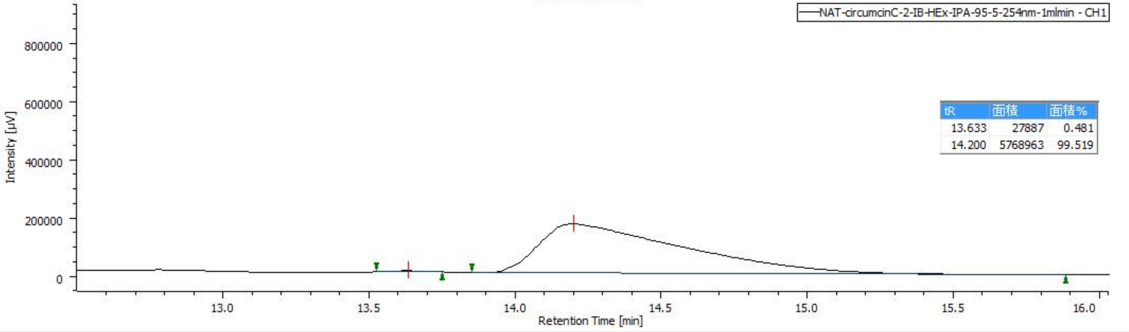
14.450	4029321	50.219



tR	面積	面積%
13.633	27887	0.481
14.200	5768963	99.519

12. References

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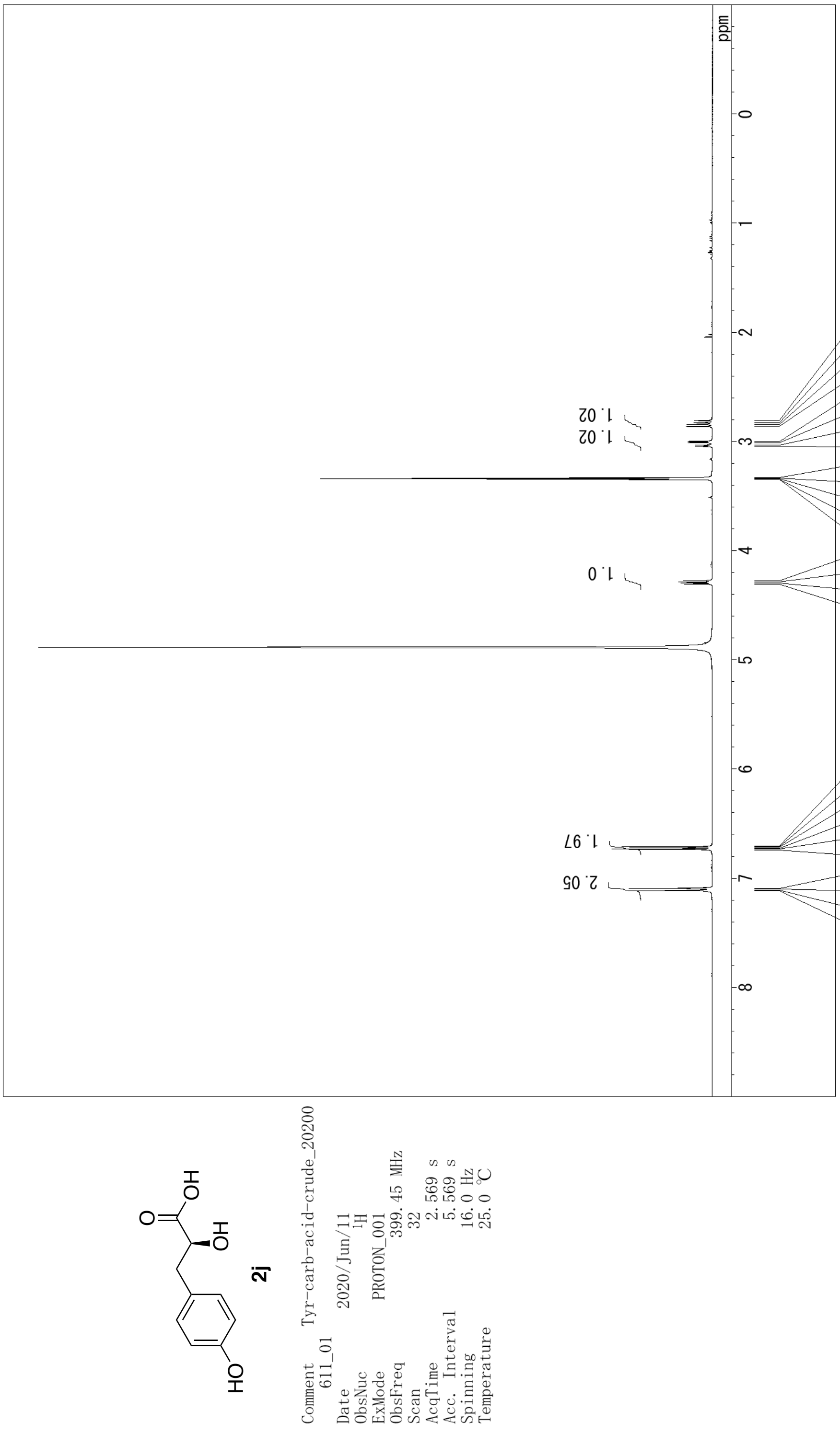
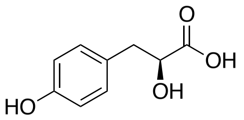
13. ^{1}H, ^{13}C and ^{19}F NMR spectra



2j



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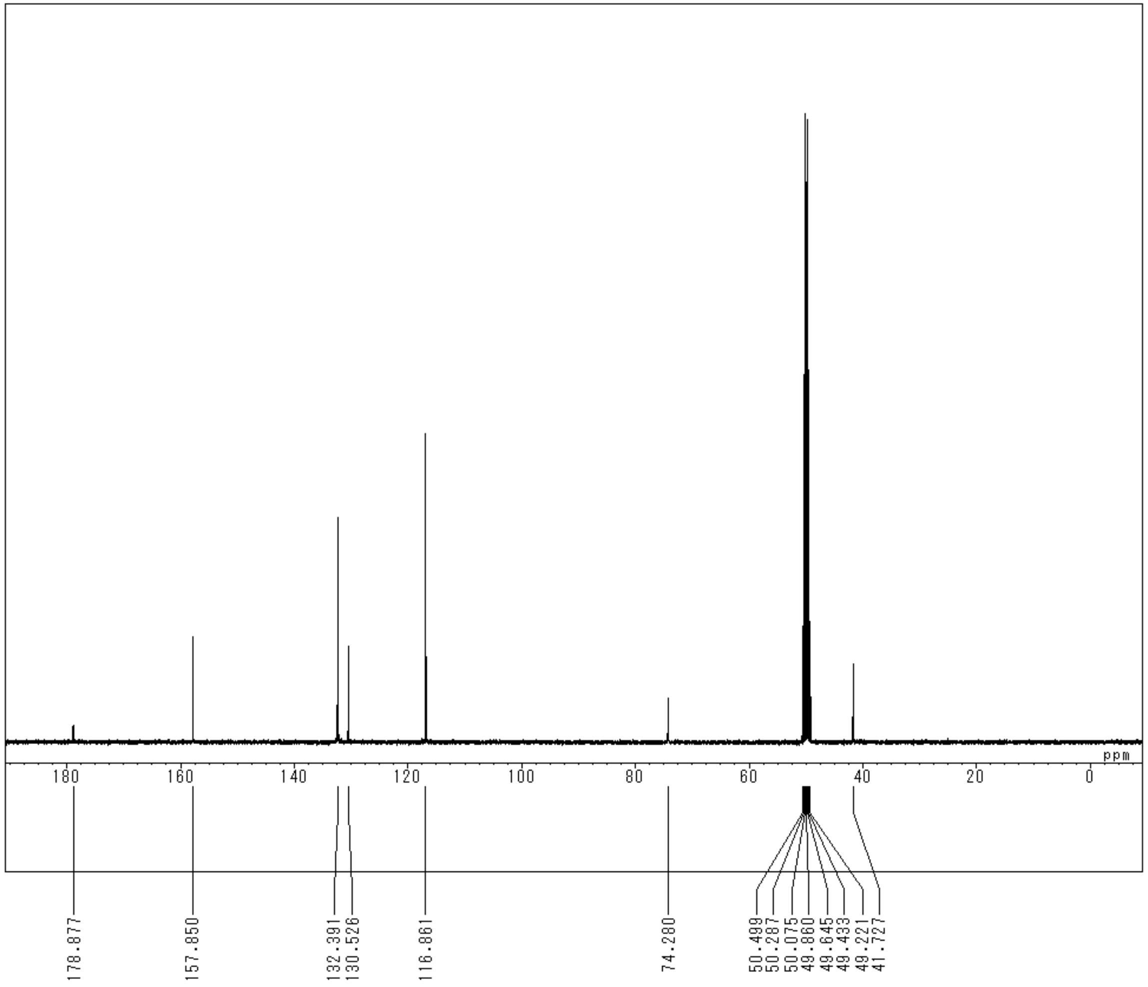

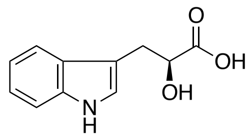

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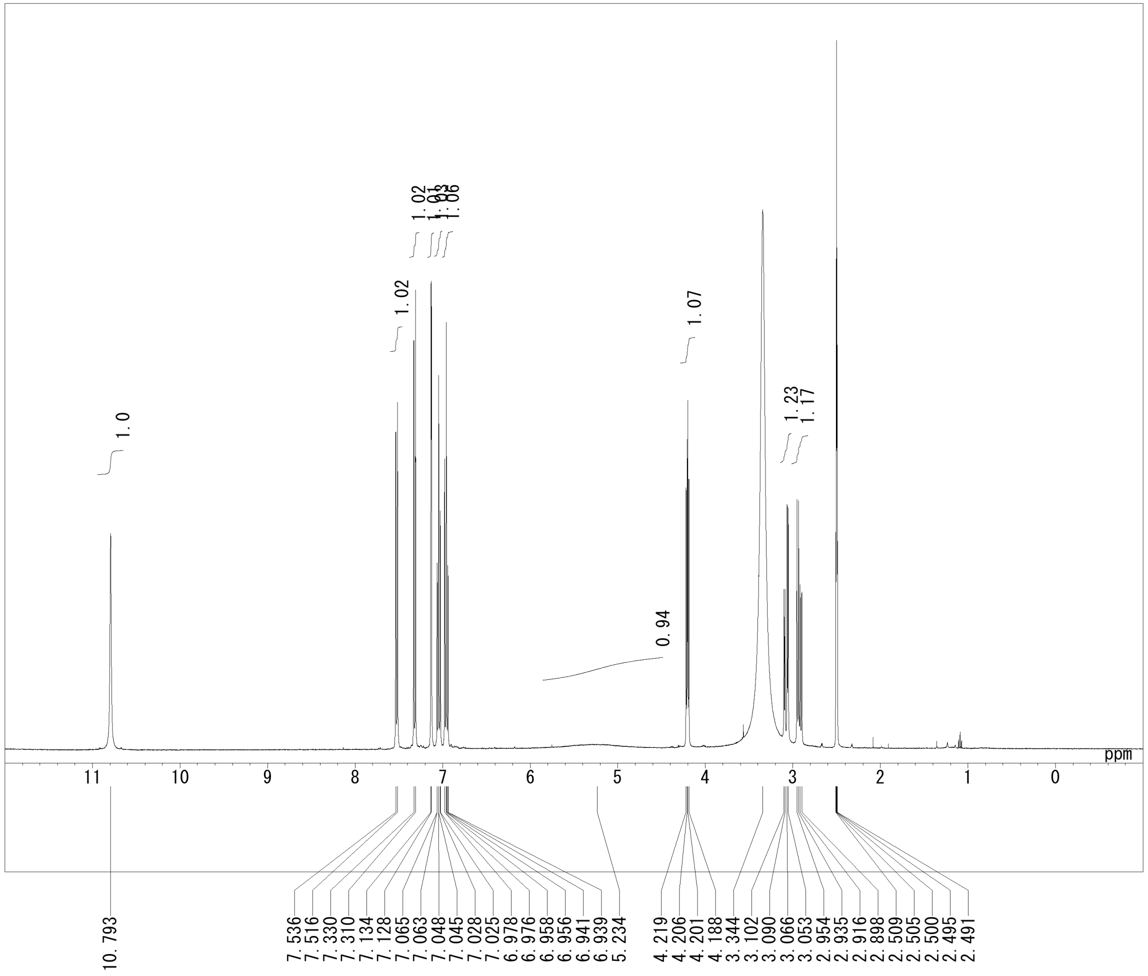

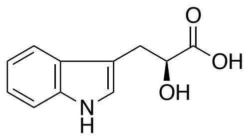

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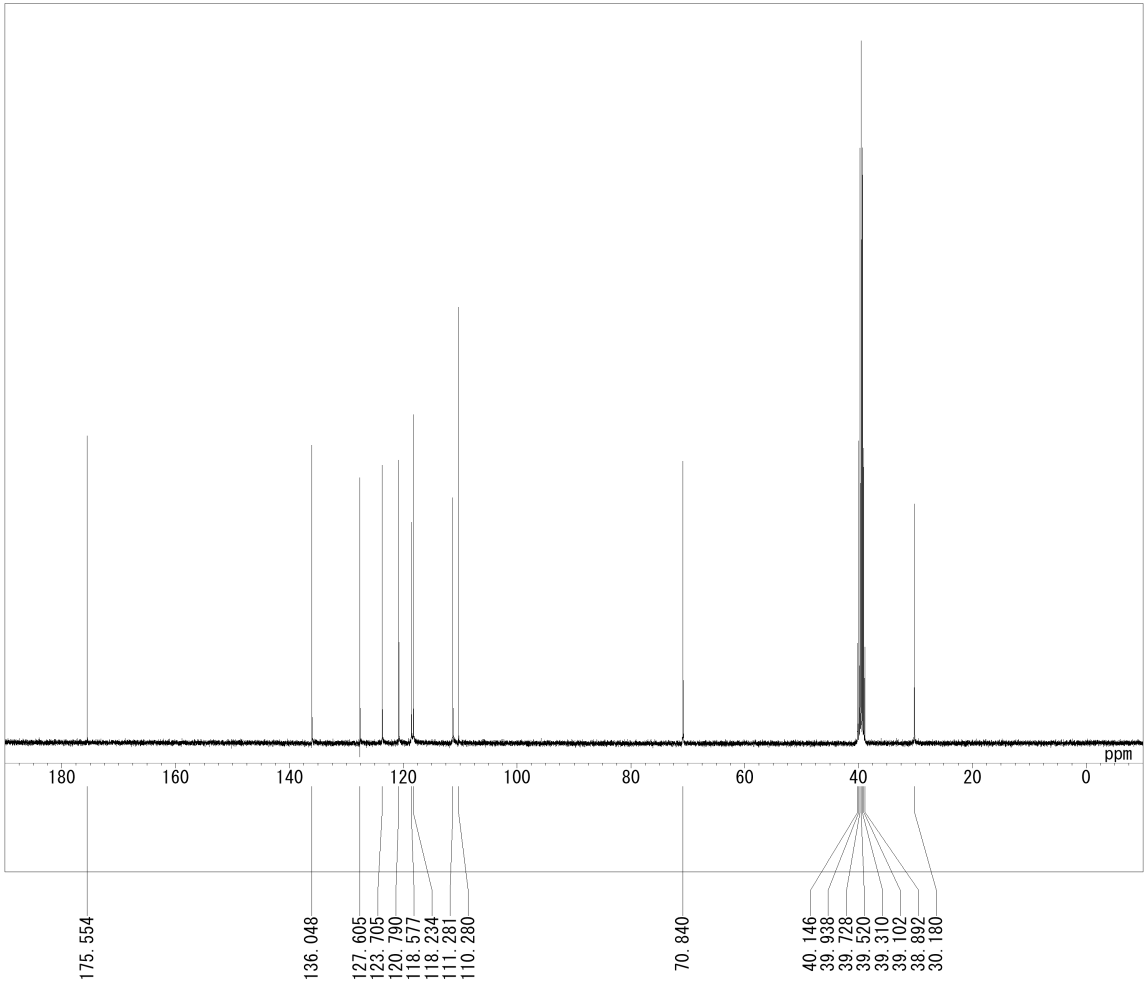

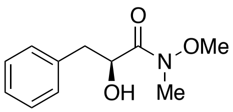

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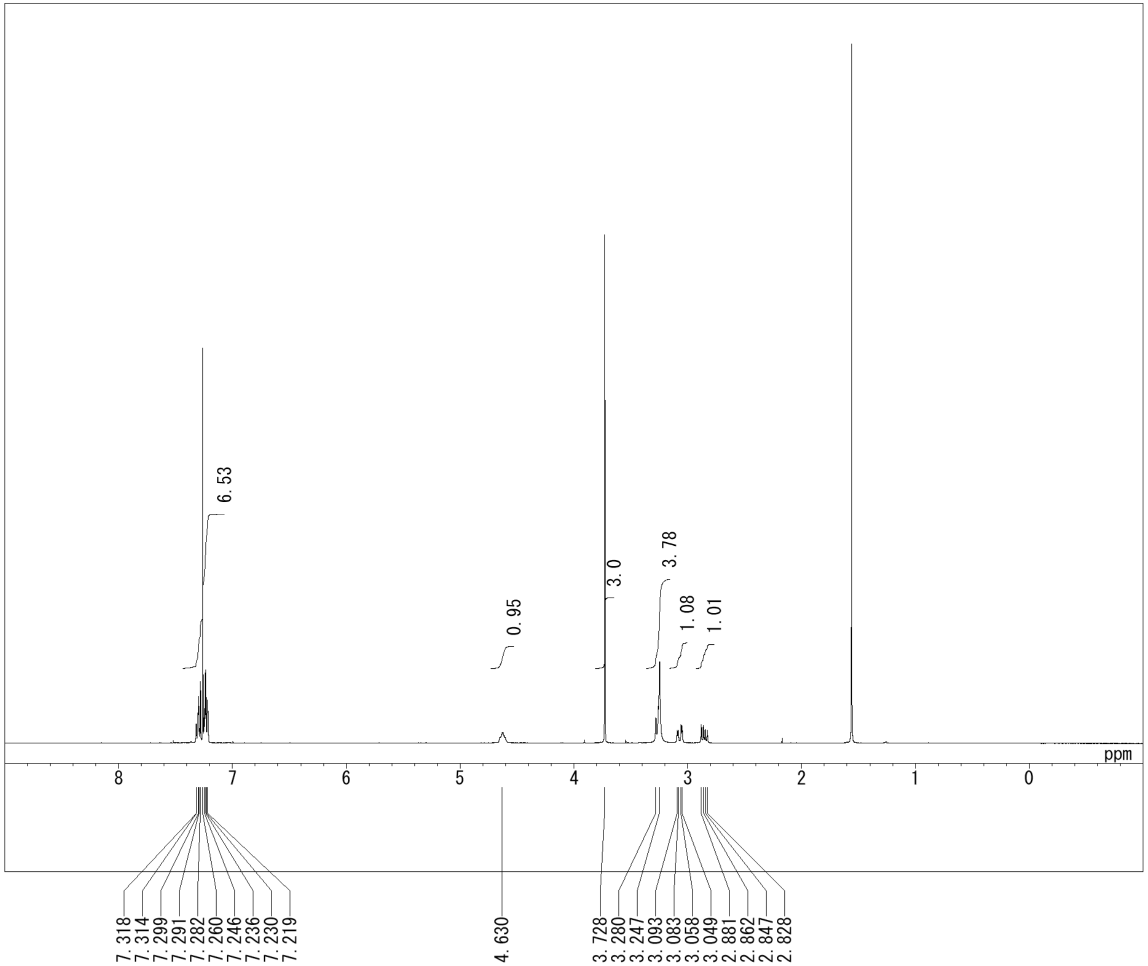

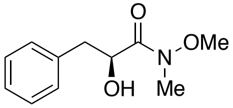

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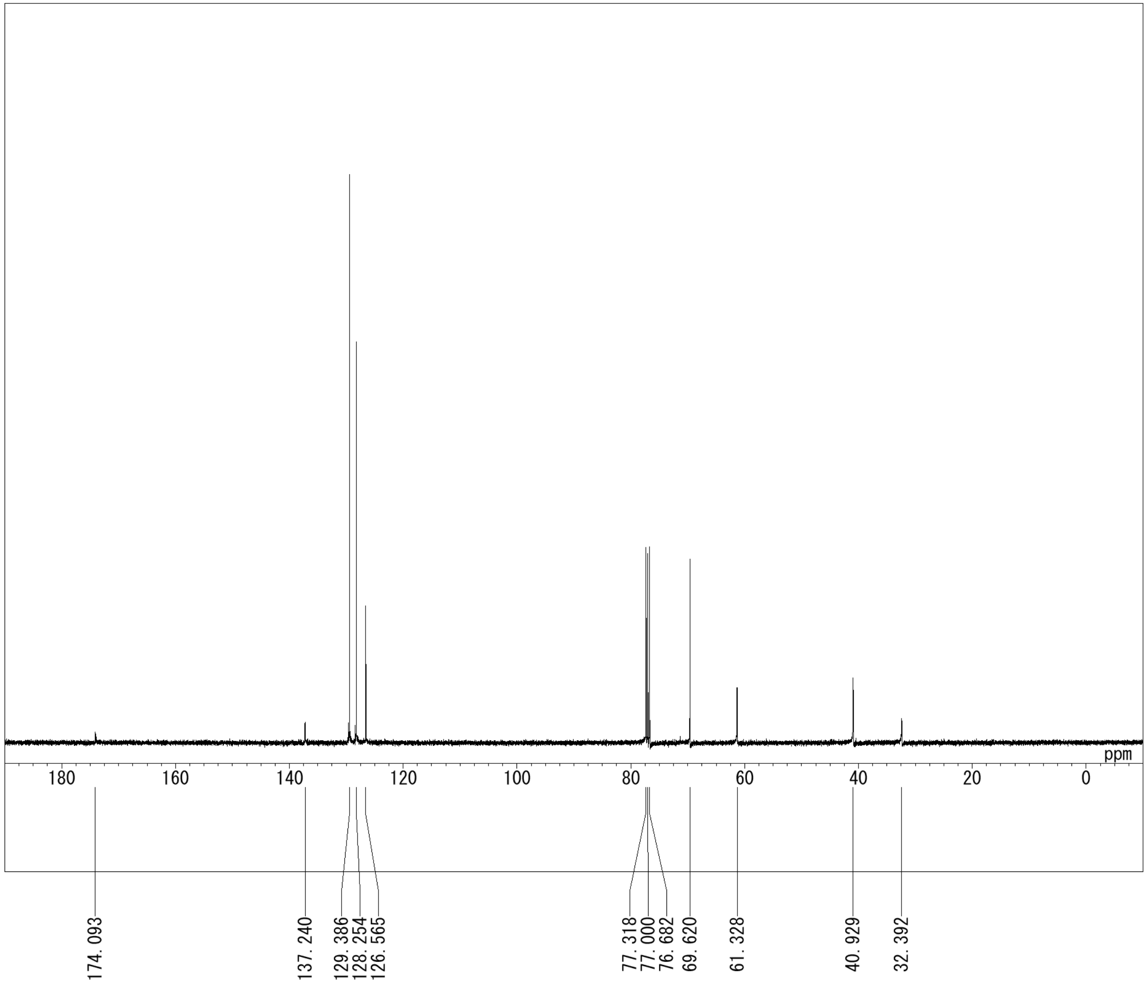

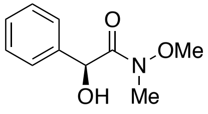

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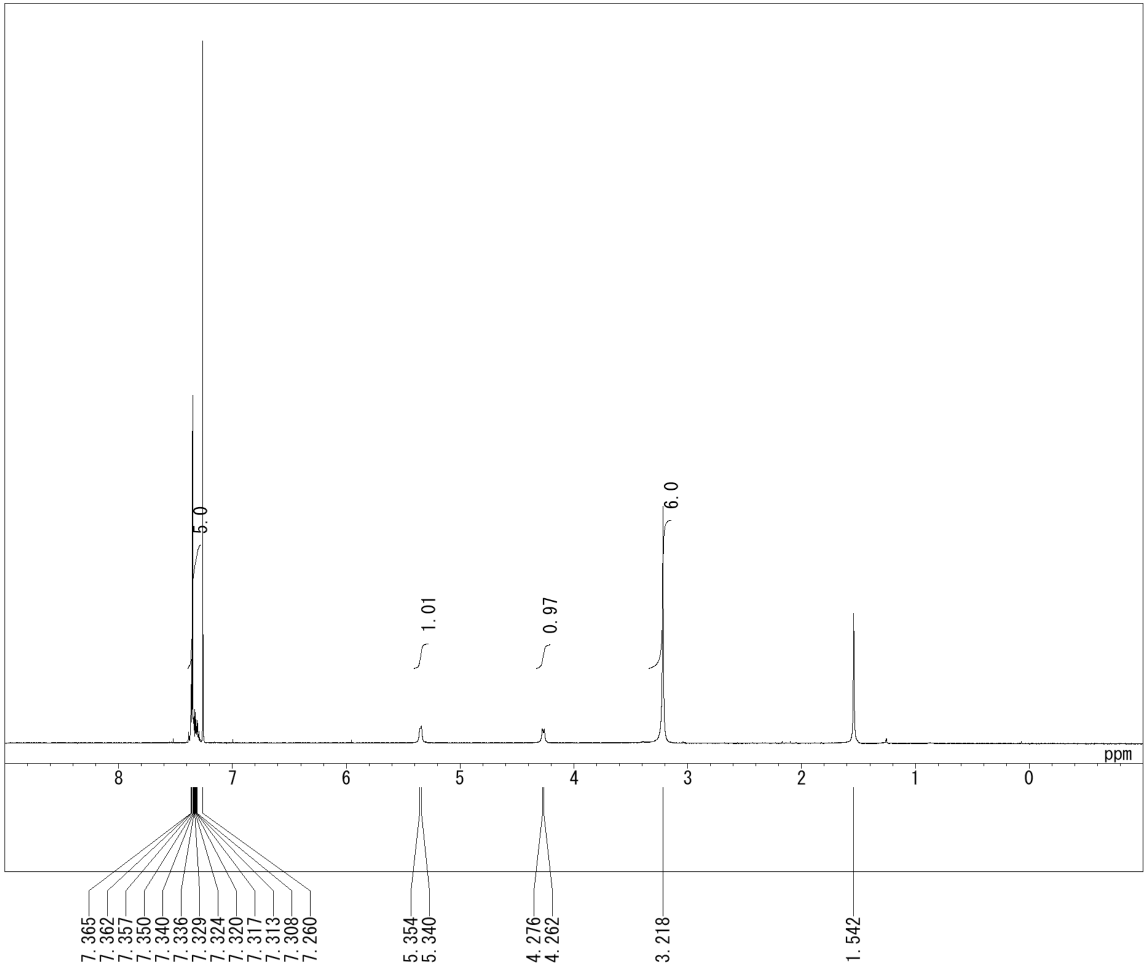

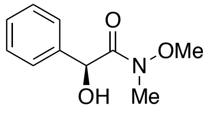

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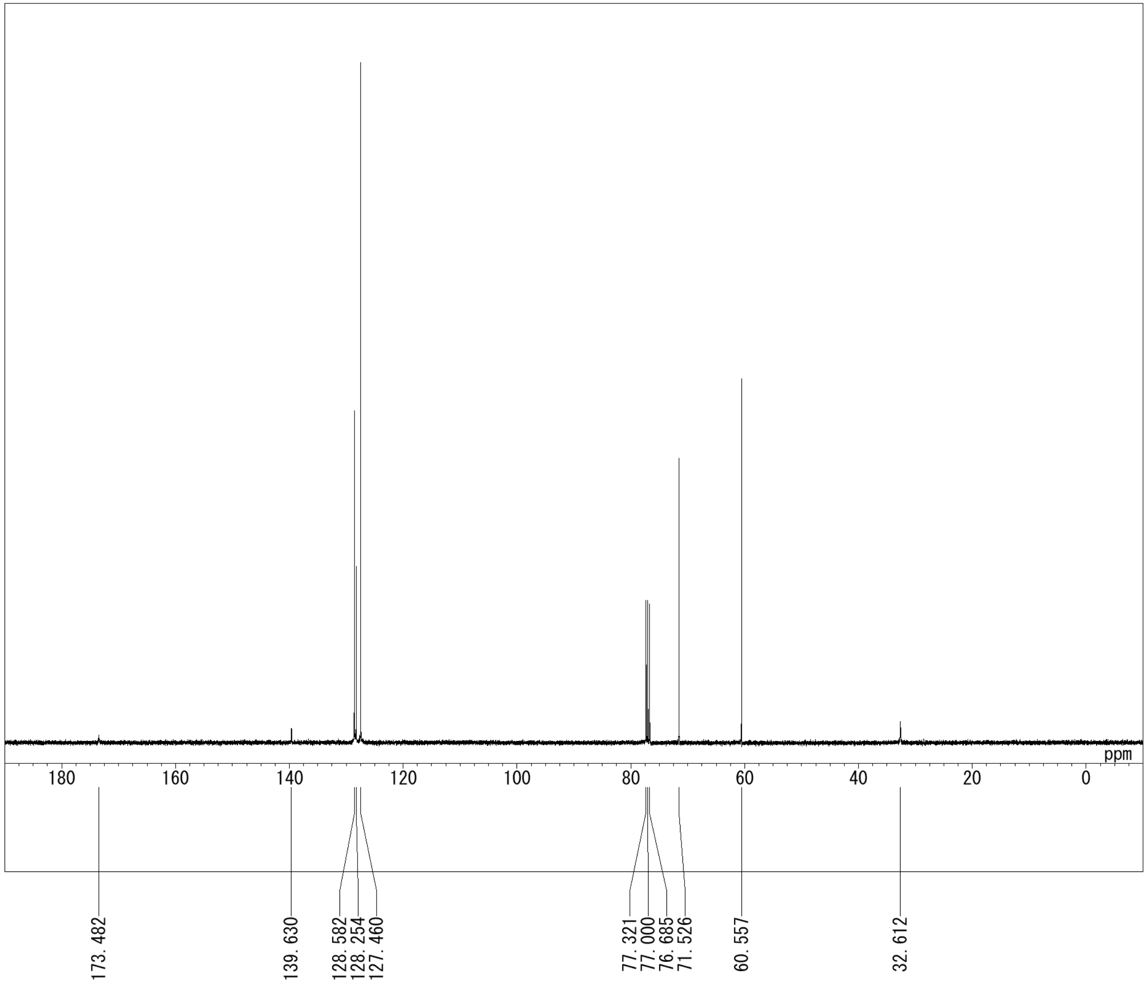

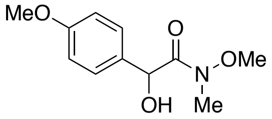

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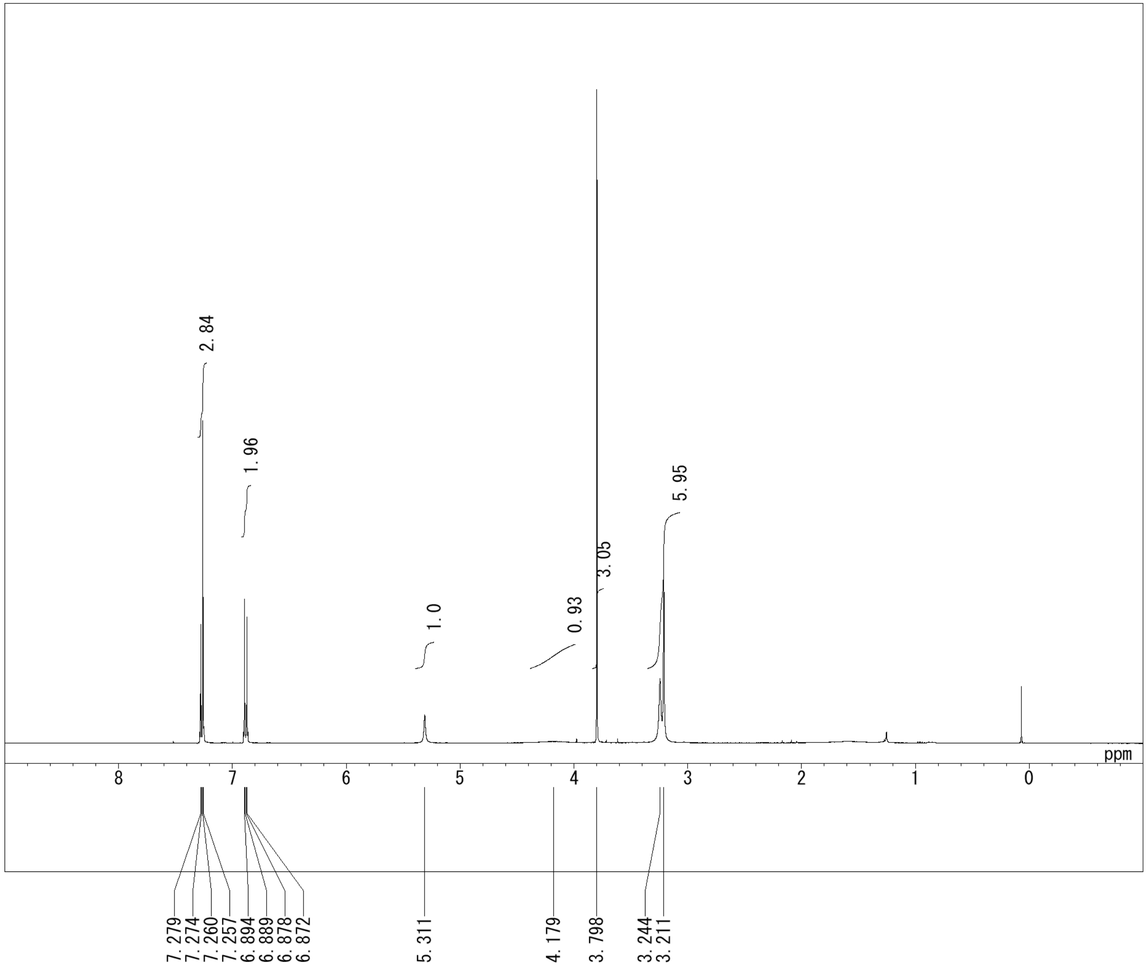

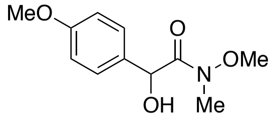

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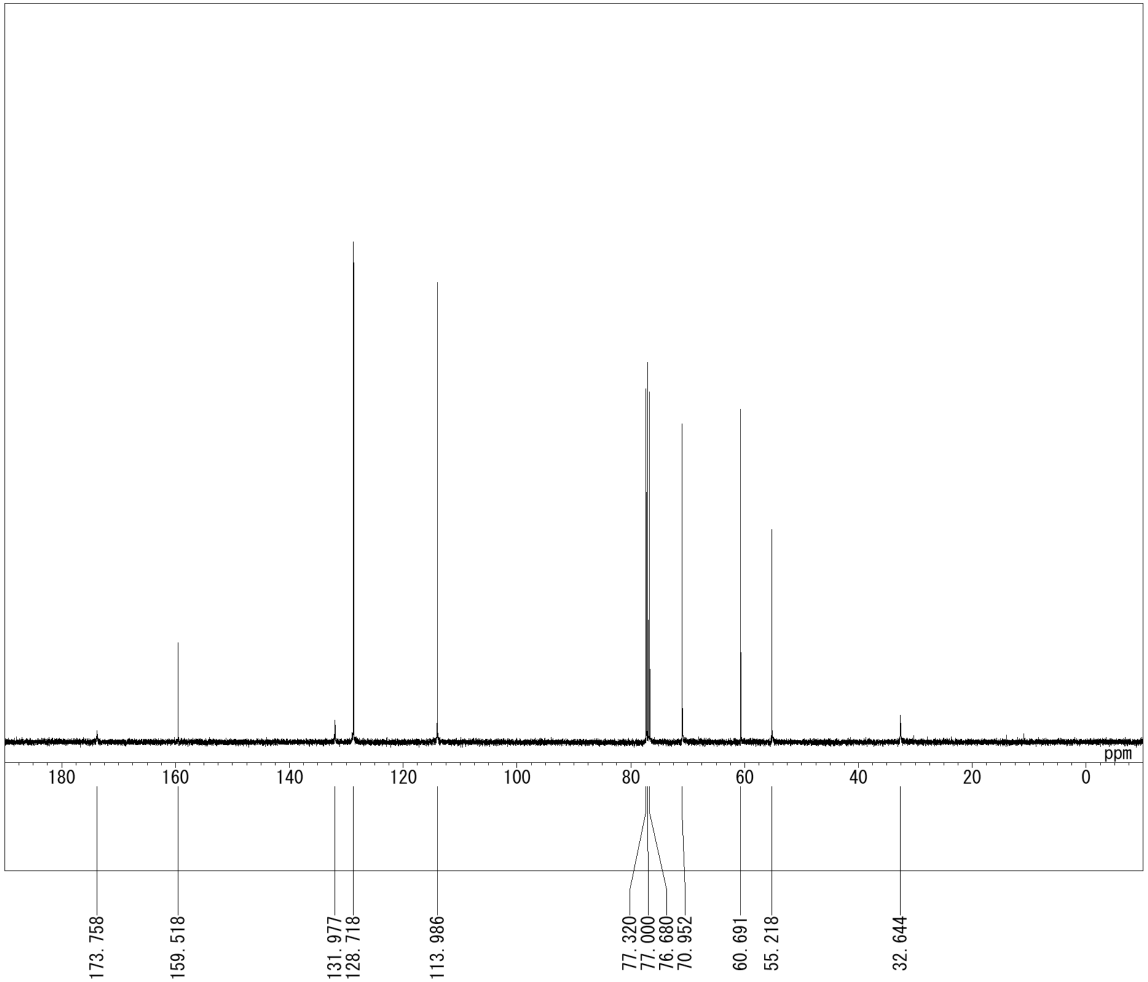

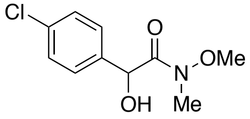

4d

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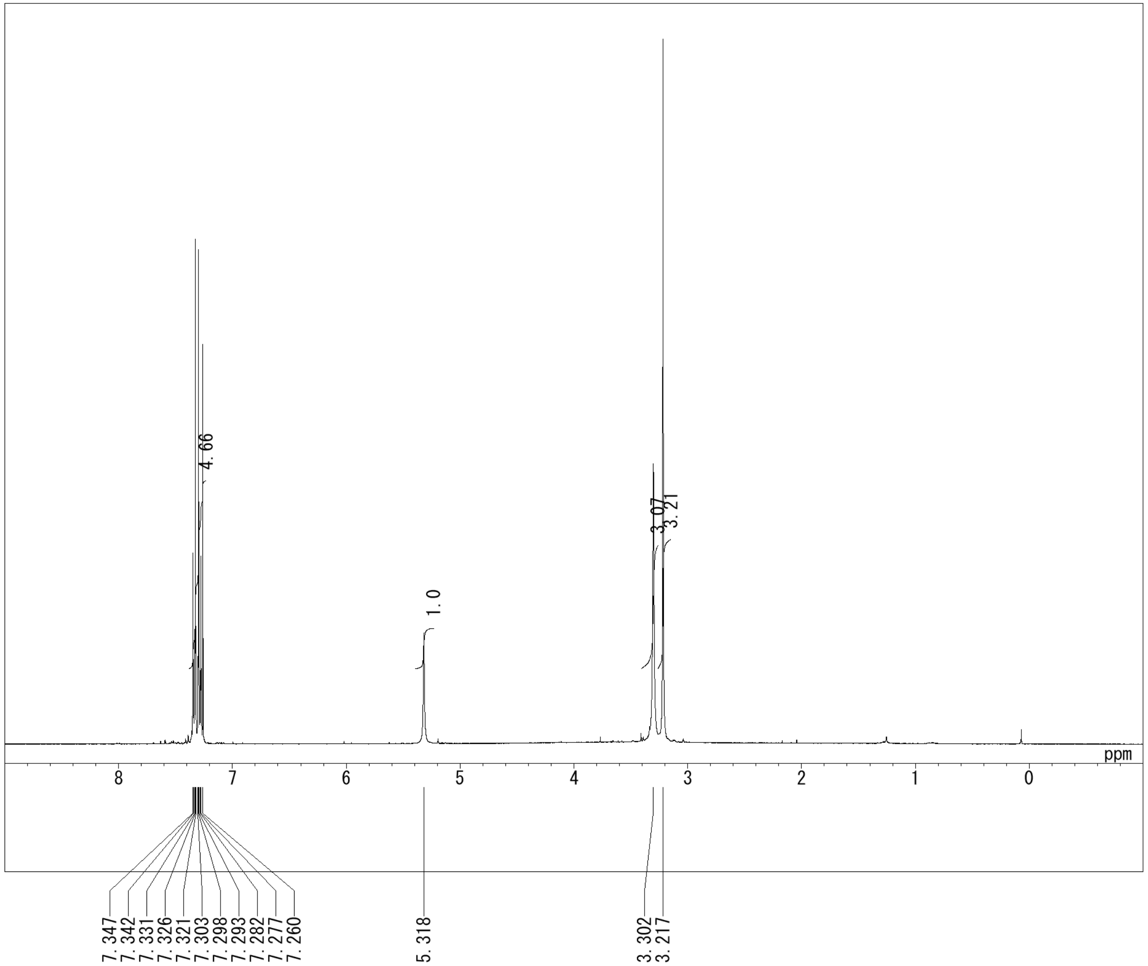

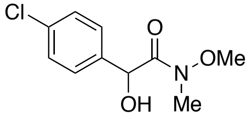

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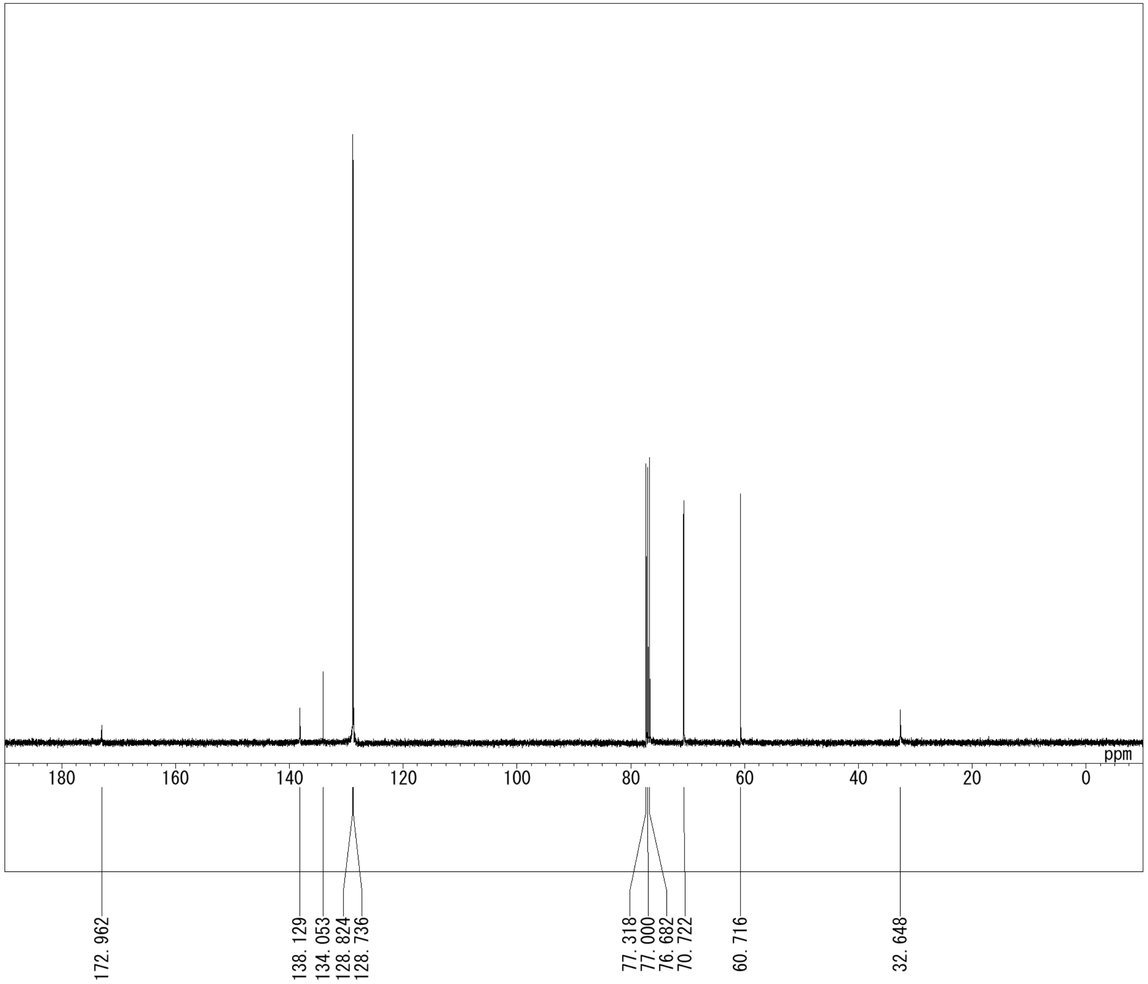

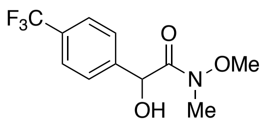

4e

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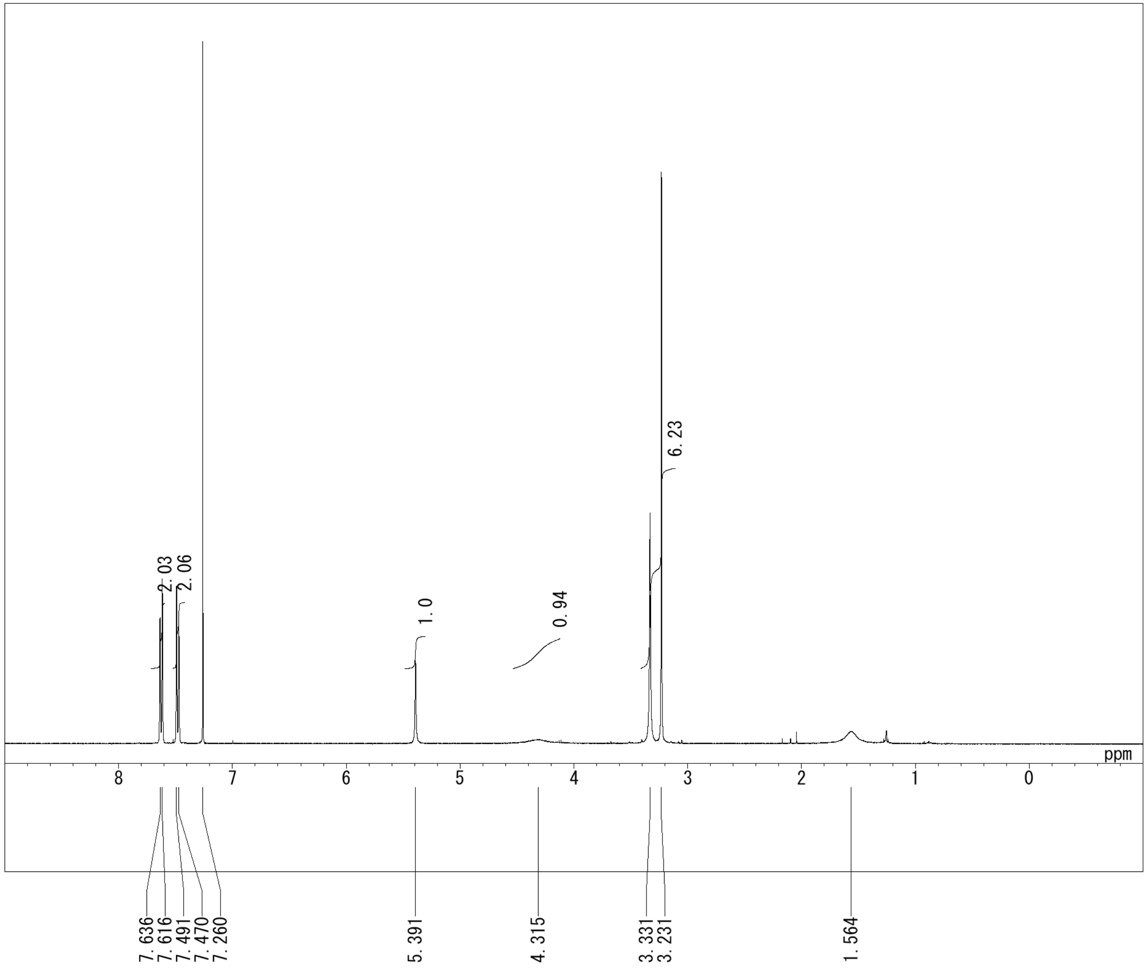

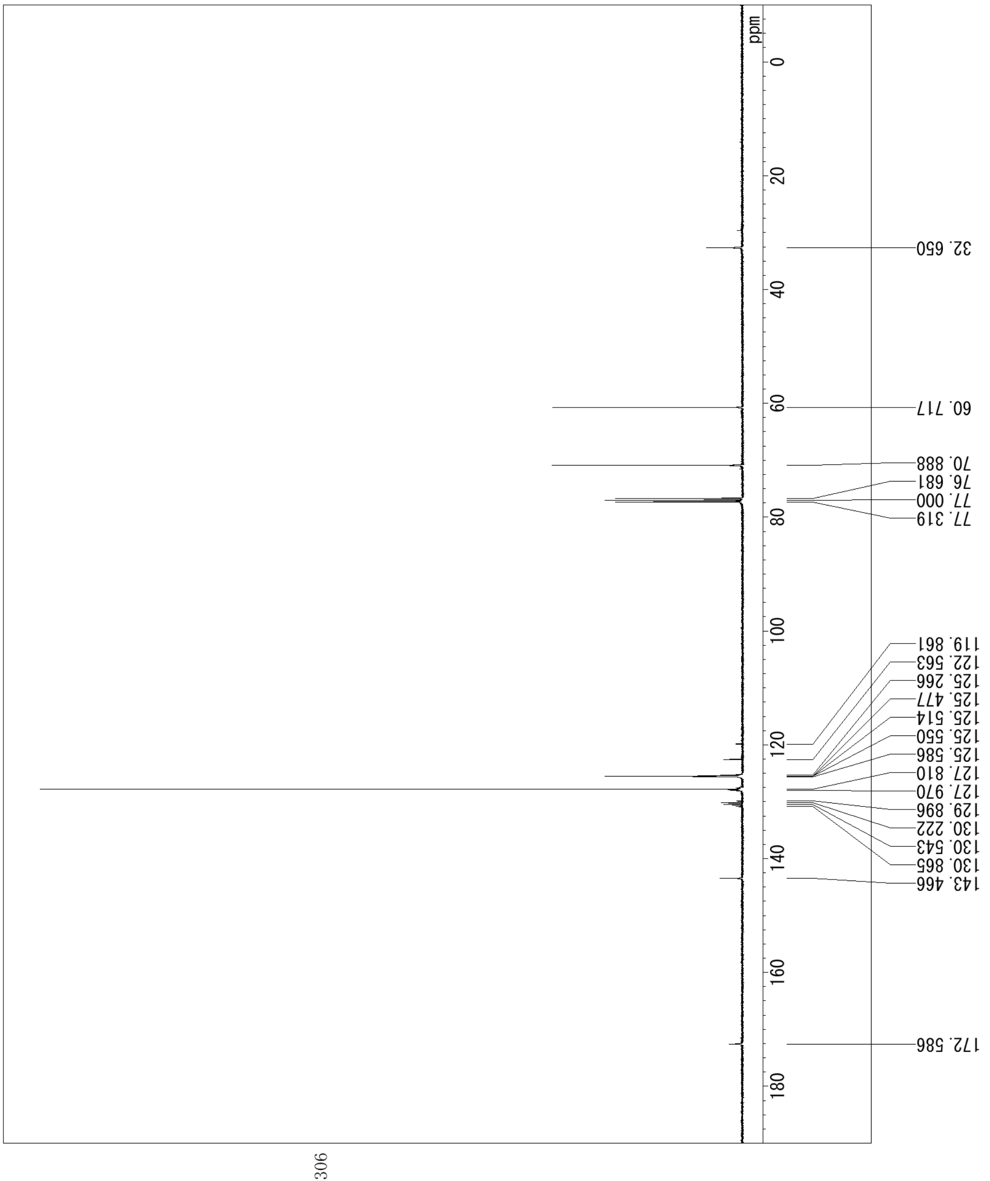

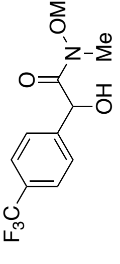

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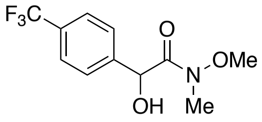
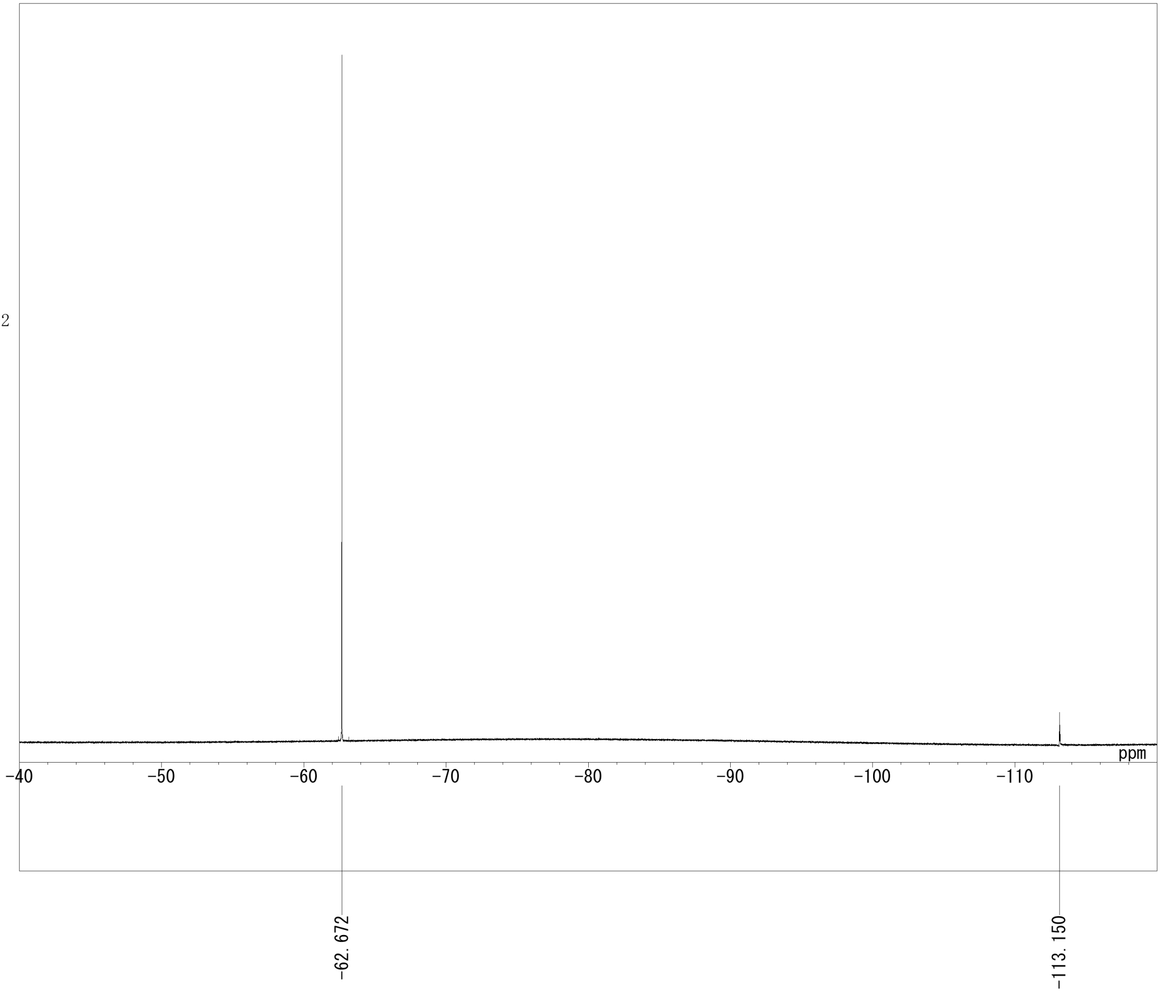
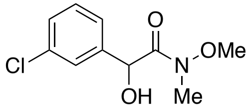
Spinning 20.0 Hz
Temperature 40.0 °C



4e

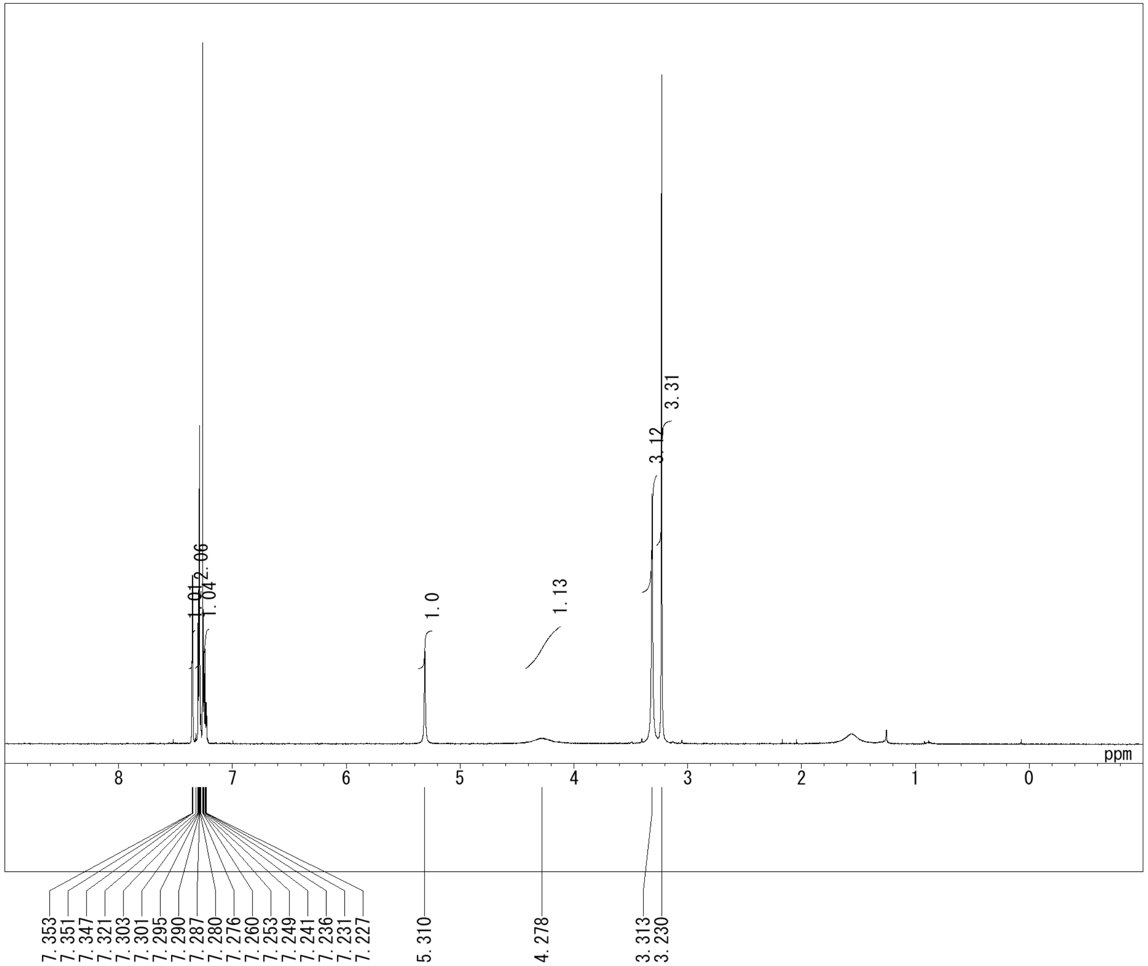
Comment NAT-a-hydroxy-CF3-19F_20200908_01
Date 2020/Sep/08
ObsNuc ^{19}F
ExMode FLUORINE_001
ObsFreq 376.58 MHz
Scan 16
AcqTime 0.8913 s
Acc. Interval 1.8913 s
Spinning 20.0 Hz
Temperature 40.0 ℃

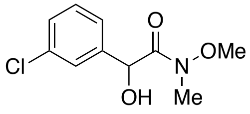




4f

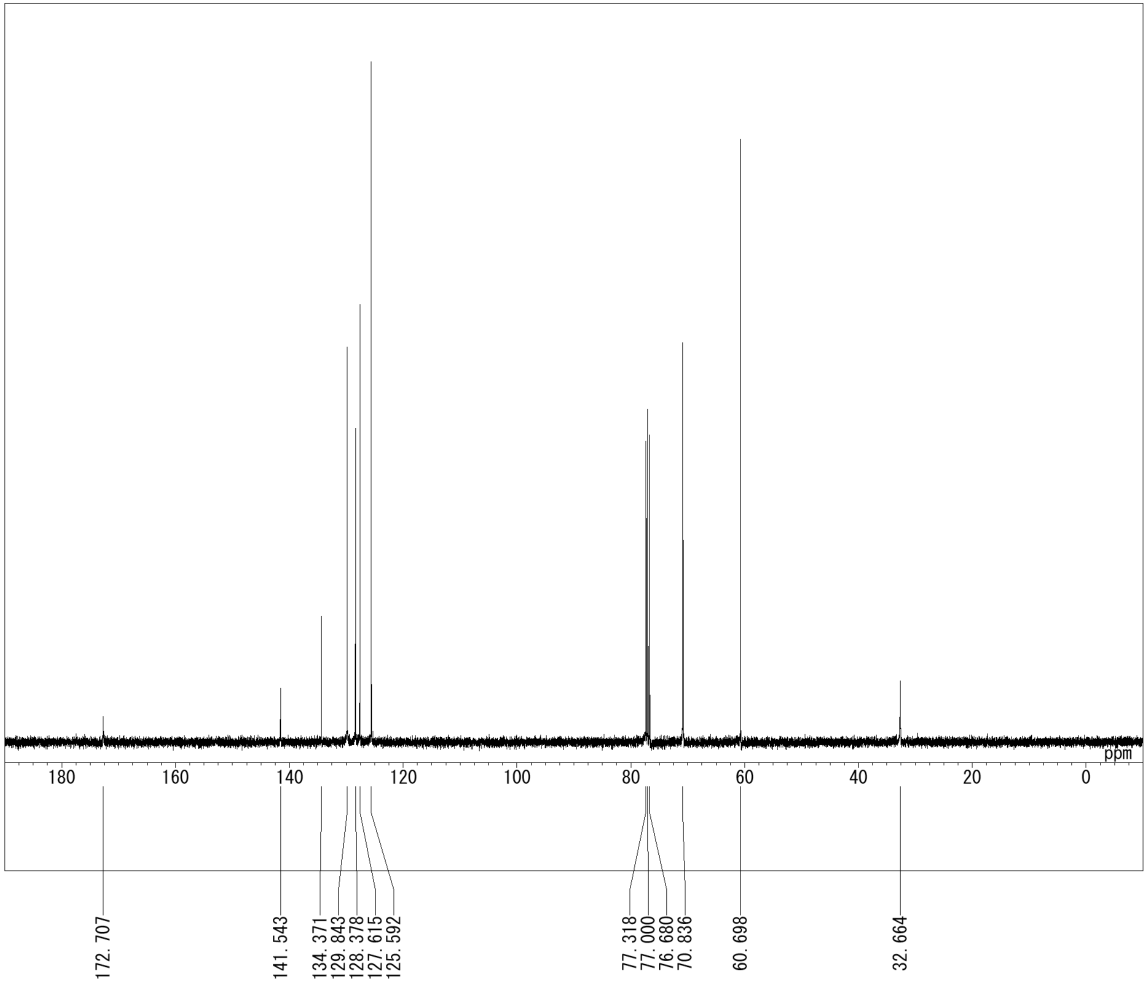
```
Comment    NAT-09-016-pure_20200113_
    01
Date          2020/Jan/13
ObsNuc                 1H
ExMode         PROTON_001
ObsFreq            399.45 MHz
Scan                16
AcqTime              2.569 s
Acc. Interval        5.569 s
Spinning            16.0 Hz
Temperature         25.0 ℃
```

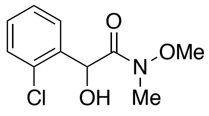




4f

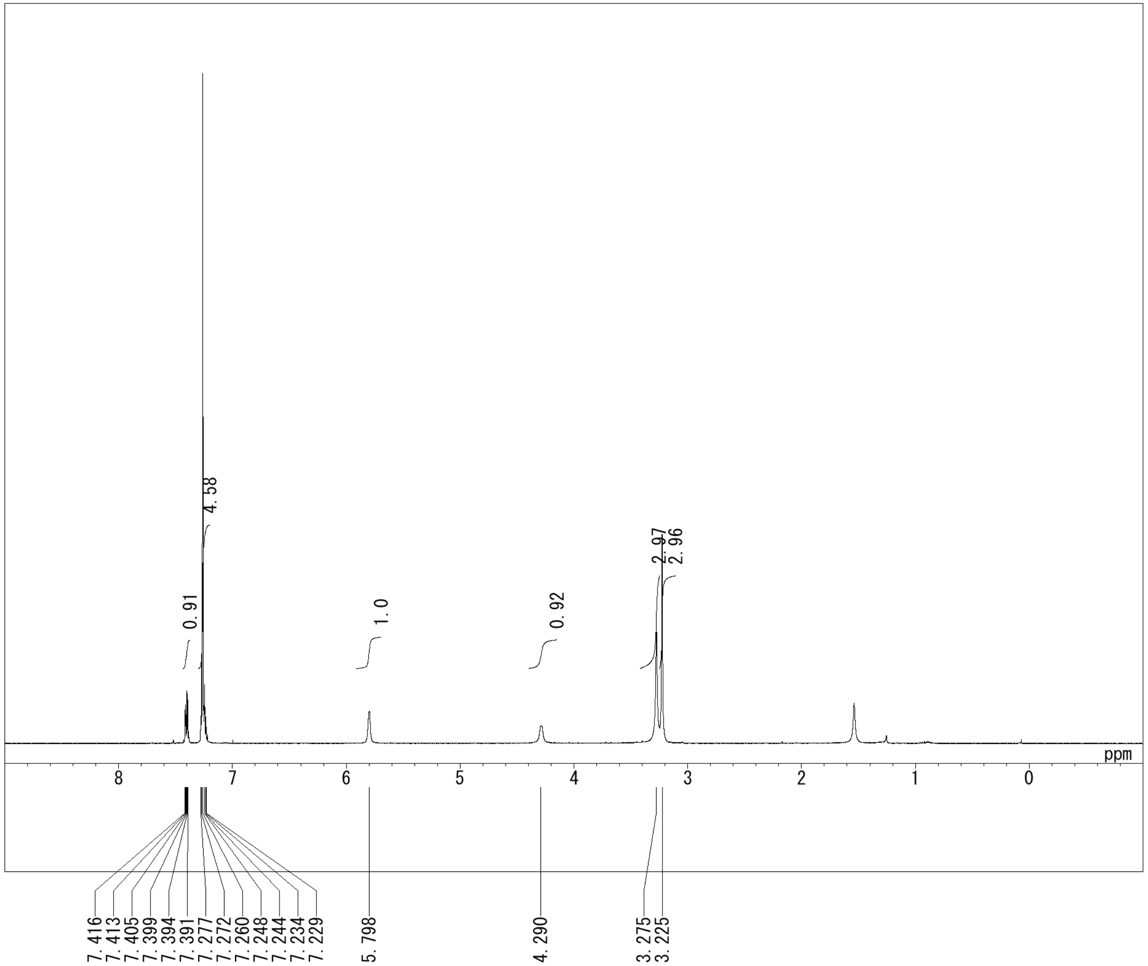
```
Comment    NAT-09-016-13C_20200308_0
    1
Date            2020/Mar/08
ObsNuc               13C
ExMode          CARBON_001
ObsFreq              100.45 MHz
Scan                 256
AcqTime                1.3631 s
Acc. Interval          3.3631 s
Spinning              20.0 Hz
Temperature           25.0 ℃
```

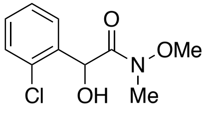




4g

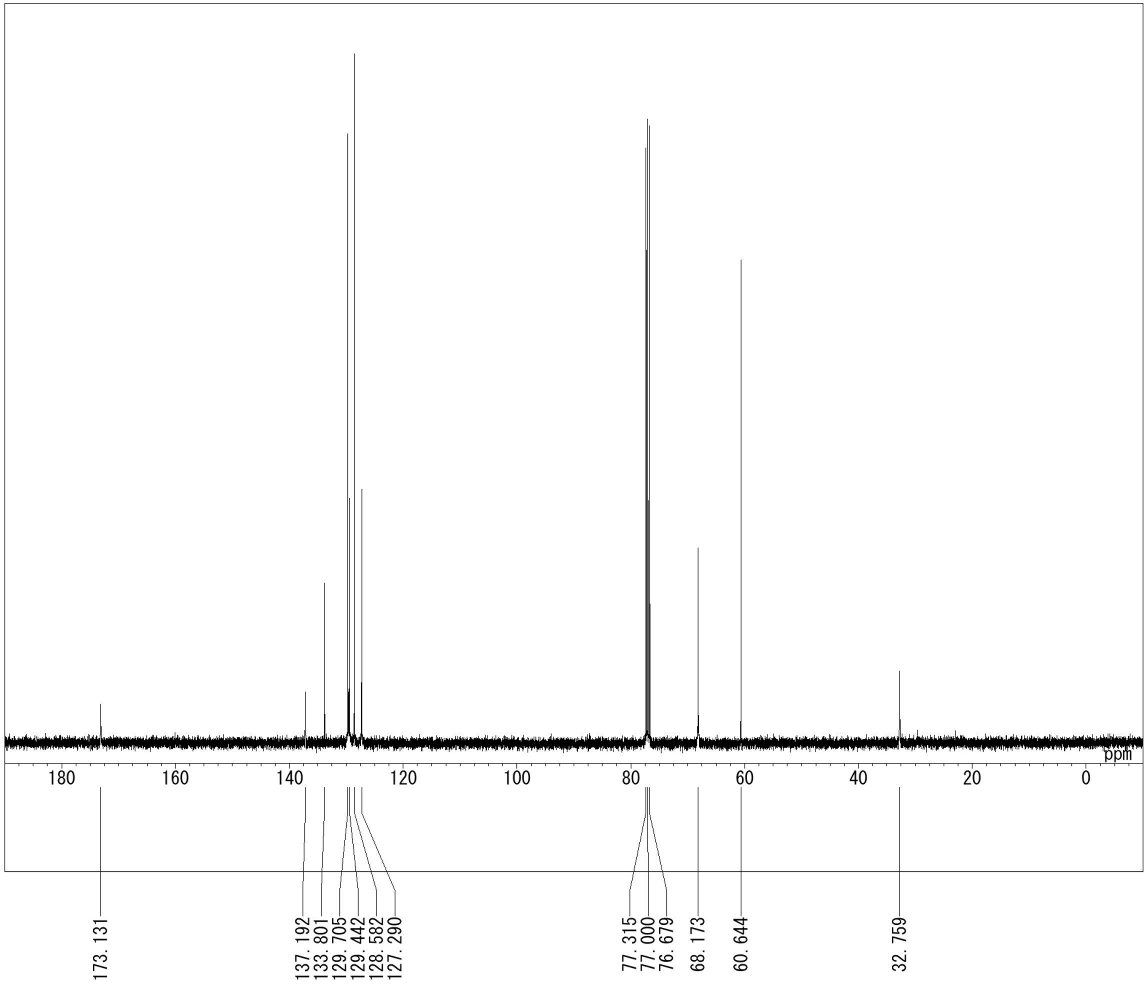
Comment	NAT-07-064-1H_20200115_01
Date	2020/Jan/15
ObsNuc	^{1}H
ExMode	PROTON_001
ObsFreq	400.27 MHz
Scan	16
AcqTime	2.5559 s
Acc. Interval	5.5559 s
Spinning	16.0 Hz
Temperature	40.0 ℃
Solvent	cdcl$_3$

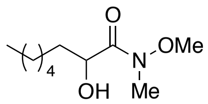




4g

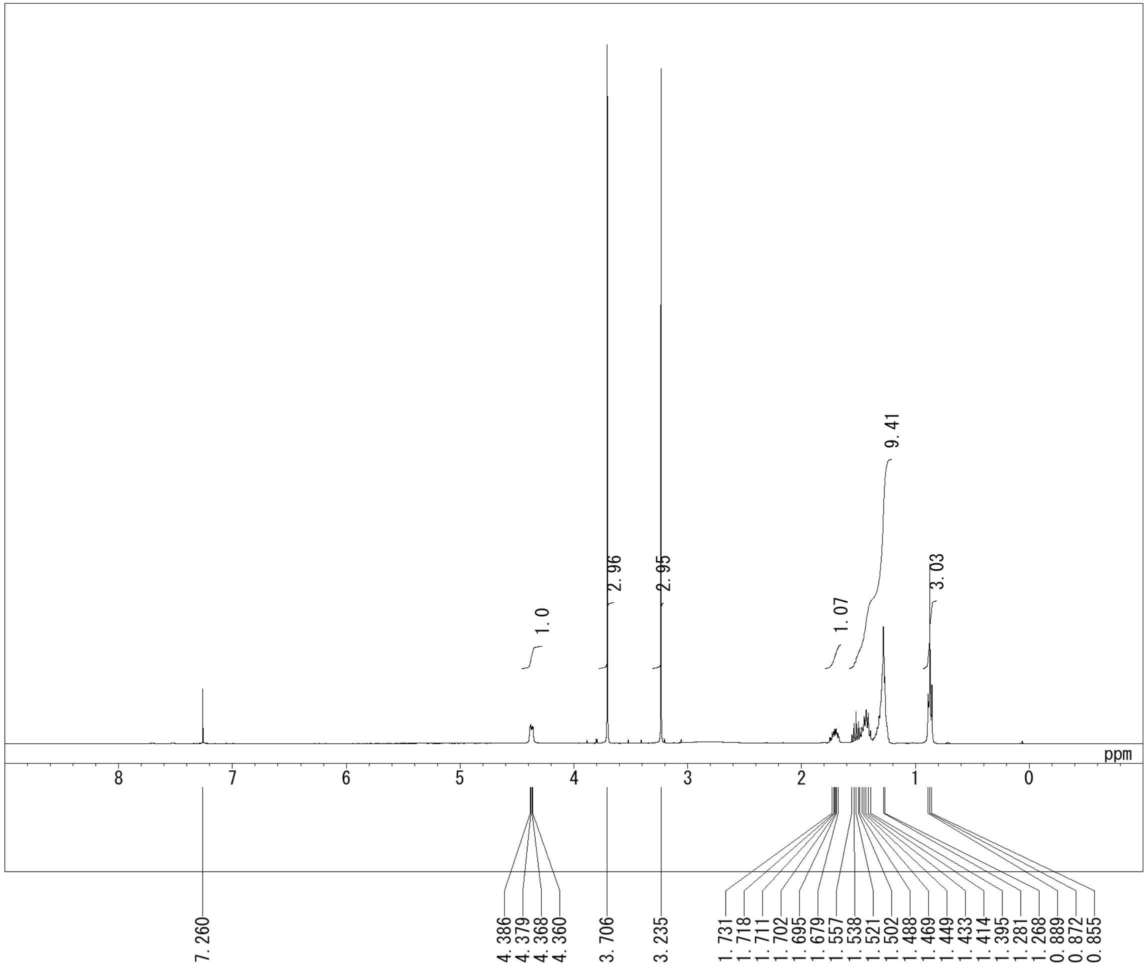
```
Comment    NAT-07-064-13C_20200227_0
    1
Date             2020/Feb/27
ObsNuc                  13C
ExMode          CARBON_001
ObsFreq               100.66 MHz
Scan                  256
AcqTime                  1.3631 s
Acc. Interval            3.3631 s
Spinning                20.0 Hz
Temperature             40.0 ℃
```

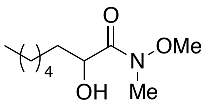




4h

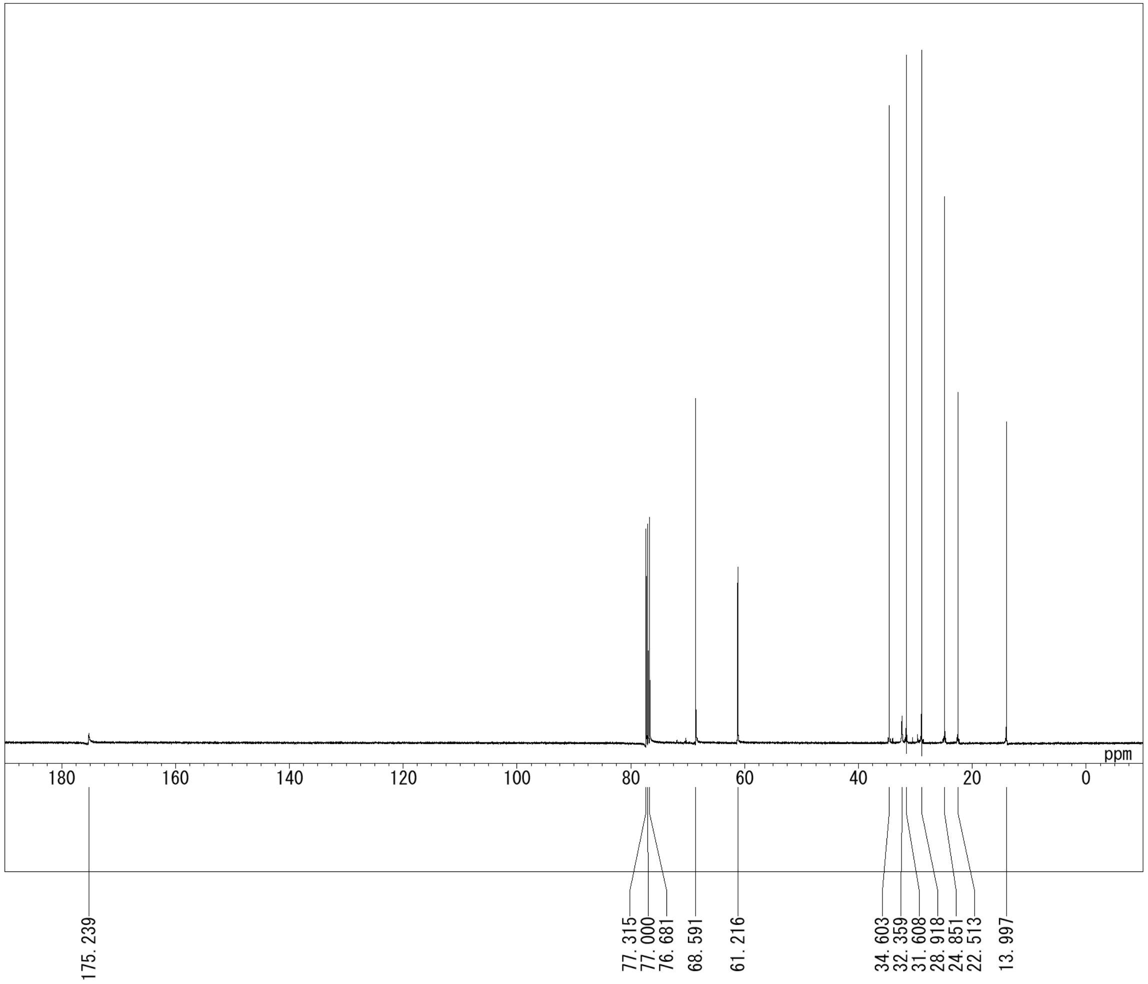
Comment   NAT-09-017-pure-3_20200304_01
Date   2020/Mar/04
ObsNuc ^{1}H
ExMode   PROTON_001
ObsFreq   399.45 MHz
Scan   16
AcqTime   2.569 s
Acc. Interval   5.569 s
Spinning   16.0 Hz
Temperature   25.0 ℃

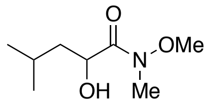




4h

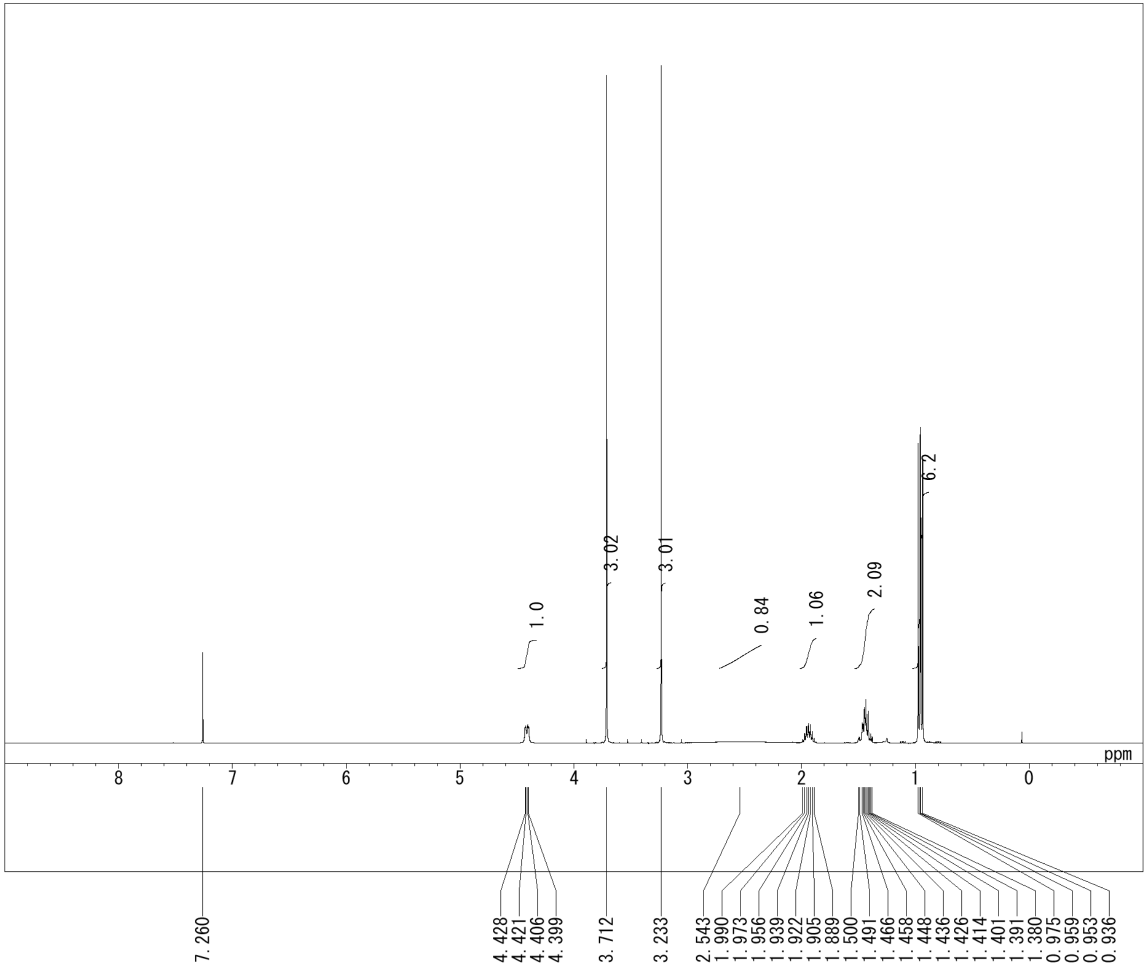
```
Comment    NAT-09-017-13C-2_20200305
    _01
Date          2020/Mar/05
ObsNuc                13C
ExMode         CARBON_001
ObsFreq             100.66 MHz
Scan               4096
AcqTime               1.3631 s
Acc. Interval         3.3631 s
Spinning             20.0 Hz
Temperature          40.0 ℃
```

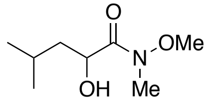




4i

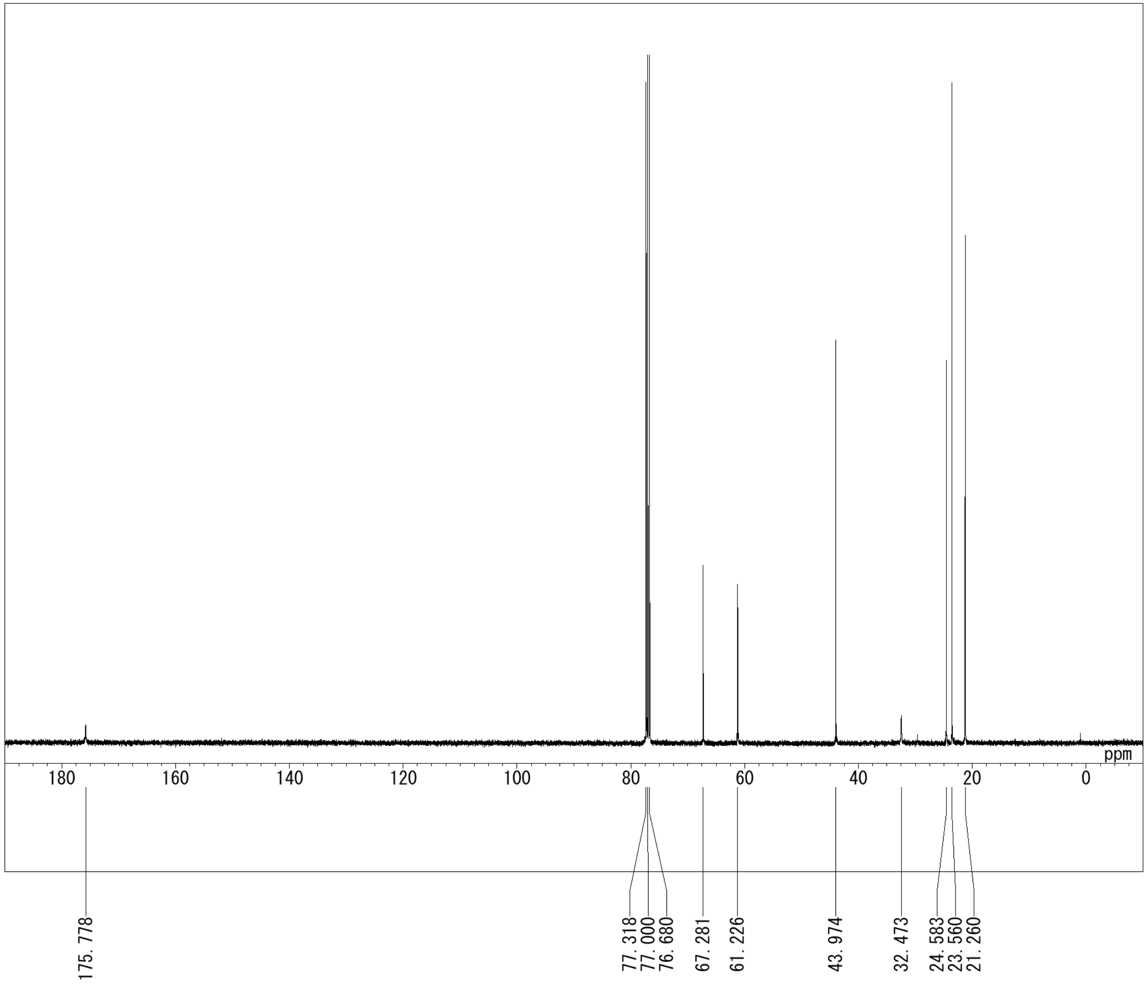
Comment NAT-09-018-pure_20200302_
01
Date 2020/Mar/02
ObsNuc ^{1}H
ExMode PROTON_001
ObsFreq 399.45 MHz
Scan 16
AcqTime 2.569 s
Acc. Interval 5.569 s
Spinning 16.0 Hz
Temperature 25.0 ℃

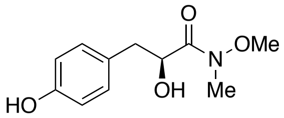




4i

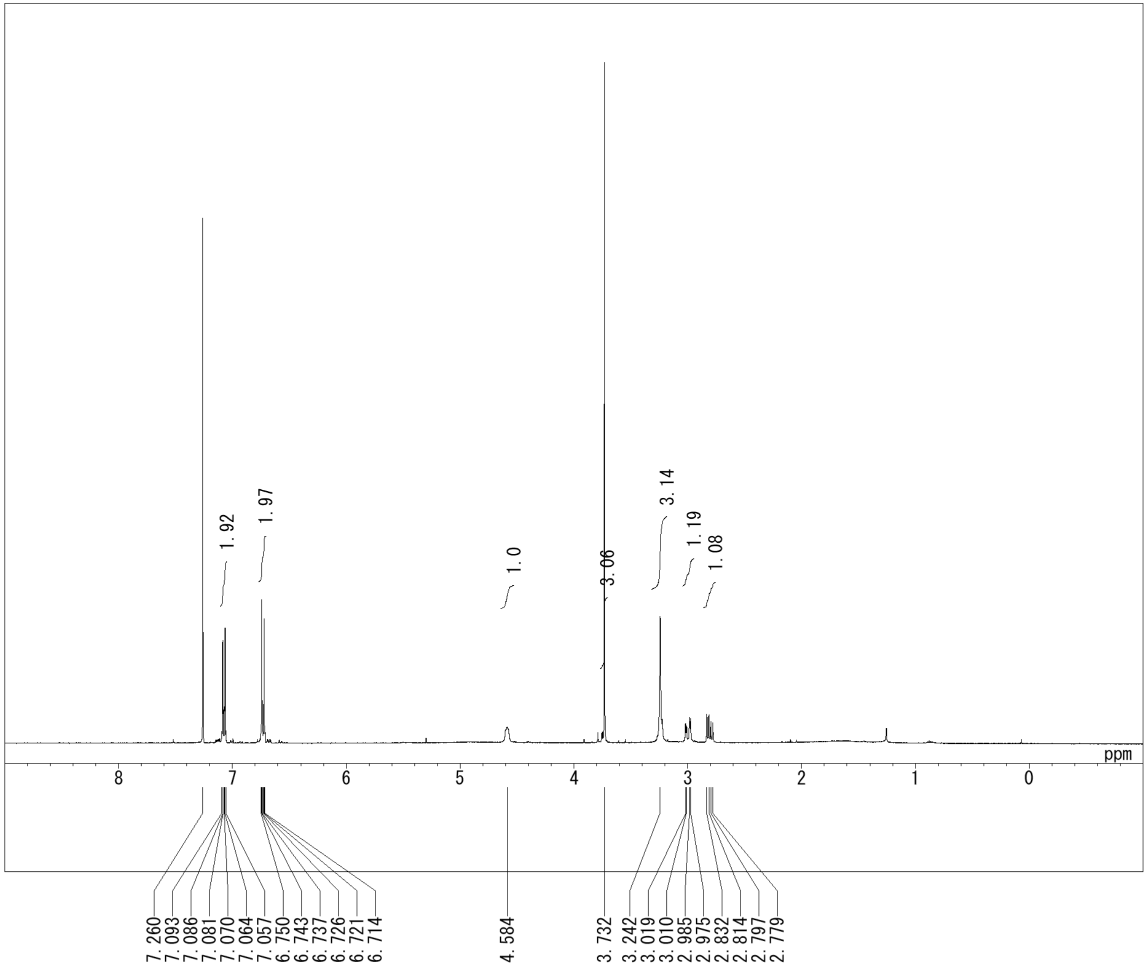
Comment	NAT-09-018-13C-2_20200309_01
Date	2020/Mar/09
ObsNuc	^{13}C
ExMode	CARBON_001
ObsFreq	100.45 MHz
Scan	4096
AcqTime	1.3631 s
Acc. Interval	3.3631 s
Spinning	20.0 Hz
Temperature	25.0 ℃

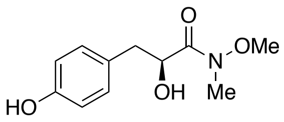




4j

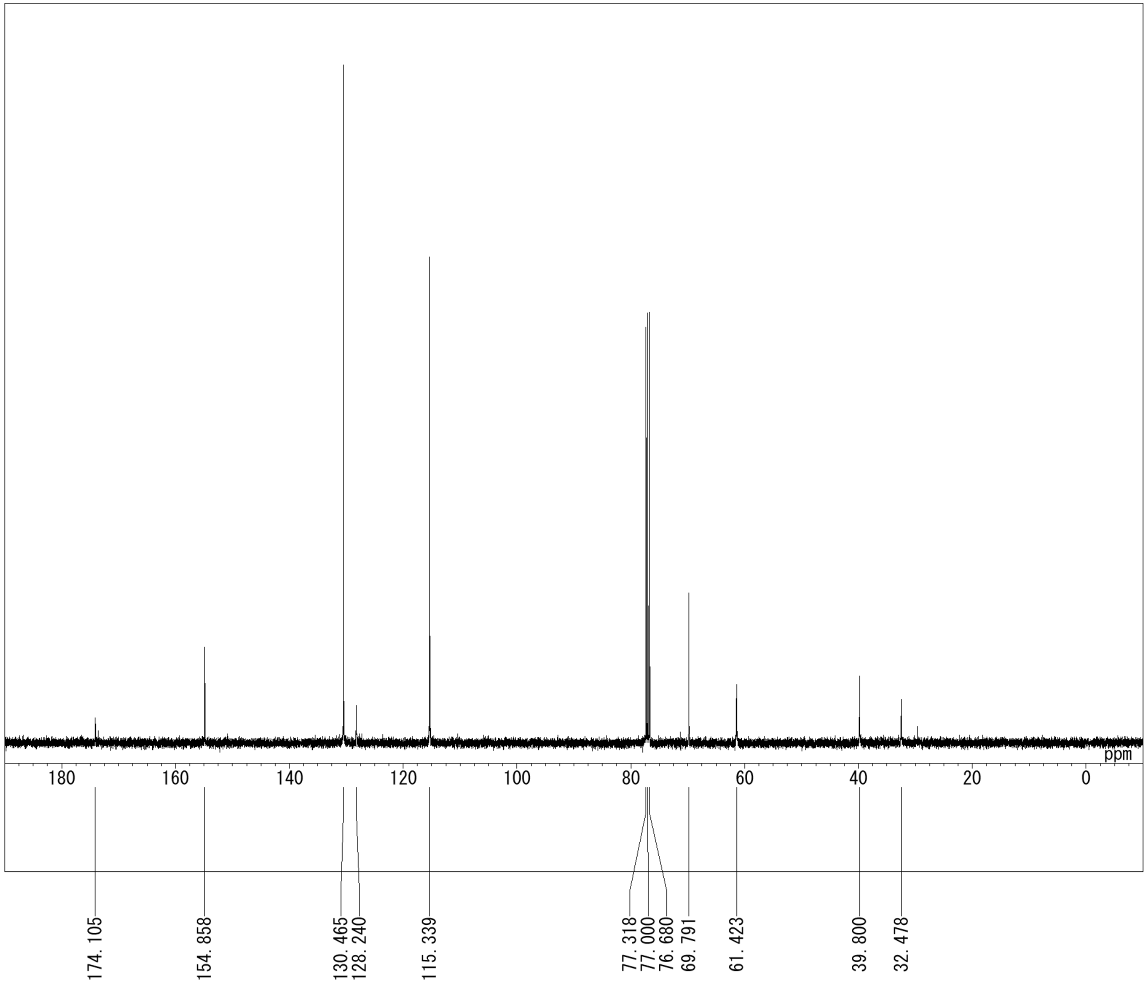
Comment NAT-09-029-pure-2_20200318_01
Date 2020/Mar/18
ObsNuc ^{1}H
ExMode PROTON_001
ObsFreq 399.45 MHz
Scan 16
AcqTime 2.569 s
Acc. Interval 5.569 s
Spinning 16.0 Hz
Temperature 25.0 ℃

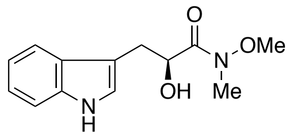




4j

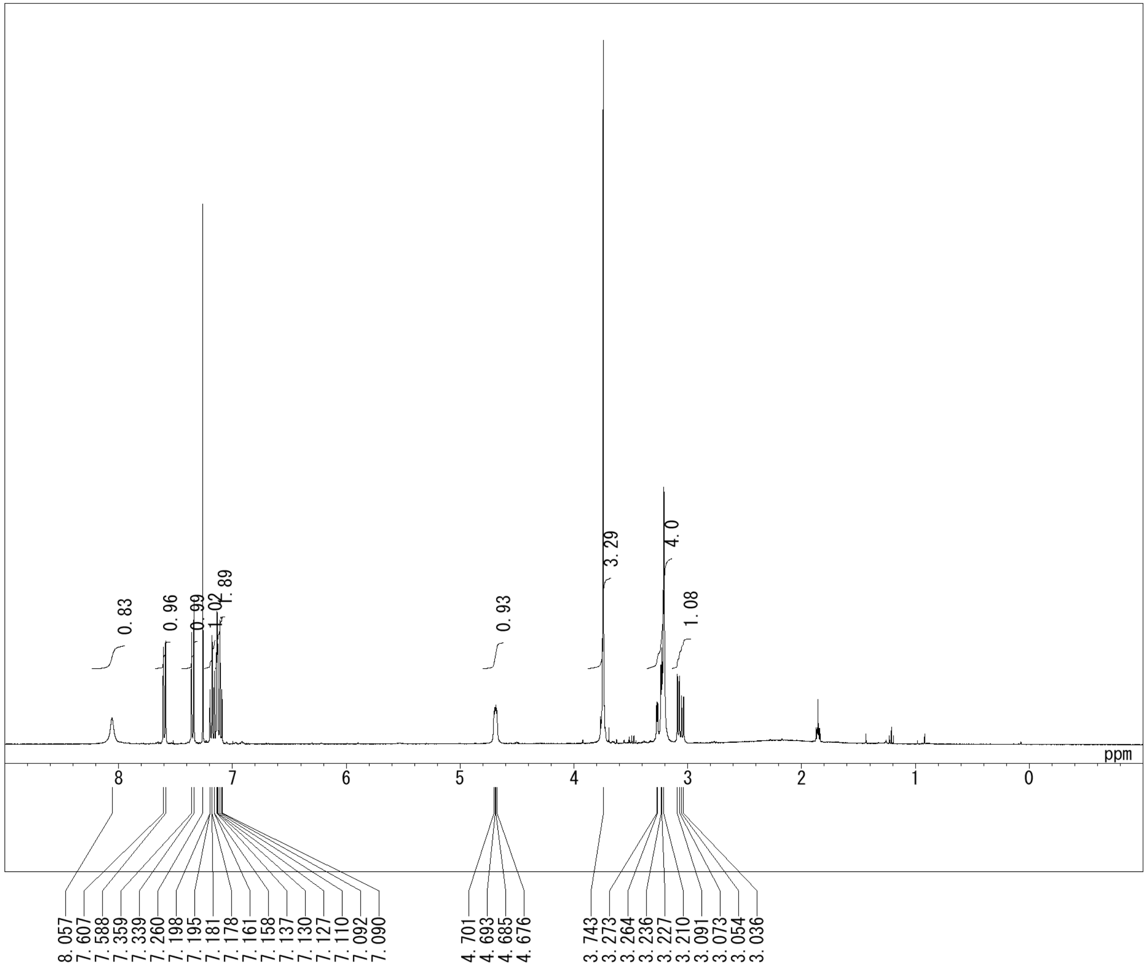
Comment NAT-09-029-13C_20200317_0
1
Date 2020/Mar/17
ObsNuc ^{13}C
ExMode CARBON_001
ObsFreq 100.45 MHz
Scan 512
AcqTime 1.3631 s
Acc. Interval 3.3631 s
Spinning 20.0 Hz
Temperature 25.0 ℃

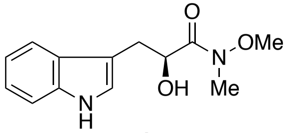




4k

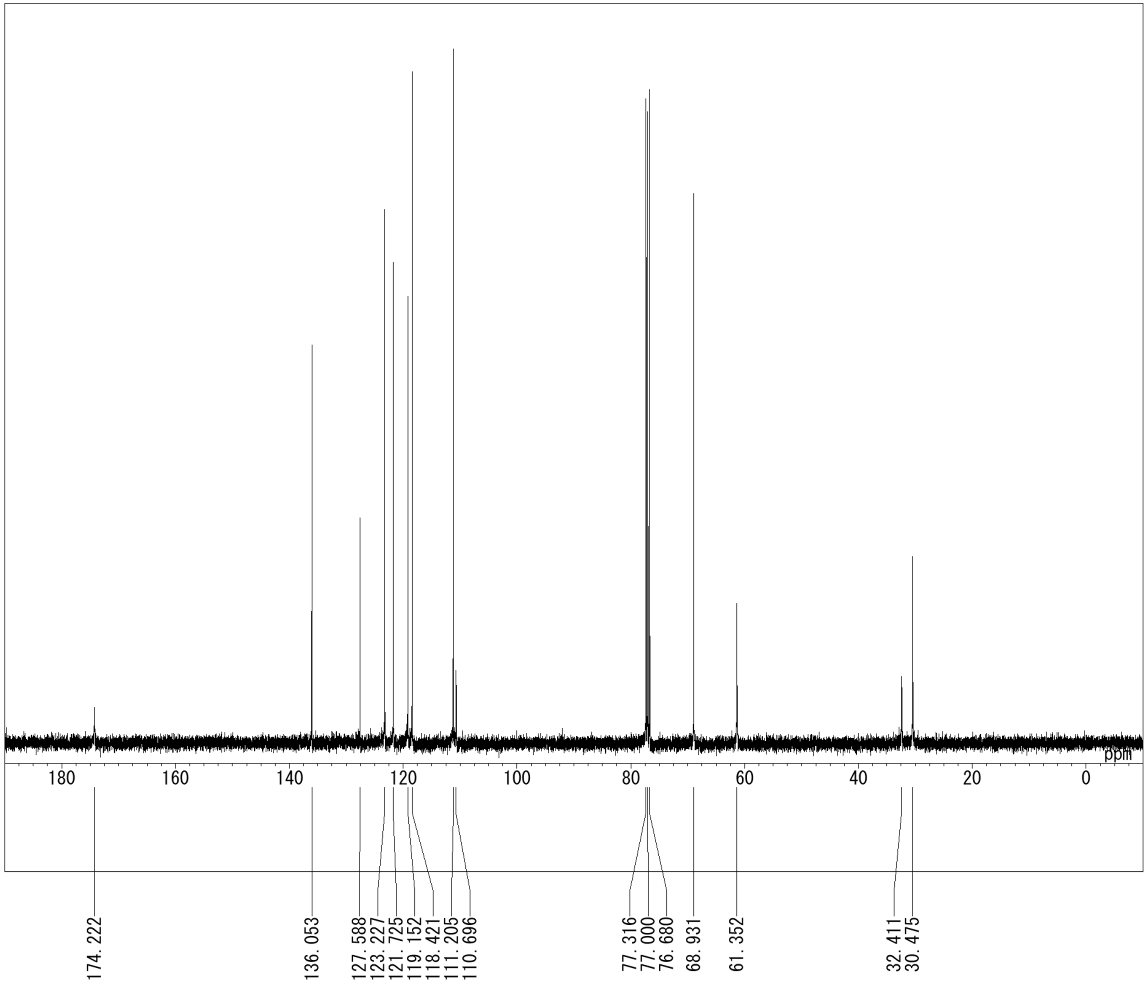
Comment	NAT-indole-weinreb-pure_2 0200328_01
Date	2020/Mar/28
ObsNuc	^{1}H
ExMode	PROTON_001
ObsFreq	399.45 MHz
Scan	16
AcqTime	2.569 s
Acc. Interval	5.569 s
Spinning	16.0 Hz
Temperature	25.0 ℃

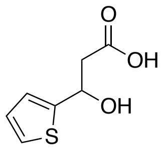




4k

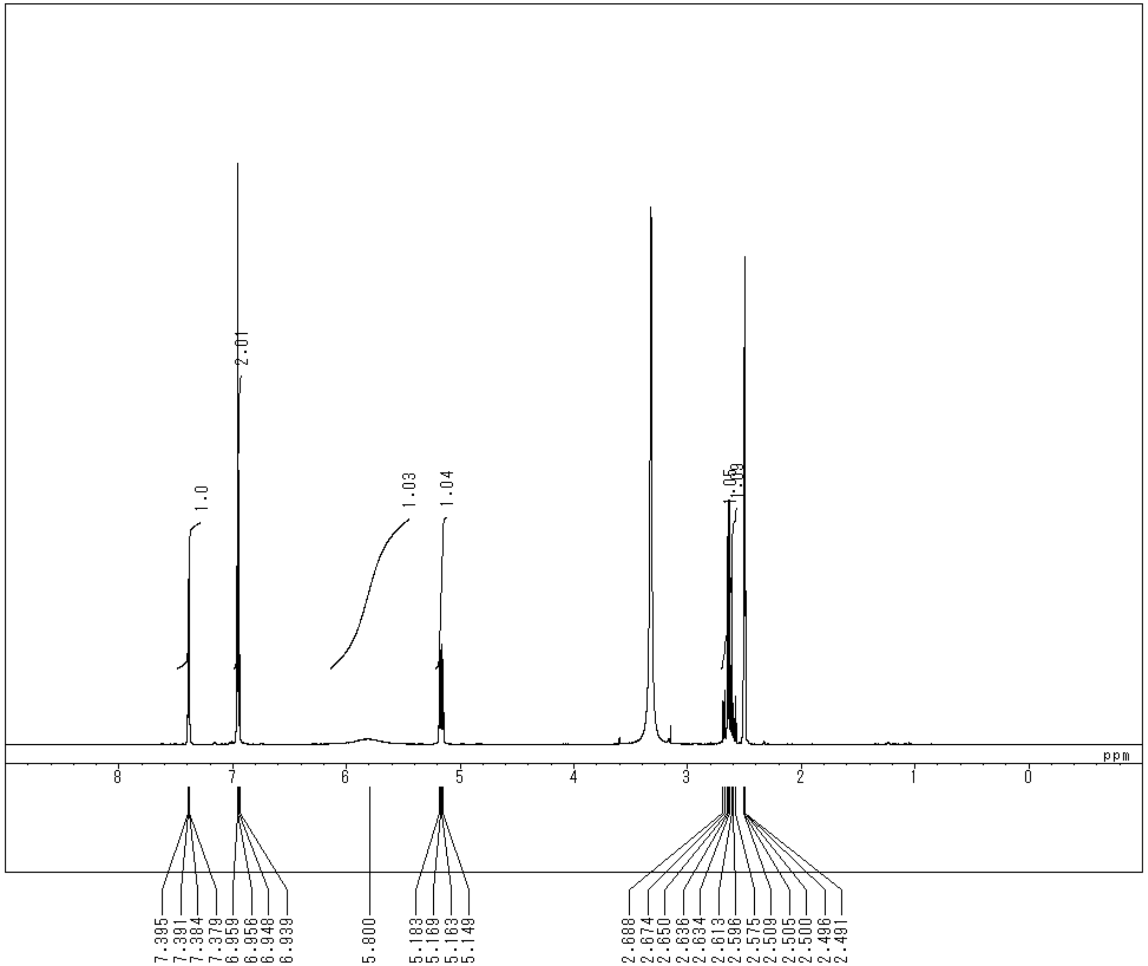
```
Comment     TKMindolWeinreb2CARBON_20
    190617_02
Date            2019/Jun/17
ObsNuc                   13C
ExMode           CARBON_001
ObsFreq               100.45 MHz
Scan                  512
AcqTime                 1.3631 s
Acc. Interval           3.3631 s
Spinning               20.0 Hz
Temperature            25.0 ℃
```

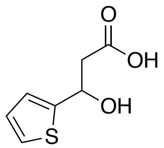




7e

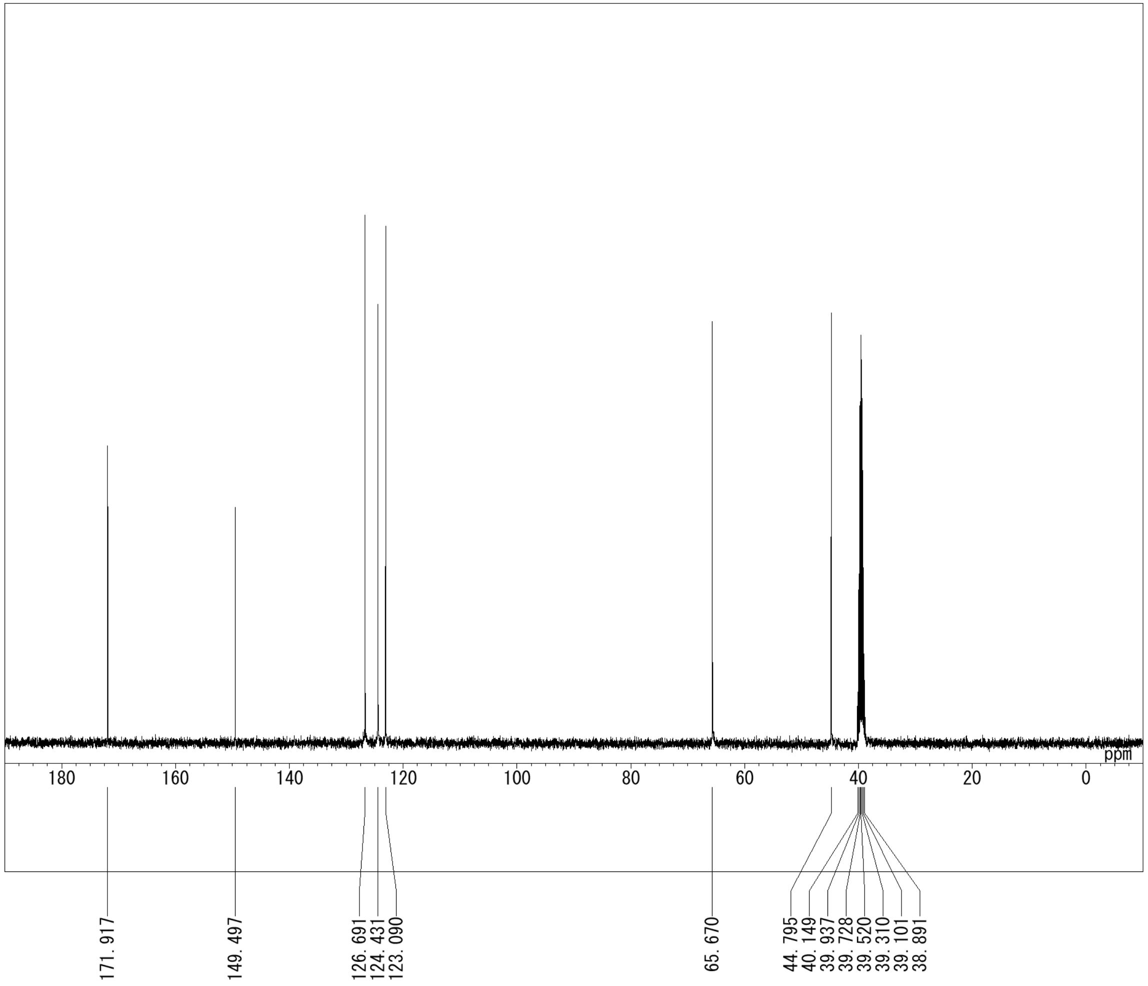
```
Comment     BNO12021-1H-DMSO_2019112
    6_02
Date          2019/Nov/26
ObsNuc               1H
ExMode          PROTON_001
ObsFreq            400.28 MHz
Scan               16
AcqTime              2.5559 s
Acc. Interval        5.5559 s
Spinning           16.0 Hz
Temperature        40.0 ℃
```

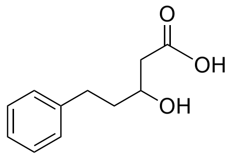




7e

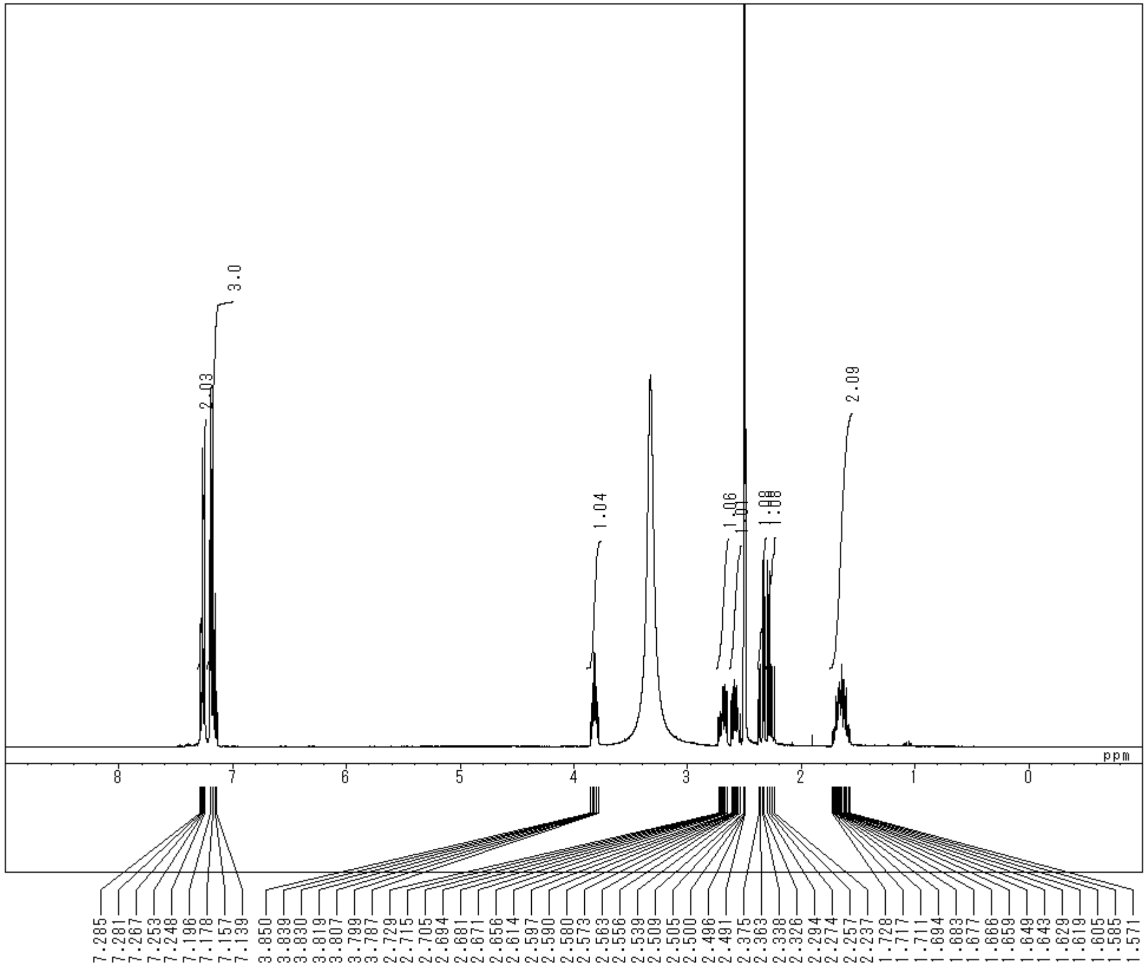
Comment	BNO12021-13C-DMSO_20191127_01
Date	2019/Nov/27
ObsNuc	^{13}C
ExMode	CARBON_001
ObsFreq	100.66 MHz
Scan	64
AcqTime	1.3631 s
Acc. Interval	3.3631 s
Spinning	20.0 Hz
Temperature	40.0 ℃

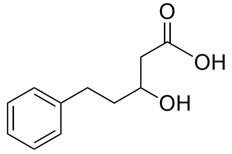




7f

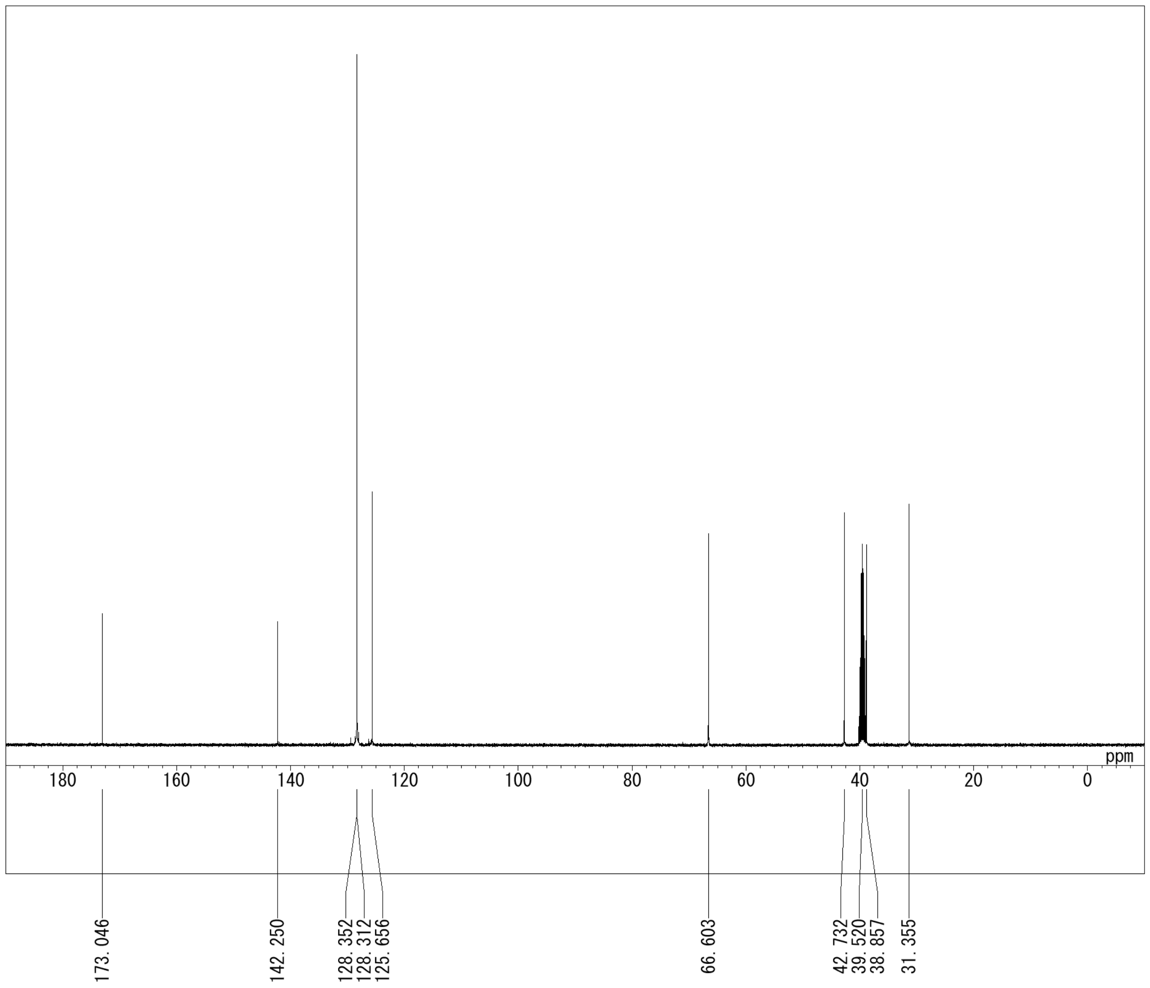
Comment BNO11001-1H-DMSO_20190826_01
Date 2019/Aug/26
ObsNuc ^{1}H
ExMode PROTON_001
ObsFreq 400.28 MHz
Scan 16
AcqTime 2.5559 s
Acc. Interval 5.5559 s
Spinning 16.0 Hz
Temperature 40.0 ℃

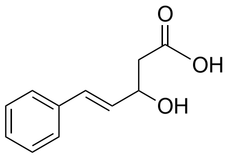




7f

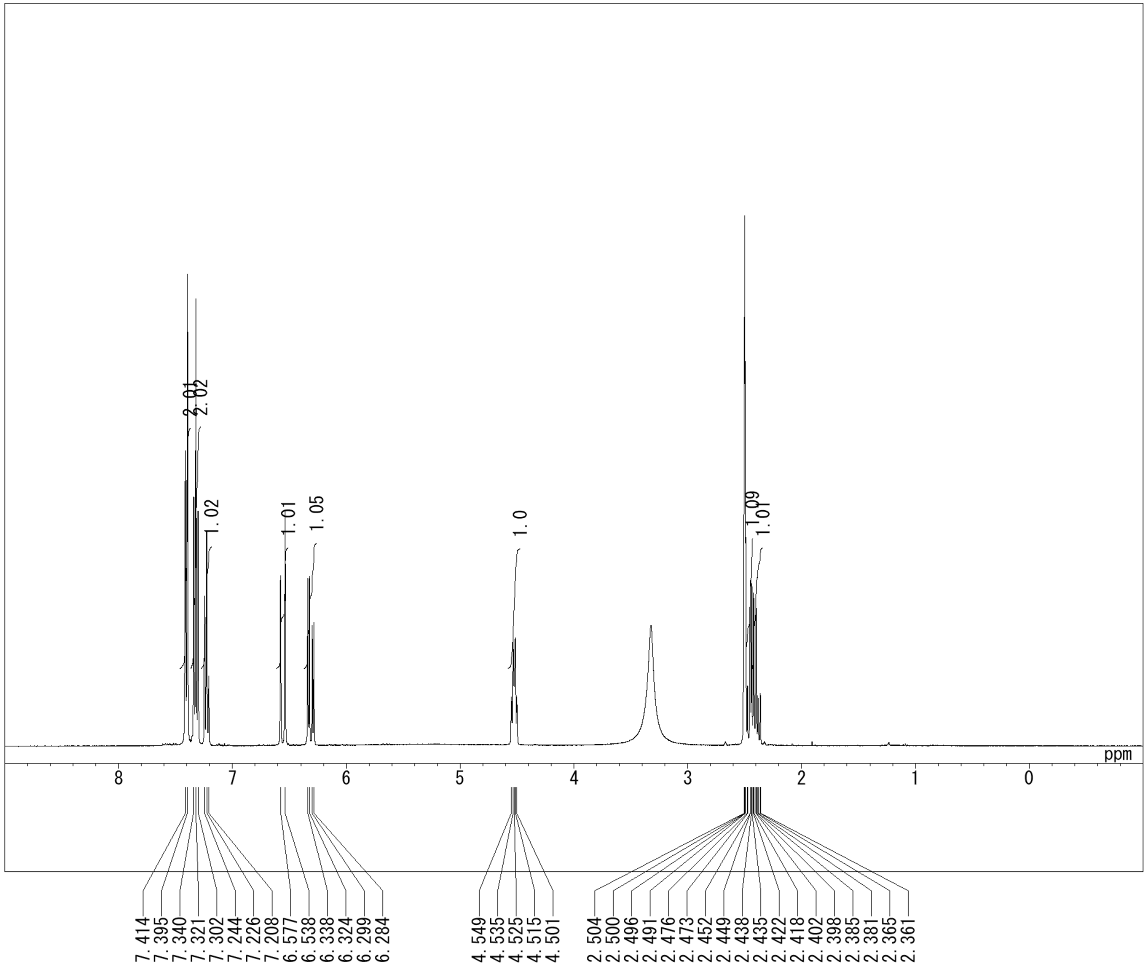
Comment BN011001-13C-DMSO-Re_2019
0826_01
Date 2019/Aug/26
ObsNuc ^{13}C
ExMode CARBON_001
ObsFreq 100.66 MHz
Scan 512
AcqTime 1.3631 s
Acc. Interval 3.3631 s
Spinning 20.0 Hz
Temperature 40.0 ℃

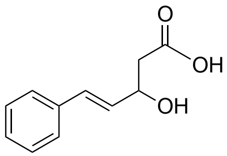




7h

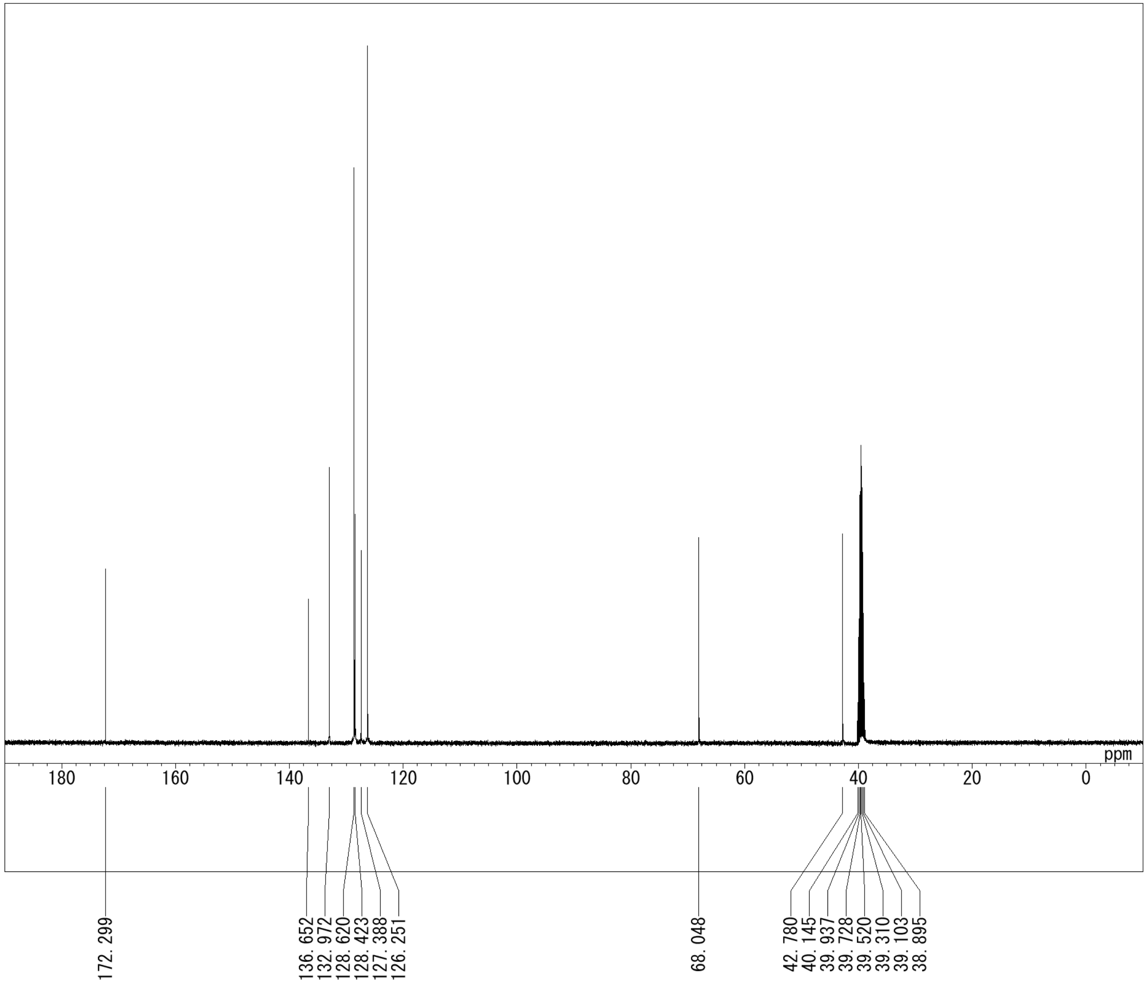
Comment BN009038-1H-DMSO_20200220
_01
Date 2020/Feb/20
ObsNuc ^{1}H
ExMode PROTON_001
ObsFreq 399.45 MHz
Scan 16
AcqTime 2.569 s
Acc. Interval 5.569 s
Spinning 16.0 Hz
Temperature 25.0 ℃

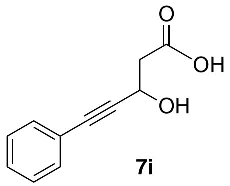




7h

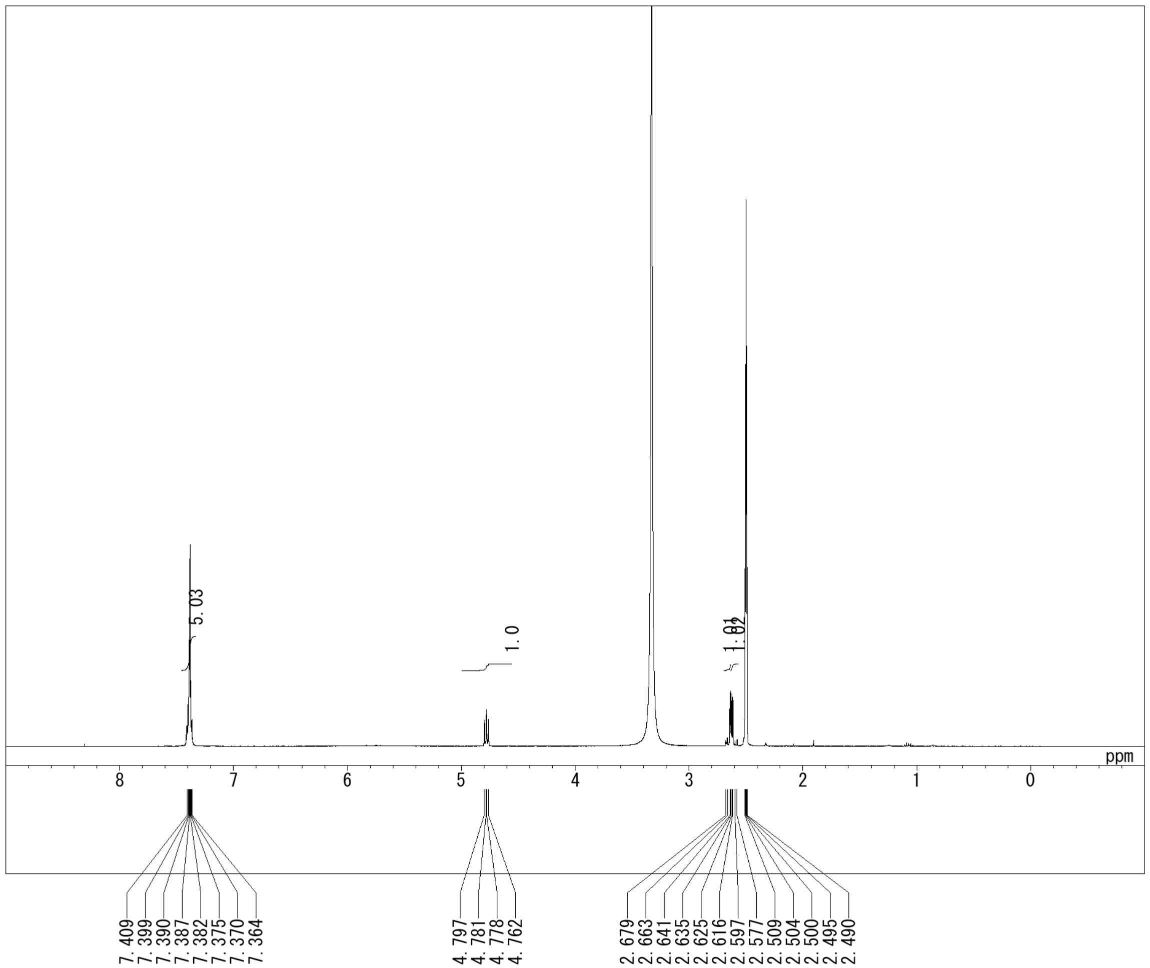
Comment	BN009038-13C-DMSO_20200217_01
Date	2020/Feb/17
ObsNuc	^{13}C
ExMode	CARBON_001
ObsFreq	100.66 MHz
Scan	512
AcqTime	1.3631 s
Acc. Interval	3.3631 s
Spinning	20.0 Hz
Temperature	40.0 ℃

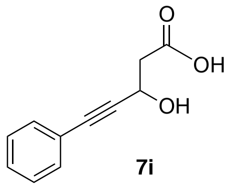




7i

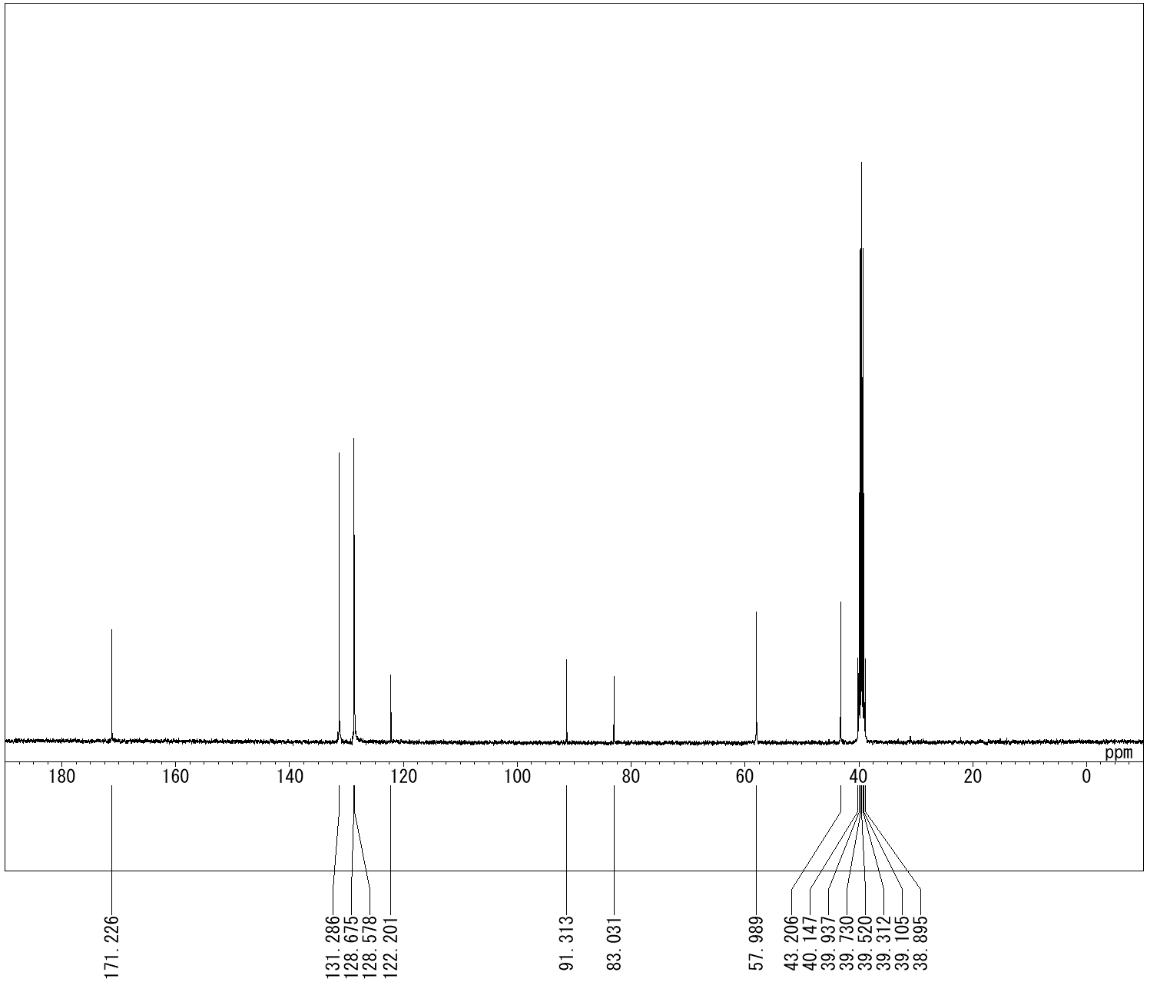
```
Comment      BN009037-1H-DMSO_20190827
    _01
Date          2019/Aug/27
ObsNuc                 1H
ExMode         PROTON_001
ObsFreq           399.45 MHz
Scan                16
AcqTime              2.569 s
Acc. Interval        5.569 s
Spinning            16.0 Hz
Temperature         25.0 ℃
```

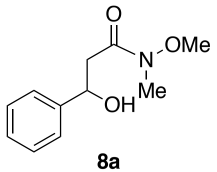




7i

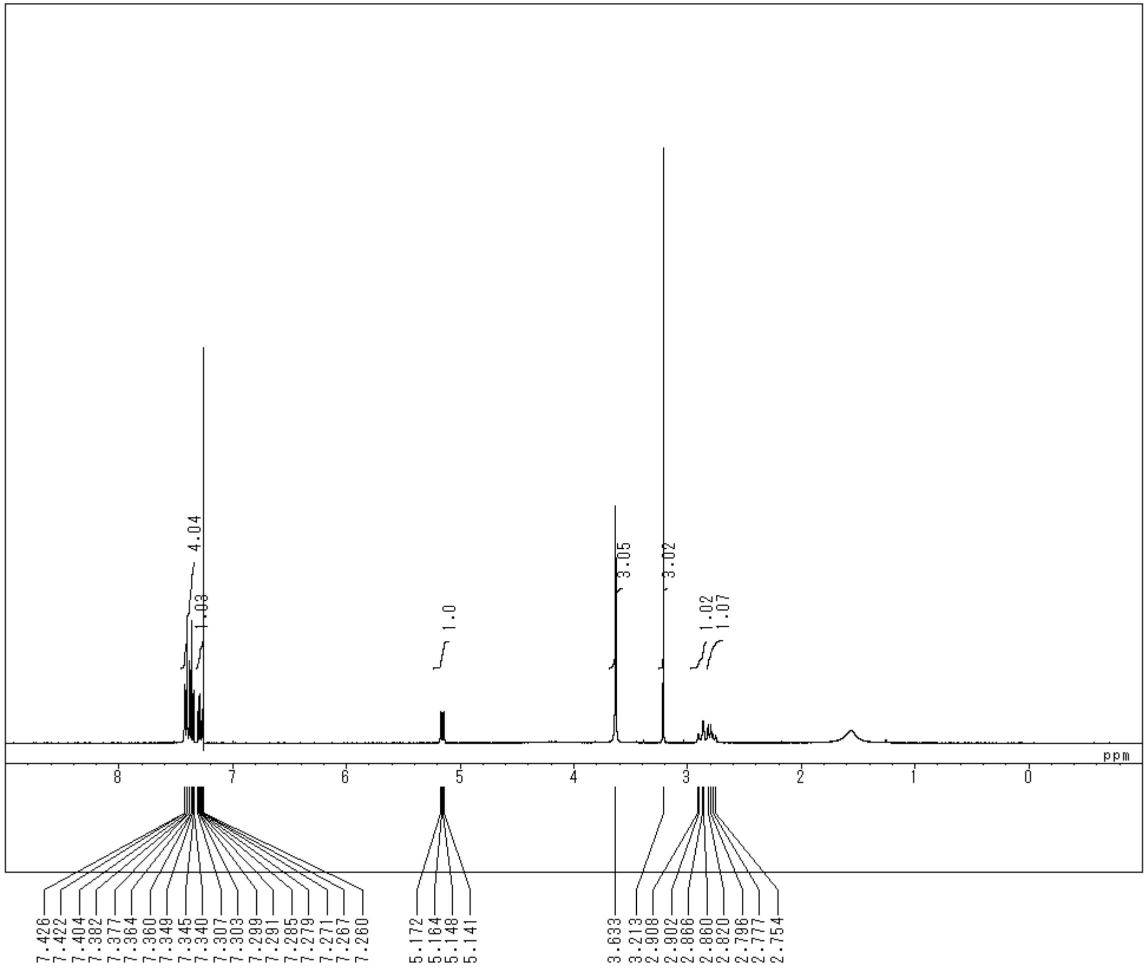
```
Comment      BN009037-13C-DMSO_2020021
    7_01
Date            2020/Feb/17
ObsNuc                  13C
ExMode           CARBON_001
ObsFreq              100.66 MHz
Scan                 512
AcqTime                1.3631 s
Acc. Interval          3.3631 s
Spinning              20.0 Hz
Temperature           40.0 ℃
```

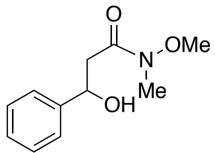




8a

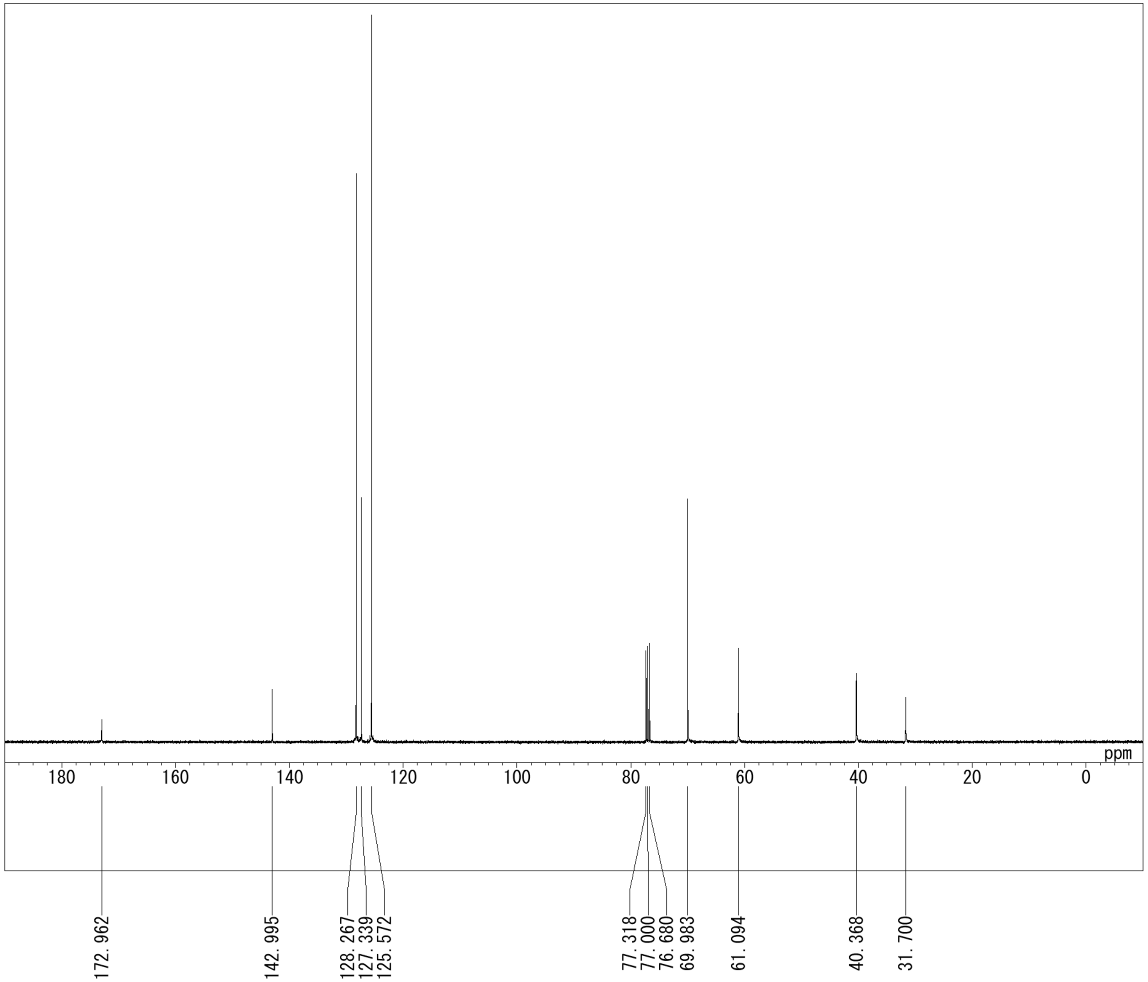
```
Comment      BNO10012-1-1H-C1_2019090
    5_01
Date          2019/Sep/05
ObsNuc                 1H
ExMode        PROTON_001
ObsFreq             400.27 MHz
Scan                16
AcqTime               2.5559 s
Acc. Interval         5.5559 s
Spinning            16.0 Hz
Temperature         40.0 ℃
```

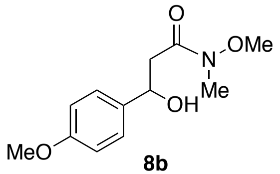




8a

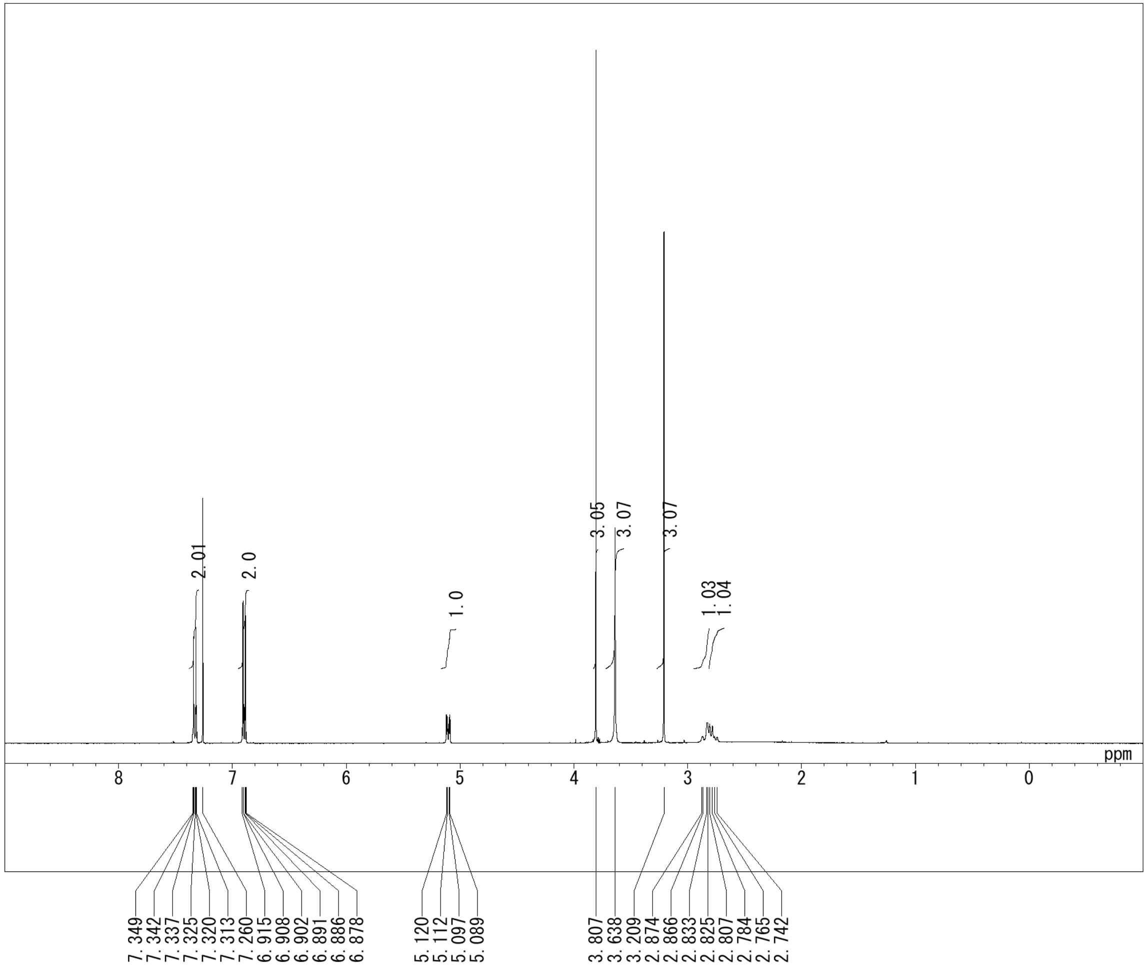
```
Comment    BNO_3-Ph-3-OH_propionic_W
    einreb_13C_20180328_01
Date          2018/Mar/28
ObsNuc                 13C
ExMode         CARBON_001
ObsFreq             100.45 MHz
Scan                448
AcqTime               1.3631 s
Acc. Interval         3.3631 s
Spinning             20.0 Hz
Temperature          25.0 ℃
```

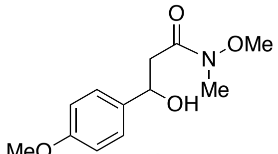




8b

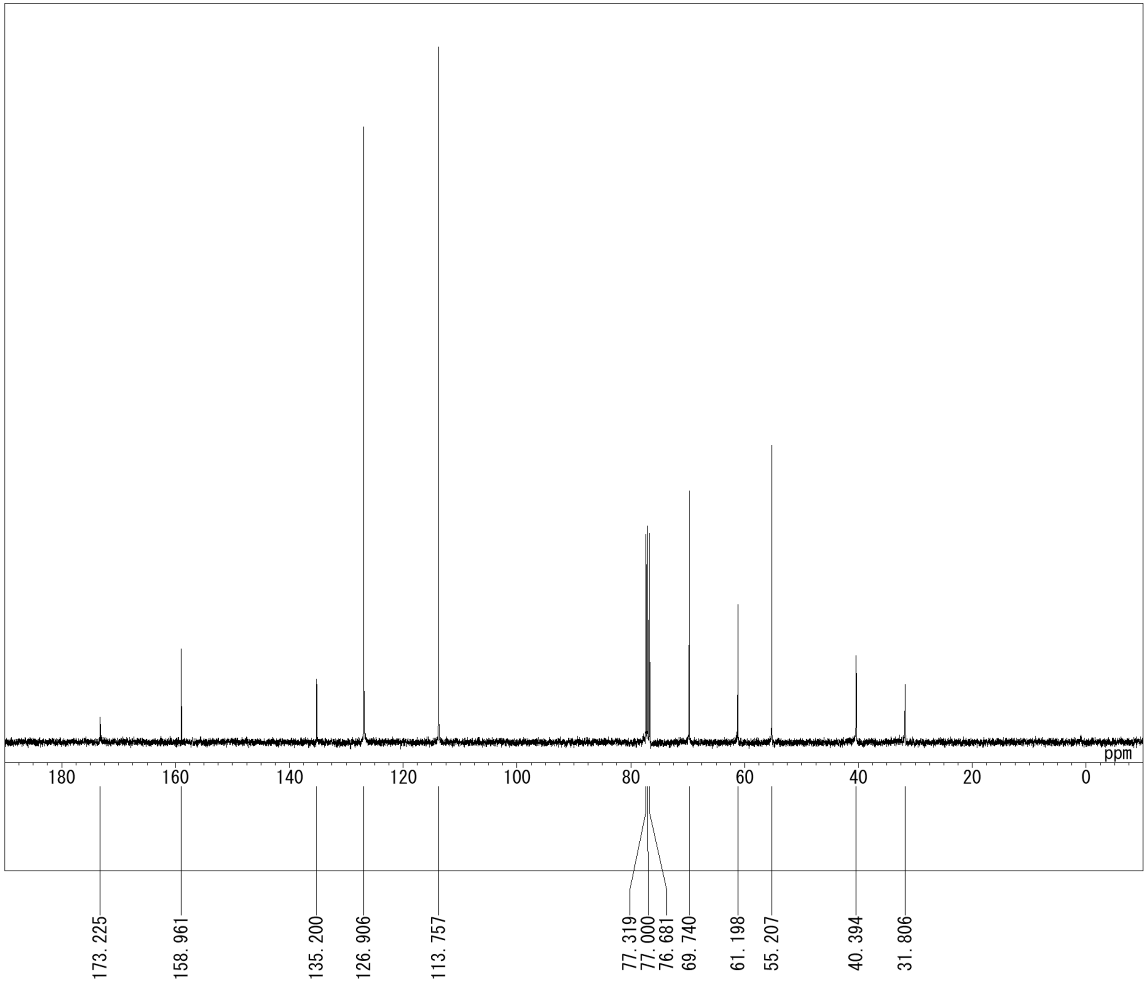
```
Comment     BN010018-1H-Cl_20191021_0
    1
Date           2019/Oct/21
ObsNuc                  1H
ExMode         PROTON_001
ObsFreq             400.27 MHz
Scan                16
AcqTime               2.5559 s
Acc. Interval         5.5559 s
Spinning            16.0 Hz
Temperature         40.0 ℃
```

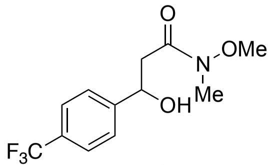




8b

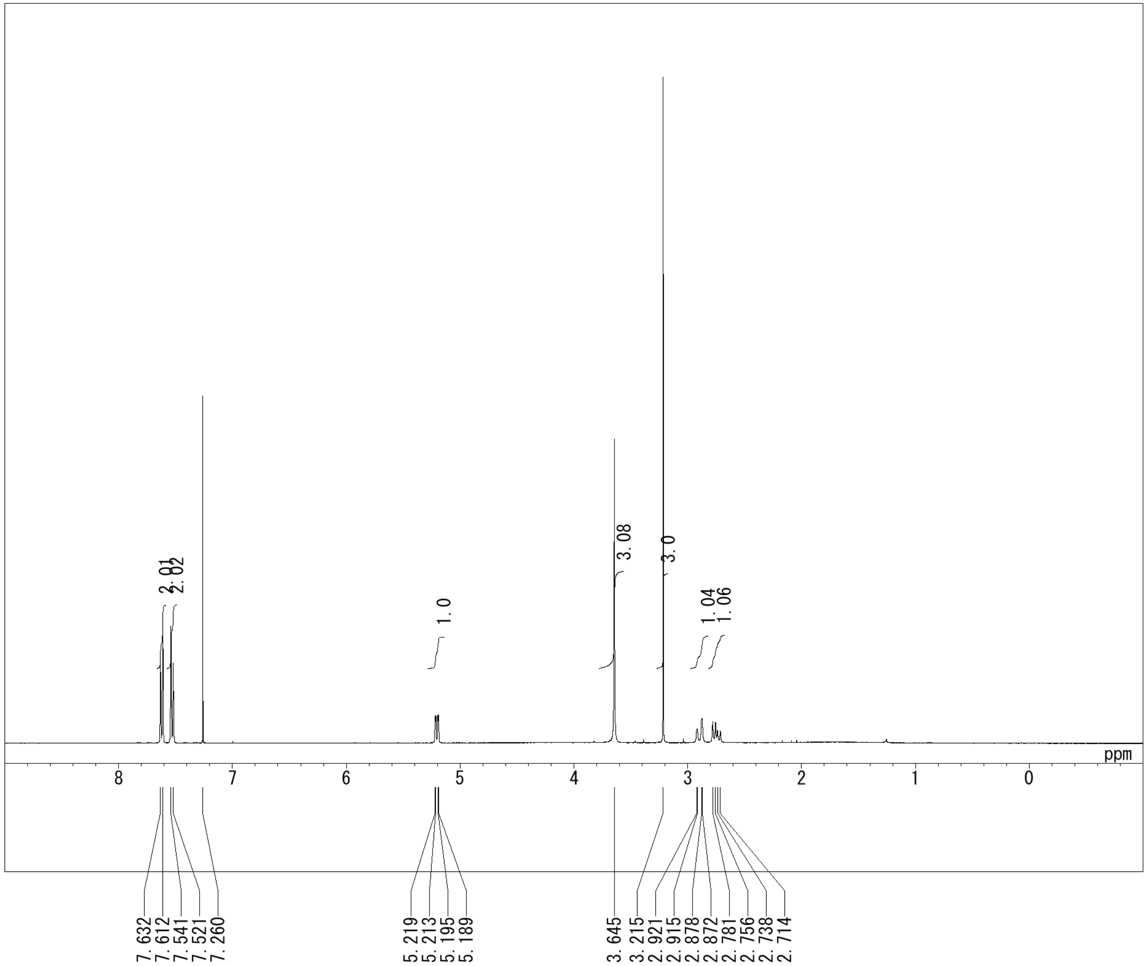
```
Comment    BNO10018-13C-C1_20191021_
    01
Date          2019/Oct/21
ObsNuc                 13C
ExMode        CARBON_001
ObsFreq              100.66 MHz
Scan                 128
AcqTime                1.3631 s
Acc. Interval          3.3631 s
Spinning              20.0 Hz
Temperature           40.0 ℃
```

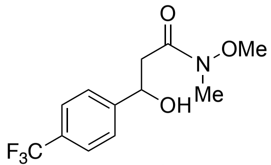




8c

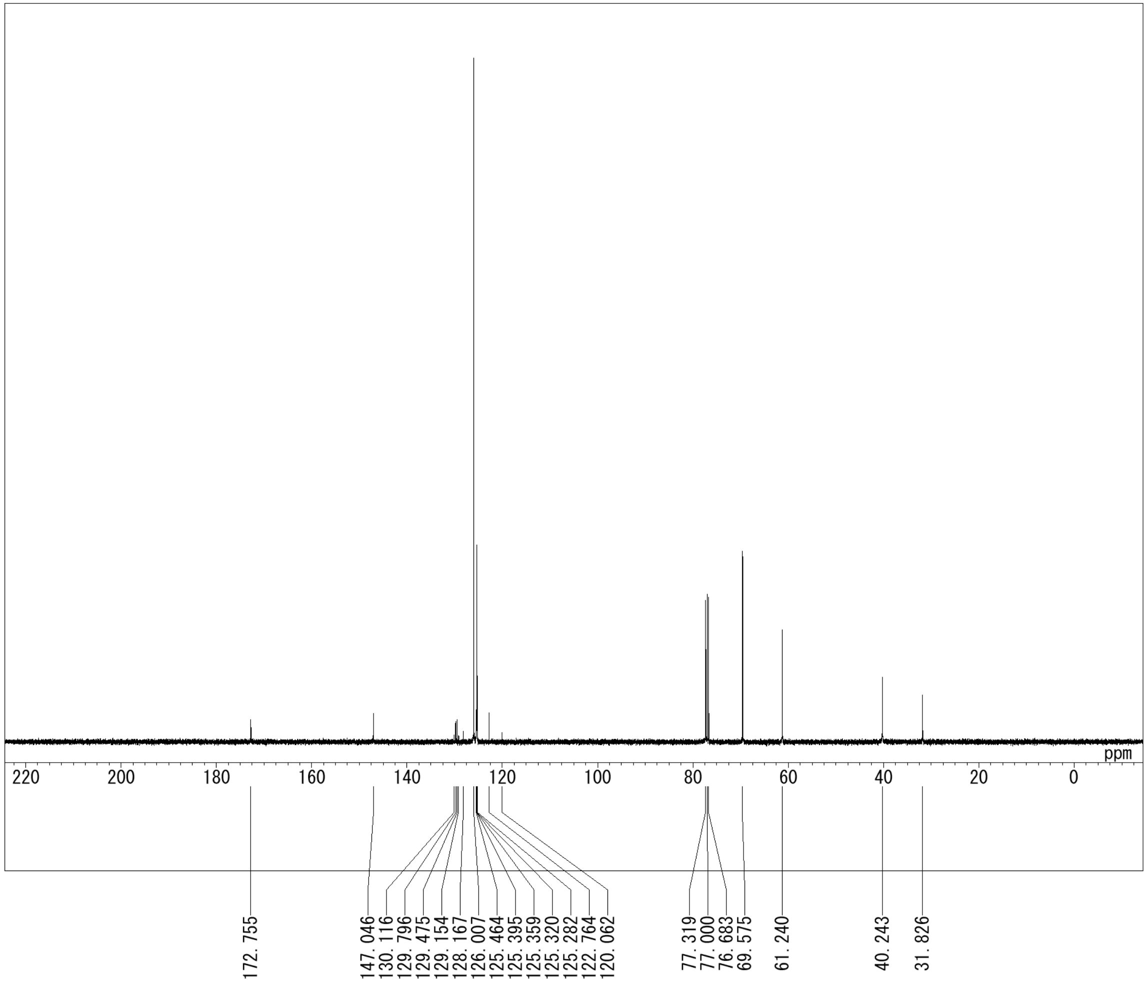
Comment	sample3-1H_20190906_01
Date	2019/Sep/06
ObsNuc	^{1}H
ExMode	PROTON_001
ObsFreq	399.45 MHz
Scan	16
AcqTime	2.569 s
Acc. Interval	5.569 s
Spinning	16.0 Hz
Temperature	25.0 ℃
Solvent	cdcl3

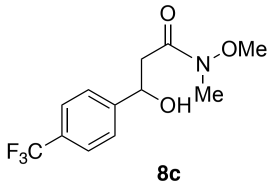




8c

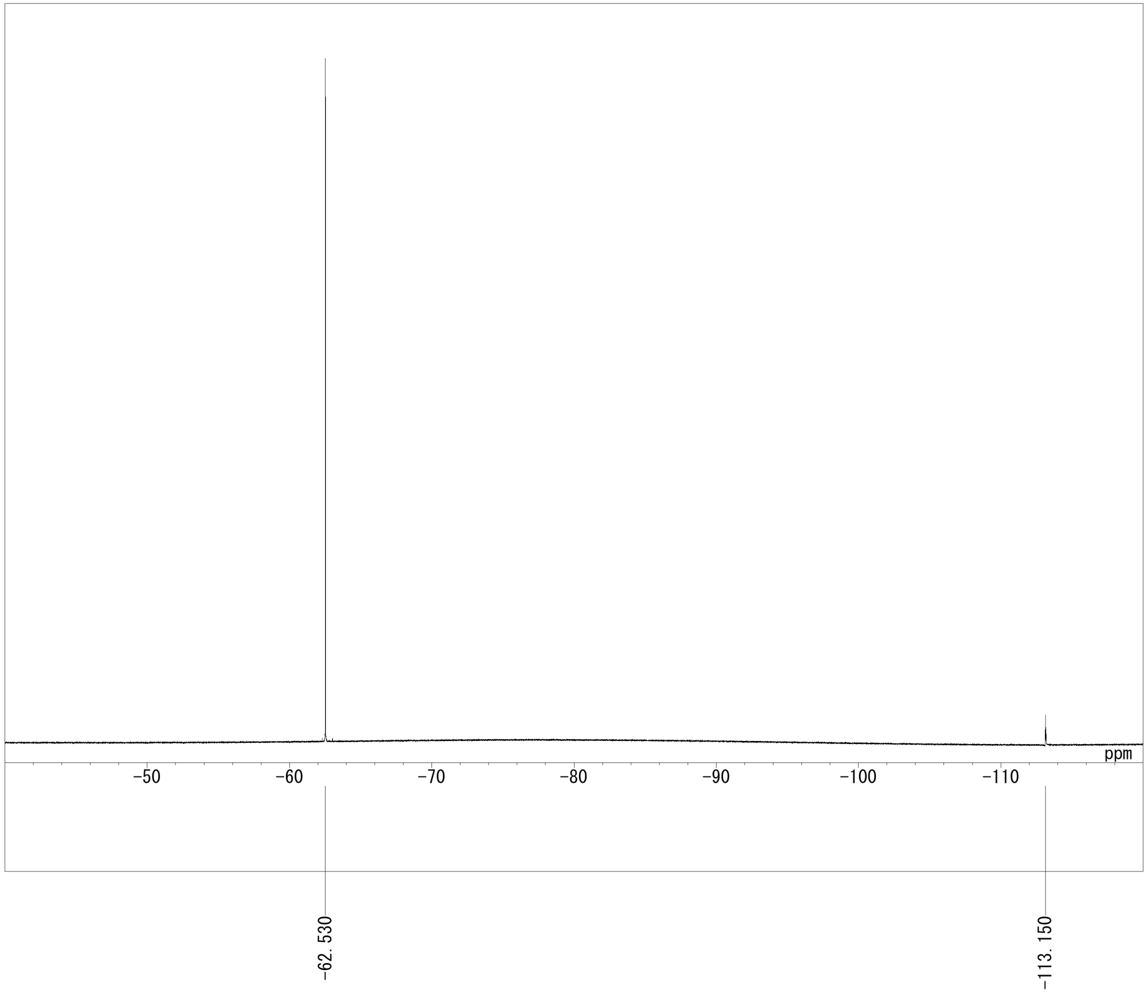
```
Comment     BN003071-3_13C_20180326_0
    1
Date            2018/Mar/26
ObsNuc                 13C
ExMode           CARBON_001
ObsFreq                100.66 MHz
Scan                   256
AcqTime                  1.3631 s
Acc. Interval            3.3631 s
Spinning                20.0 Hz
Temperature             25.0 ℃
```

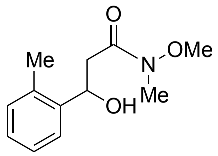




8c

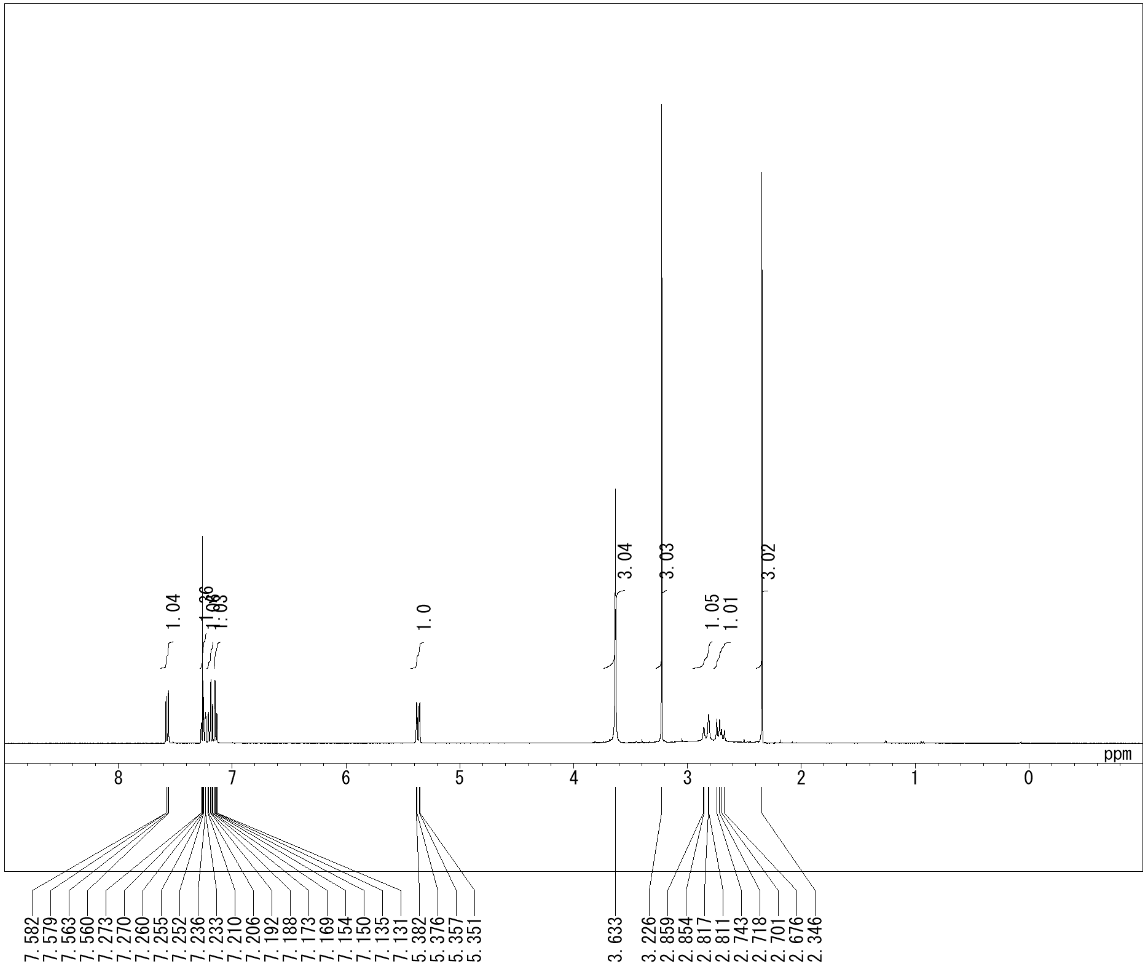
Comment NAT-b-hydroxy-CF3-19F_20200908_01
Date 2020/Sep/08
ObsNuc ^{19}F
ExMode FLUORINE_001
ObsFreq 376.58 MHz
Scan 16
AcqTime 0.8913 s
Acc. Interval 1.8913 s
Spinning 20.0 Hz
Temperature 40.0 ℃

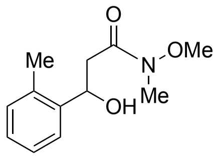




8d

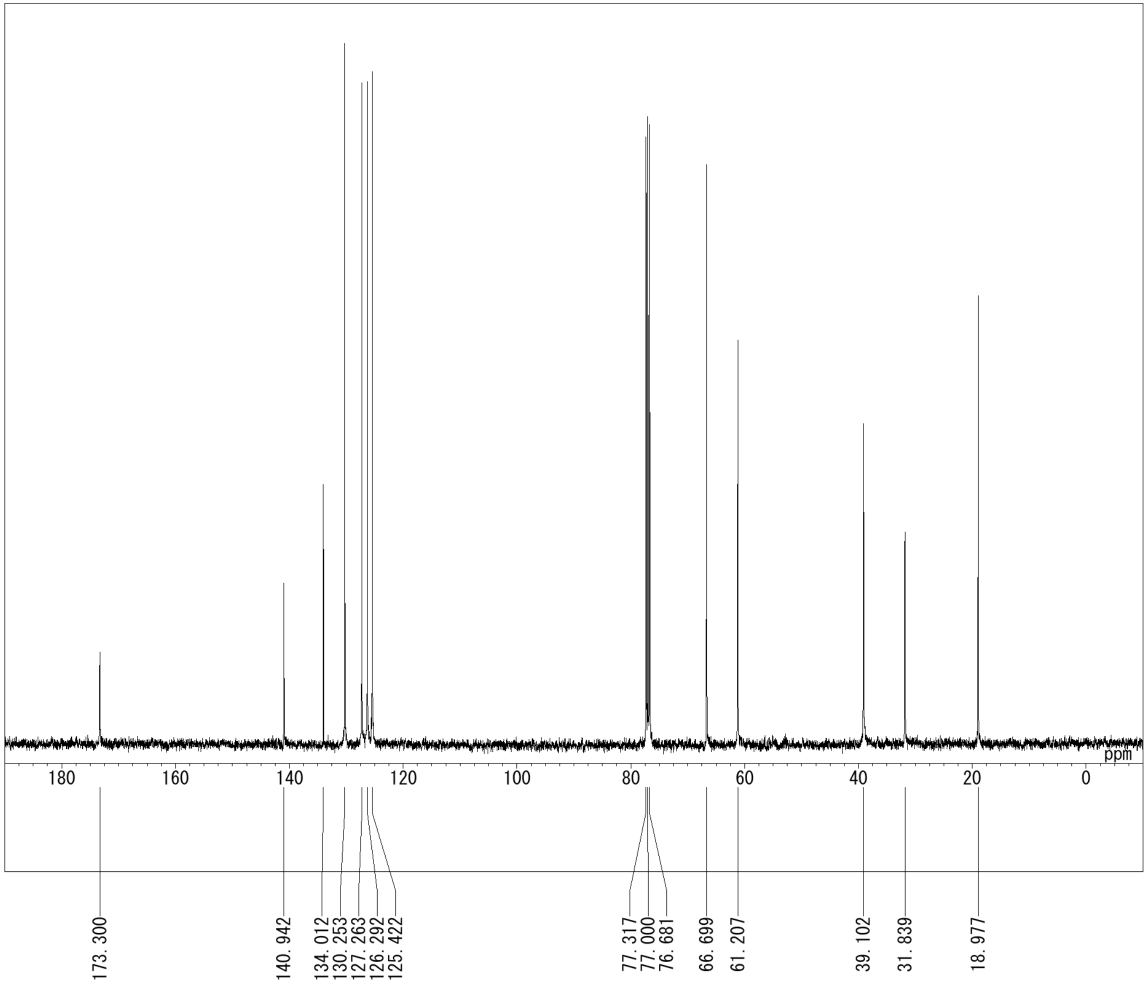
Comment	BN010023-1H-C1_20190906_0 1
Date	2019/Sep/06
ObsNuc	^{1}H
ExMode	PROTON_001
ObsFreq	399.45 MHz
Scan	16
AcqTime	2.569 s
Acc. Interval	5.569 s
Spinning	16.0 Hz
Temperature	25.0 ℃

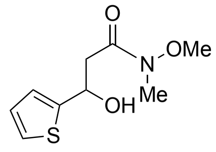




8d

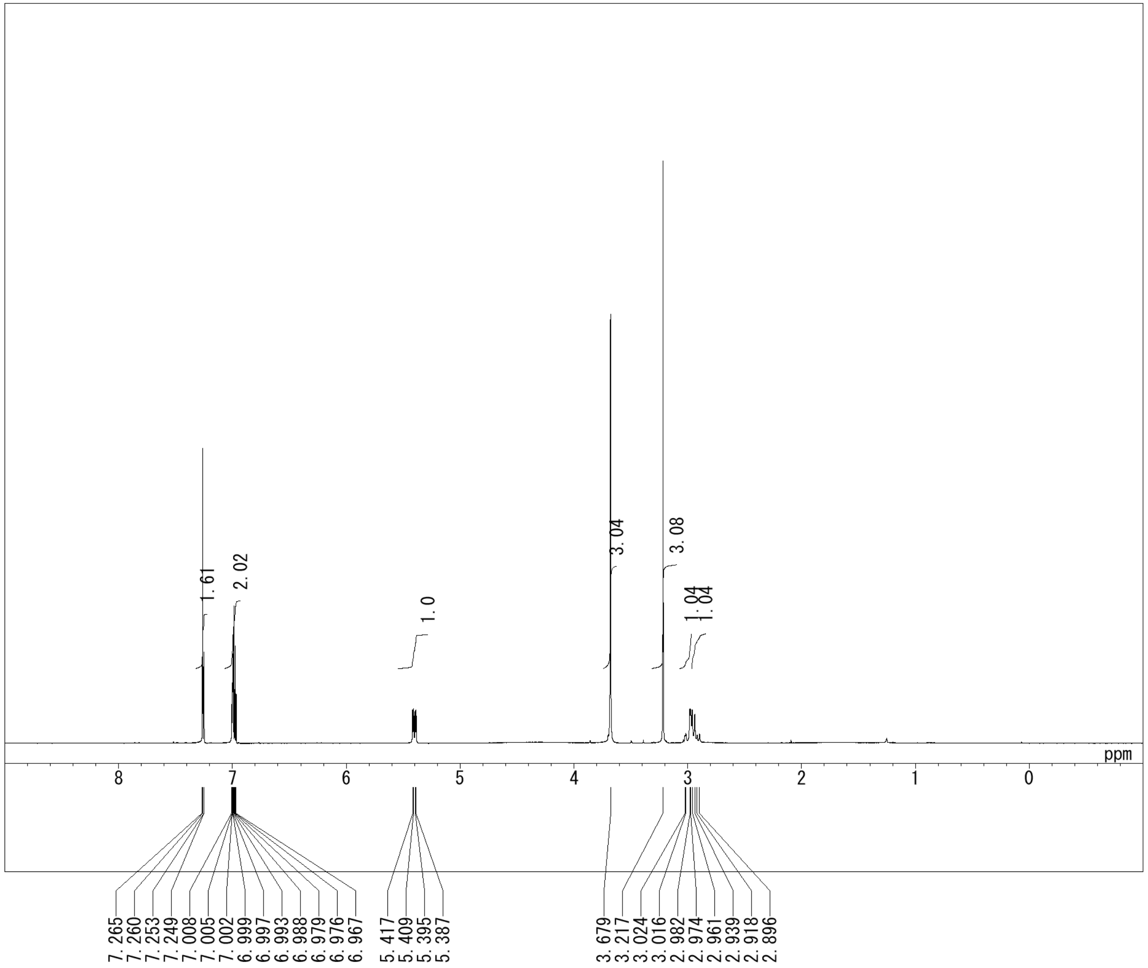
Comment	BN003071-6_13C_20180326_0 1
Date	2018/Mar/26
ObsNuc	^{13}C
ExMode	CARBON_001
ObsFreq	100.66 MHz
Scan	448
AcqTime	1.3631 s
Acc. Interval	3.3631 s
Spinning	20.0 Hz
Temperature	25.0 ℃

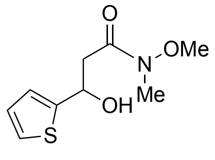




8e

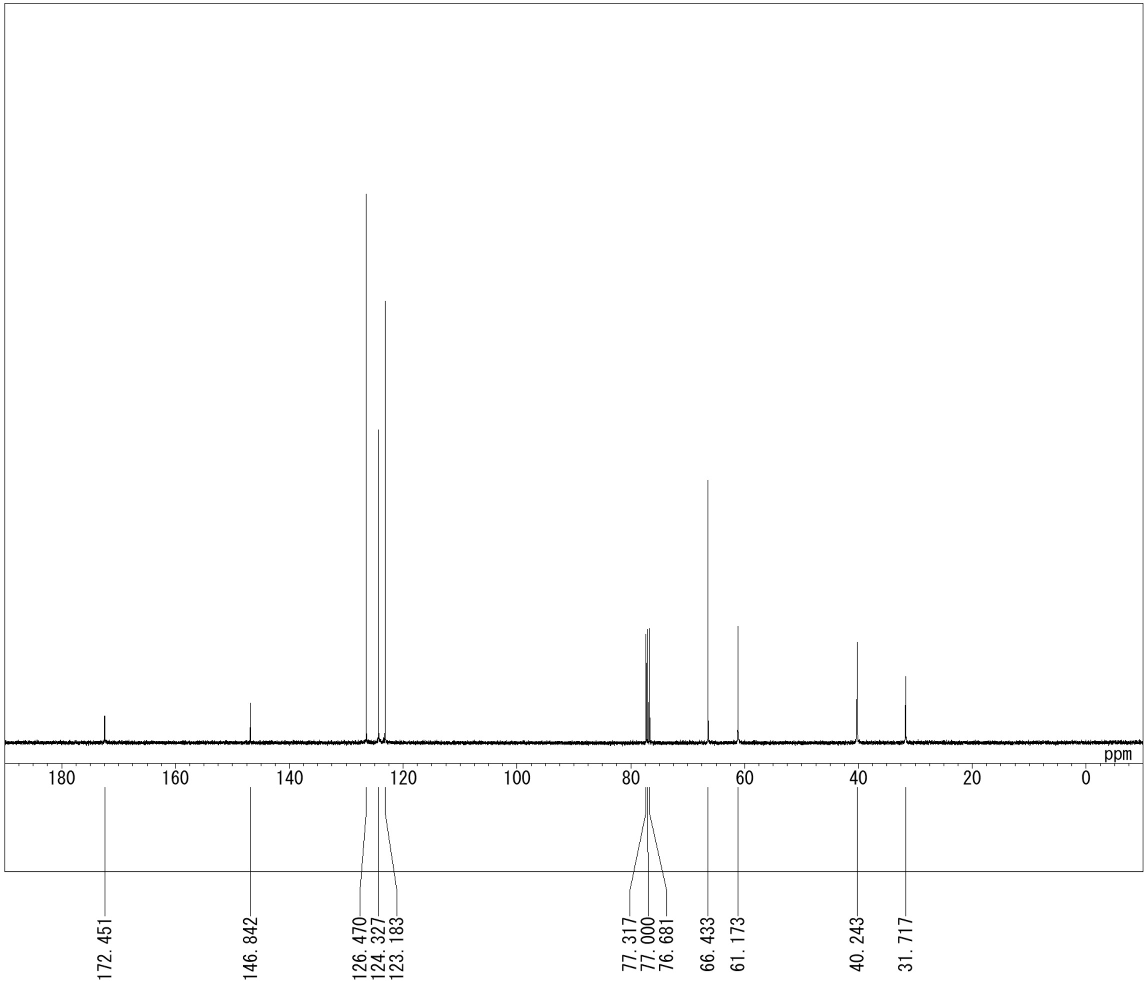
```
Comment      BN013003-1H-C1_20191206_0
    1
Date            2019/Dec/06
ObsNuc                   1H
ExMode          PROTON_002
ObsFreq              400.27 MHz
Scan                 16
AcqTime                2.5559 s
Acc. Interval          5.5559 s
Spinning              16.0 Hz
Temperature           40.0 ℃
```

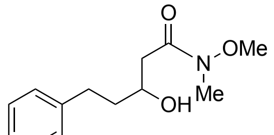




8e

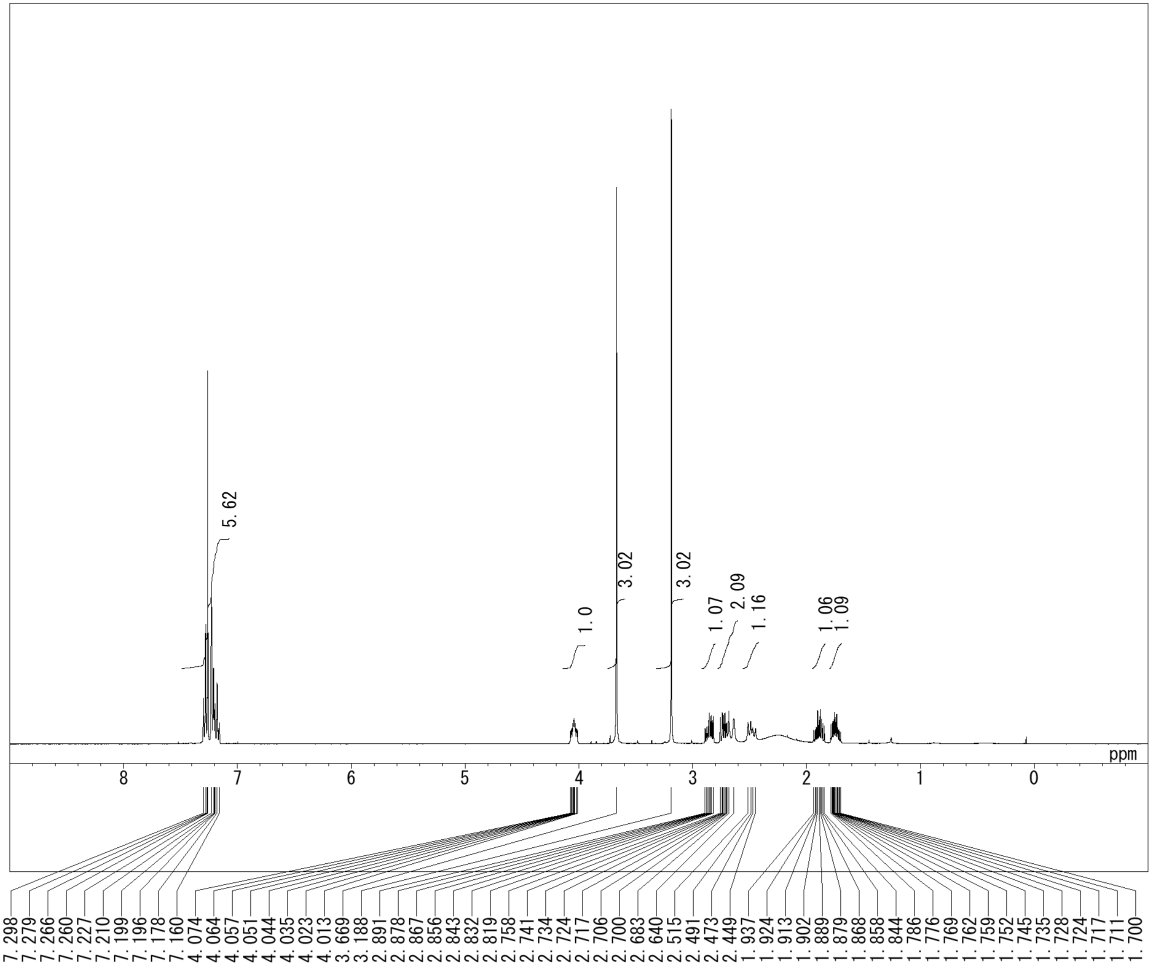
Comment BN013003-13C-C1_20191209_01
Date 2019/Dec/09
ObsNuc ^{13}C
ExMode CARBON_001
ObsFreq 100.66 MHz
Scan 256
AcqTime 1.3631 s
Acc. Interval 3.3631 s
Spinning 20.0 Hz
Temperature 40.0 ℃

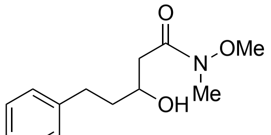




8f

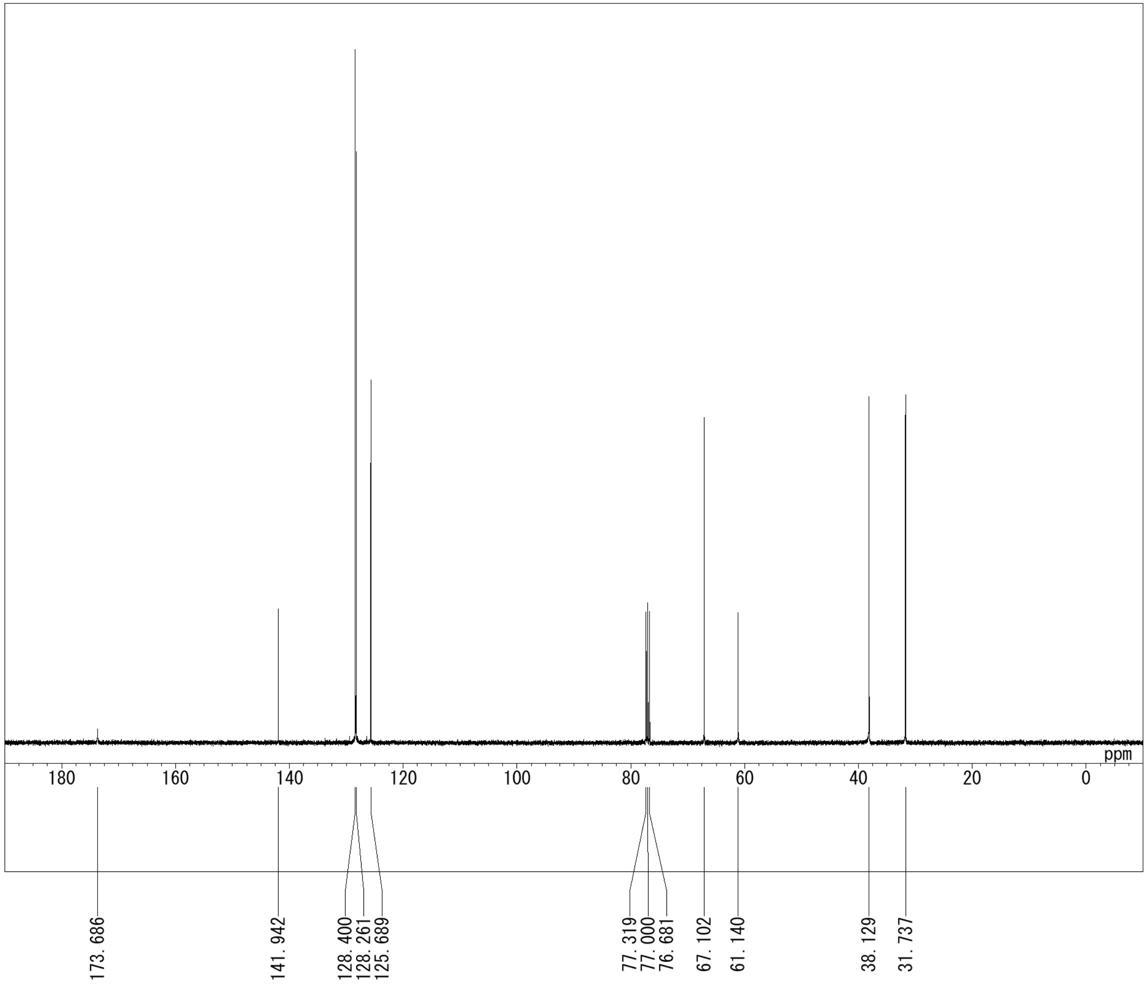
```
Comment    BN010029-1H-C1_20190909_0
    1
Date          2019/Sep/09
ObsNuc                  1H
ExMode         PROTON_001
ObsFreq             400.27 MHz
Scan                16
AcqTime               2.5559 s
Acc. Interval         5.5559 s
Spinning            16.0 Hz
Temperature         40.0 ℃
```

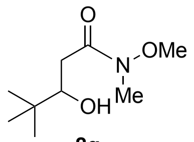




8f

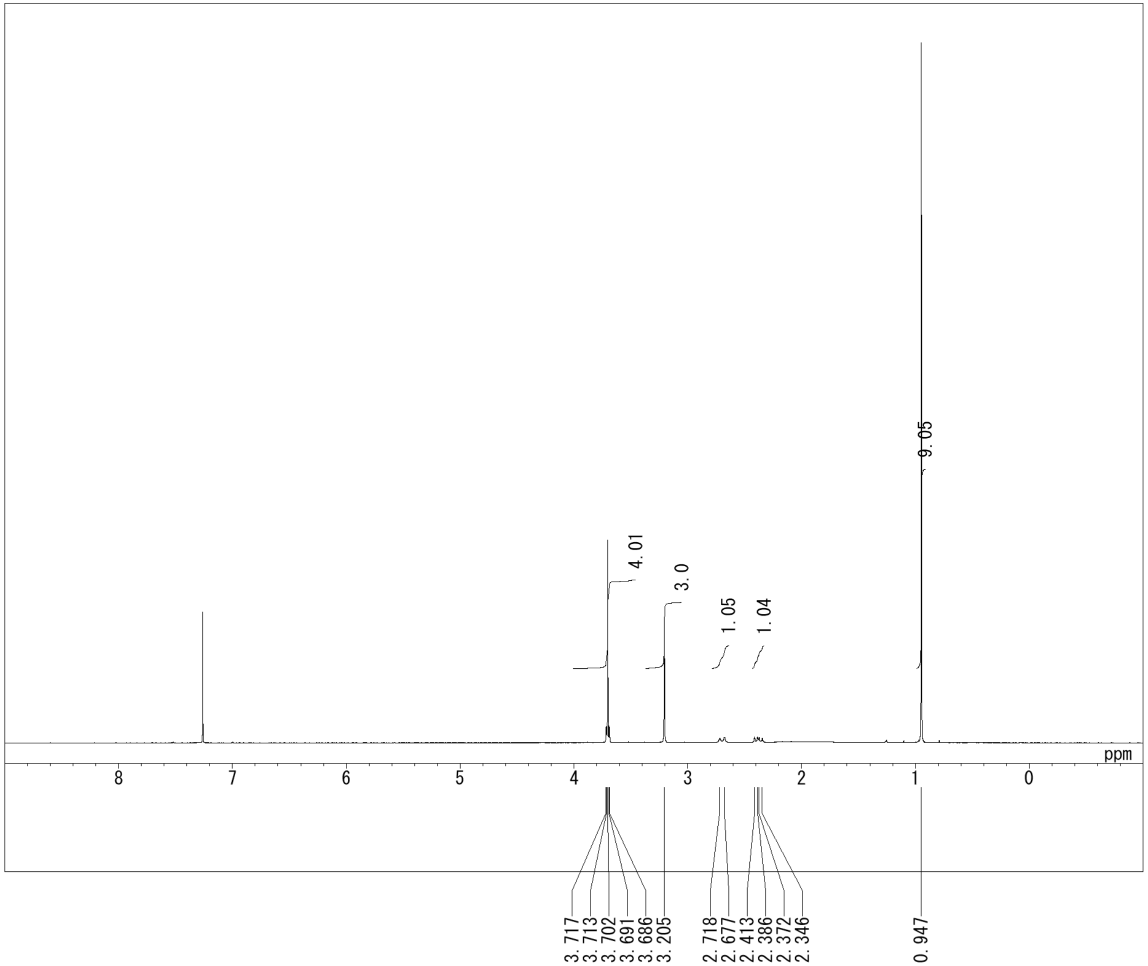
```
Comment    BN010029-13C-C1_20190910_
    01
Date           2019/Sep/10
ObsNuc                 13C
ExMode          CARBON_001
ObsFreq             100.66 MHz
Scan                256
AcqTime               1.3631 s
Acc. Interval         3.3631 s
Spinning             20.0 Hz
Temperature          40.0 ℃
```

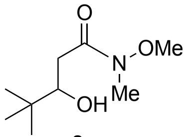




8g

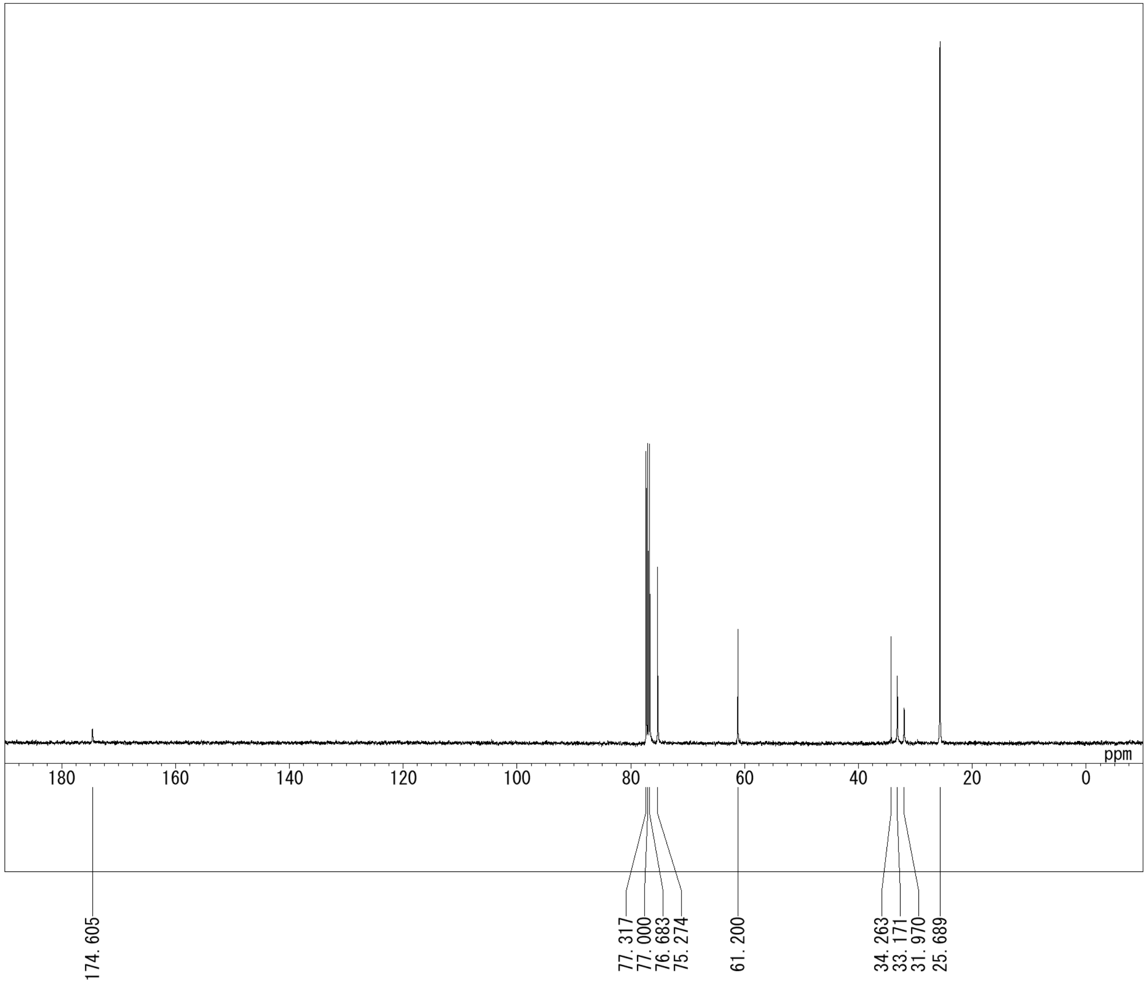
```
Comment    BNO10014-1H-C1_20190905_0
    1
Date          2019/Sep/05
ObsNuc                 1H
ExMode        PROTON_001
ObsFreq             400.27 MHz
Scan                32
AcqTime               2.5559 s
Acc. Interval         5.5559 s
Spinning            16.0 Hz
Temperature         40.0 ℃
```

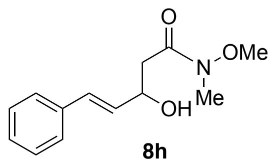




8g

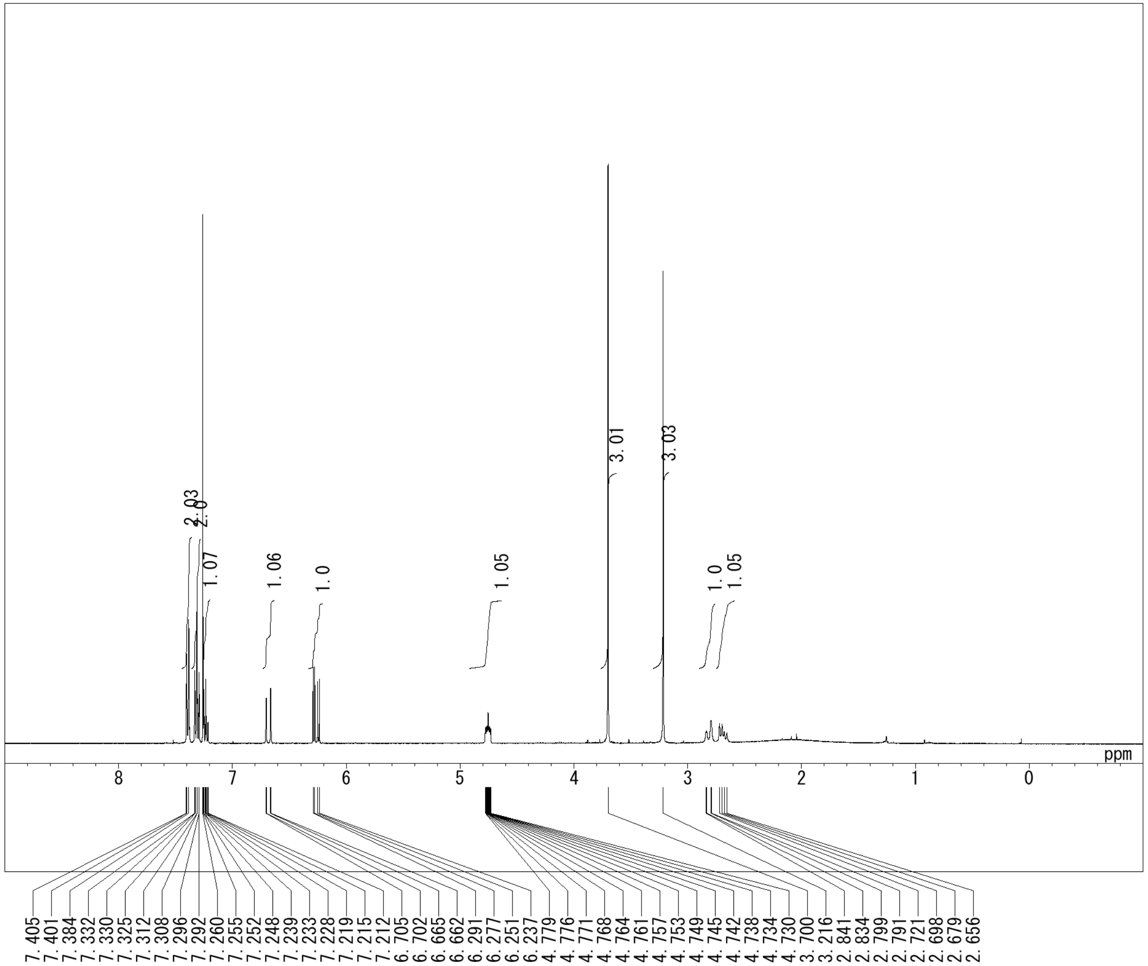
Comment	BN010014-13C-C1_20190905_01
Date	2019/Sep/05
ObsNuc	^{13}C
ExMode	CARBON_001
ObsFreq	100.66 MHz
Scan	1024
AcqTime	1.3631 s
Acc. Interval	3.3631 s
Spinning	20.0 Hz
Temperature	40.0 ℃

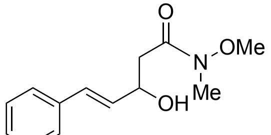




8h

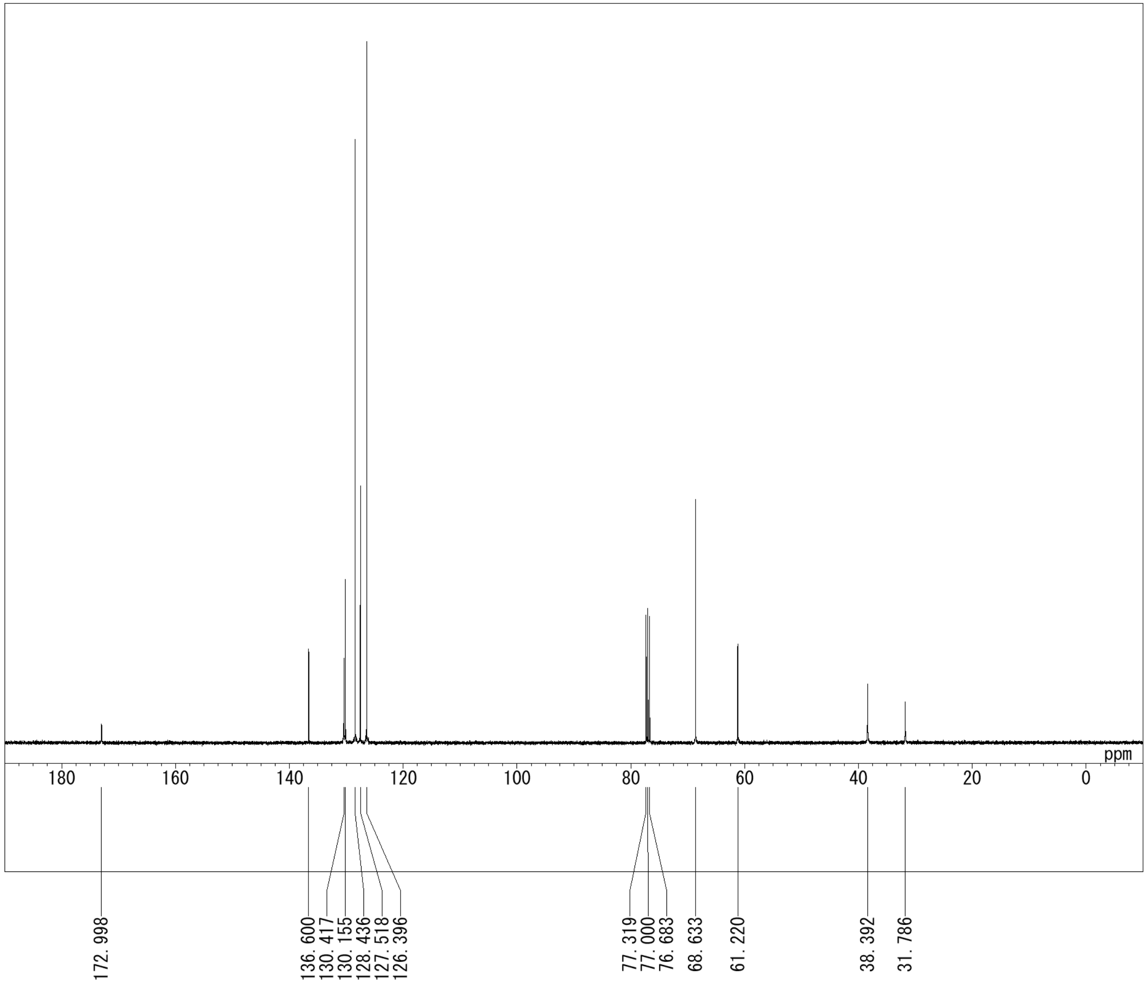
Comment BN010025-1-1H-C1_20190827
_01
Date 2019/Aug/27
ObsNuc ^{1}H
ExMode PROTON_001
ObsFreq 399.45 MHz
Scan 16
AcqTime 2.569 s
Acc. Interval 5.569 s
Spinning 16.0 Hz
Temperature 25.0 ℃

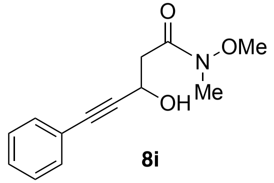




8h

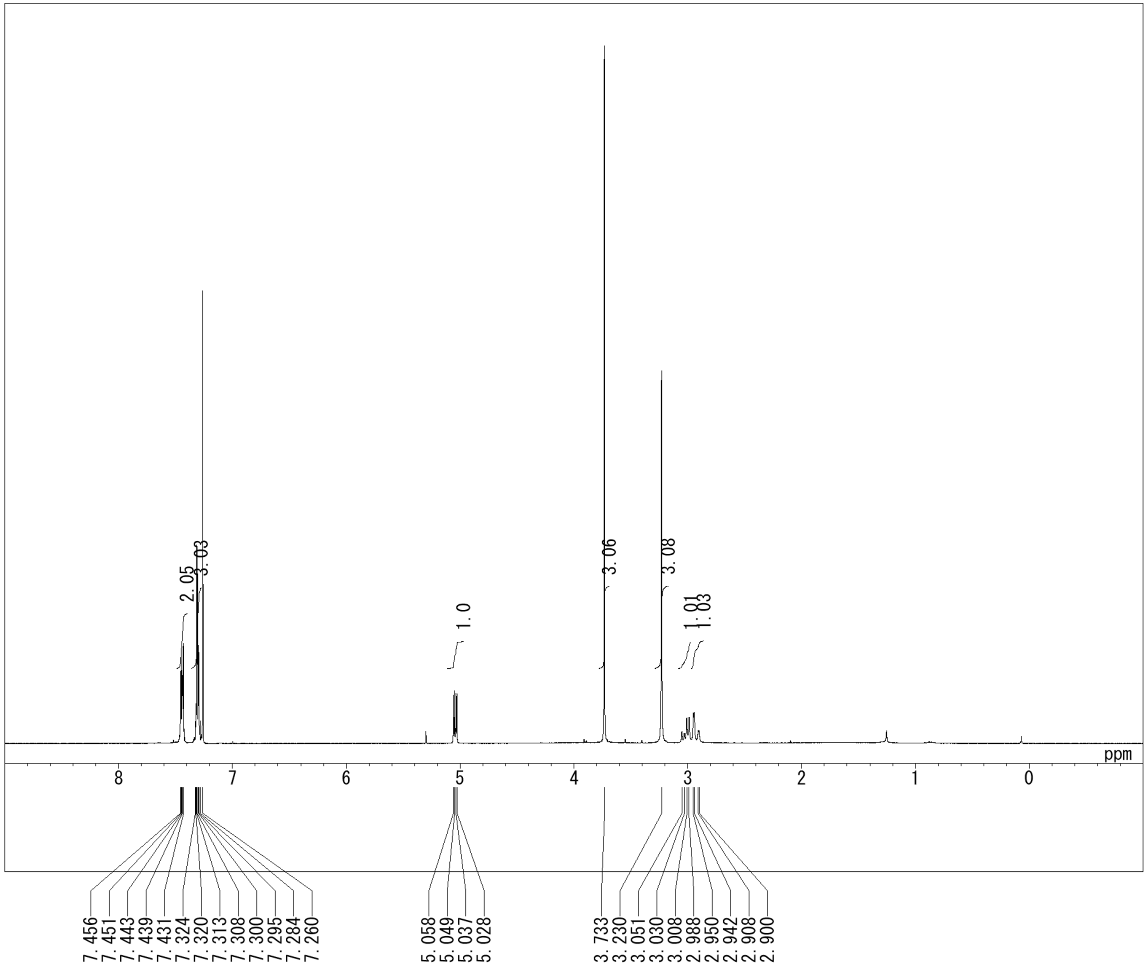
```
Comment     BNO10025-13C-C1_20190827_
    01
Date           2019/Aug/27
ObsNuc                 13C
ExMode          CARBON_001
ObsFreq            100.66 MHz
Scan               512
AcqTime              1.3631 s
Acc. Interval        3.3631 s
Spinning            20.0 Hz
Temperature         40.0 ℃
```

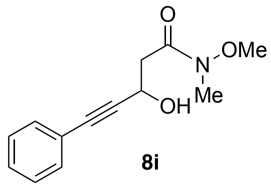




8i

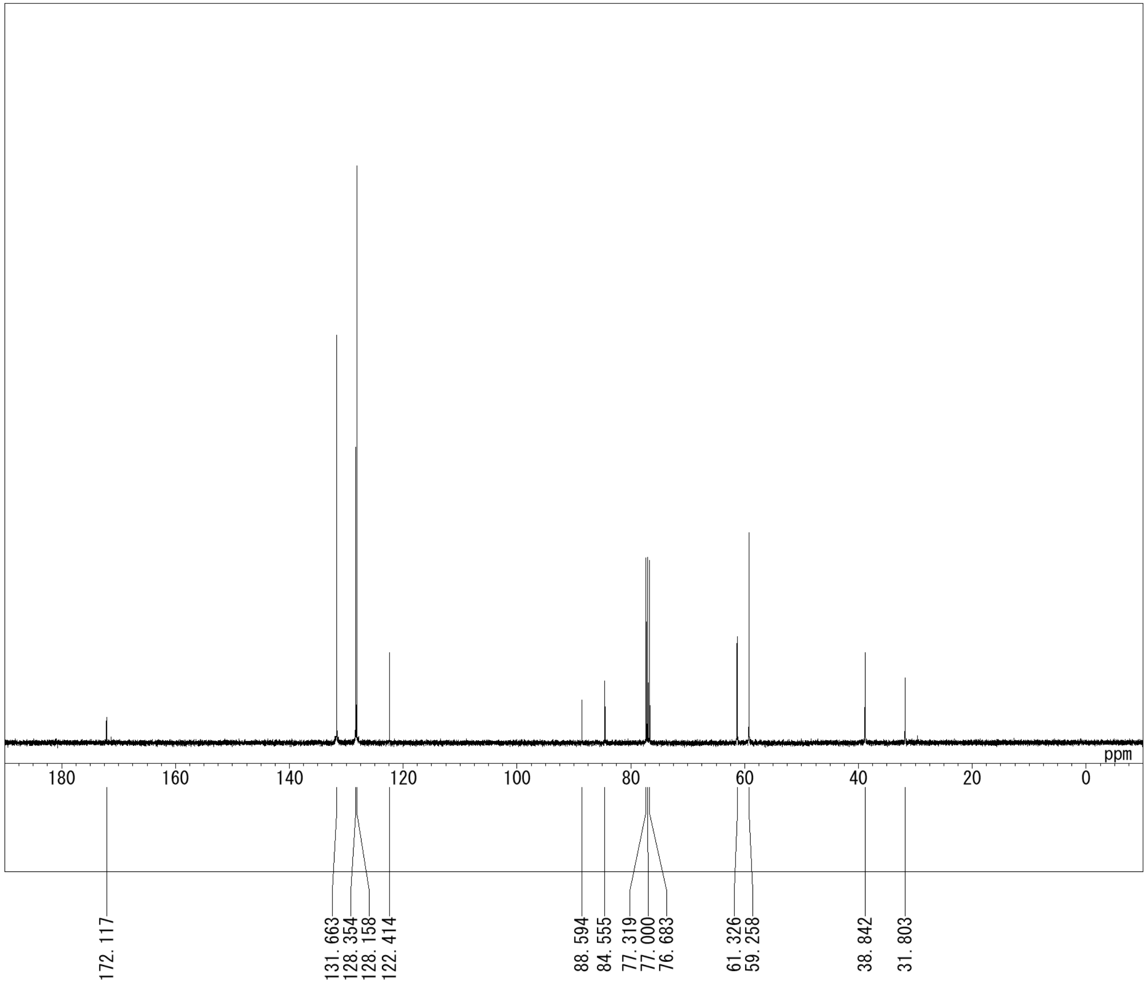
```
Comment    BN013001-1H-C1_20191206_0
    2
Date            2019/Dec/06
ObsNuc                   ¹H
ExMode           PROTON_001
ObsFreq              400.27 MHz
Scan                 16
AcqTime                2.5559 s
Acc. Interval          5.5559 s
Spinning              16.0 Hz
Temperature           40.0 ℃
```

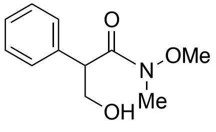




8i

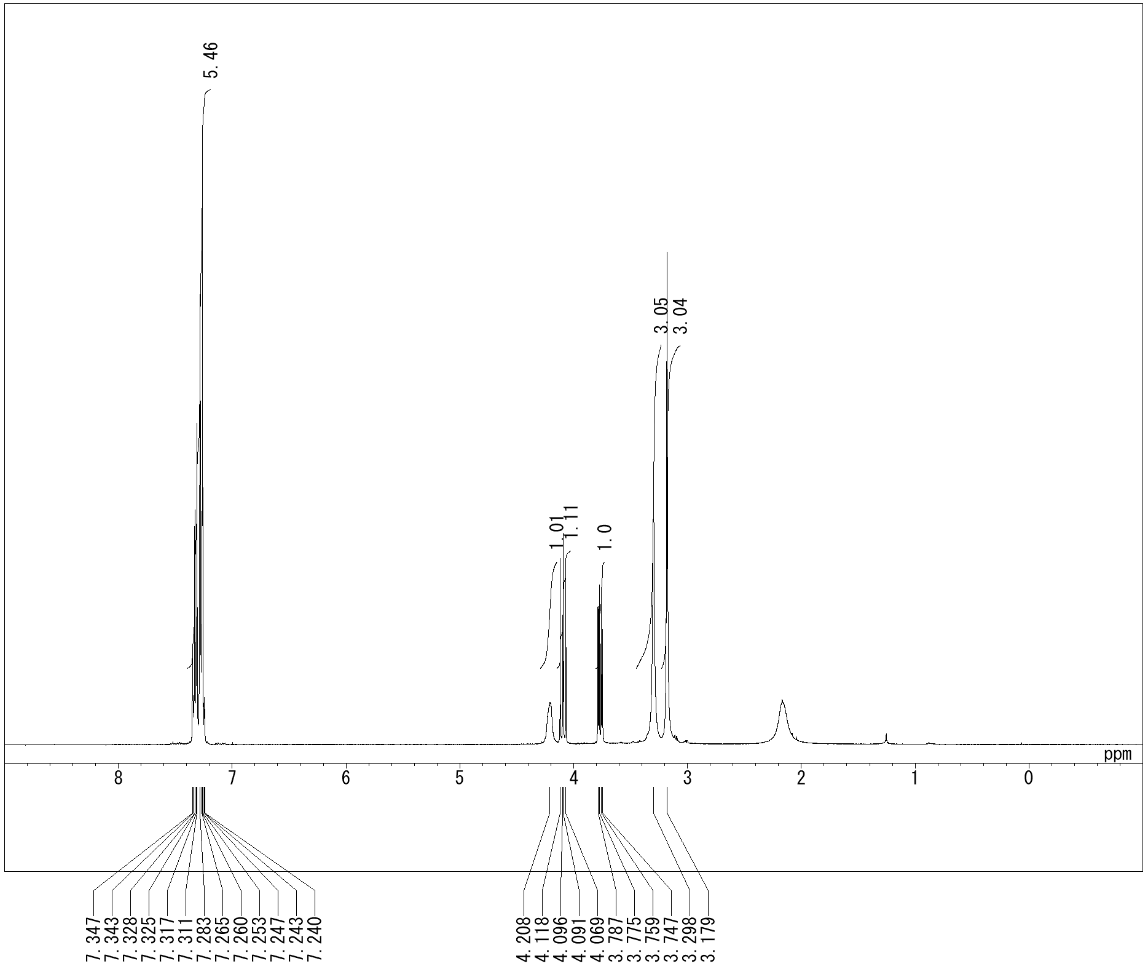
```
Comment    BN013001-13C-C1_20191206_
    01
Date          2019/Dec/06
ObsNuc                 13C
ExMode         CARBON_001
ObsFreq              100.66 MHz
Scan                 336
AcqTime                1.3631 s
Acc. Interval          3.3631 s
Spinning              20.0 Hz
Temperature           40.0 ℃
```

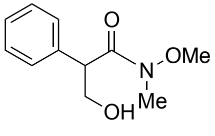




8j

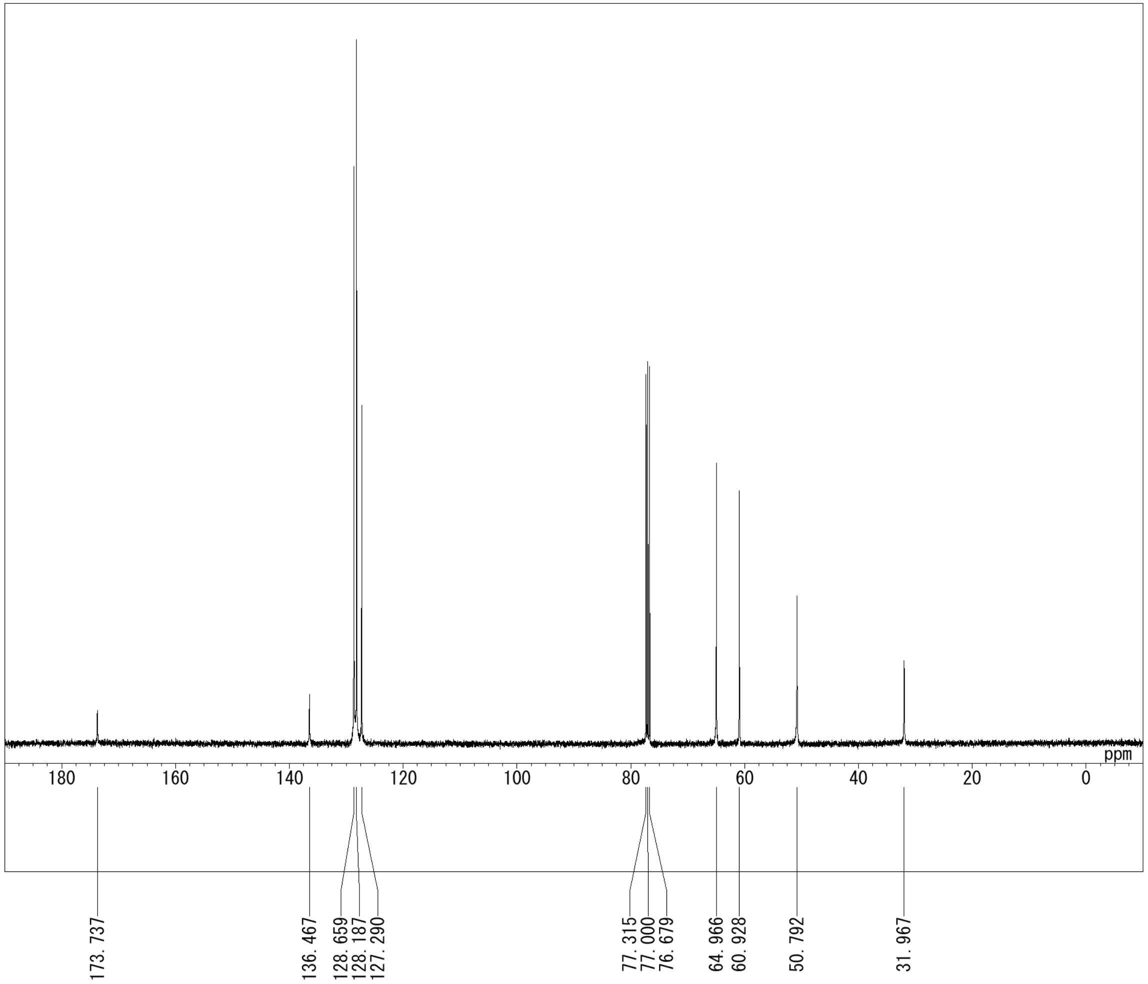
Comment	BN010013-1H_20190906_01
Date	2019/Sep/06
ObsNuc	^{1}H
ExMode	PROTON_001
ObsFreq	399.45 MHz
Scan	16
AcqTime	2.569 s
Acc. Interval	5.569 s
Spinning	16.0 Hz
Temperature	25.0 ℃
Solvent	cdcl3

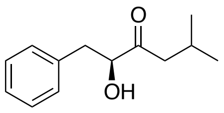




8j

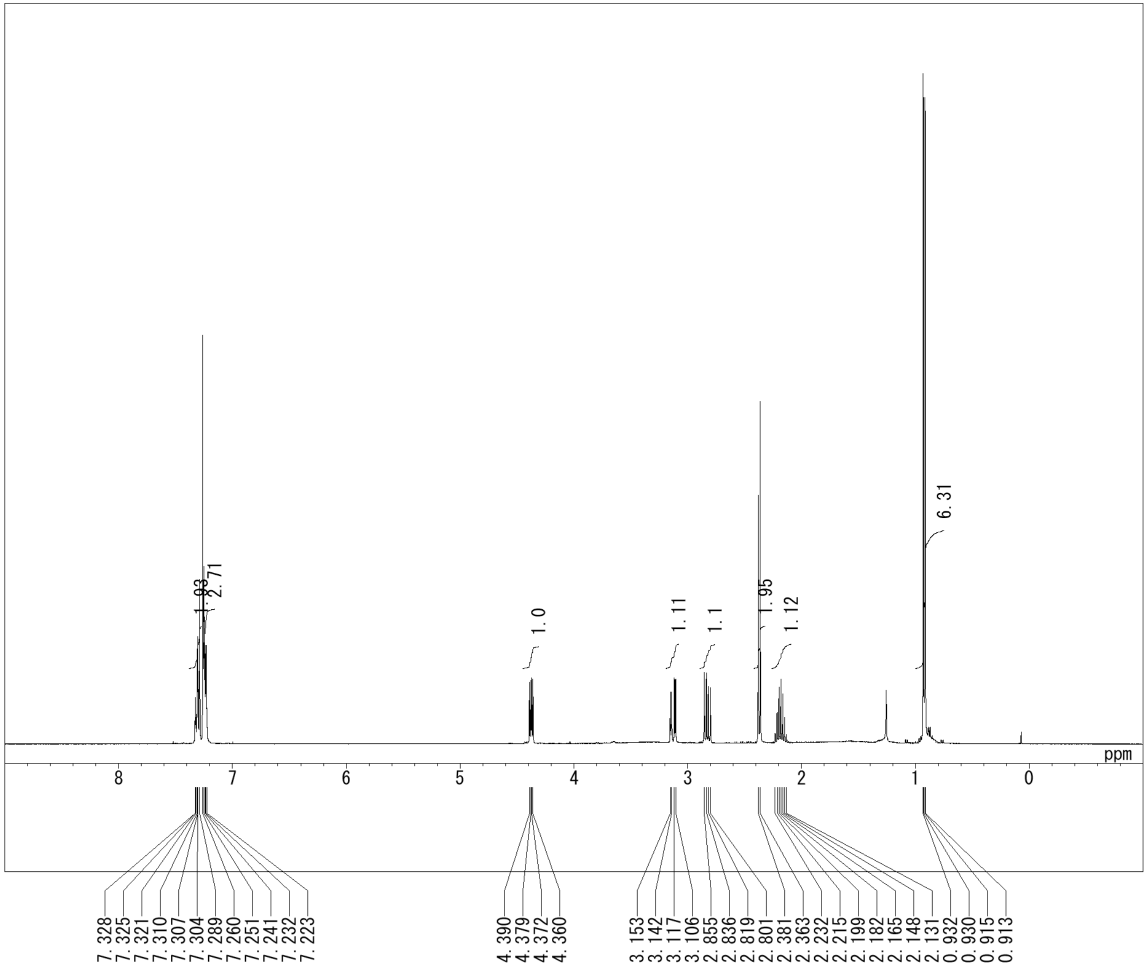
Comment	BN003067-1_13C_20180326_01
Date	2018/Mar/26
ObsNuc	^{13}C
ExMode	CARBON_001
ObsFreq	100.66 MHz
Scan	512
AcqTime	1.3631 s
Acc. Interval	3.3631 s
Spinning	20.0 Hz
Temperature	25.0 ℃

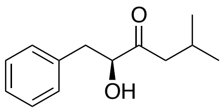




sattabacin (**9**)

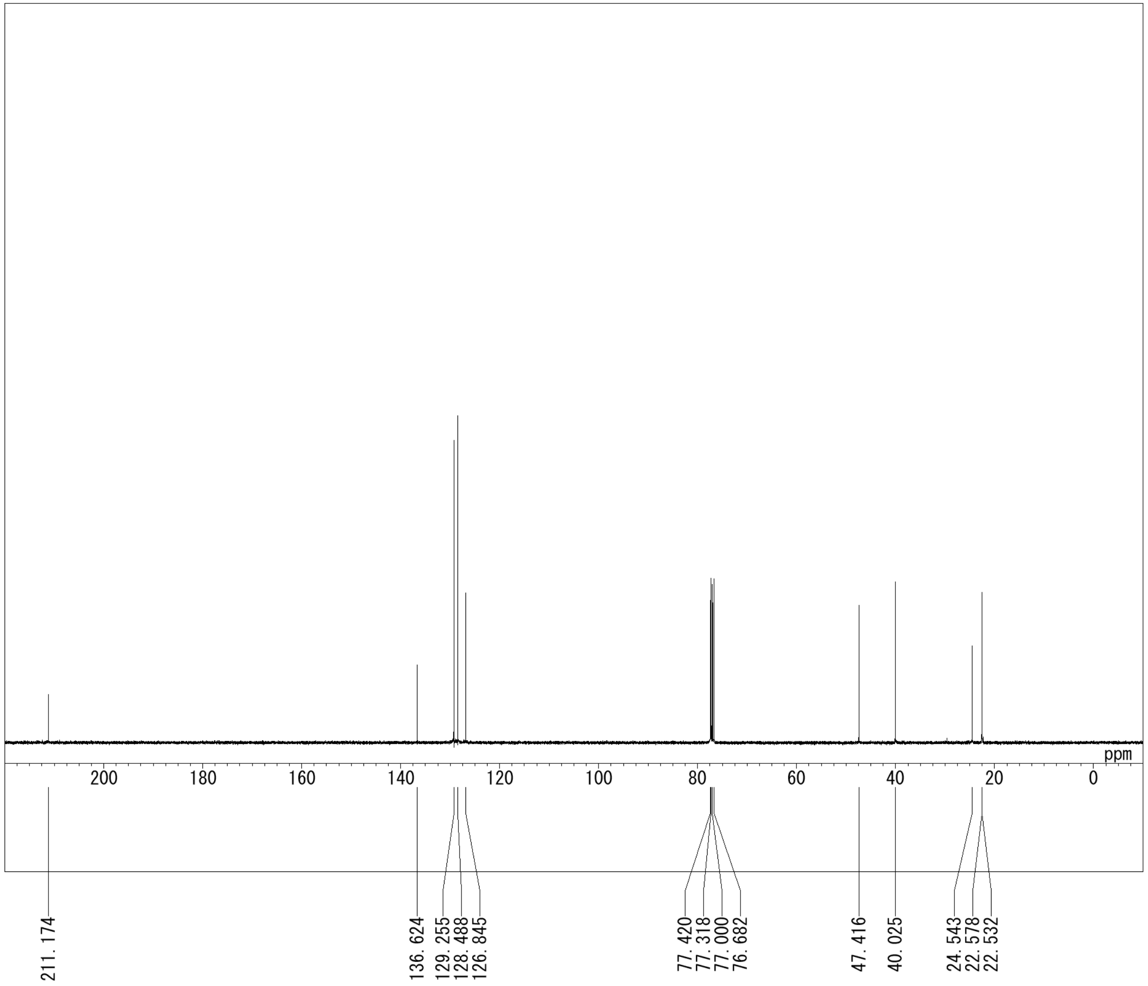
```
Comment     NAT-09-059-pure-2_2020030
    2_01
Date           2020/Mar/02
ObsNuc                  1H
ExMode         PROTON_001
ObsFreq            399.45 MHz
Scan                   16
AcqTime                 2.569 s
Acc. Interval           5.569 s
Spinning               16.0 Hz
Temperature            25.0 ℃
```

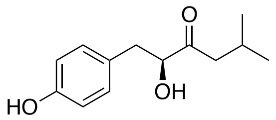




sattabacin (**9**)

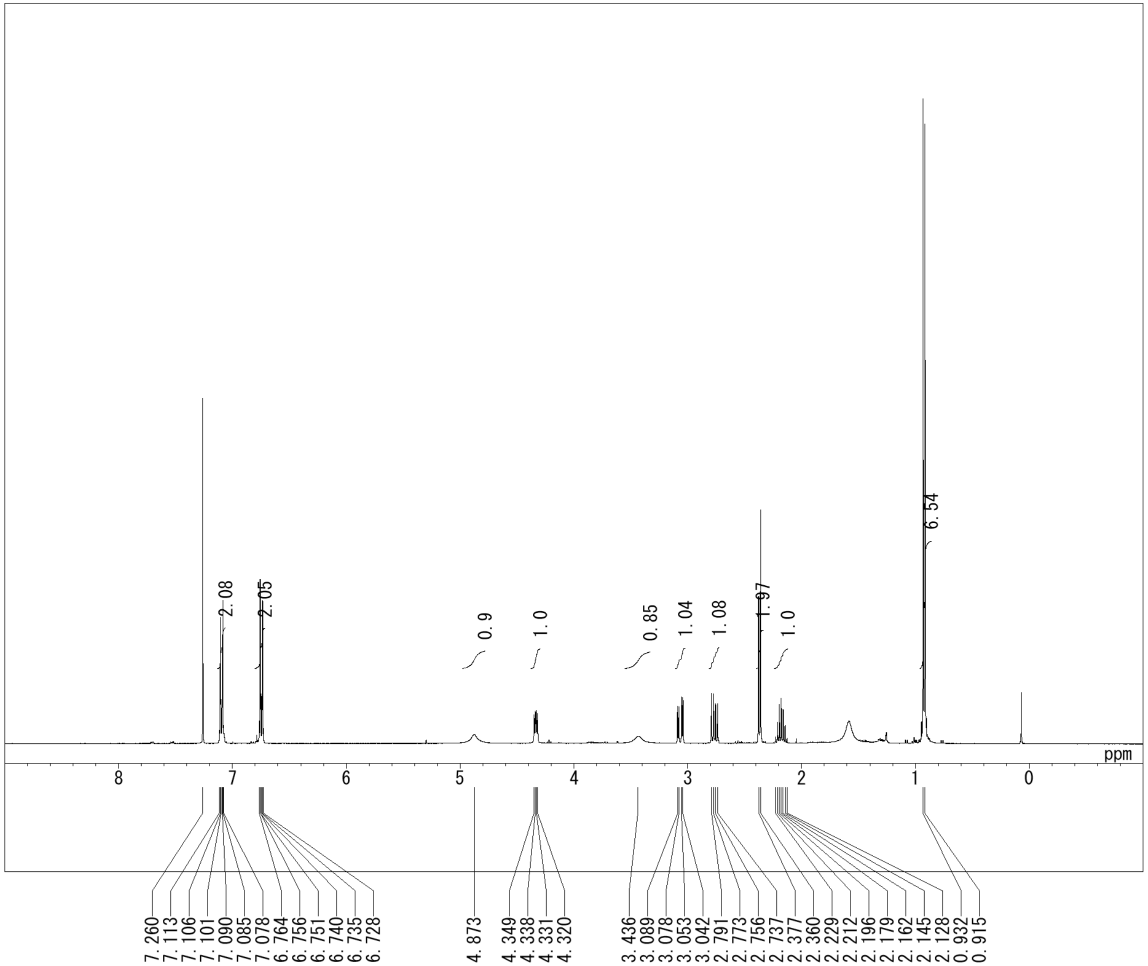
```
Comment     OJN-02005-pure-CDCl3-13C_
    20190610_01
Date          2019/Jun/10
ObsNuc                 13C
ExMode        CARBON_001
ObsFreq              100.45 MHz
Scan                1024
AcqTime                1.3631 s
Acc. Interval          3.3631 s
Spinning              20.0 Hz
Temperature           25.0 ℃
```

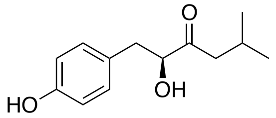




4-hydroxy sattabacin (**10**)

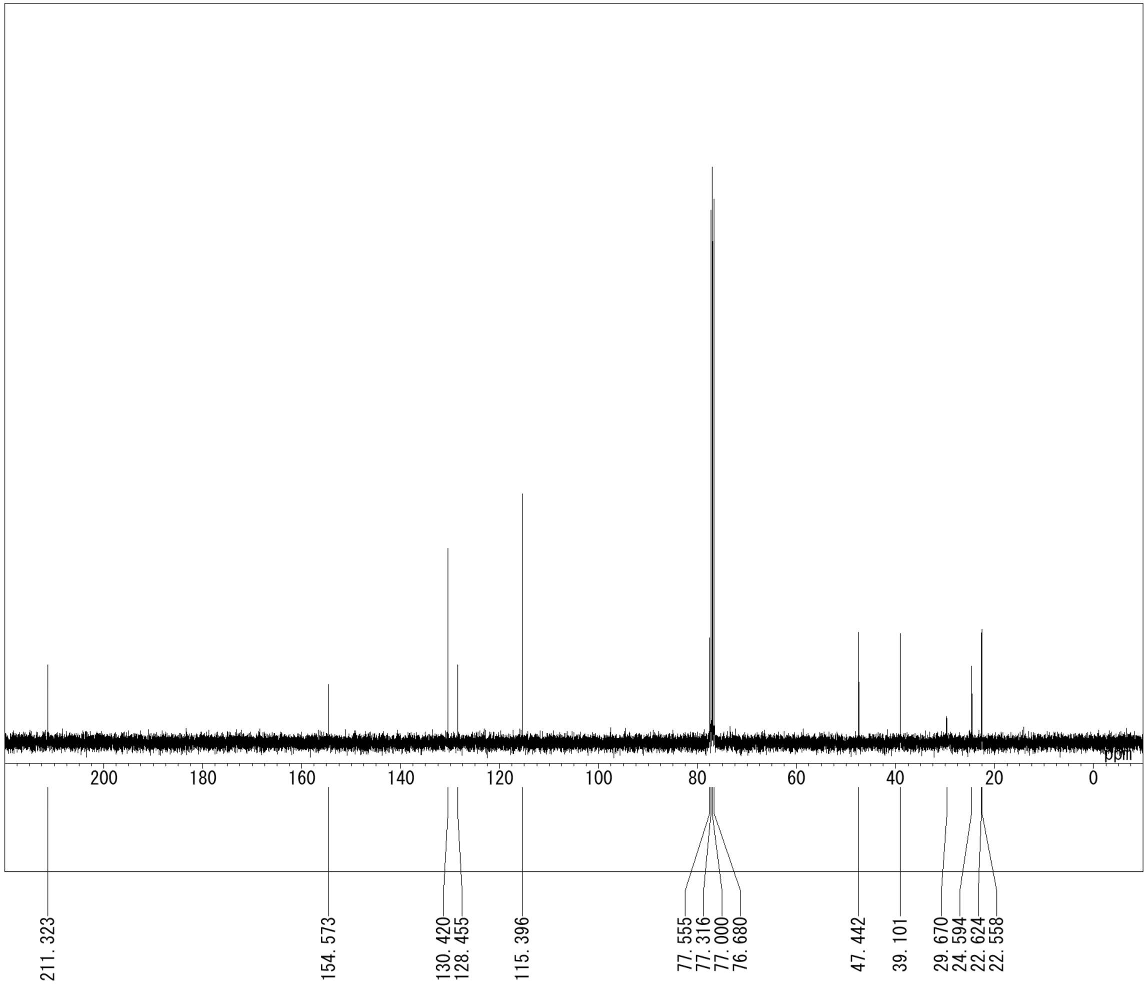
```
Comment     NAT-4-hydroxysattabacin-p
    ure3_20200403_01
Date            2020/Apr/03
ObsNuc                   ¹H
ExMode           PROTON_001
ObsFreq              399.45 MHz
Scan                     32
AcqTime                   2.569 s
Acc. Interval             5.569 s
Spinning                 16.0 Hz
Temperature              25.0 ℃
```

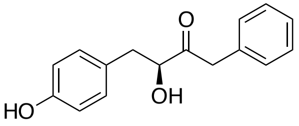




4-hydroxy sattabacin (**10**)

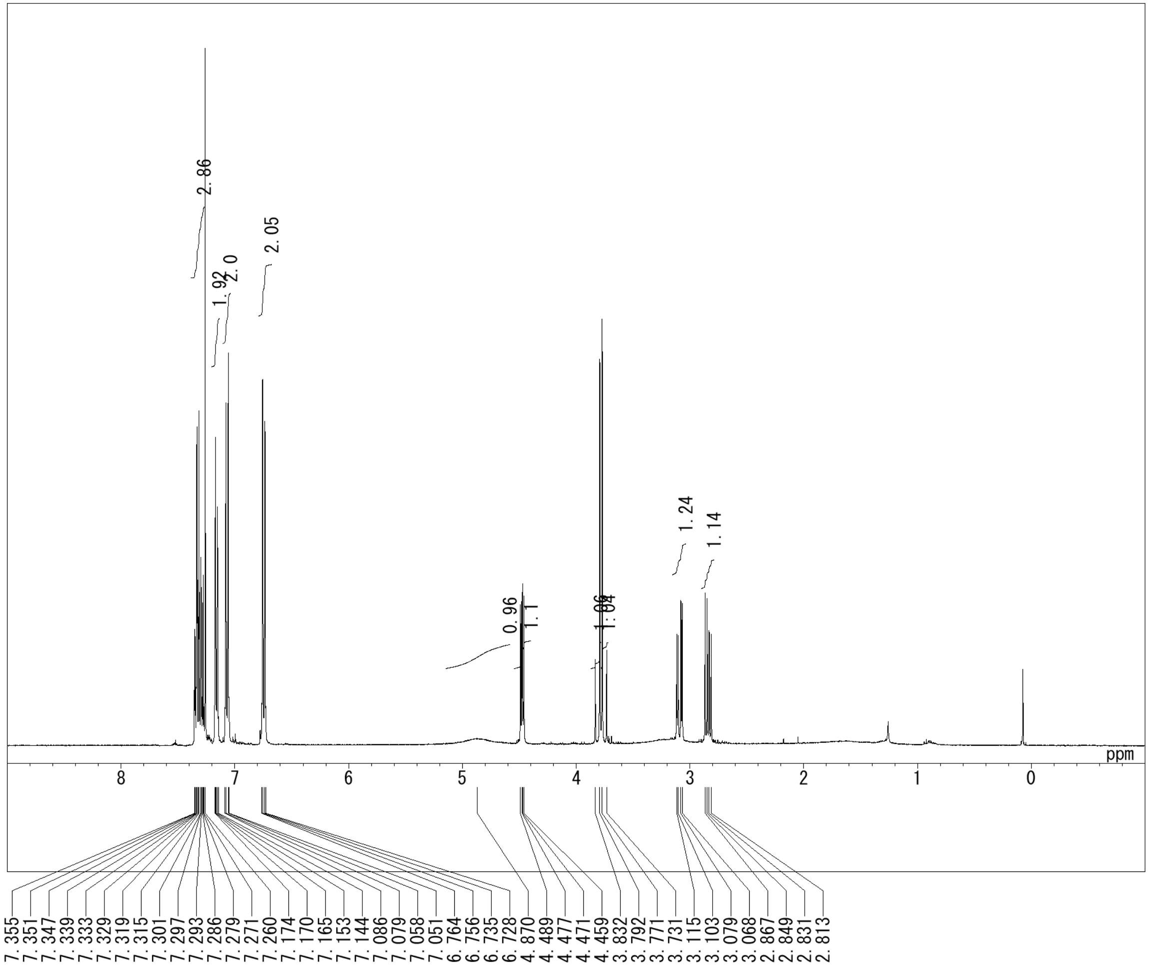
```
Comment    NAT-09-062-13C_20200303_0
    1
Date          2020/Mar/03
ObsNuc                 13C
ExMode         CARBON_001
ObsFreq              100.45 MHz
Scan                 256
AcqTime                1.3631 s
Acc. Interval          3.3631 s
Spinning              20.0 Hz
Temperature           25.0 ℃
```

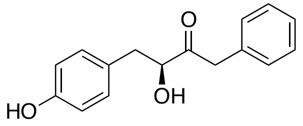




kurasoin A (**11**)

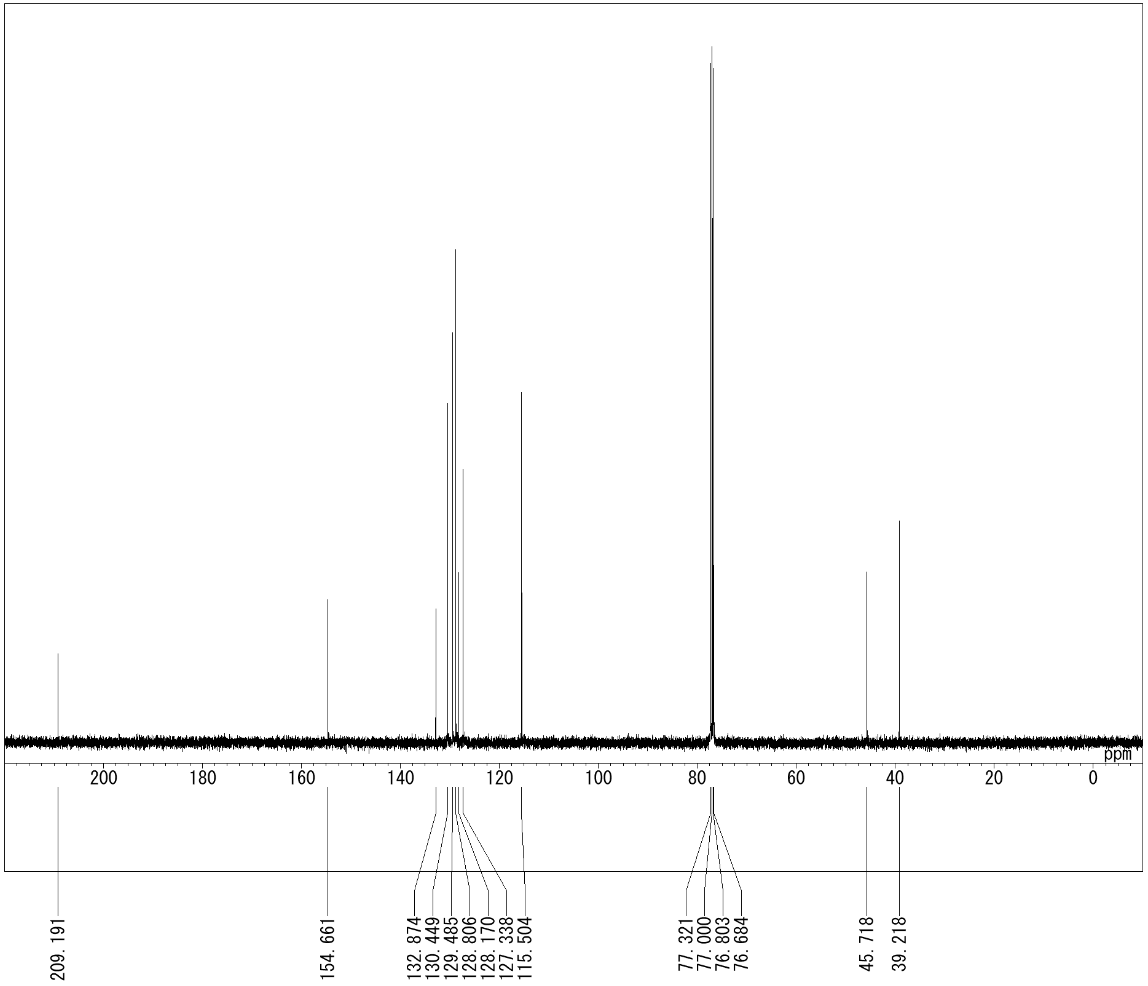
```
Comment     NAT-kurasoinA-pure2_20200
    325_01
Date            2020/Mar/25
ObsNuc                   1H
ExMode         PROTON_001
ObsFreq             399.45 MHz
Scan                    16
AcqTime                  2.569 s
Acc. Interval            5.569 s
Spinning                16.0 Hz
Temperature             25.0 ℃
```

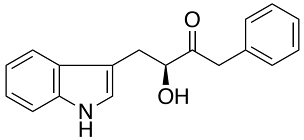




kurasoin A (**11**)

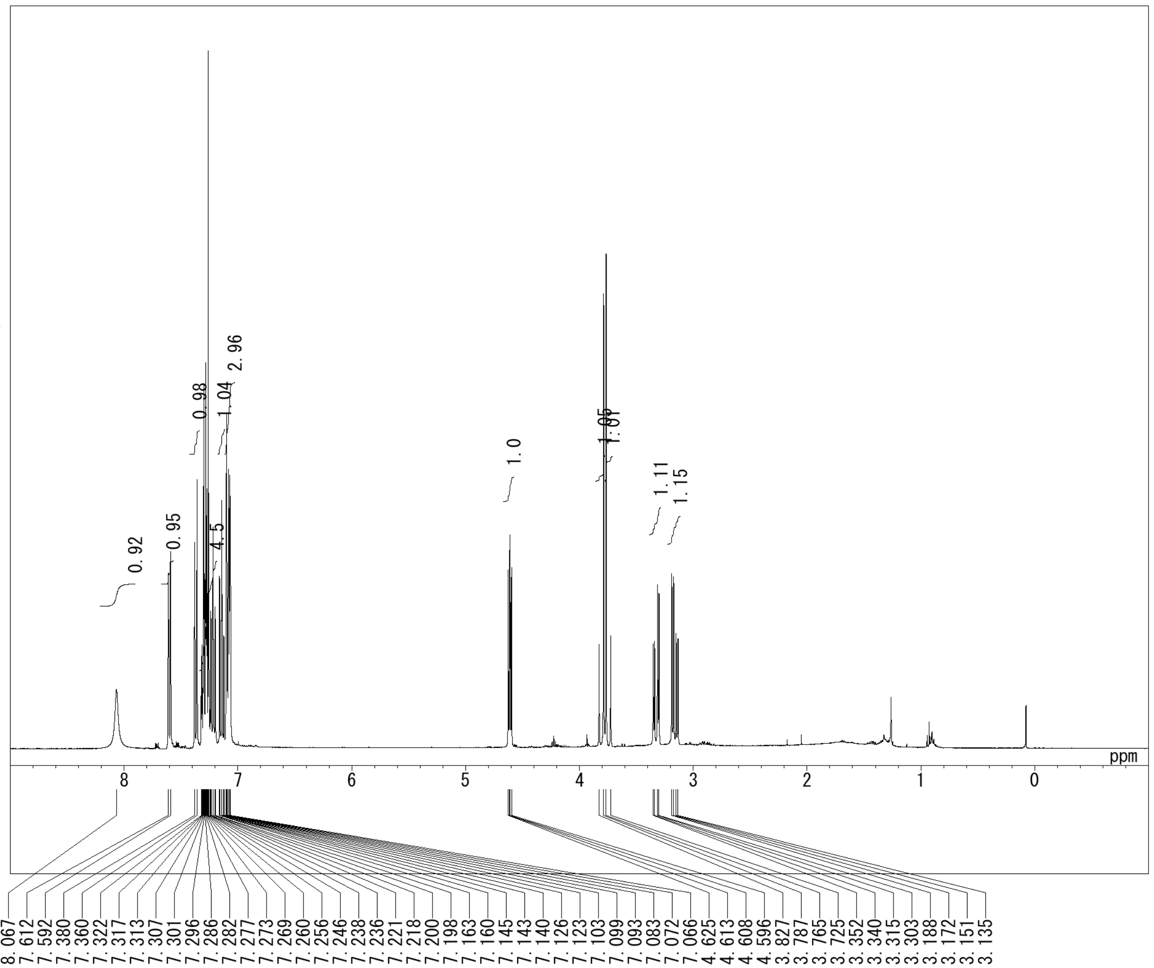
```
Comment    NAT-kurasoinA-13C_2020032
    6_01
Date           2020/Mar/26
ObsNuc                 13C
ExMode          CARBON_001
ObsFreq              100.45 MHz
Scan                 1024
AcqTime                 1.3631 s
Acc. Interval           3.3631 s
Spinning               20.0 Hz
Temperature            25.0 ℃
```

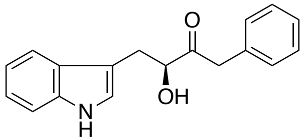




kurasoin B (**12**)

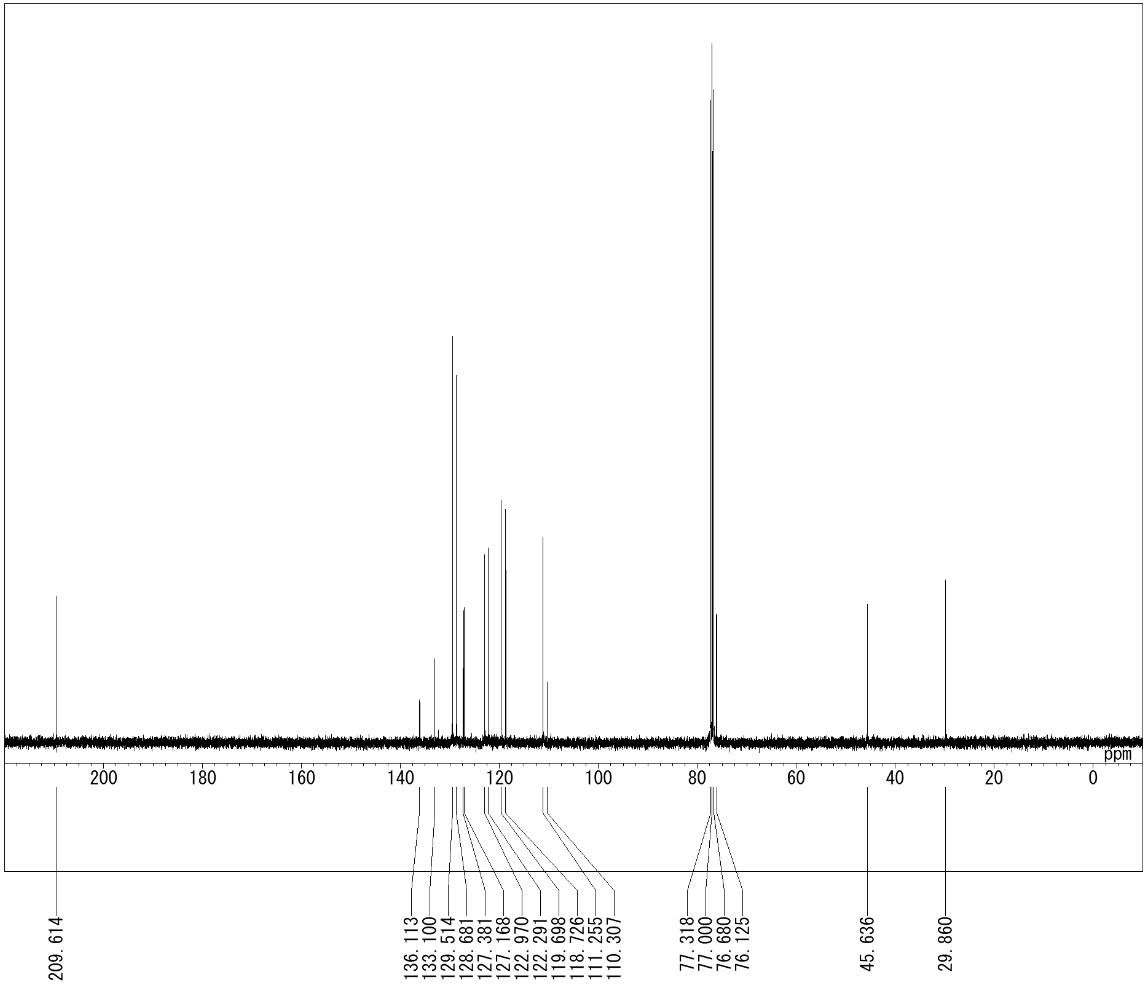
Comment   NAT-kurasoinB-1H-2_202003
    31_01
Date   2020/Mar/31
ObsNuc ^{1}H
ExMode   PROTON_001
ObsFreq   399.45 MHz
Scan   64
AcqTime   2.569 s
Acc. Interval   5.569 s
Spinning   16.0 Hz
Temperature   25.0 ℃

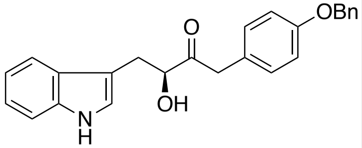




kurasoin B (**12**)

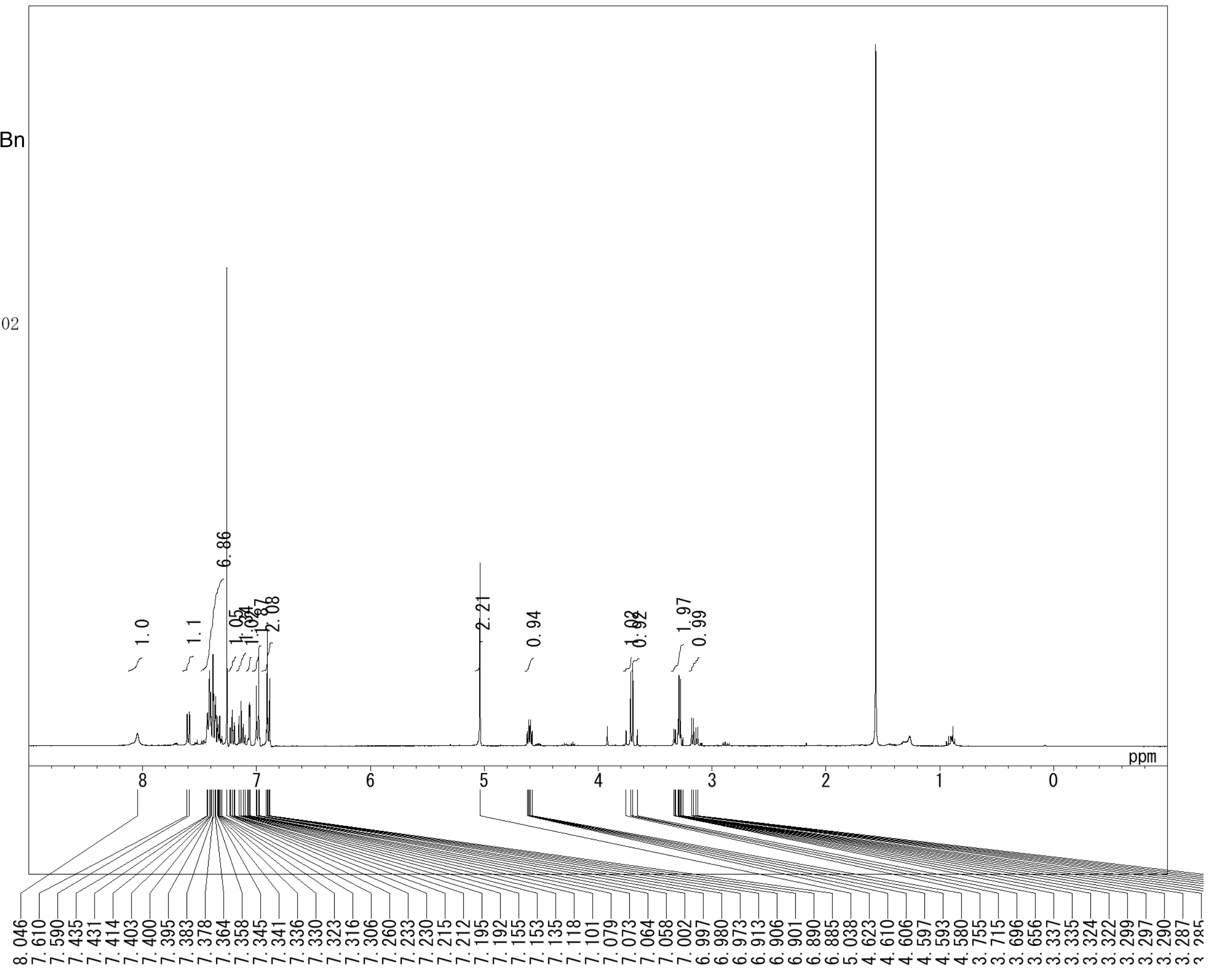
Comment   NAT-kurasoinB-13C-6_20200
    331_01
Date   2020/Mar/31
ObsNuc ^{13}C
ExMode   CARBON_001
ObsFreq   100.45 MHz
Scan   1024
AcqTime   1.3631 s
Acc. Interval   3.3631 s
Spinning   20.0 Hz
Temperature   25.0 ℃

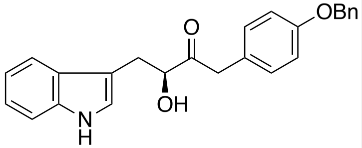




13

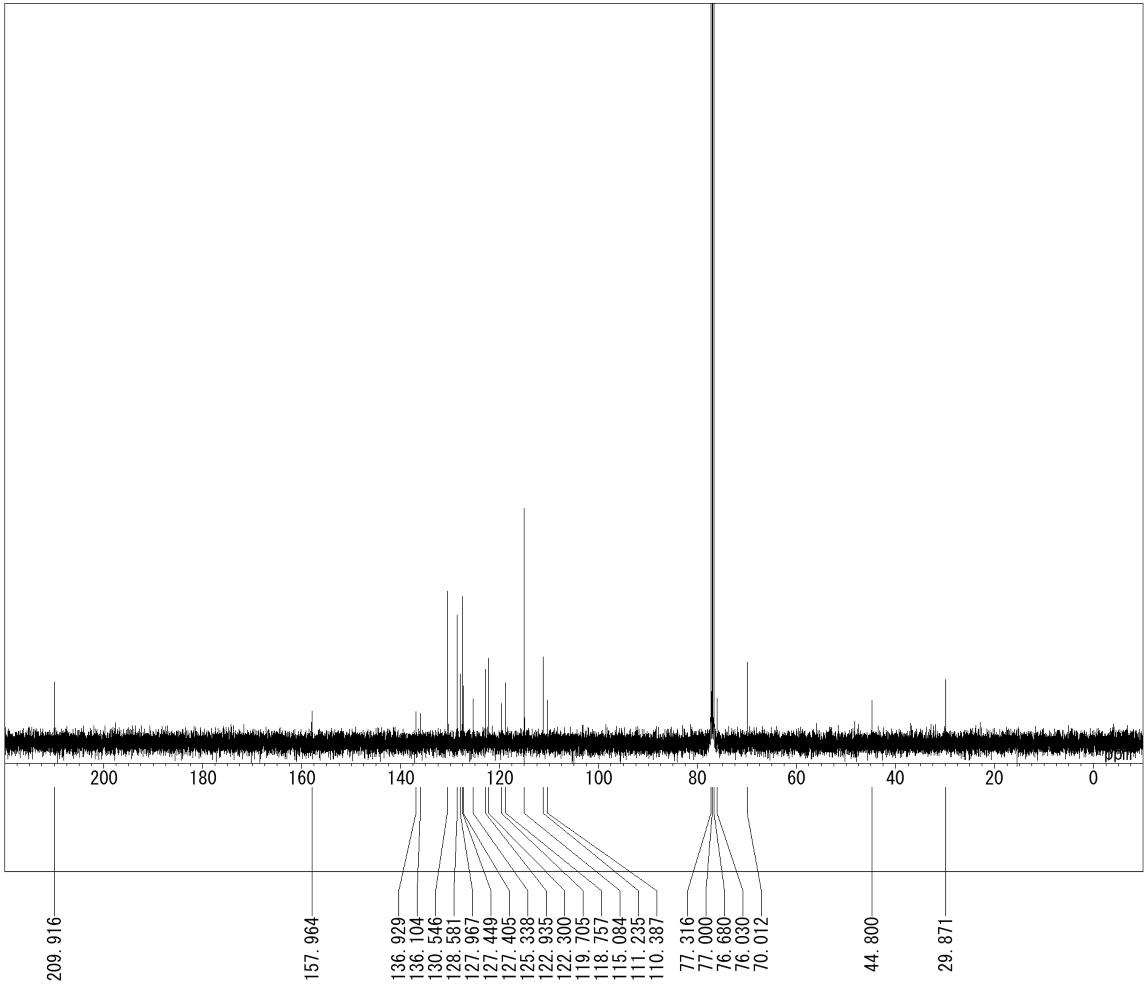
```
Comment    NAT-indole-obn-pure-6_202
    00613_01
Date           2020/Jun/13
ObsNuc                  1H
ExMode         PROTON_001
ObsFreq              399.45 MHz
Scan                  32
AcqTime                2.569 s
Acc. Interval          5.569 s
Spinning              16.0 Hz
Temperature           25.0 ℃
```

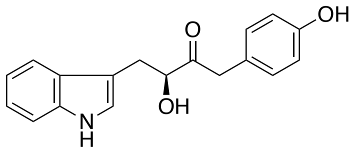




13

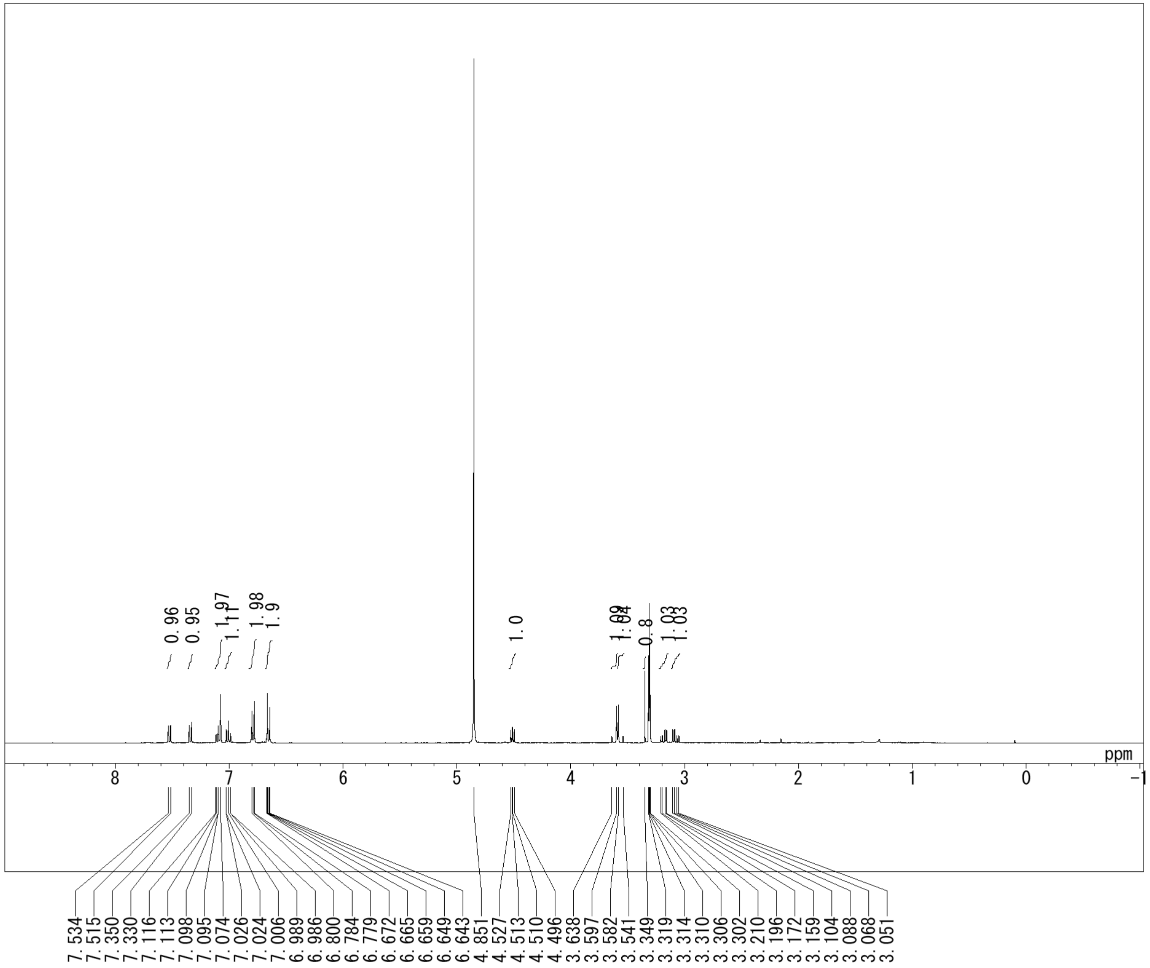
```
Comment    NAT-indole-obn-13C-2_2020
    0613_01
Date          2020/Jun/13
ObsNuc               13C
ExMode         CARBON_001
ObsFreq              100.45 MHz
Scan                1024
AcqTime                1.3631 s
Acc. Interval          3.3631 s
Spinning              20.0 Hz
Temperature           25.0 ℃
```

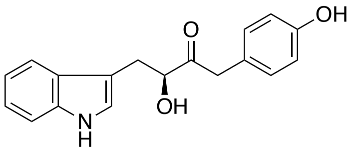




soraphinol A (**17**)

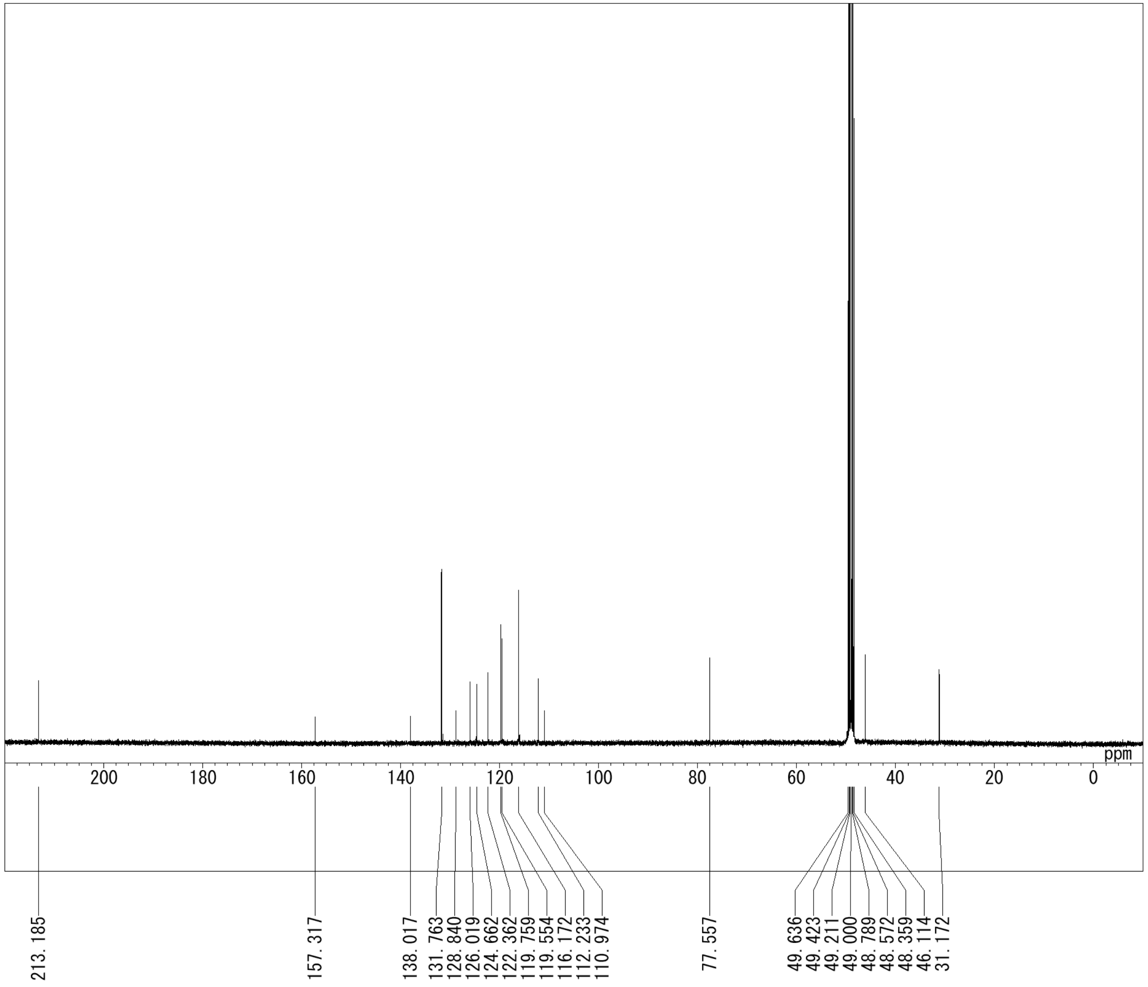
Comment NAT-soraphinolA-pure-4_20
200713_01
Date 2020/Jul/13
ObsNuc ^{1}H
ExMode PROTON_001
ObsFreq 399.45 MHz
Scan 16
AcqTime 2.569 s
Acc. Interval 5.569 s
Spinning 16.0 Hz
Temperature 25.0 ℃

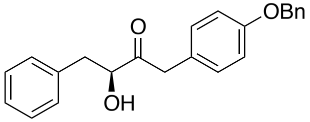




soraphinol A (**17**)

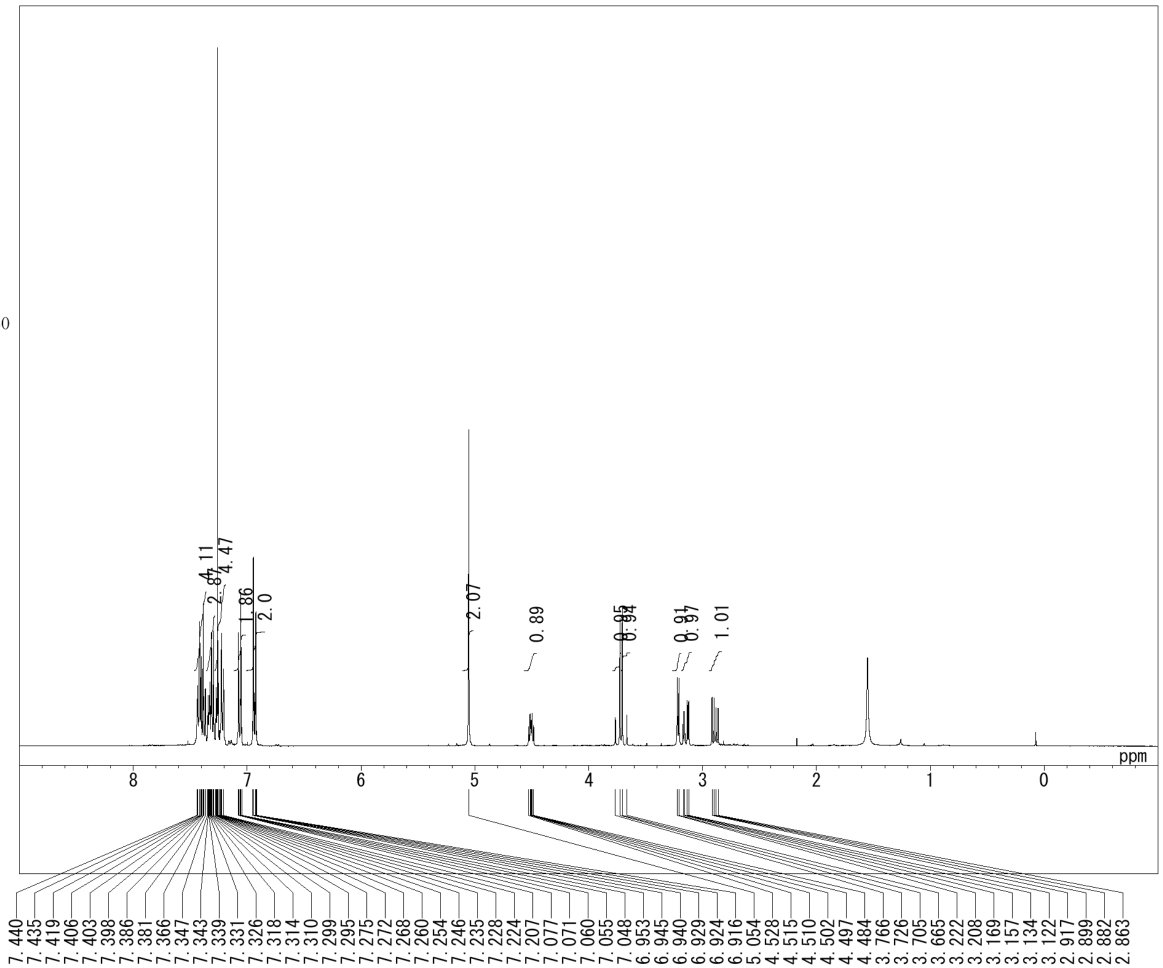
```
Comment     NAT-soraphinolA-13C_20200
    713_01
Date            2020/Jul/13
ObsNuc                   13C
ExMode          CARBON_001
ObsFreq                100.66 MHz
Scan                10000
AcqTime                  1.3631 s
Acc. Interval            3.3631 s
Spinning                20.0 Hz
Temperature             40.0 ℃
```

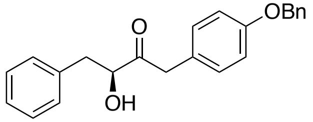




14

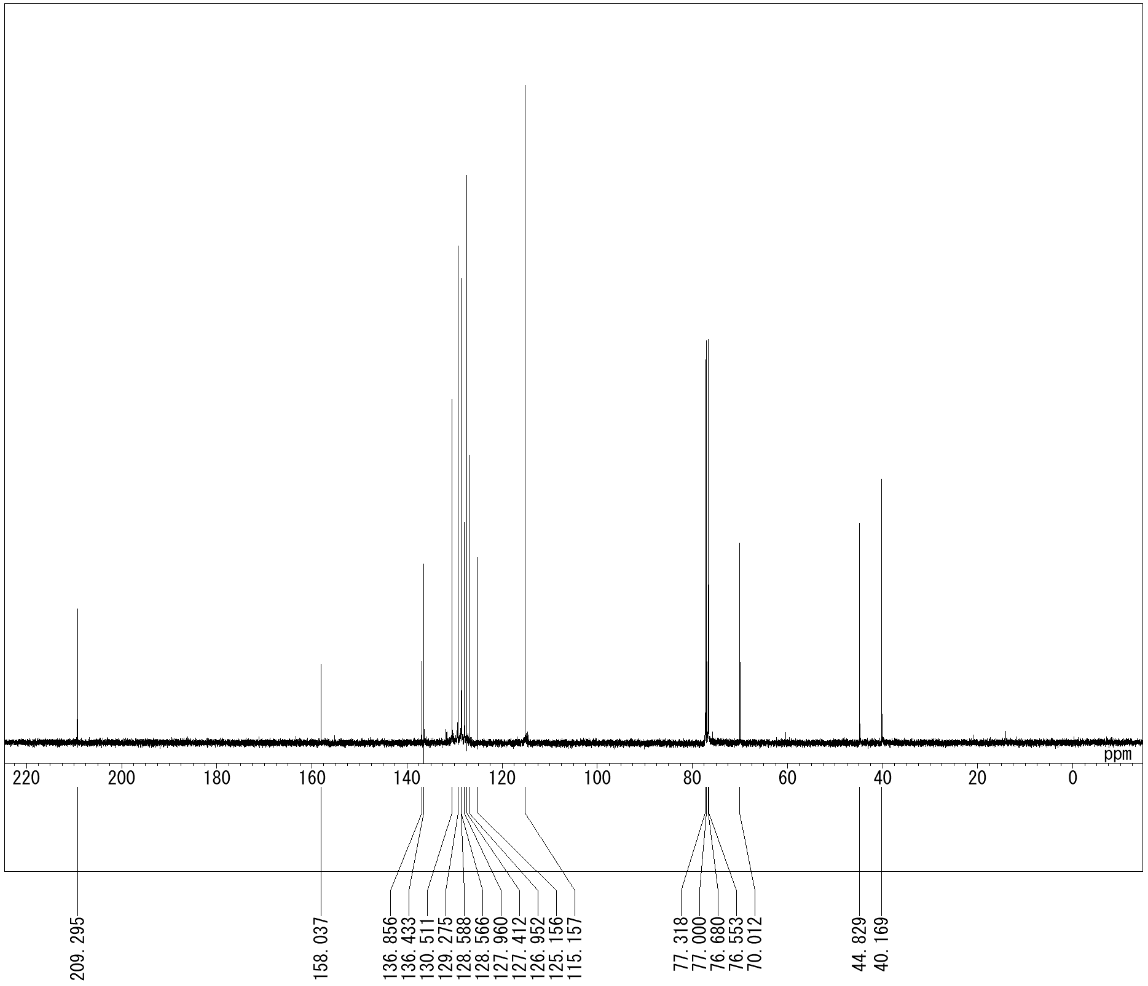
```
Comment    NAT-Phe-OBn-pure5_2020060
    4_01
Date          2020/Jun/04
ObsNuc                 1H
ExMode        PROTON_001
ObsFreq             399.45 MHz
Scan                64
AcqTime               2.569 s
Acc. Interval         5.569 s
Spinning            16.0 Hz
Temperature         25.0 ℃
```

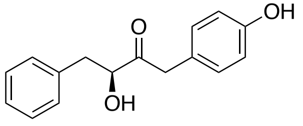




14

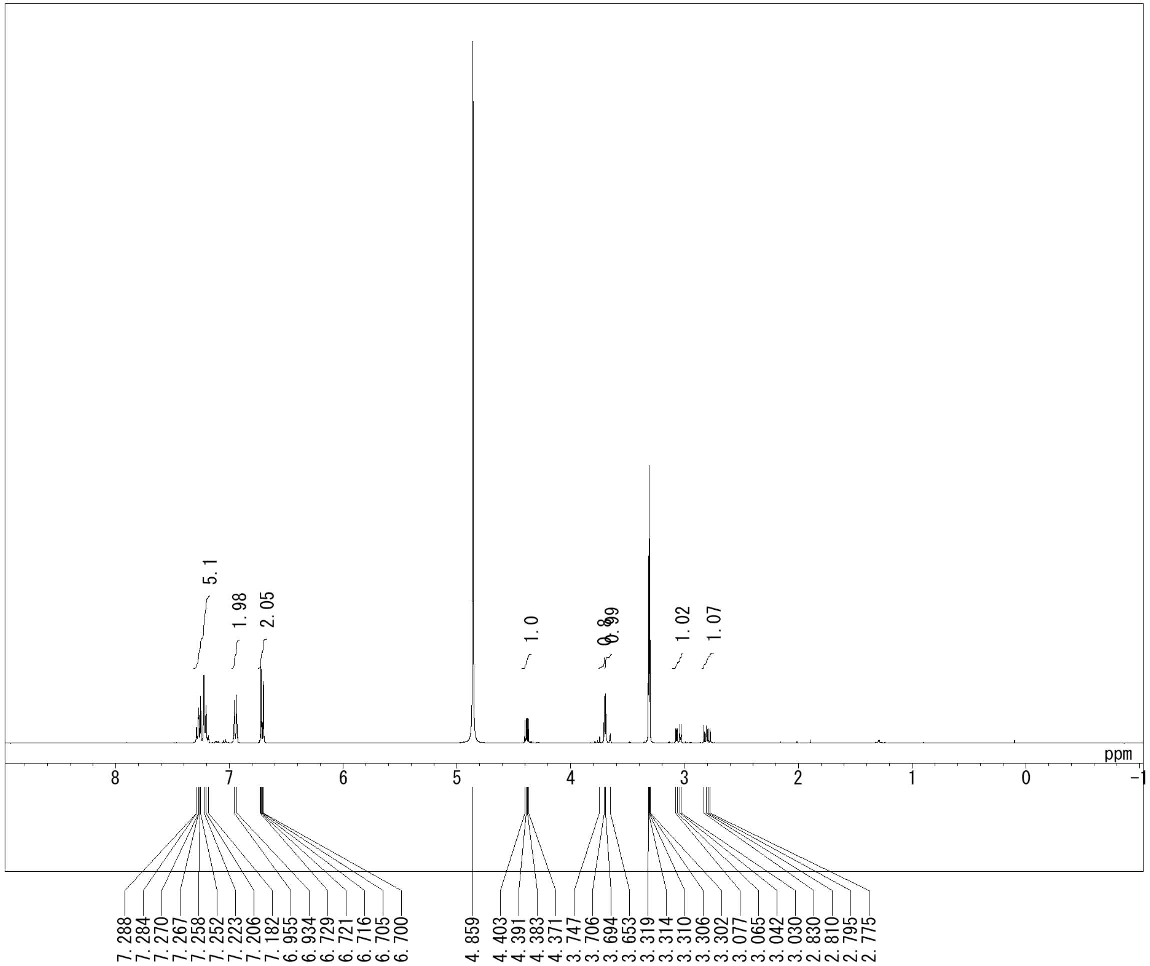
Comment	NAT-phe-OBn-13C_20200404_01
Date	2020/Apr/04
ObsNuc	^{13}C
ExMode	CARBON_001
ObsFreq	100. 45 MHz
Scan	1024
AcqTime	1. 3631 s
Acc. Interval	3. 3631 s
Spinning	20. 0 Hz
Temperature	25. 0 ℃

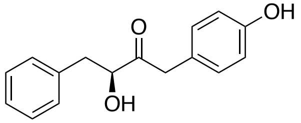




soraphinol B (**18**)

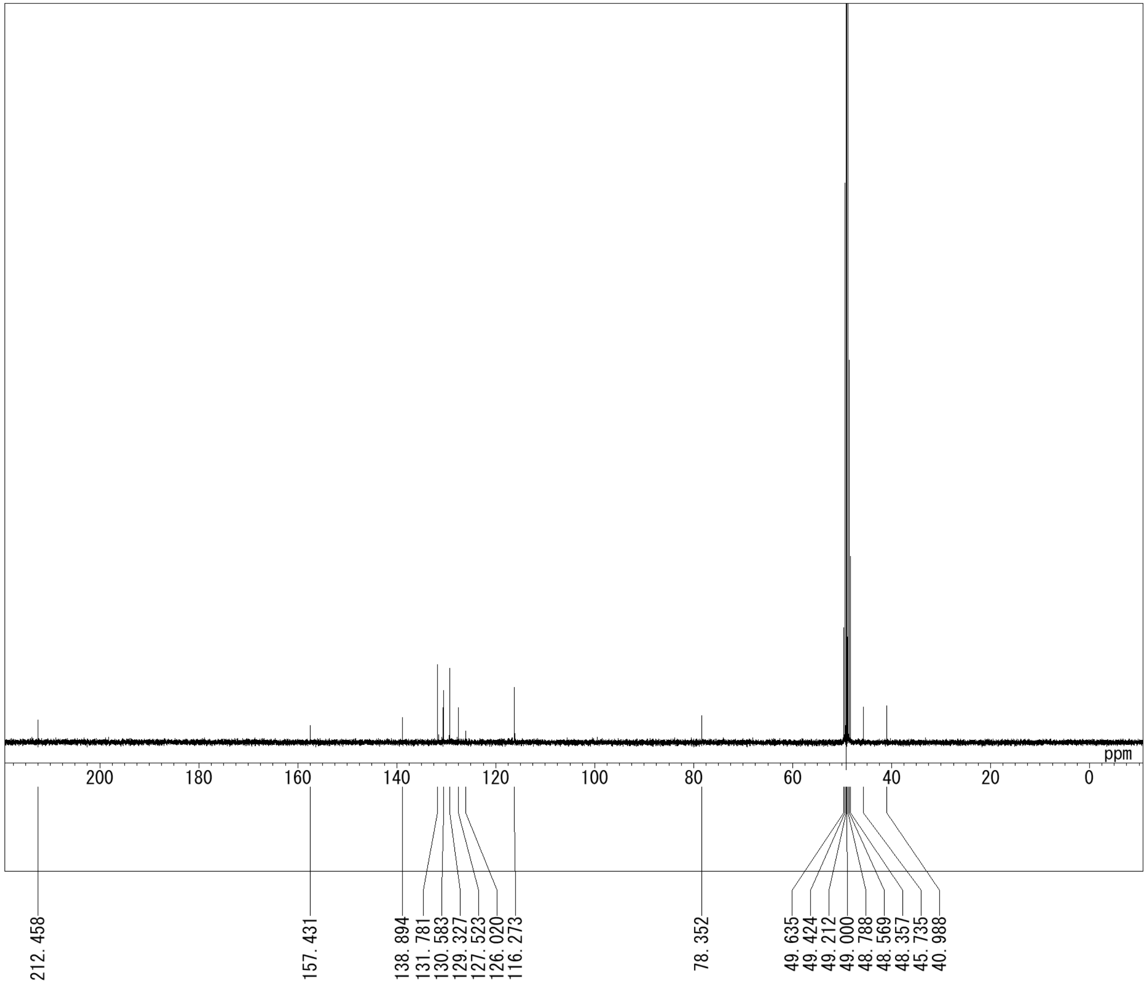
```
Comment     NAT-soraphinolB-pure-3_20
    200709_01
Date          2020/Jul/09
ObsNuc                 1H
ExMode         PROTON_001
ObsFreq           400.28 MHz
Scan                  32
AcqTime             2.5559 s
Acc. Interval       5.5559 s
Spinning           16.0 Hz
Temperature        40.0 ℃
```

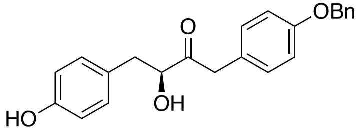




soraphinol B (**18**)

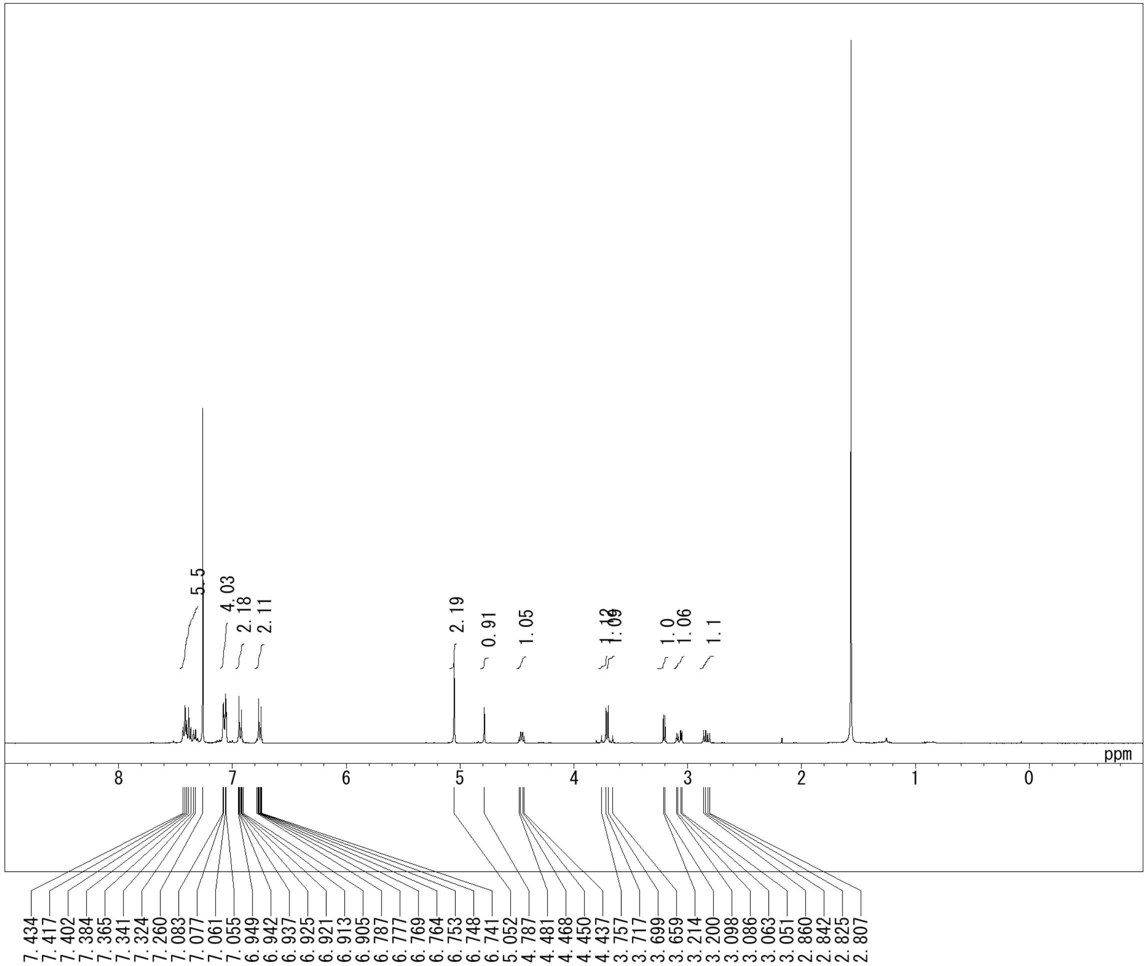
```
Comment     NAT-soraphinolB-13C_20200
    708_01
Date          2020/Jul/08
ObsNuc               13C
ExMode         CARBON_001
ObsFreq              100.45 MHz
Scan                 512
AcqTime                1.3631 s
Acc. Interval          3.3631 s
Spinning              20.0 Hz
Temperature           25.0 ℃
```

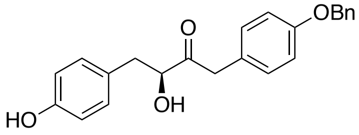




15

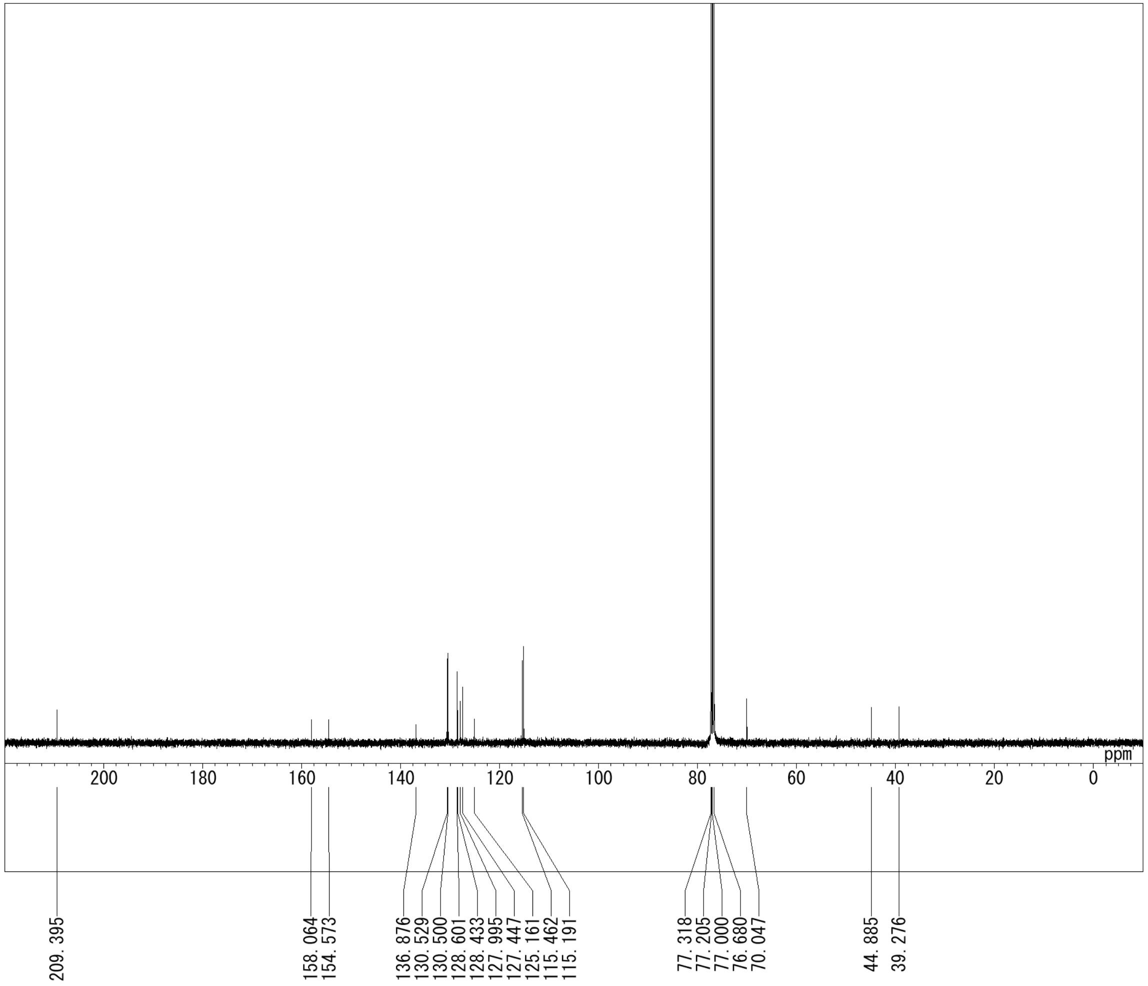
```
Comment    NAT-tyr-obn-pure-6_202006
    15_01
Date          2020/Jun/15
ObsNuc                 ¹H
ExMode         PROTON_001
ObsFreq            400.27 MHz
Scan                32
AcqTime              2.5559 s
Acc. Interval        5.5559 s
Spinning            16.0 Hz
Temperature         40.0 ℃
```

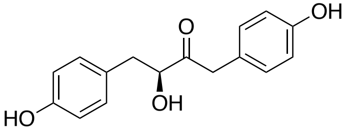




15

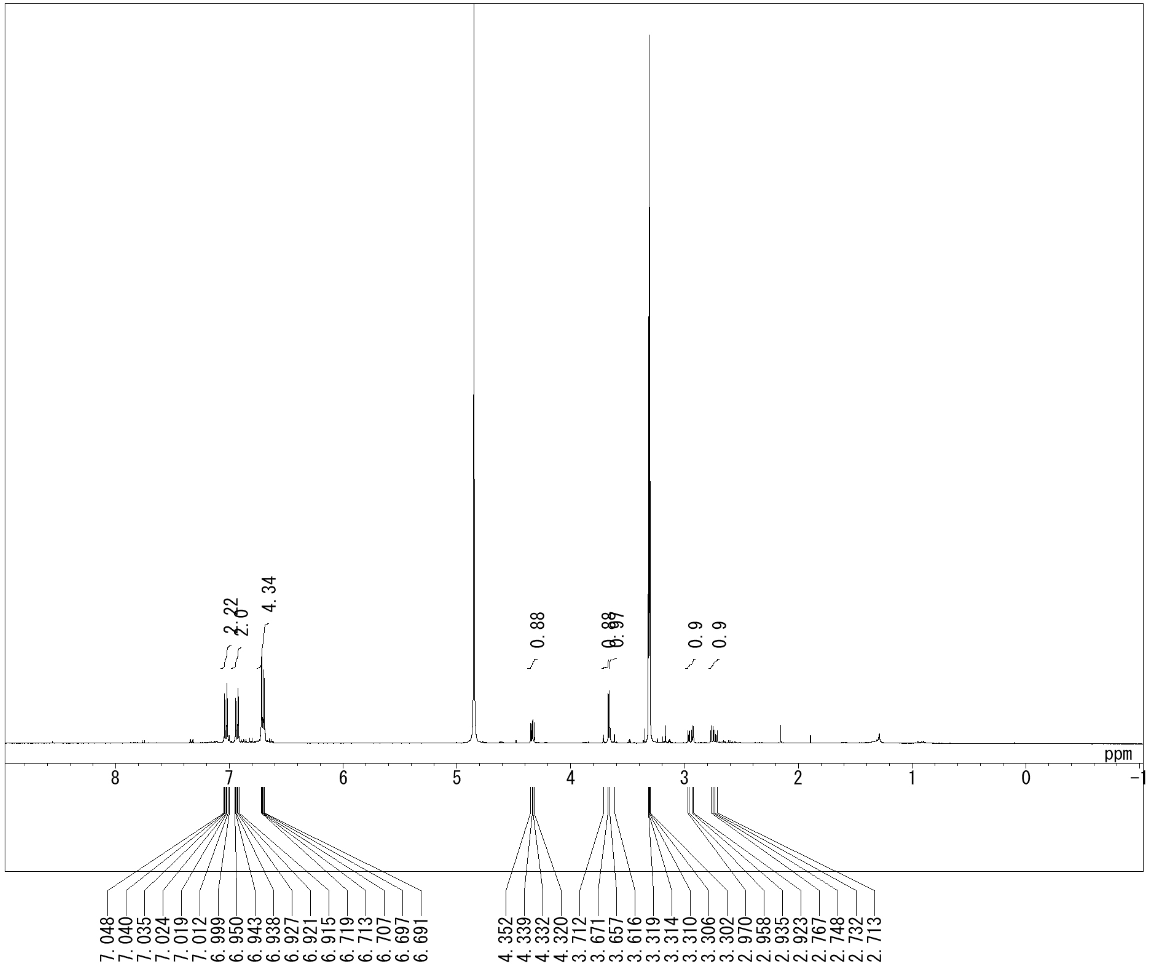
```
Comment    NAT-tyr-OBN-13C-3_2020061
    5_01
Date            2020/Jun/15
ObsNuc                 13C
ExMode          CARBON_001
ObsFreq                100.45 MHz
Scan               10000
AcqTime                  1.3631 s
Acc. Interval            3.3631 s
Spinning                20.0 Hz
Temperature             25.0 ℃
```

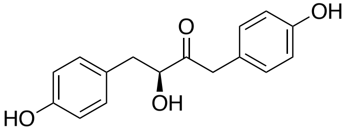




circumcin B (**19**)

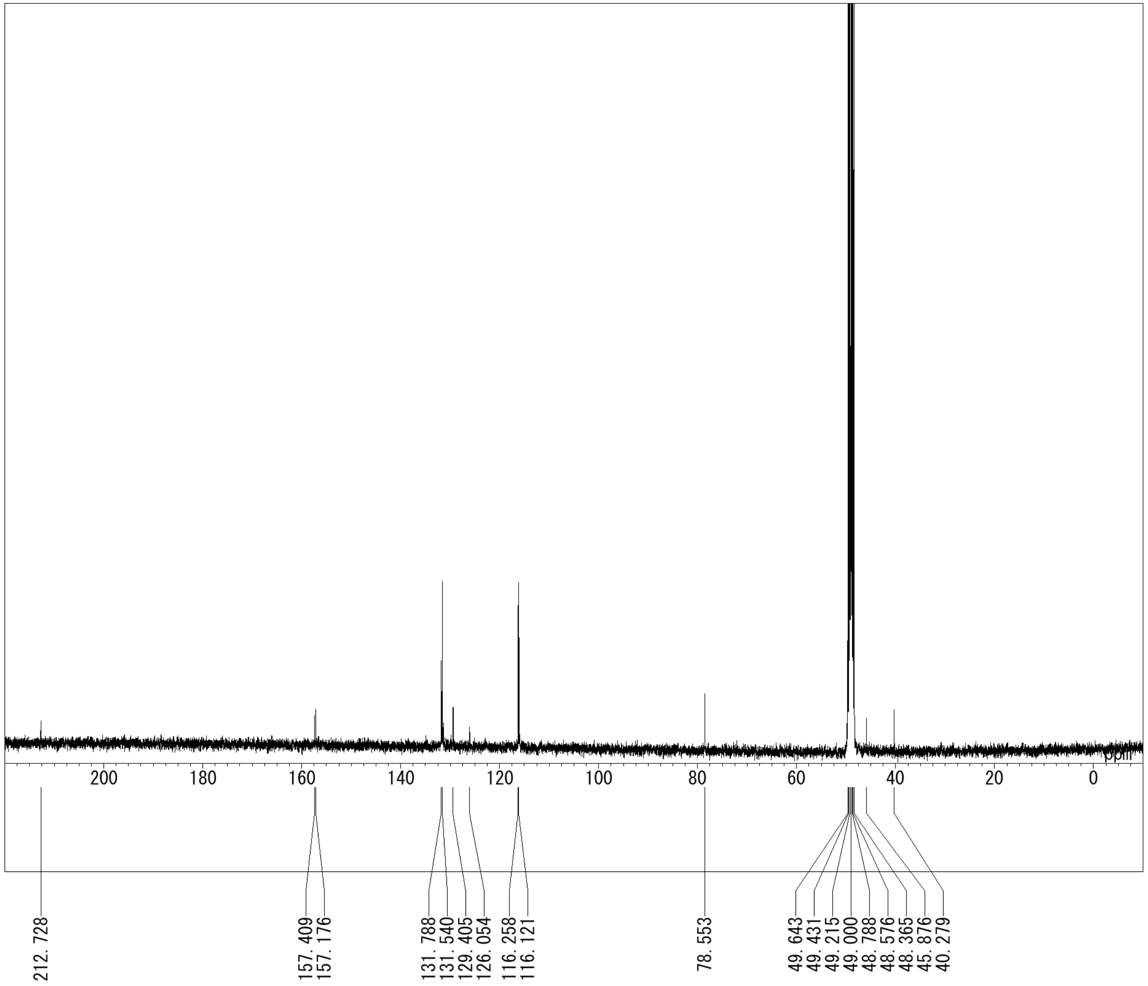
Comment   NAT-circumcinB-pure-wash_
    20200617_01
Date   2020/Jun/17
ObsNuc ^{1}H
ExMode   PROTON_001
ObsFreq   399.45 MHz
Scan   64
AcqTime   2.569 s
Acc. Interval   5.569 s
Spinning   16.0 Hz
Temperature   25.0 ℃

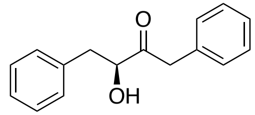




circumcin B (**19**)

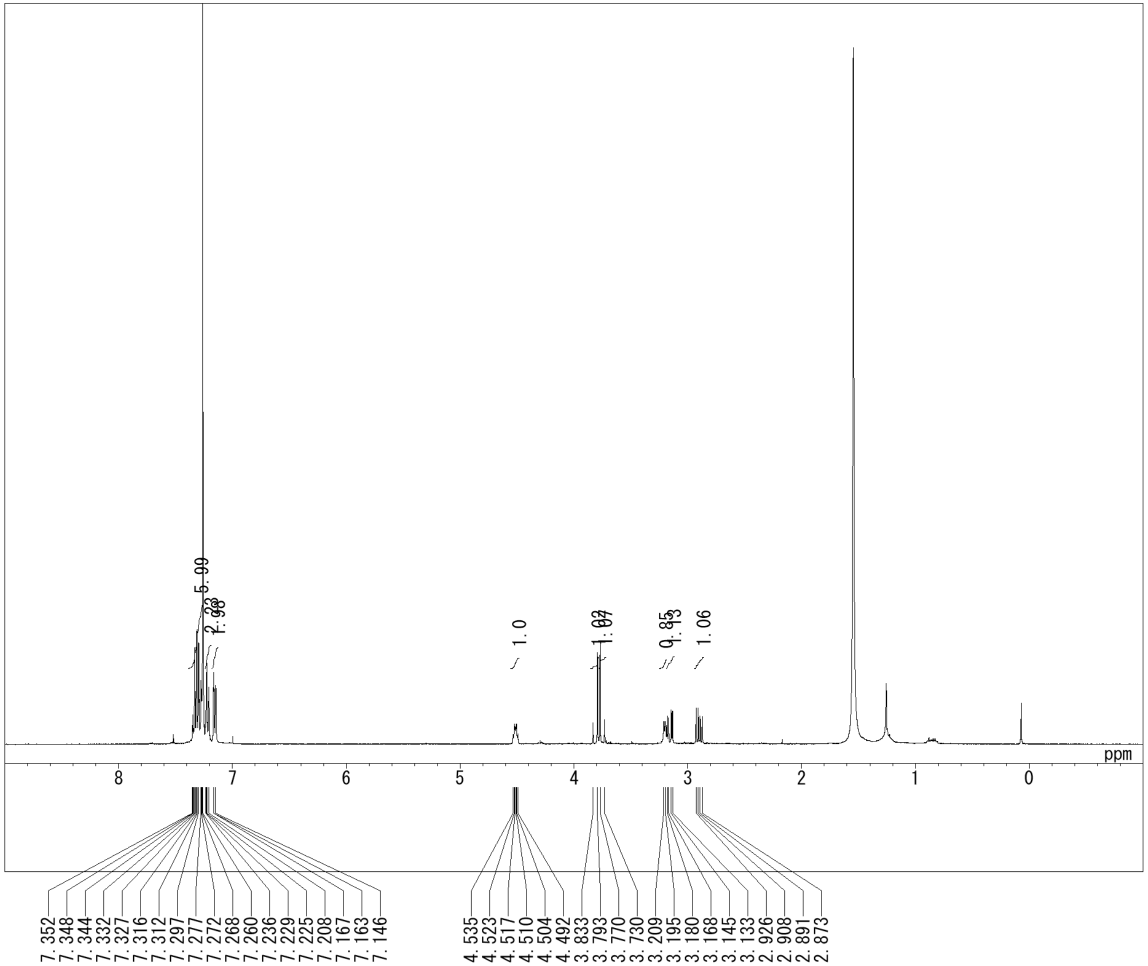
```
Comment     NAT-circumcinB-13C-2_2020
    0617_01
Date            2020/Jun/17
ObsNuc                  13C
ExMode          CARBON_001
ObsFreq              100.45 MHz
Scan                  10000
AcqTime               1.3631 s
Acc. Interval         3.3631 s
Spinning              20.0 Hz
Temperature           25.0 ℃
```

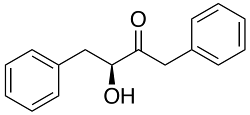




circumcin C (**16**)

```
Comment     NAT-circumcinC-pure4_2020
    0328_01
Date          2020/Mar/28
ObsNuc                 1H
ExMode         PROTON_001
ObsFreq             400.27 MHz
Scan                128
AcqTime               2.5559 s
Acc. Interval         5.5559 s
Spinning             16.0 Hz
Temperature          40.0 ℃
```





circumcin C (**16**)

```
Comment    NAT-09-060-13C_20200304_0
    1
Date         2020/Mar/04
ObsNuc              13C
ExMode        CARBON_001
ObsFreq             100.45 MHz
Scan                256
AcqTime               1.3631 s
Acc. Interval         3.3631 s
Spinning             20.0 Hz
Temperature          25.0 ℃
```