α-Geminal Dihydroxymethyl Piperidine and Pyrrolidine Iminosugars: Synthesis, Conformational Analysis, Glycosidase Inhibitory Activity and Molecular docking Studies

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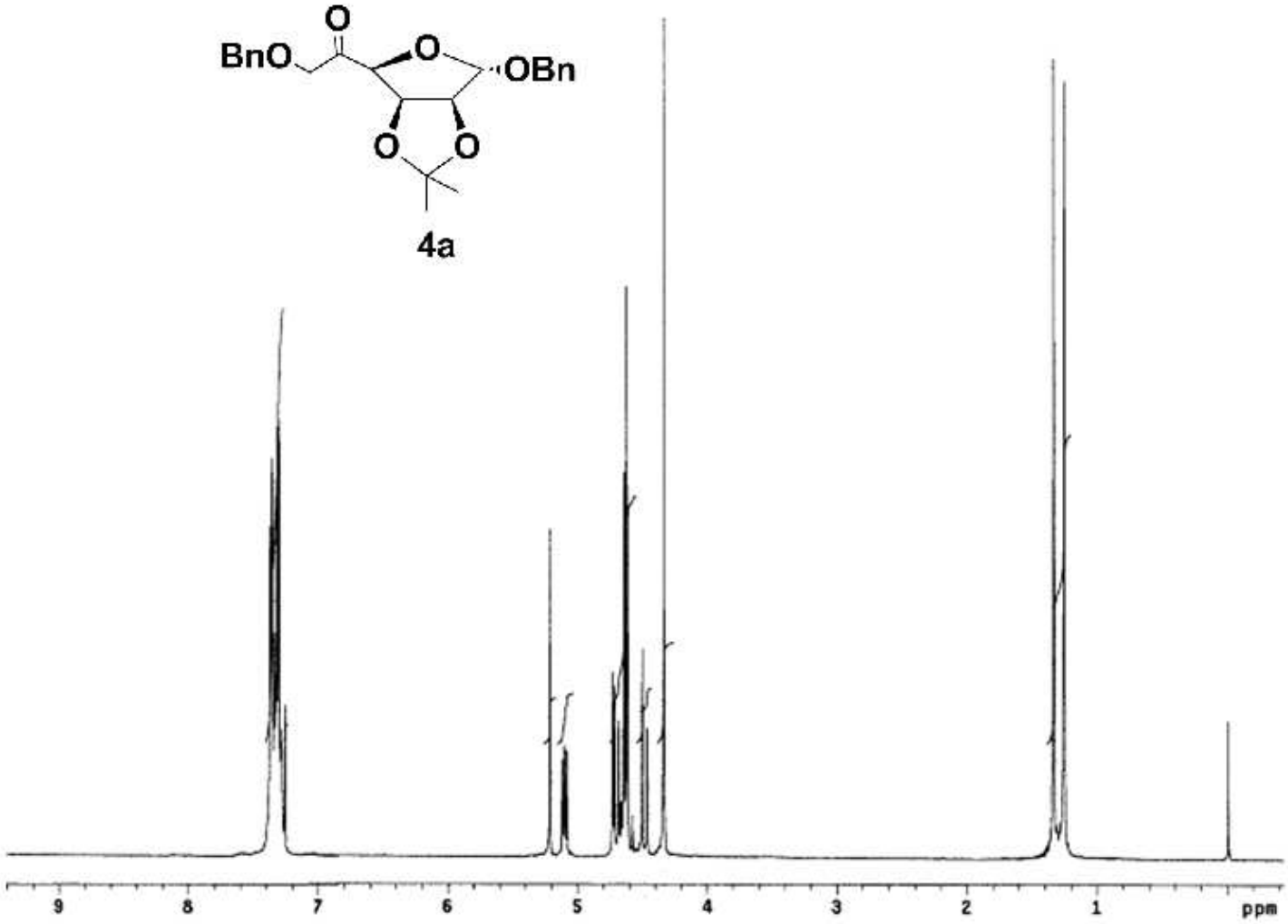


Figure 1: 1H NMR (300 MHz, CDCl3 spectrum of compound 4a)

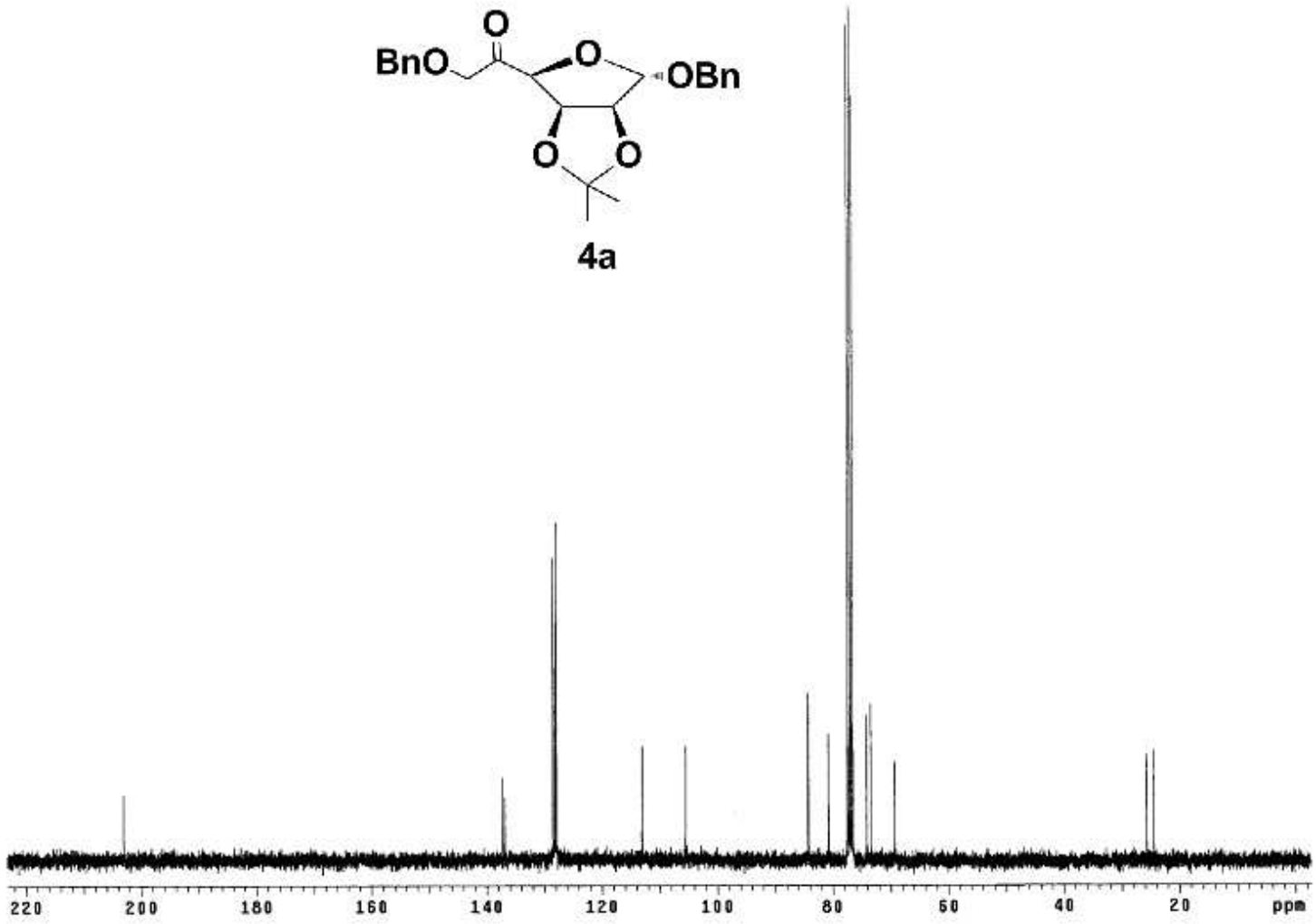


Figure 2: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compound 4a

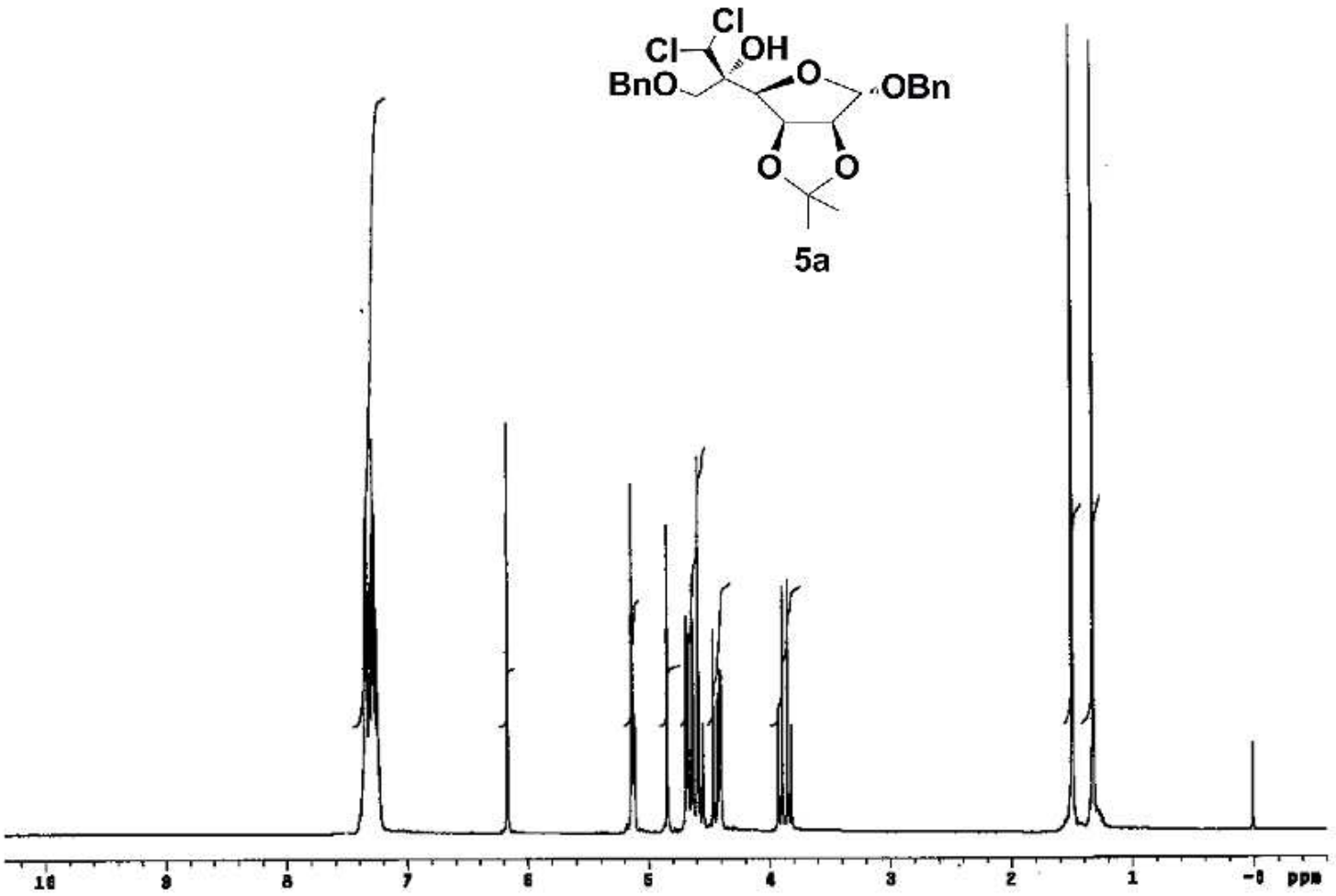


Figure 3: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compound 5a

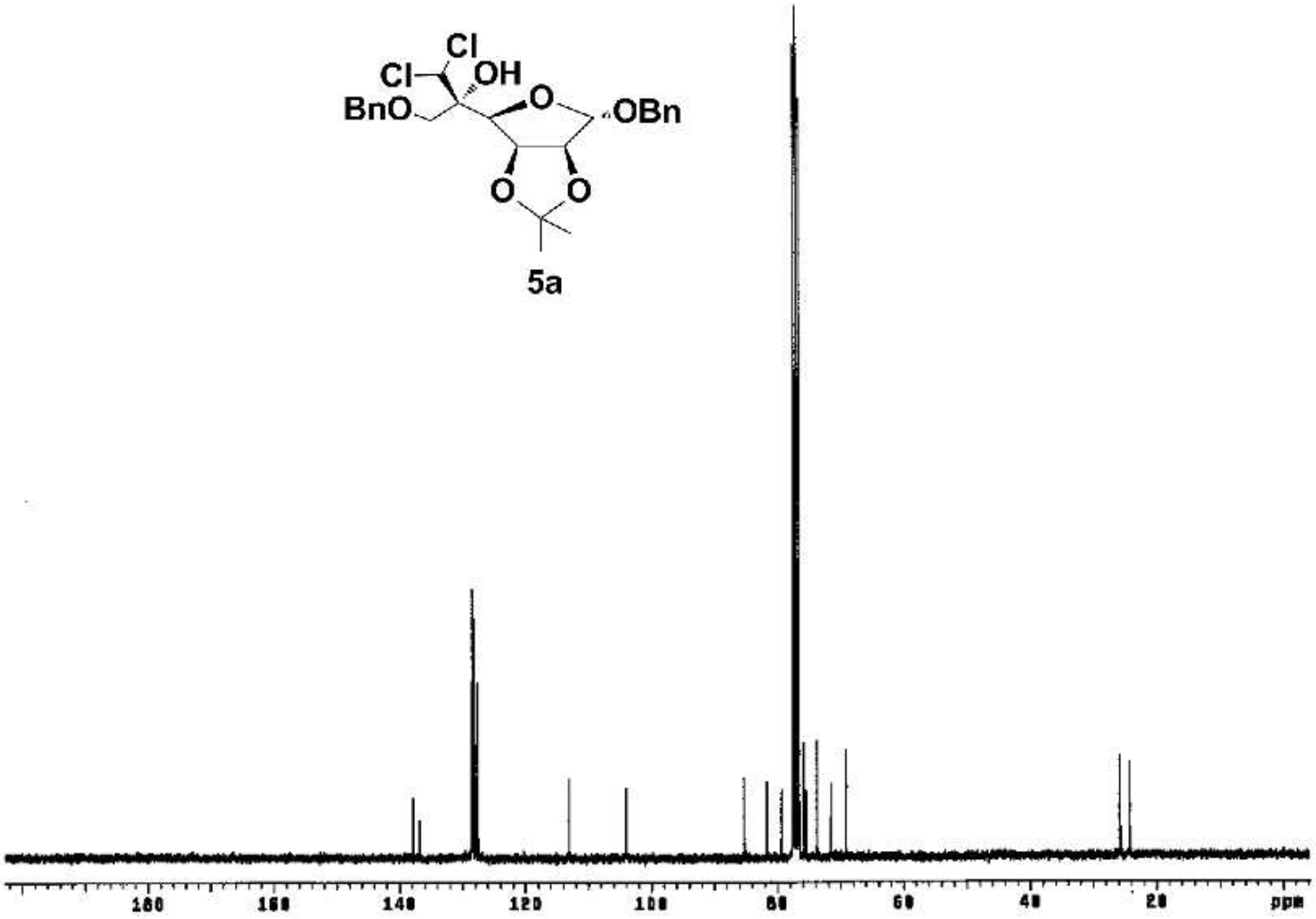


Figure 4: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compound 5a

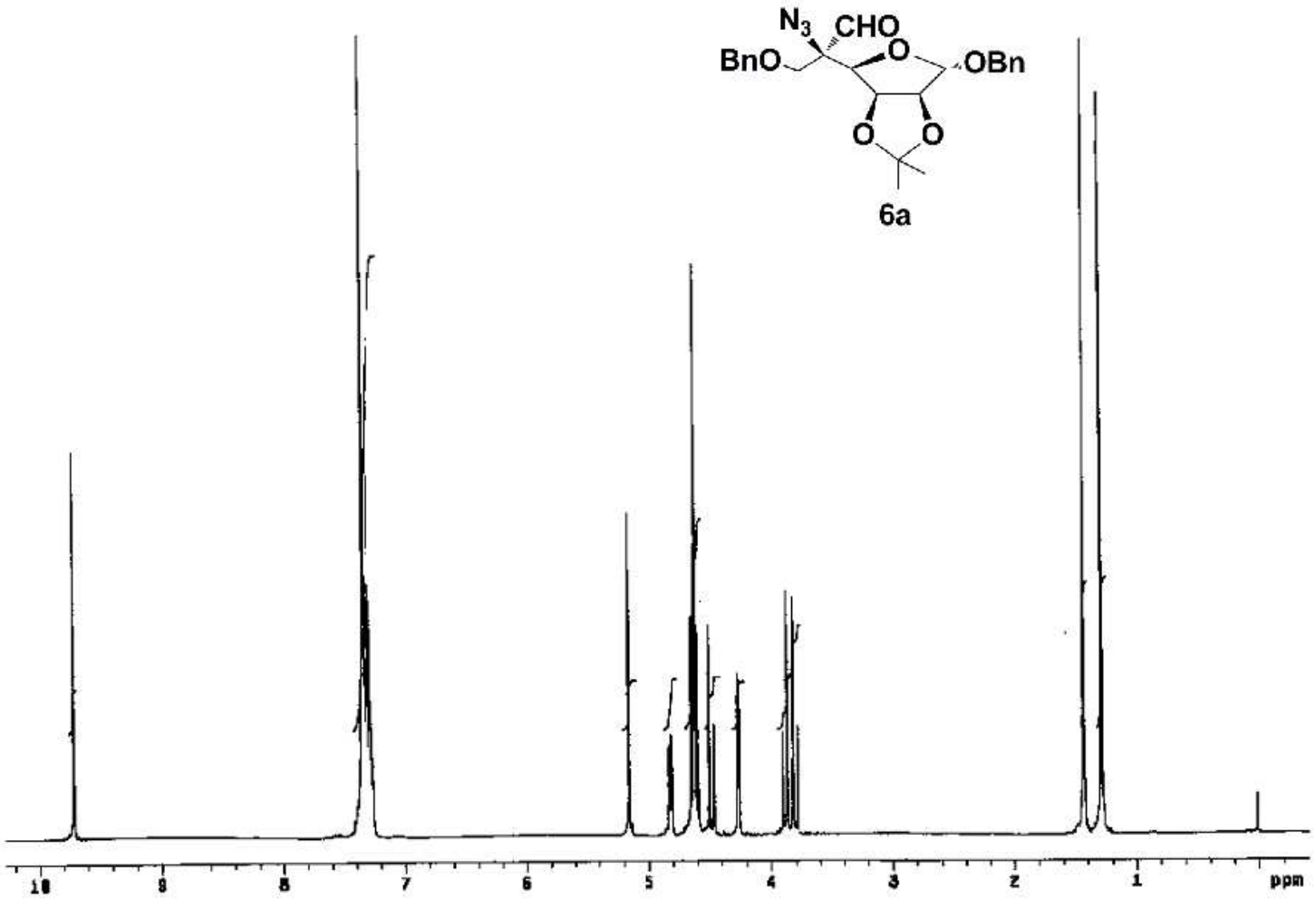


Figure 7: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compound 6a)

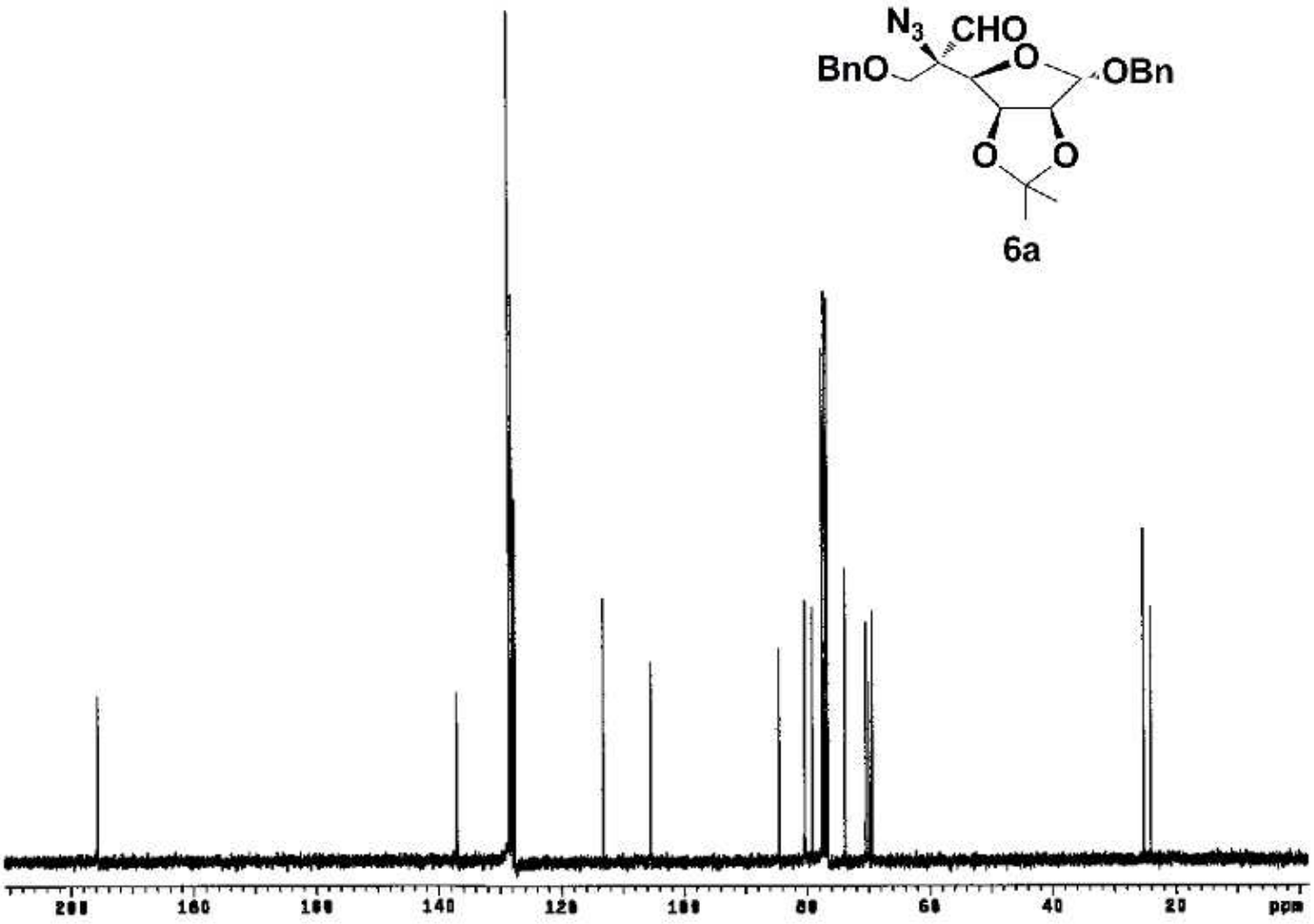


Figure 8: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compound 6a

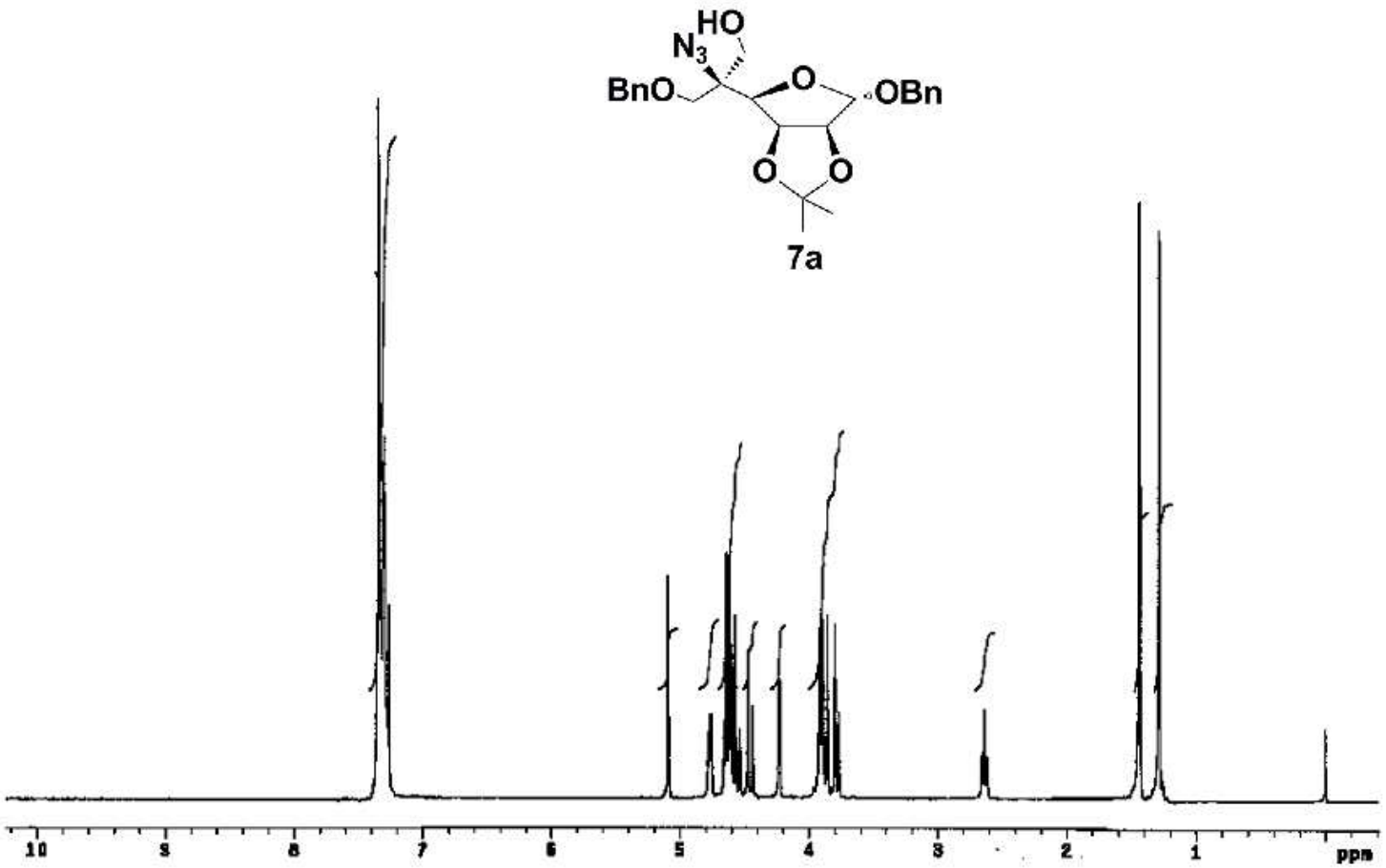


Figure 9: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compound 7a

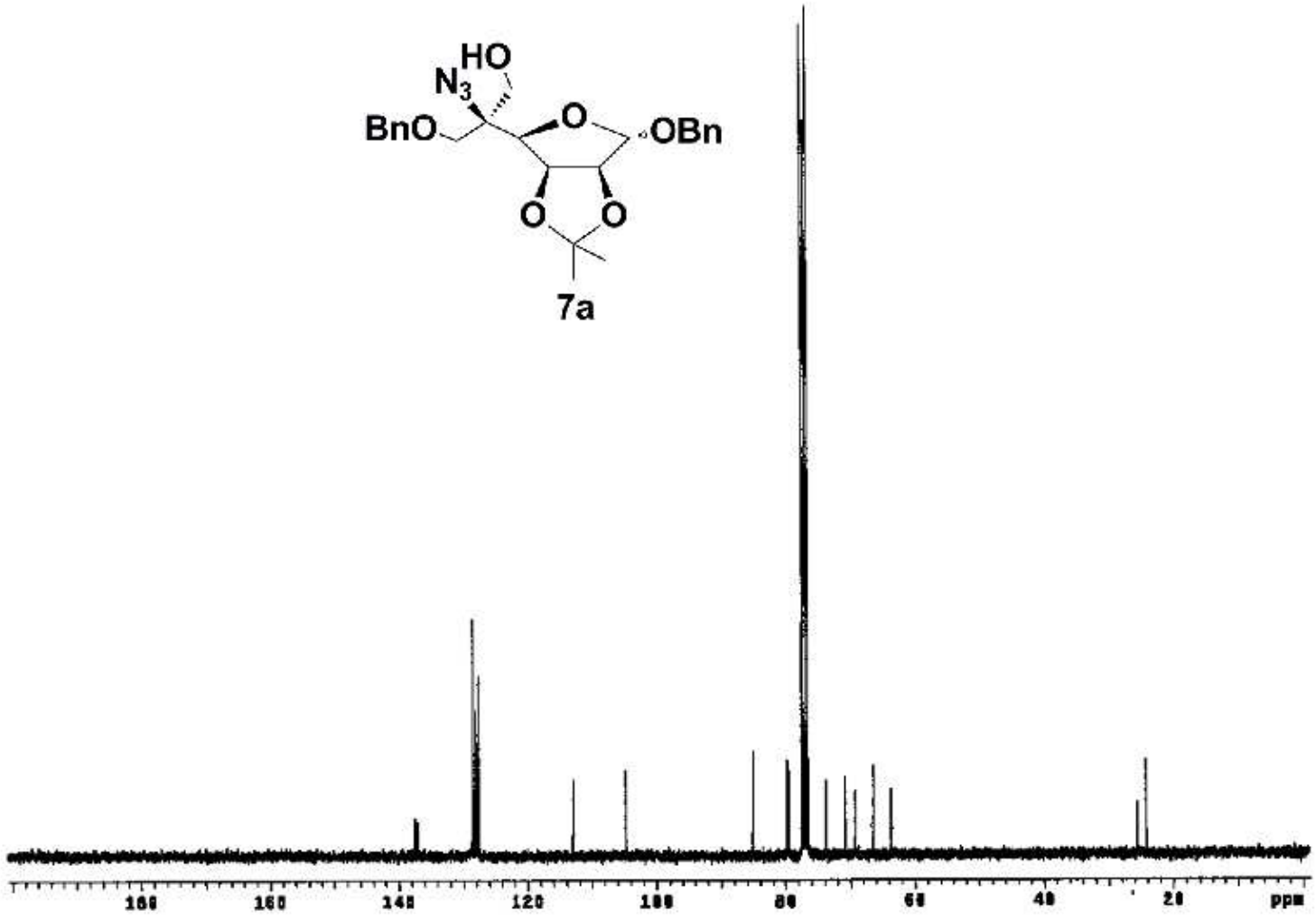


Figure 10: ^{13}C NMR (75 MHz, $CDCl_3$ spectrum of compound 7a

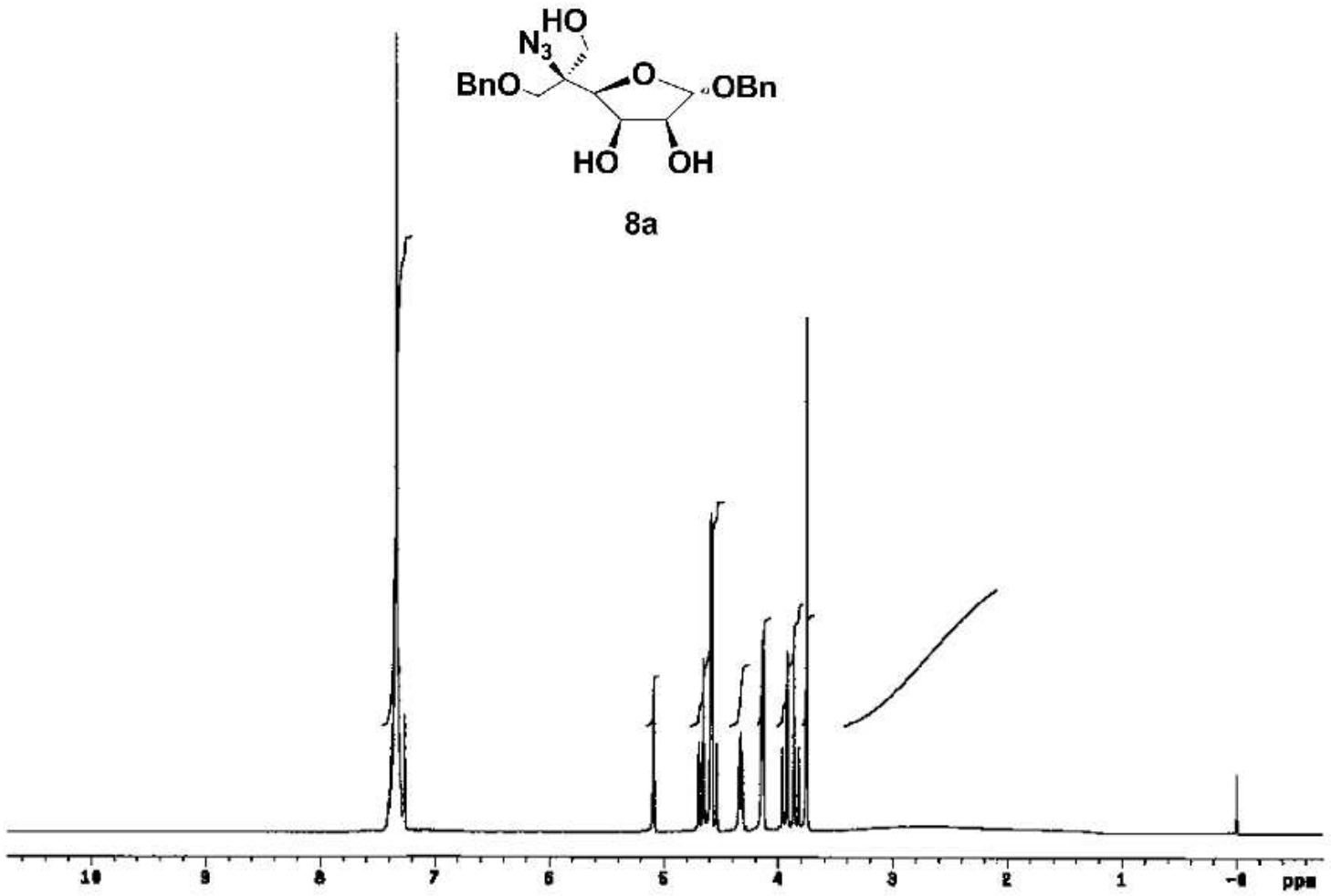


Figure 11: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compound 8a

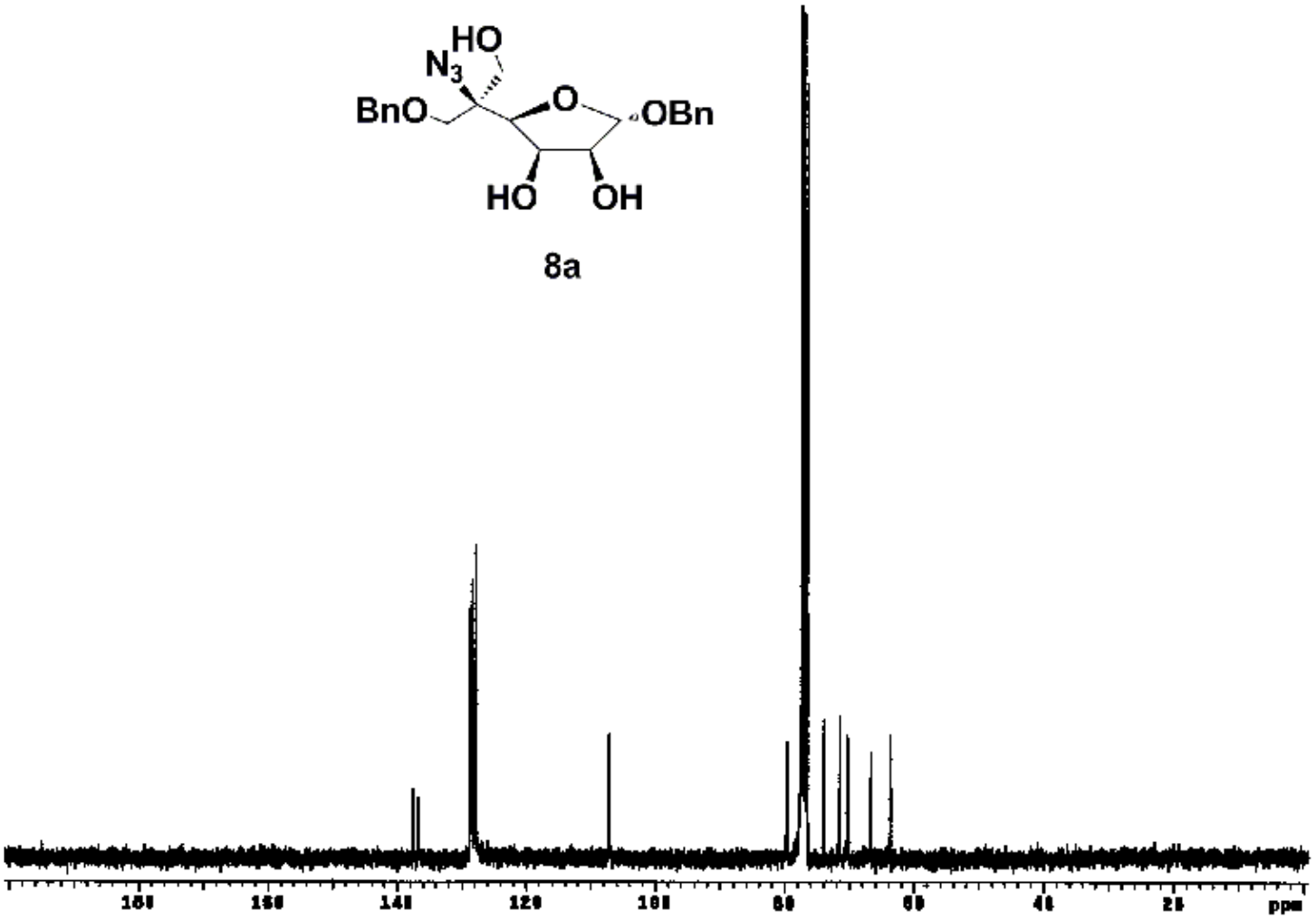


Figure 12: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compound 8a

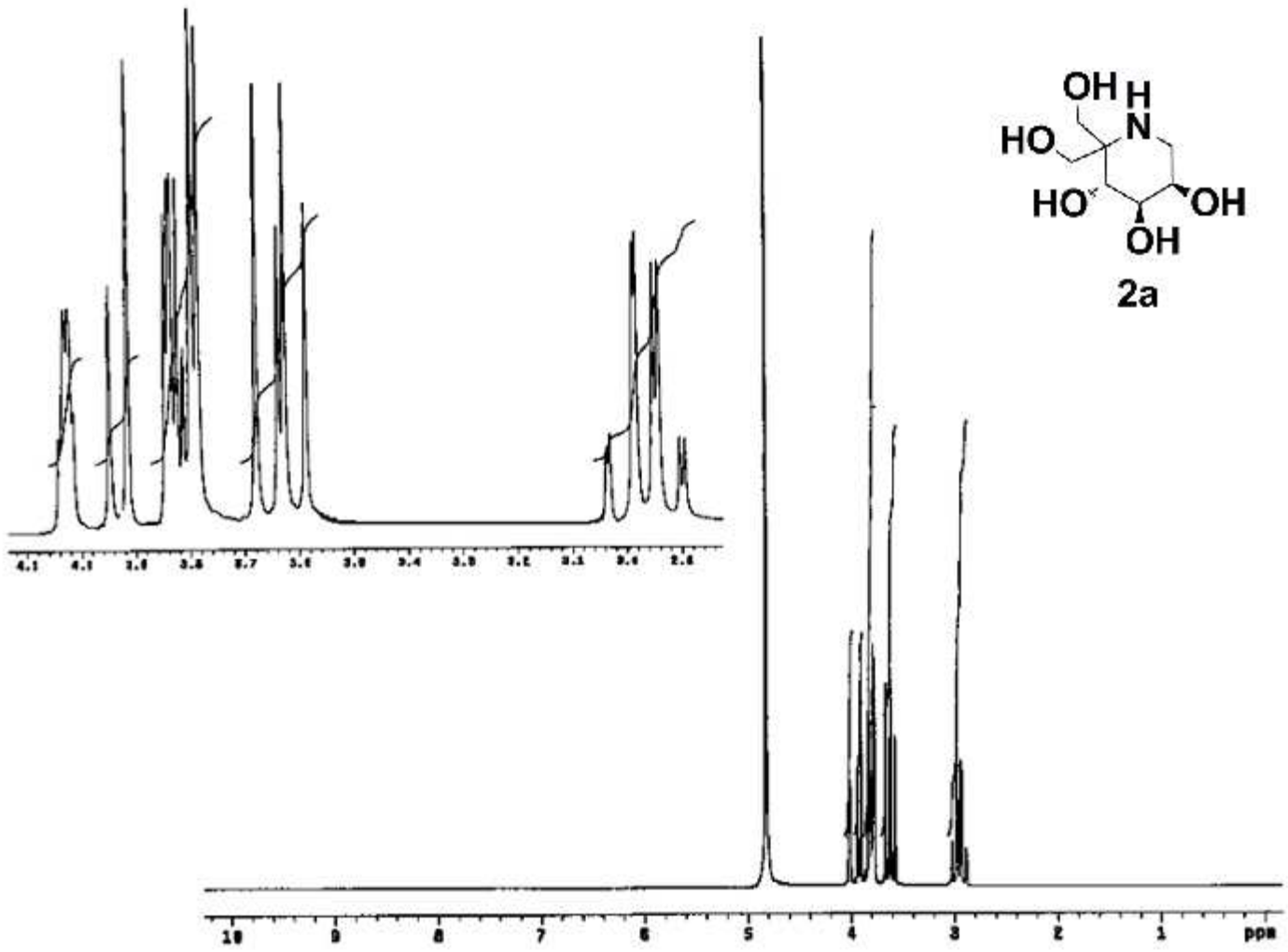


Figure 13: ^{1}H NMR (300 MHz, D_2O) spectrum of compound 2a

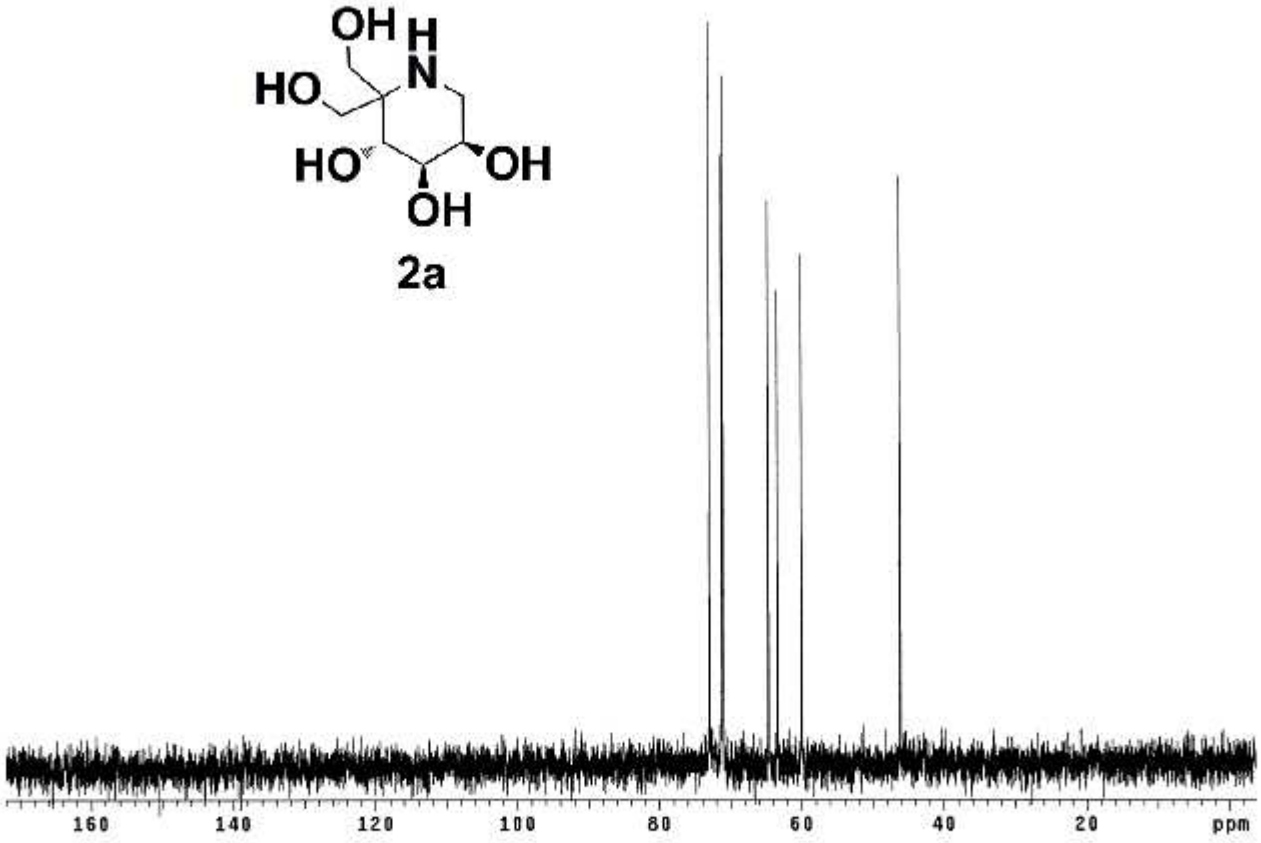


Figure 14: ^{13}C NMR (75 MHz, D_2O) spectrum of compound 2a

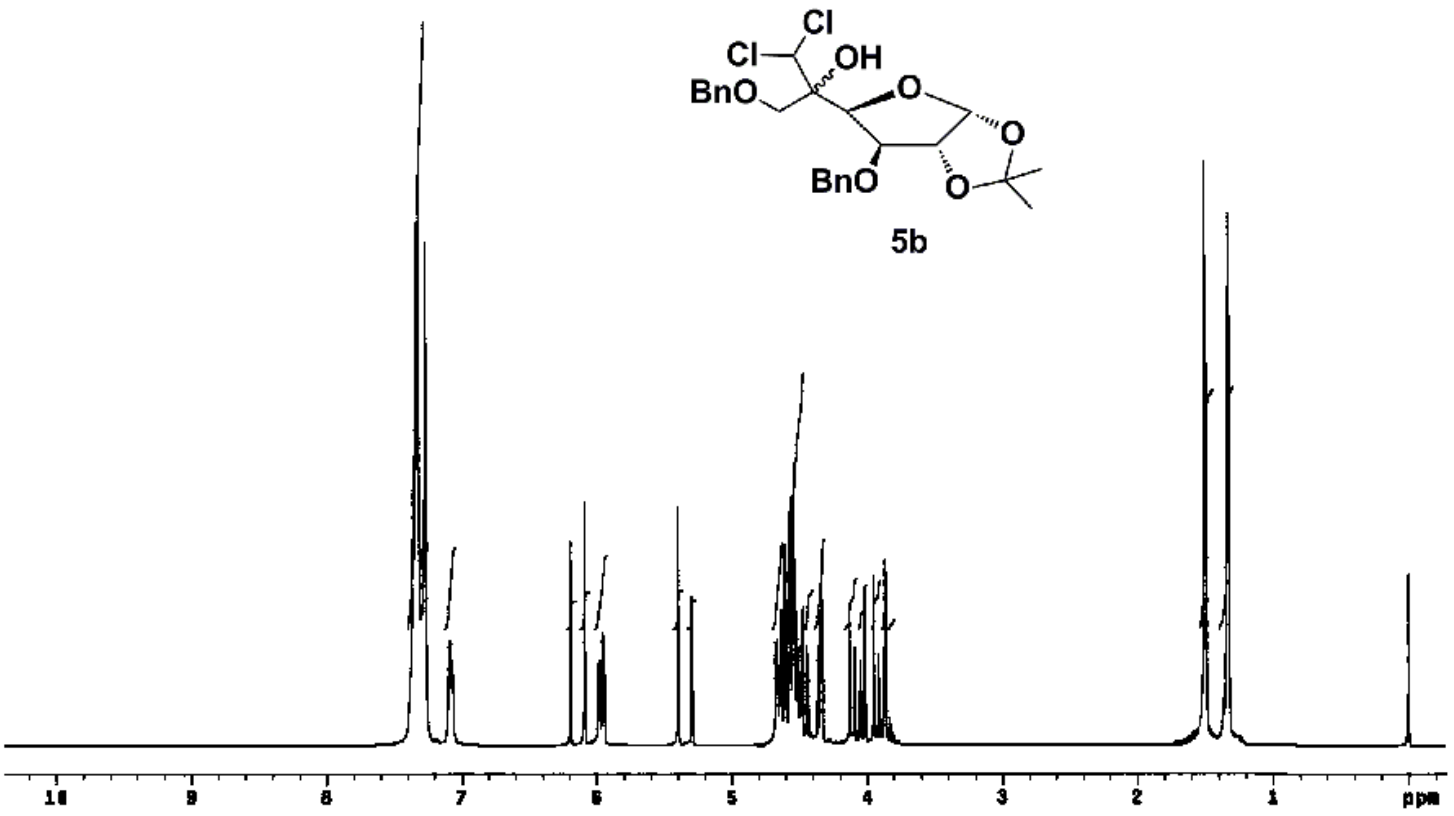


Figure 15: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compounds 5b

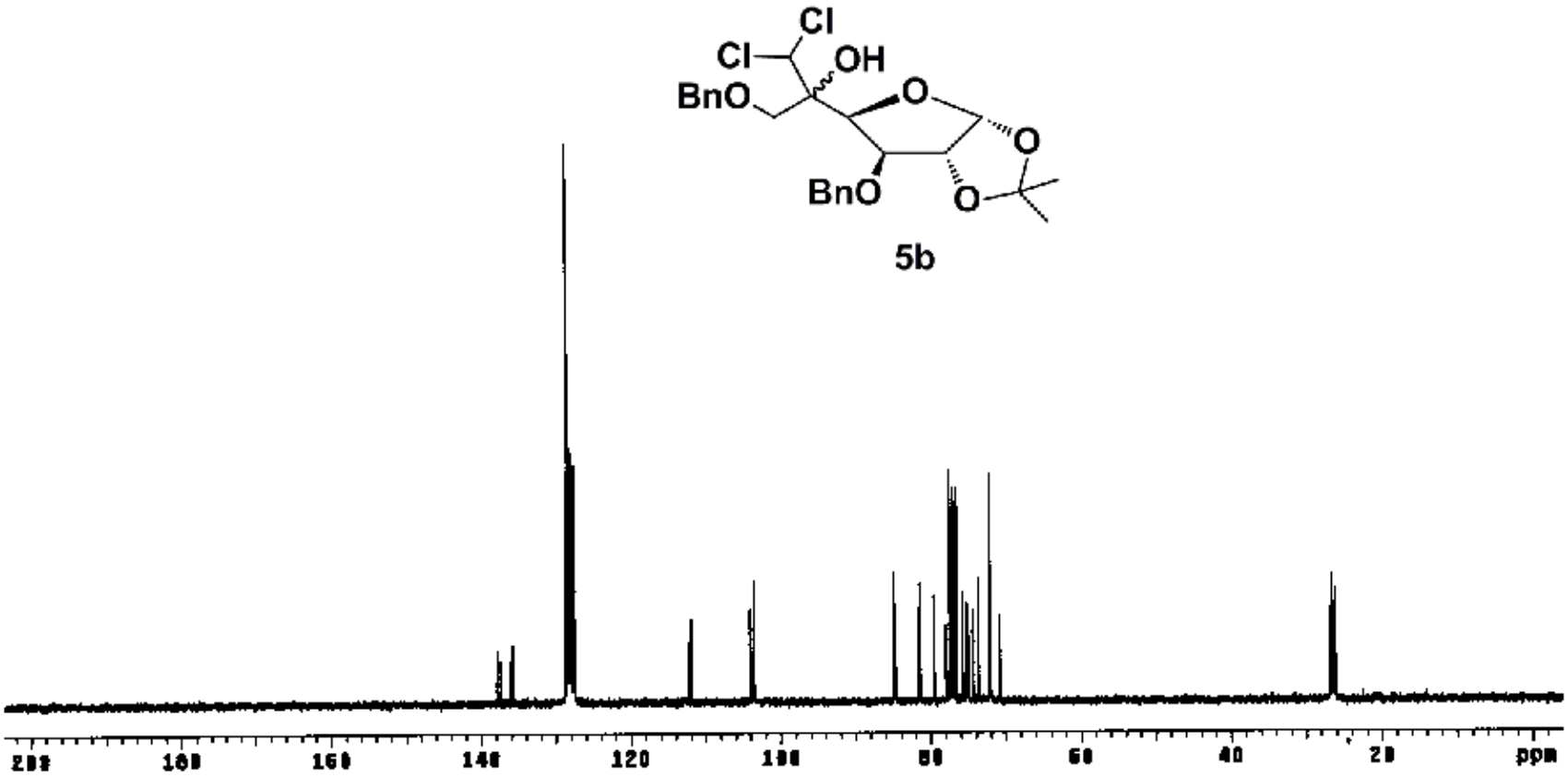


Figure 16: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compounds 5b

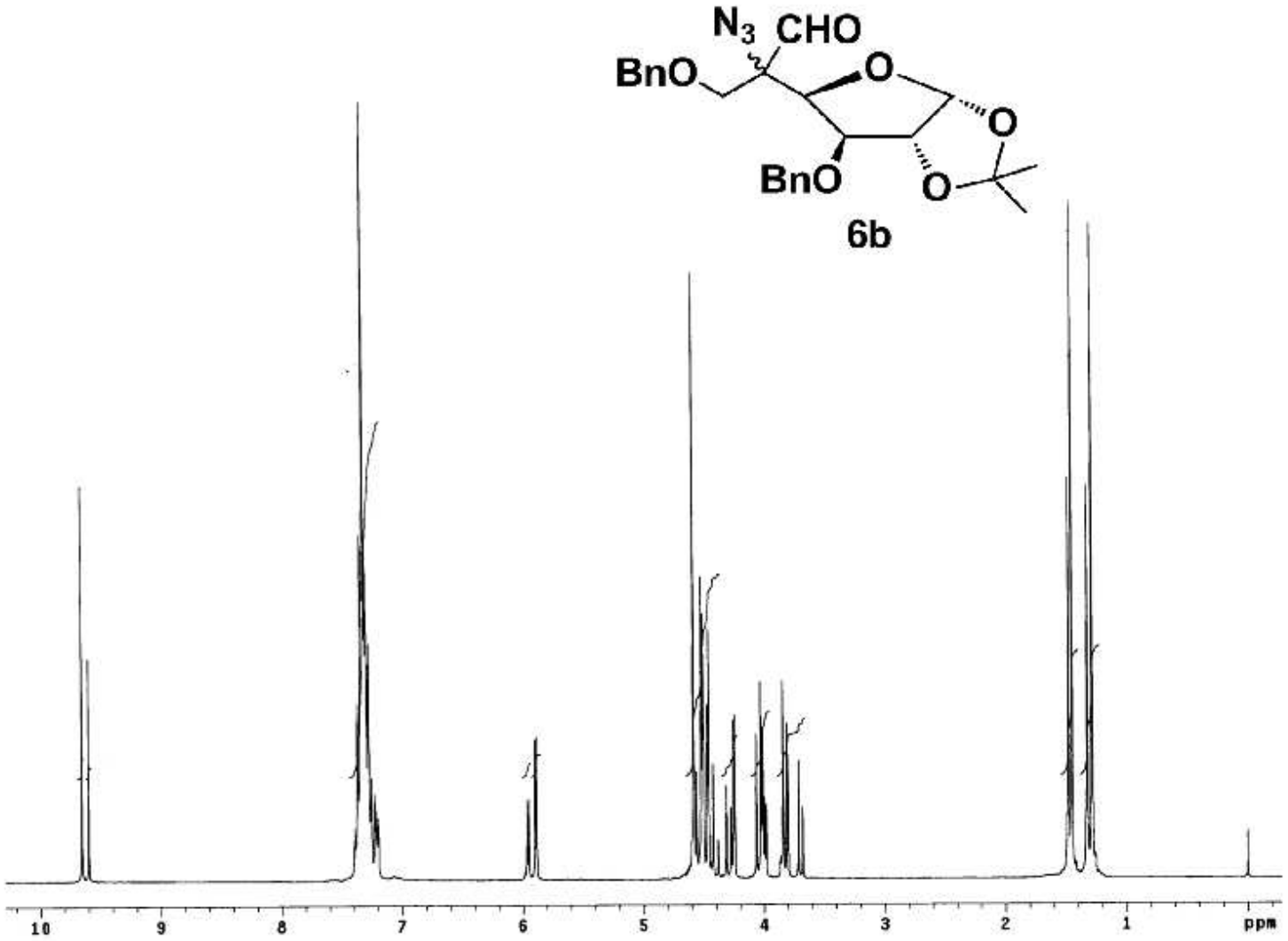


Figure 17: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compounds 6b

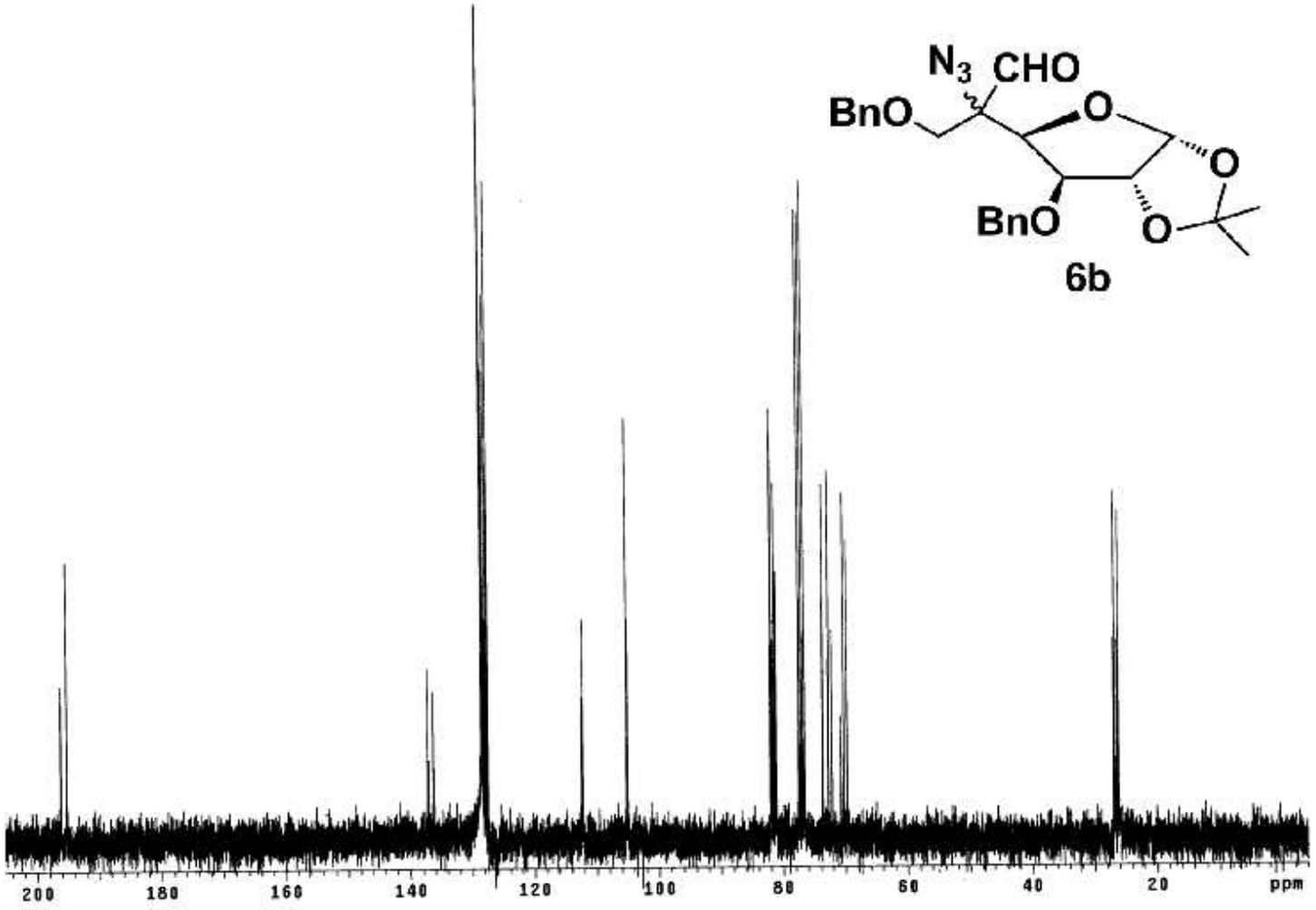


Figure 18: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compounds 6b

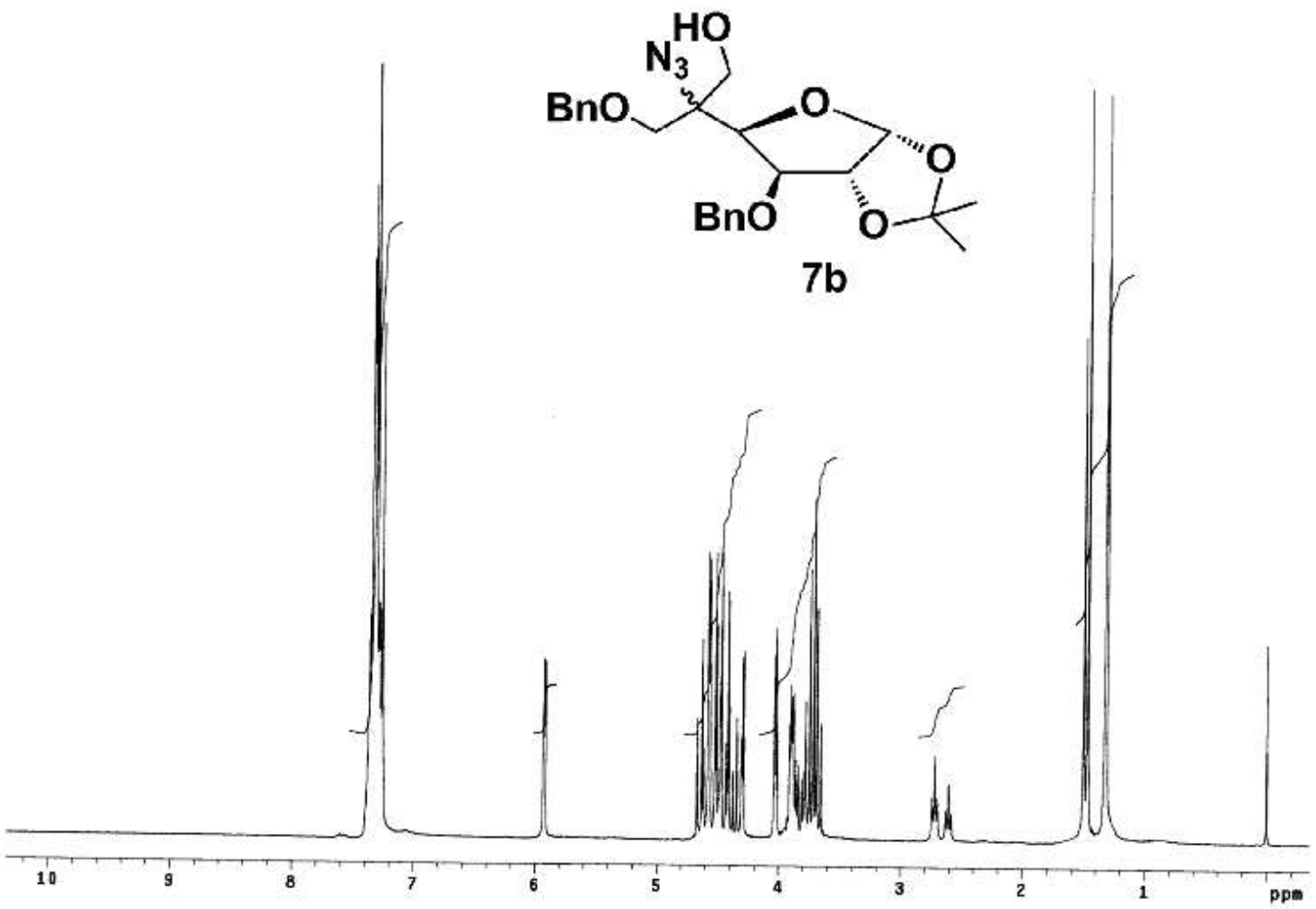


Figure 19: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compounds 7b

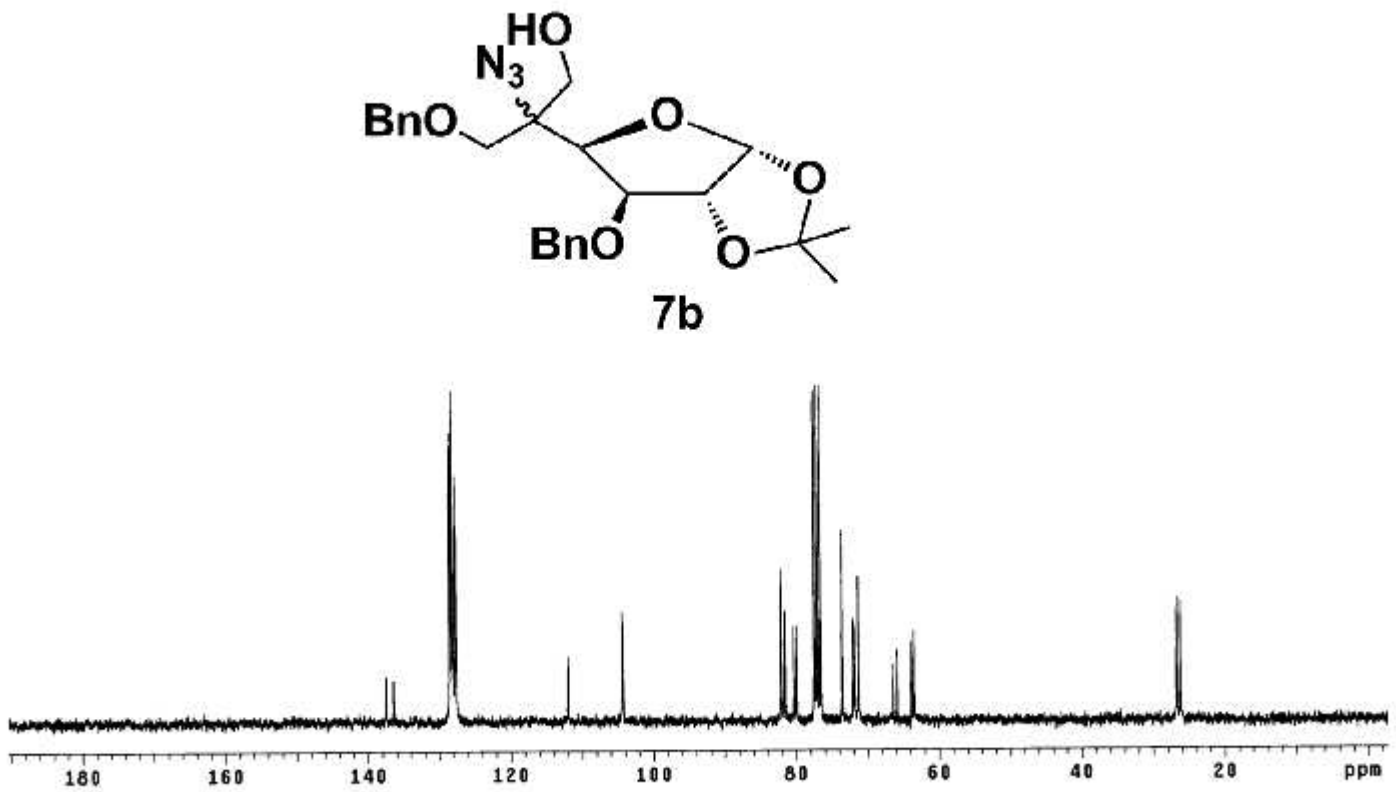


Figure 20: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compounds 7b

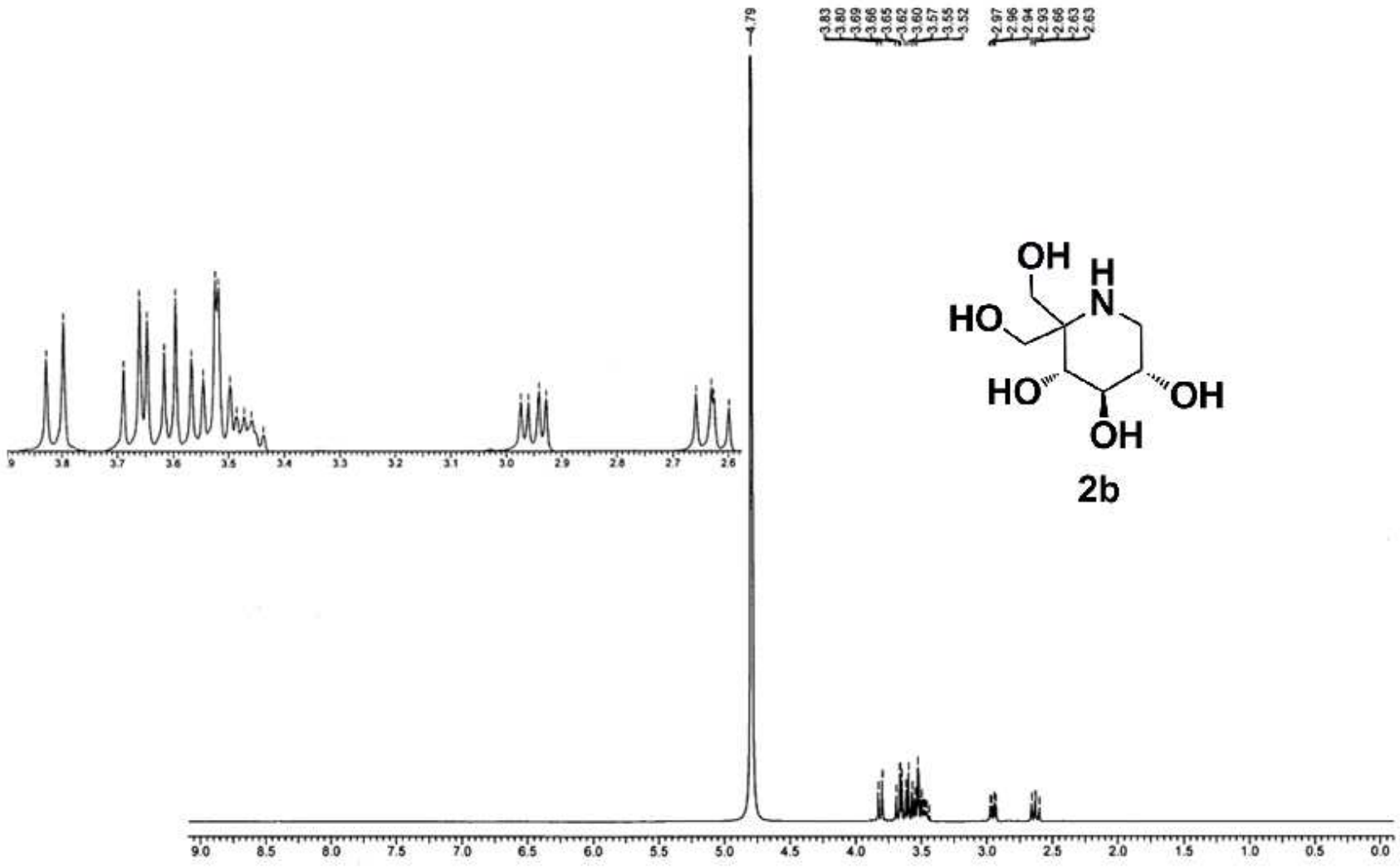
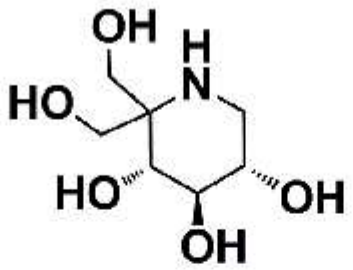


Figure 21: ^{1}H NMR (400 MHz, D_2O) spectrum of compound 2b



2b

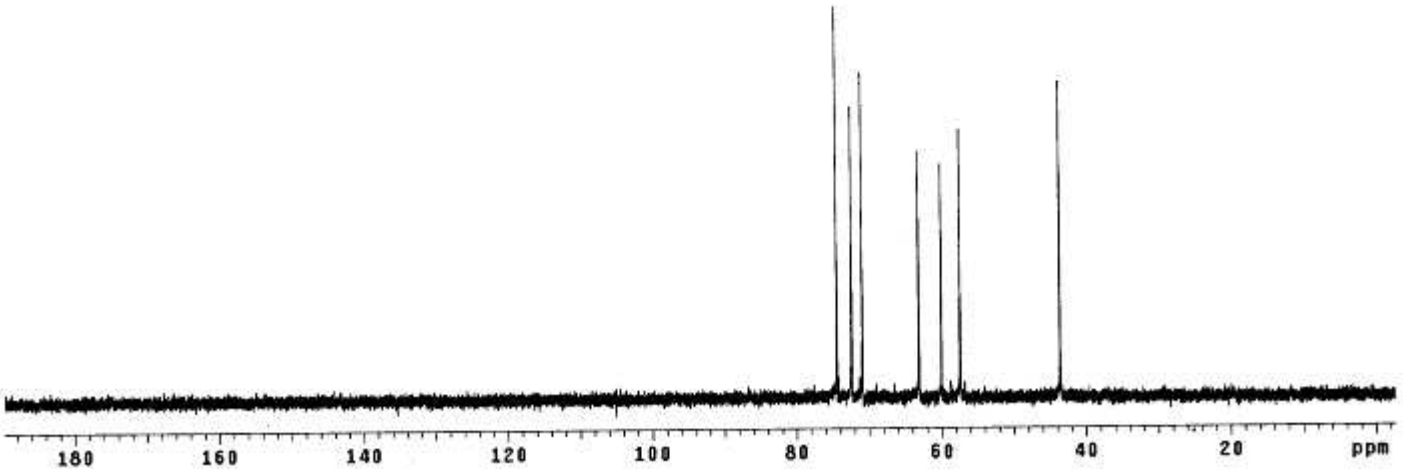


Figure 22: ^{13}C NMR (75 MHz, D_2O) spectrum of compound 2b

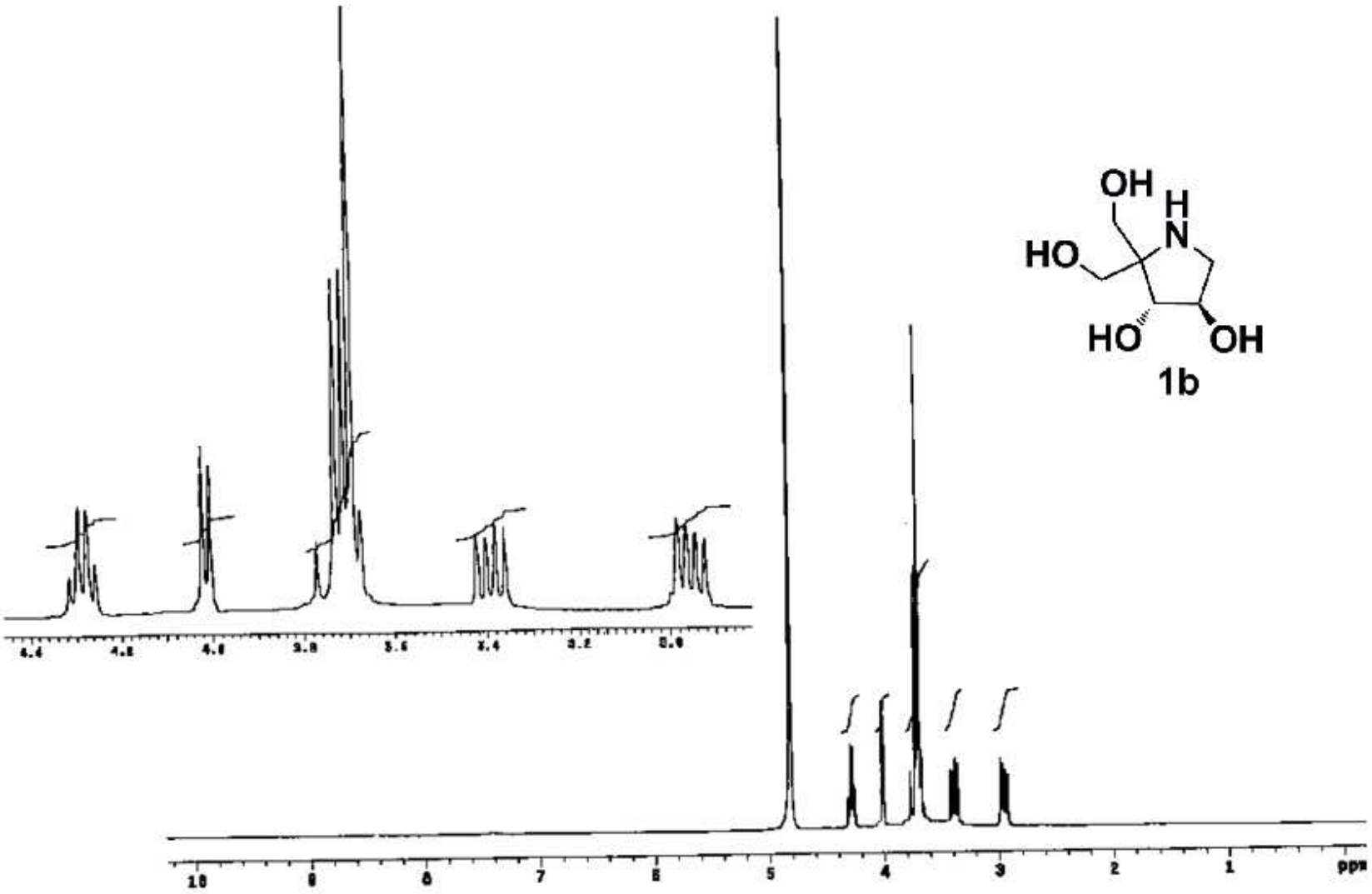
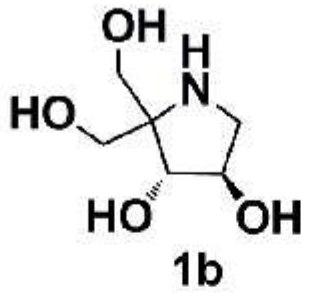


Figure 23: ^{1}H NMR (300 MHz, D_2O) spectrum of compound 1b



1b

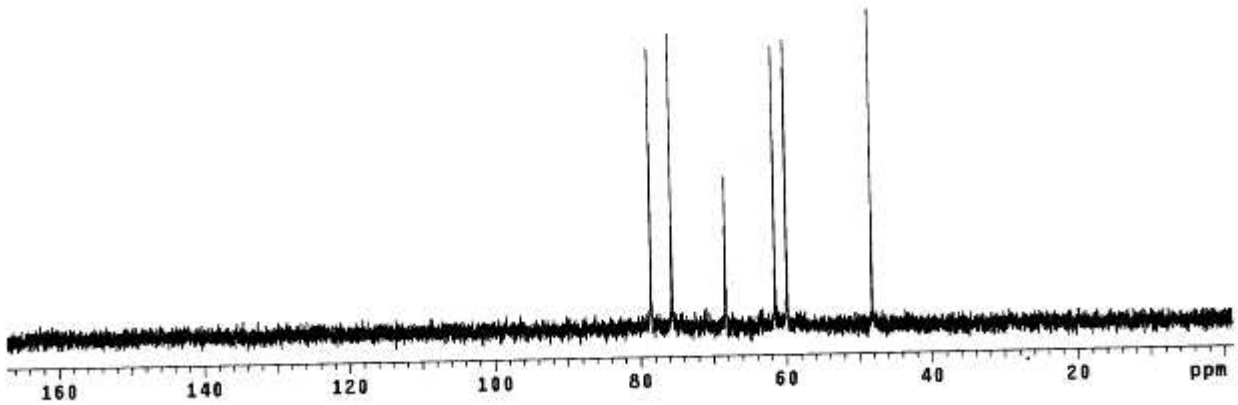


Figure 24: ^{13}C NMR (75 MHz, D_2O) spectrum of compound 1b

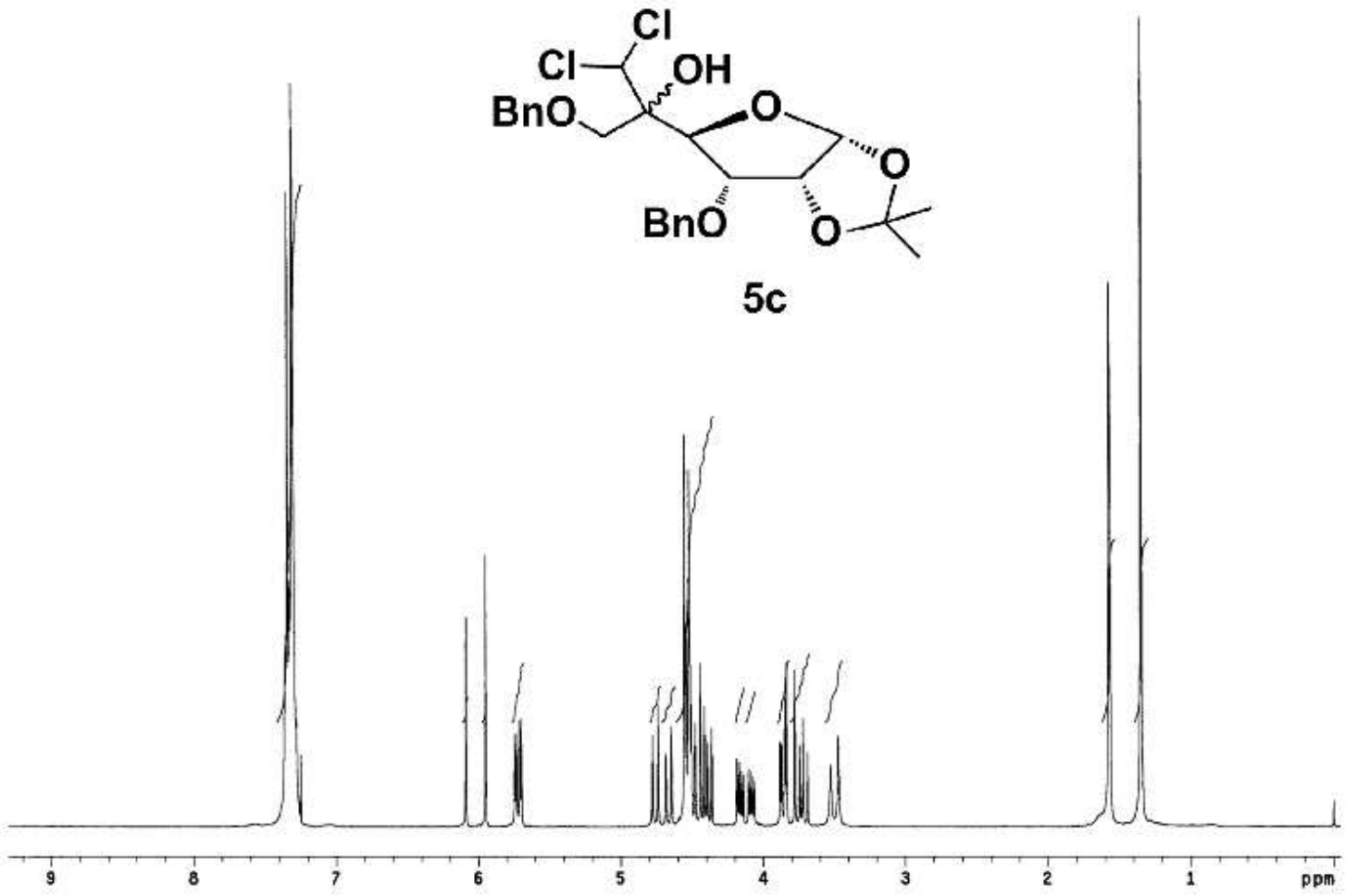


Figure 25: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compounds 5c

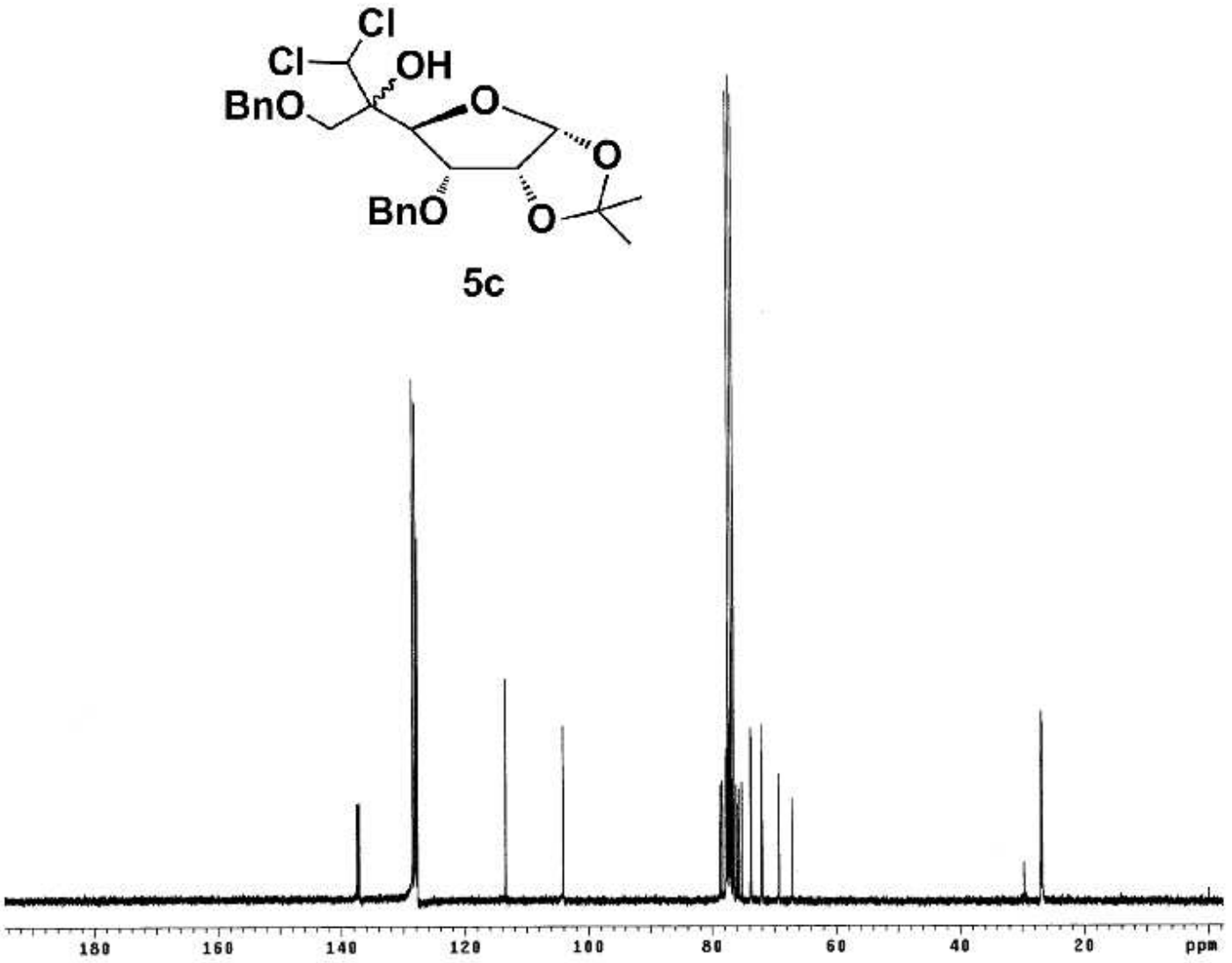


Figure 26: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compounds 5c

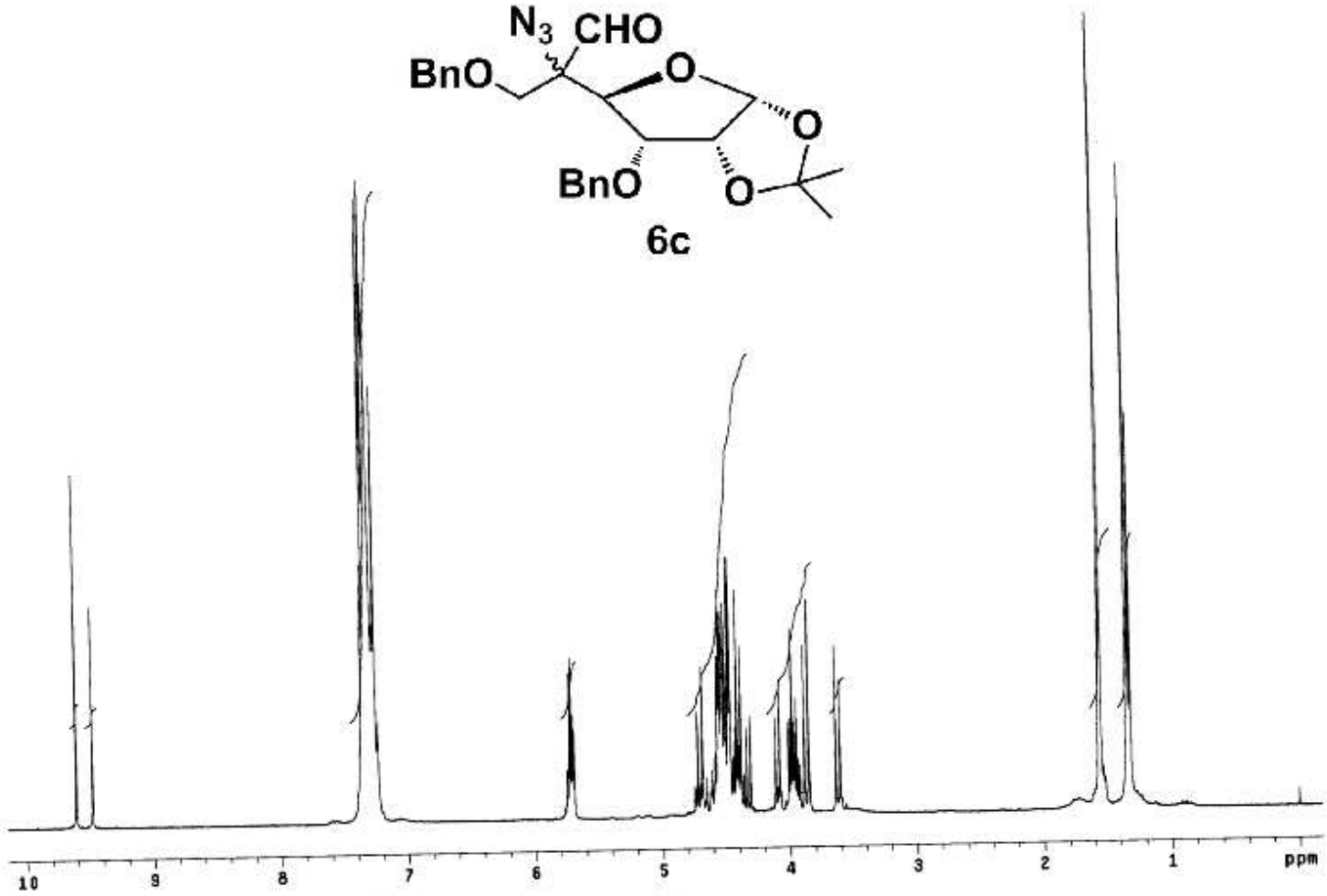


Figure 27: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compounds 6c

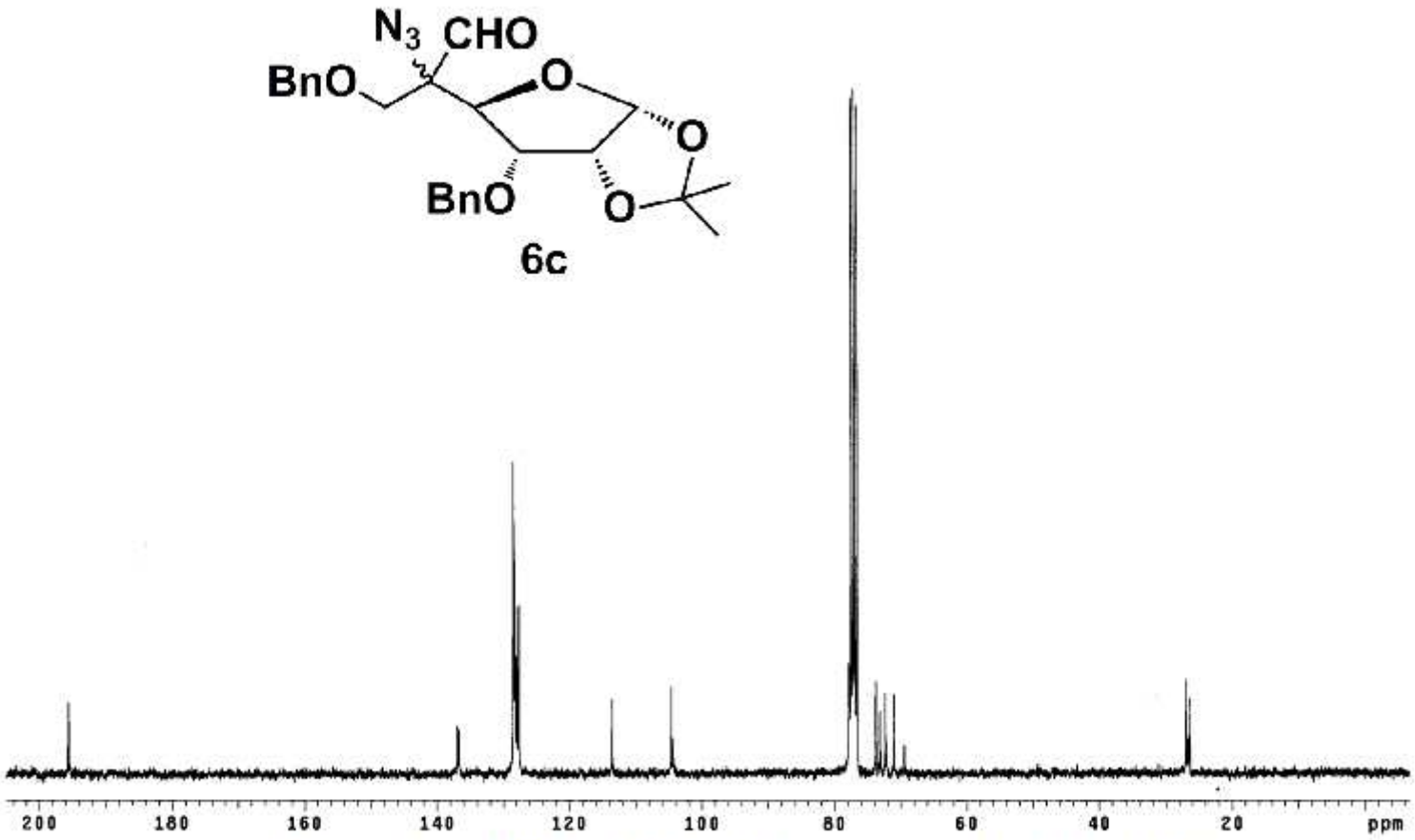


Figure 28: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compounds 6c

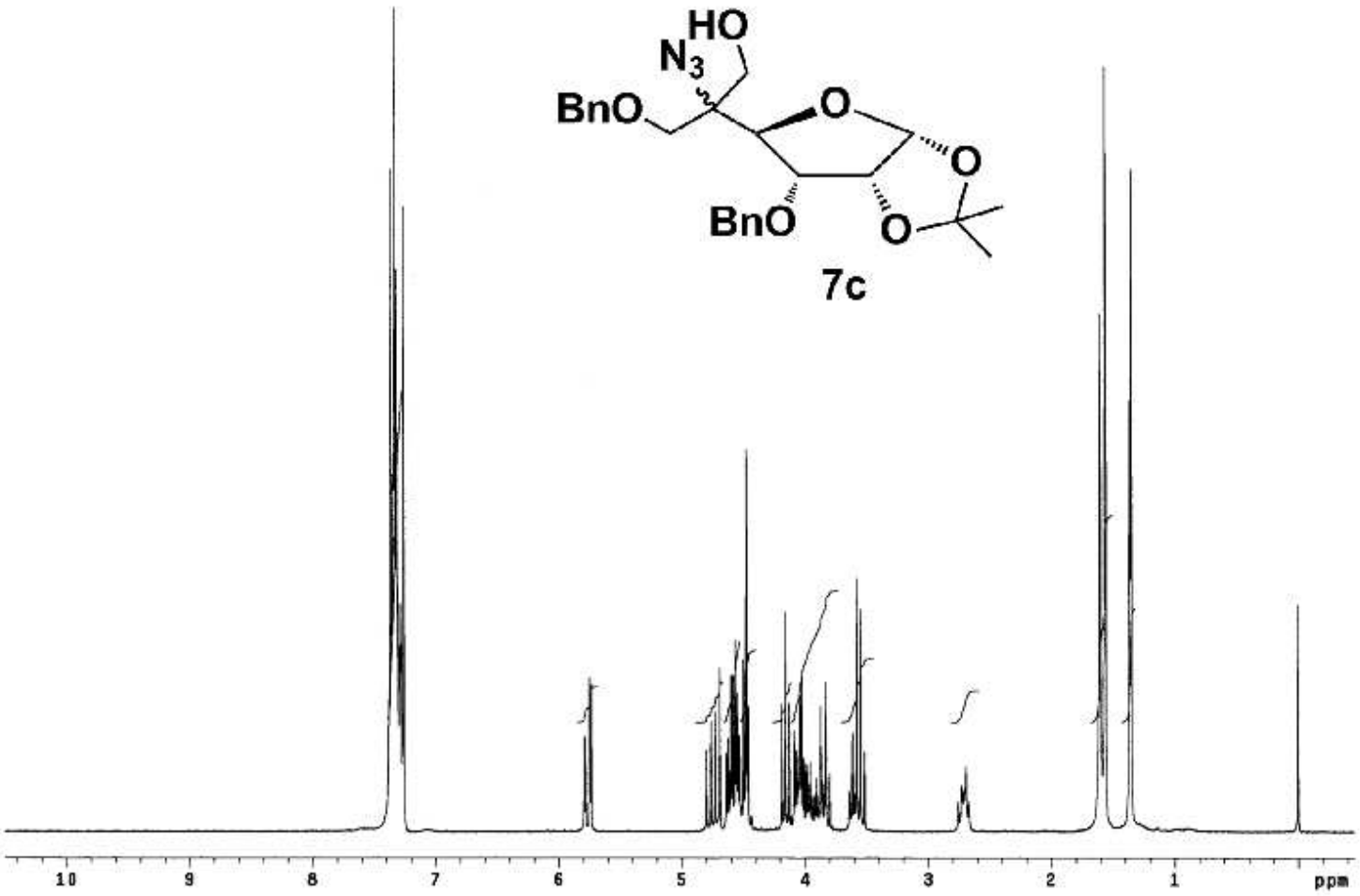


Figure 29: ^{1}H NMR (300 MHz, $CDCl_3$) spectrum of compounds 7c

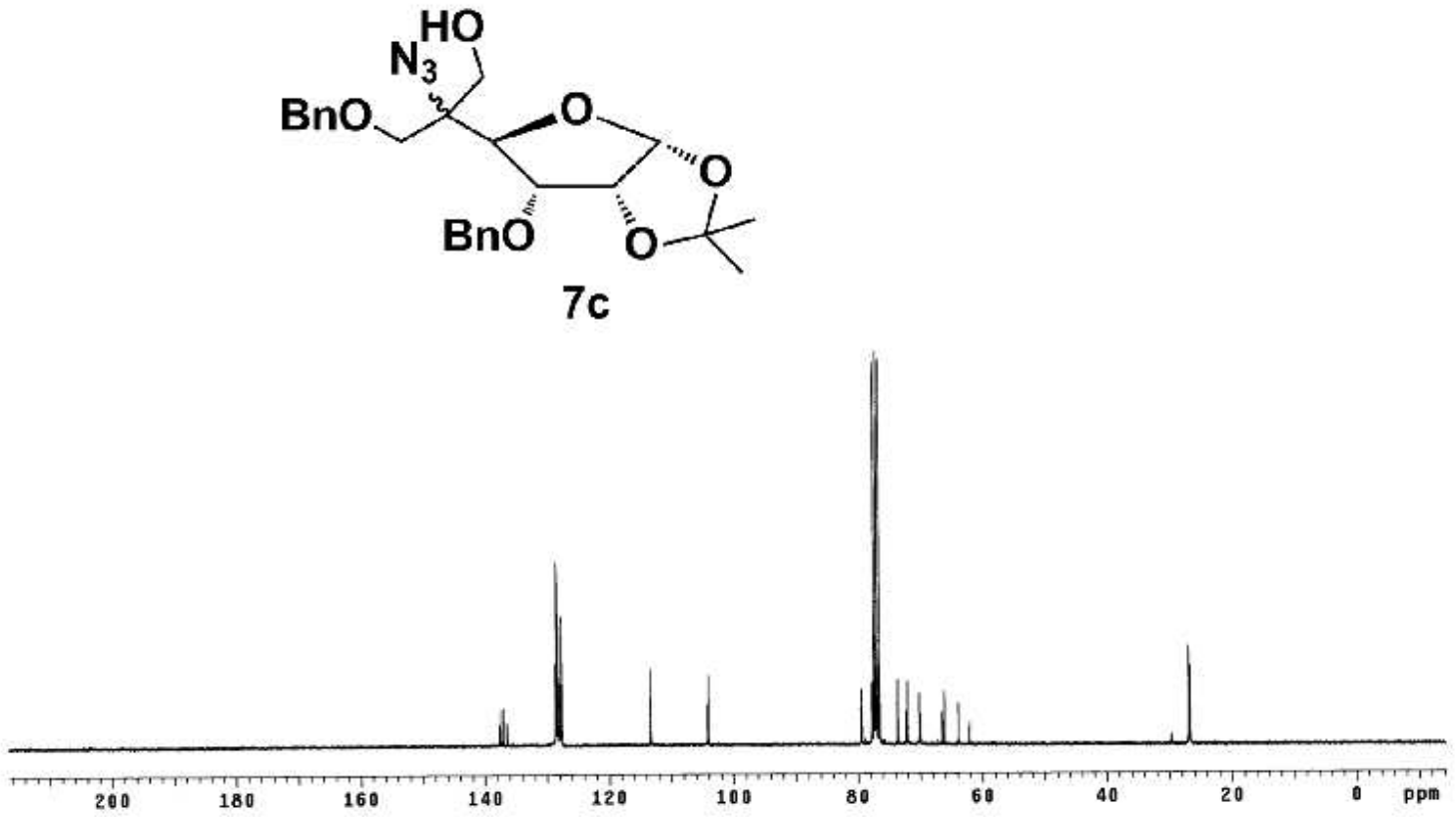


Figure 30: ^{13}C NMR (75 MHz, $CDCl_3$) spectrum of compounds 7c

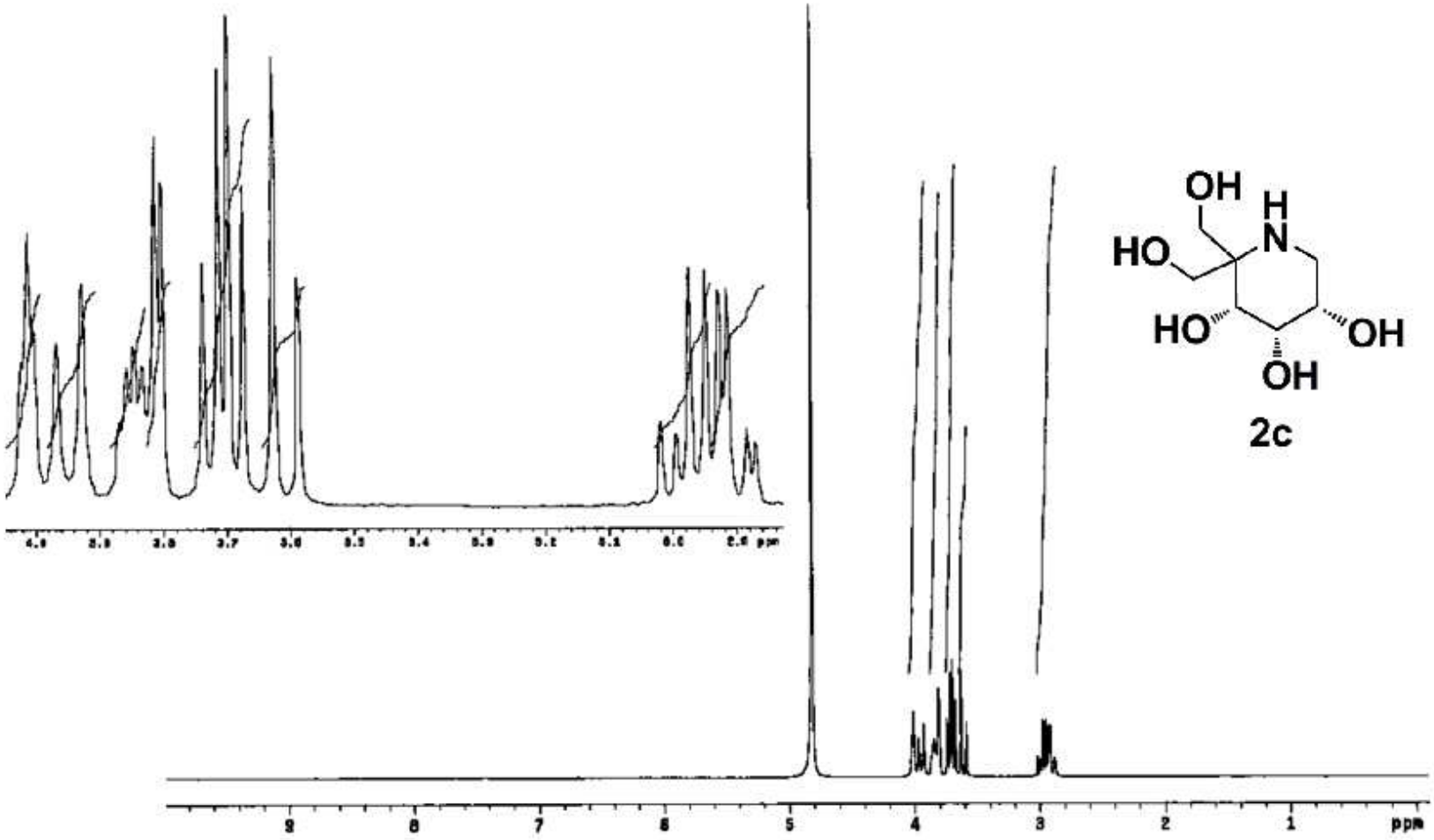


Figure 31: ^{1}H NMR (300 MHz, D_2O) spectrum of compound 2c

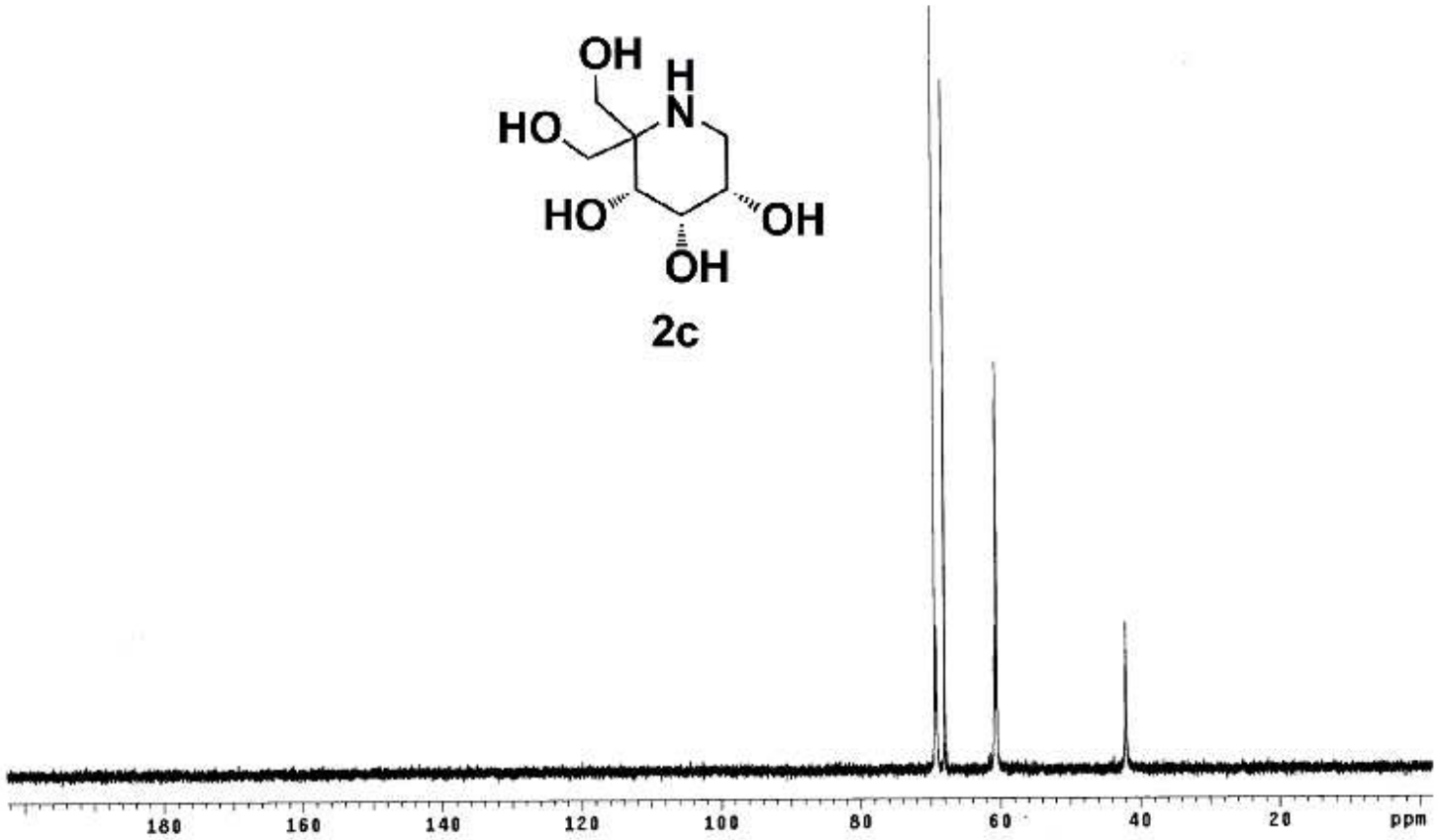


Figure 32: ^{13}C NMR (75 MHz, D_2O) spectrum of compound 2c

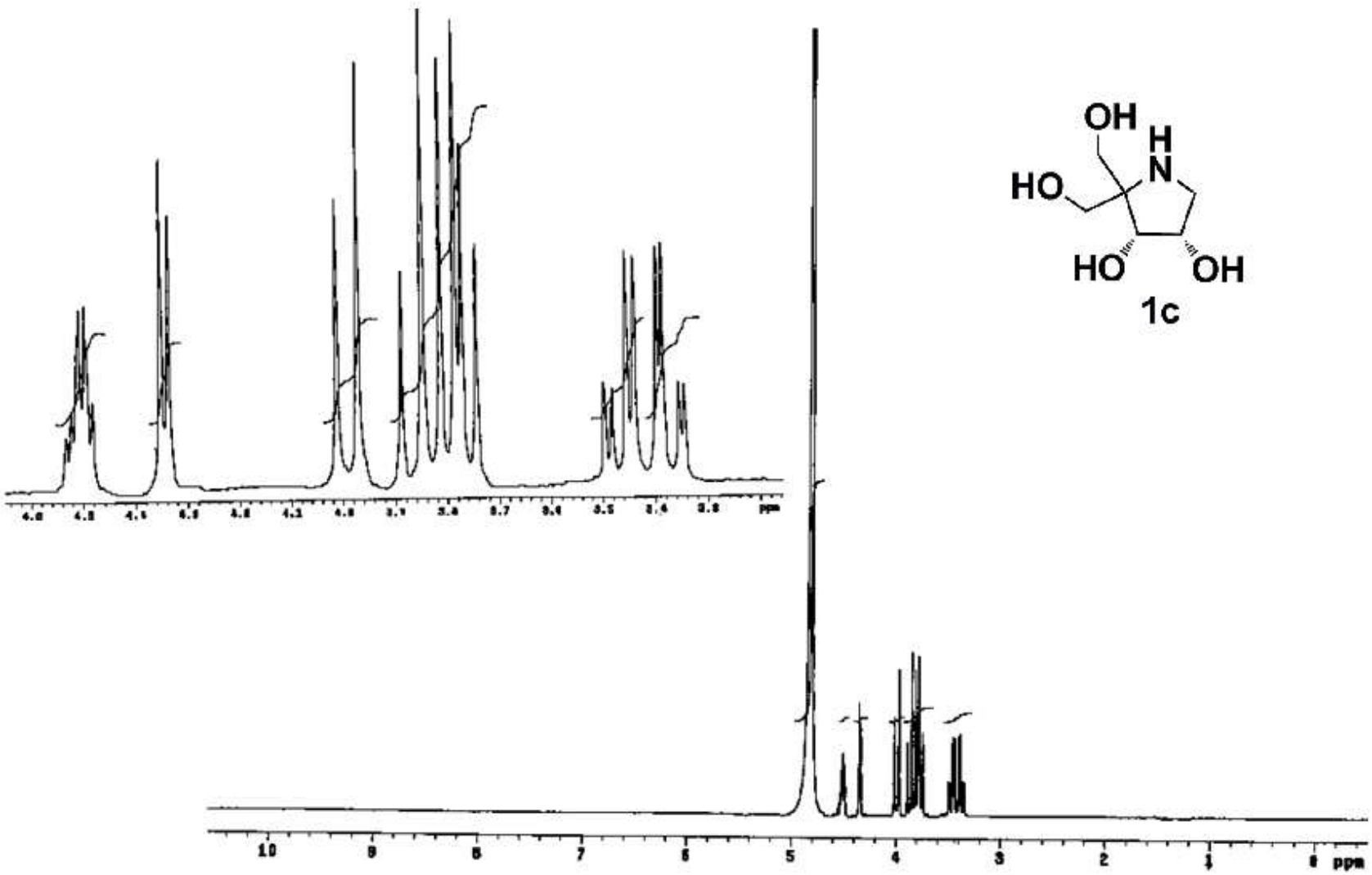
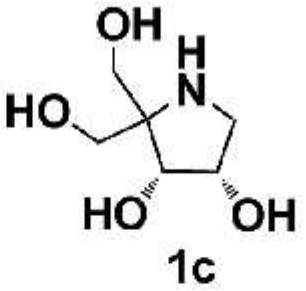


Figure 33: ^{1}H NMR (300 MHz, D_2O) spectrum of compound 1c



1c

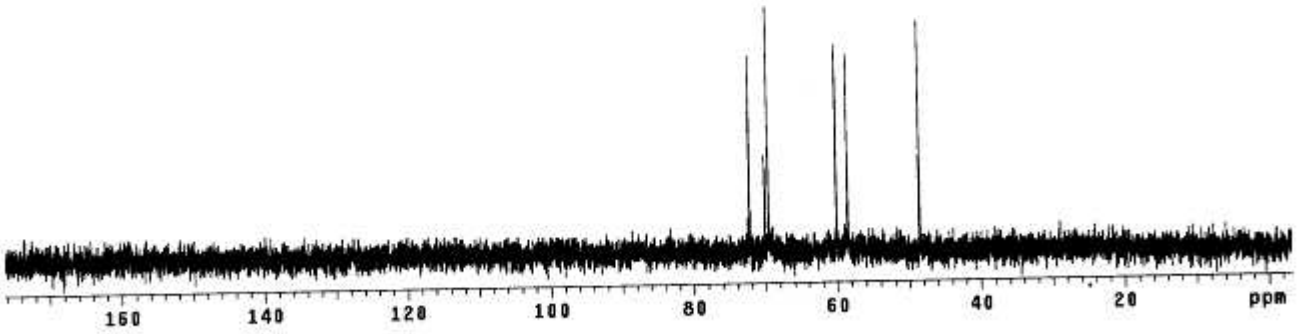


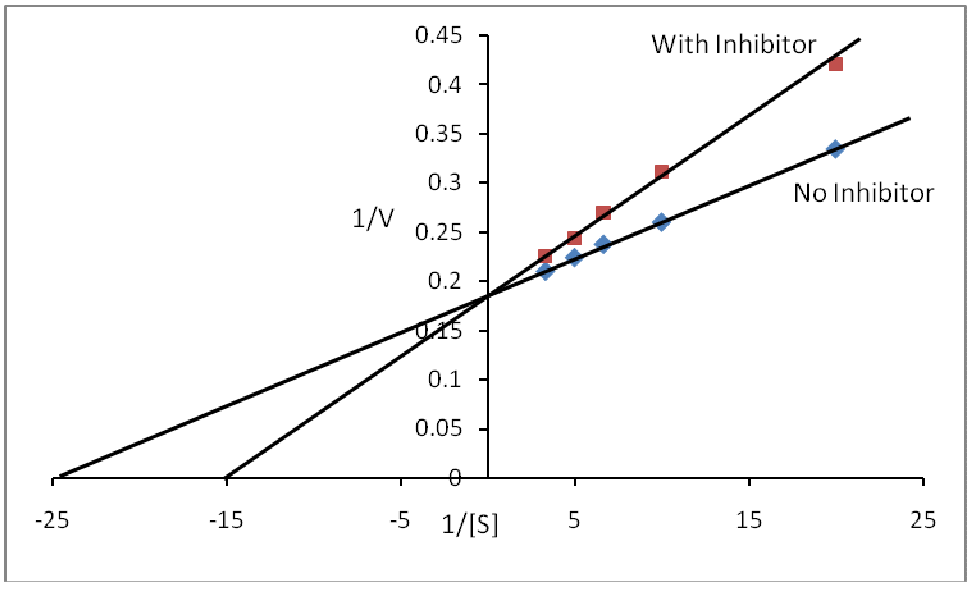
Figure 34: ^{13}C NMR (75 MHz, D_2O) spectrum of compound 1c

4. General Procedure for glycosidase inhibition assay:

The substrates *p*-nitrophenyl-*α*-D-glucopyranoside, *p*-nitrophenyl-*β*-D-glucopyranoside, *p*-nitrophenyl-*α*-D-galactopyranoside *p*-nitrophenyl-*β*-D-galactopyranoside, *p*-nitrophenyl-α-D-mannopyranoside and *p*-nitrophenyl *N*-acetyl-*β*-D-glucosaminidase were procured from sigma chemicals. The inhibition assay with compound was performed by measuring the residual hydrolytic activities of the glycosidases with 2 mM concentration of *p*-nitrophenyl-glycopyranoside prepared in citrate buffer (0.025 M, pH 4.0) and used for assay. The test compound was pre-incubated with the enzyme, buffered at its optimal pH, for 1 h at 37 ºC (for α-galactosidase at 60 ºC). The enzyme reaction was initiated by the addition of 100 µL of substrate. Reaction was terminated with the addition of 0.05 M Borate buffer (pH 9.8) and absorbance of the liberated *p*-nitrophenol was measured at 405 nm with a UV-visible Spectrophotometer. Controls were run simultaneously in the absence of test compound. One unit of glycosidase activity is defined as the amount of enzyme that hydrolyzed 1 µmol of *p*-nitrophenol per minute under assay condition.

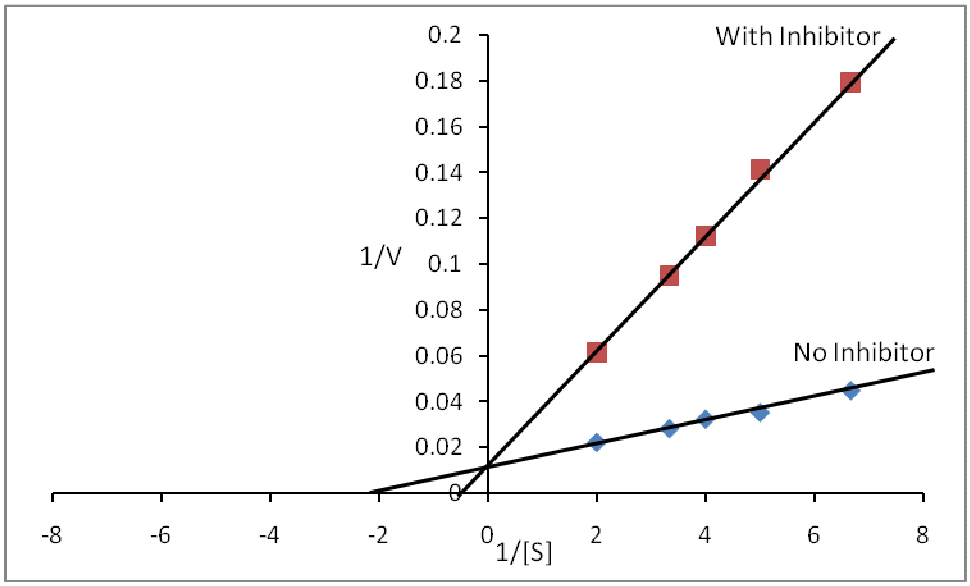
Lineweaver Burk Plots:

Lineweaver Burk plot of D-*Gluco*-deoxynojirimycin with *α*-glucosidase from Rice



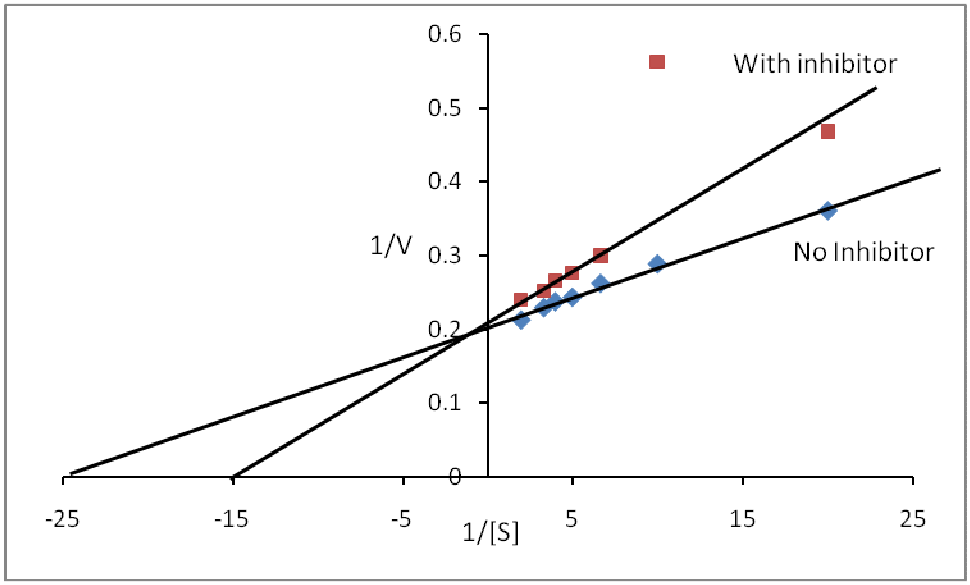
K_i= 0.066 µM

Lineweaver Burk plot of **2a** with α-glucosidase from Rice seeds



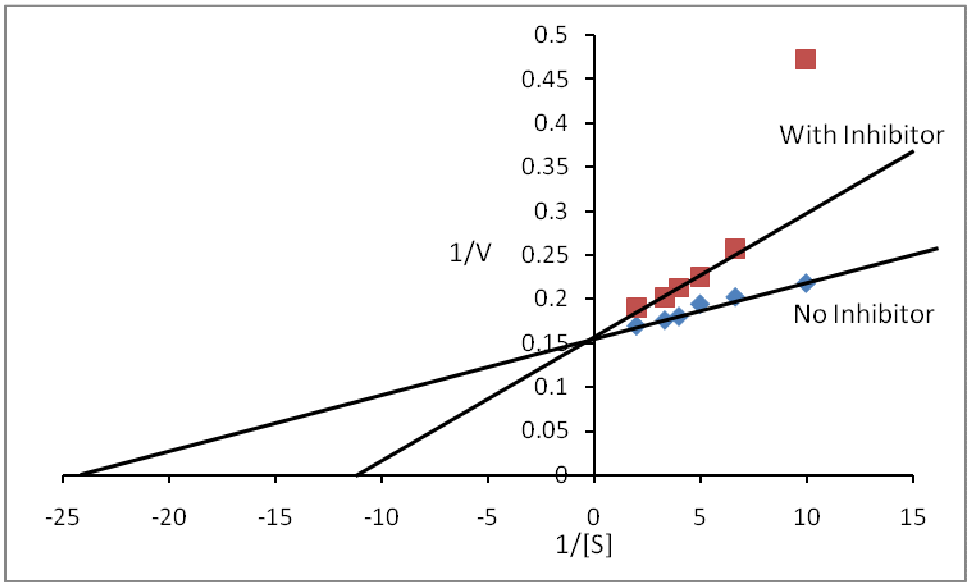
K_i= 3 µM

Lineweaver Burk plot of **2b** with α-glucosidase from Rice seeds



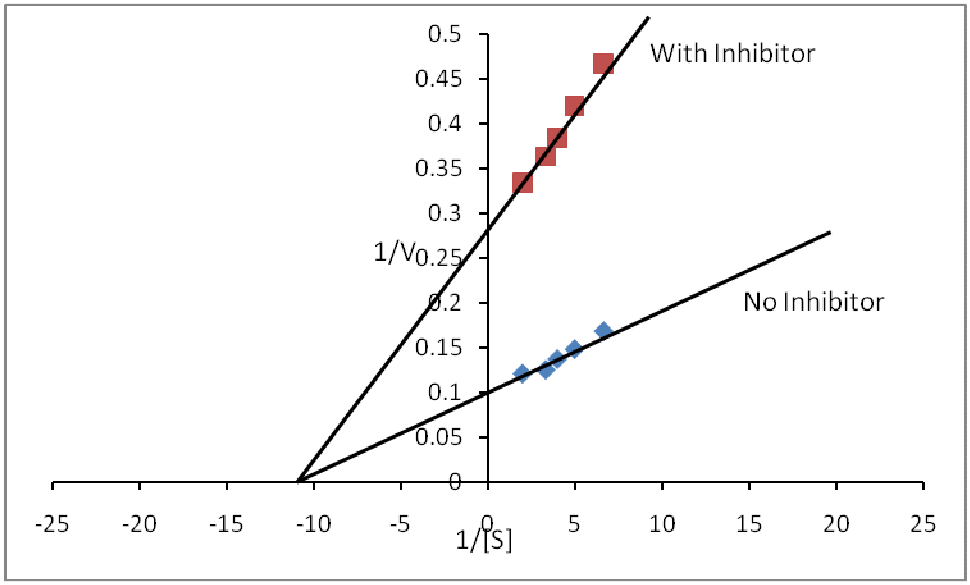
K_i= 0.066µM

Lineweaver Burk plot of **2c** with α-glucosidase from Rice seeds



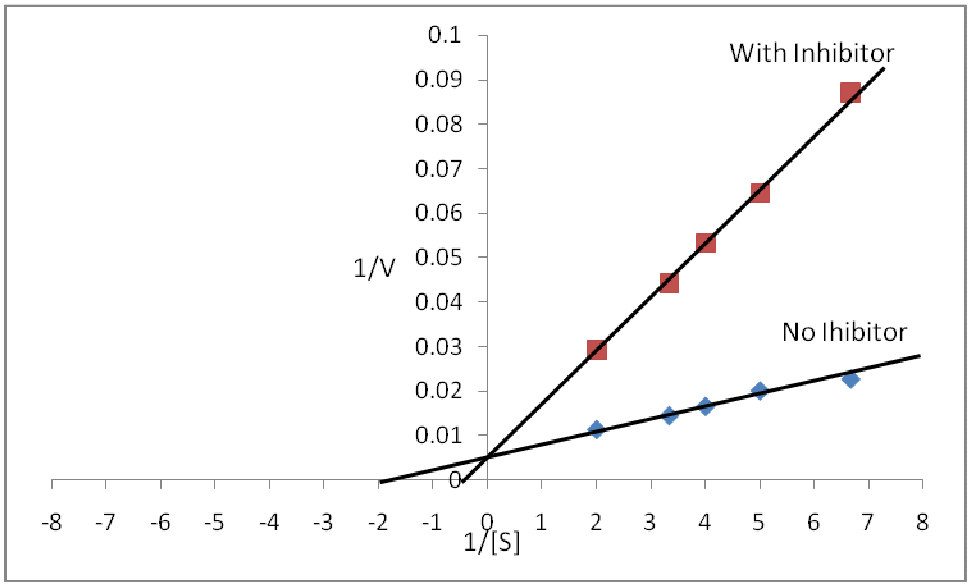
K_i= 0.083µM

Lineweaver Burk plot of **1b** with α-glucosidase from Rice seeds



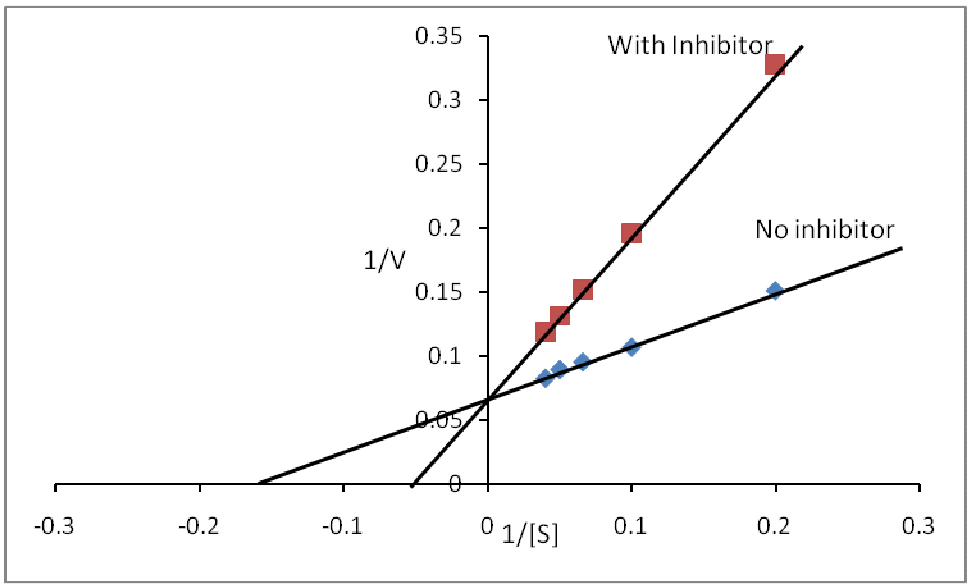
K_i= 0.083 µM

Lineweaver Burk plot of **1c** with α-glucosidase from Rice seeds



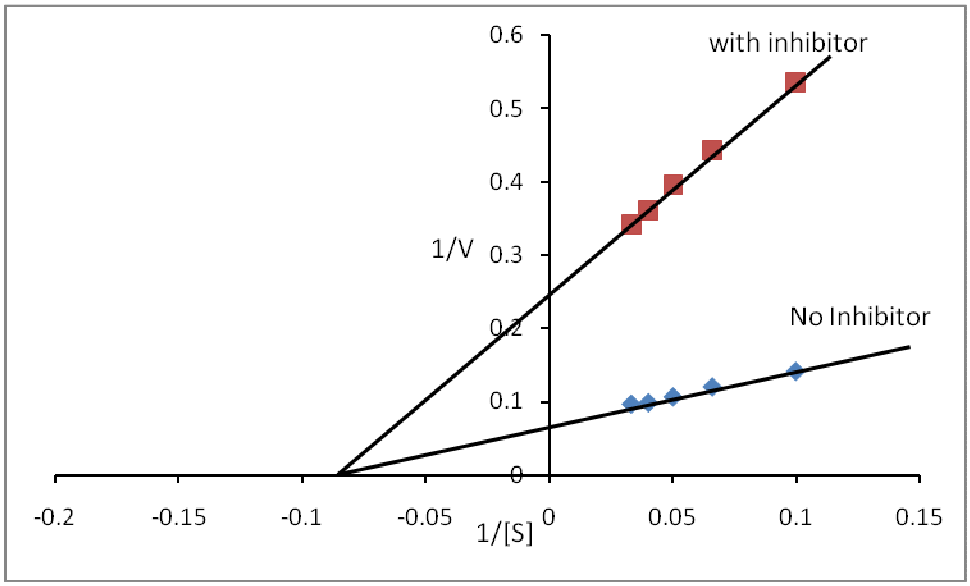
K_i= 4 µM

Lineweaver Burk plot of **2a** with α-galactosidase from Geobacillus NJ704808



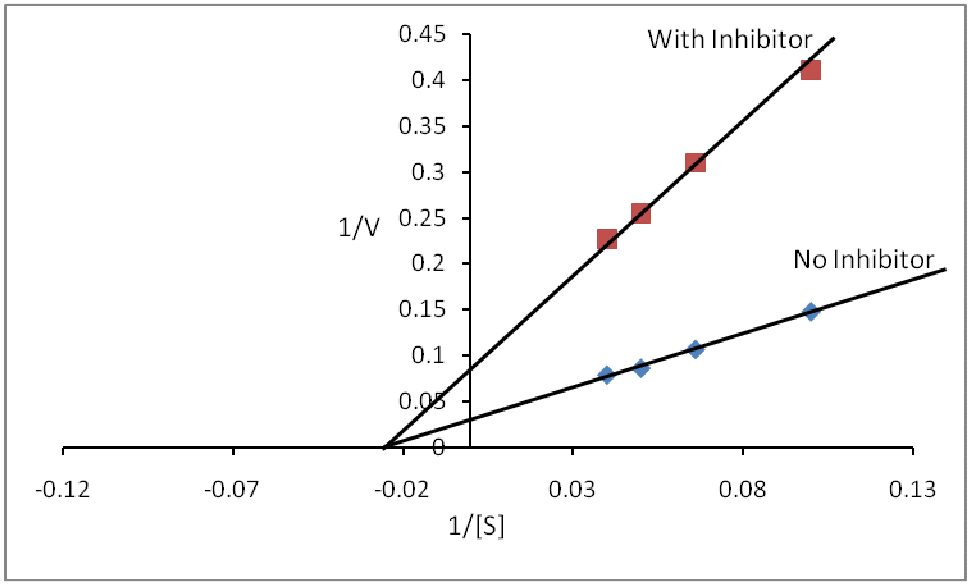
K_i= 20µM

Lineweaver Burk plot of **2b** with α-galactosidase from Geobacillus NJ704808 .



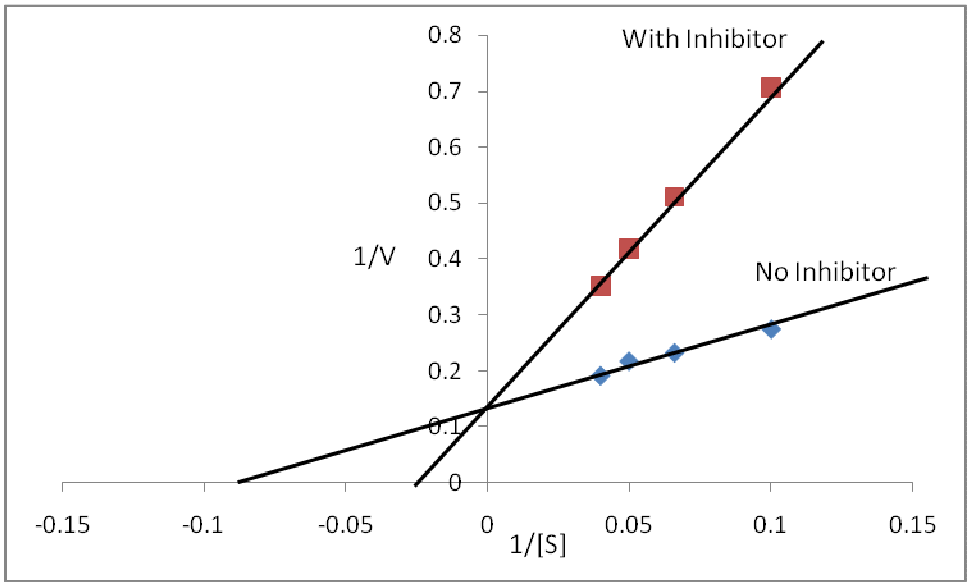
K_i= 13µM

Lineweaver Burk plot of **2c** with α-galactosidase from Geobacillus NJ704808



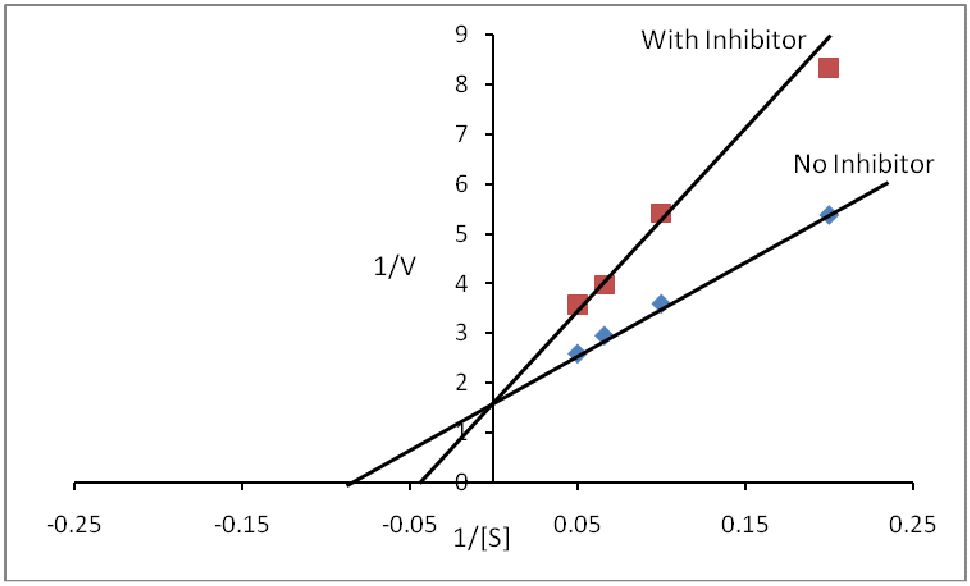
K_i= 34µM

Lineweaver Burk plot of **1b** with α-galactosidase from Geobacillus NJ704808



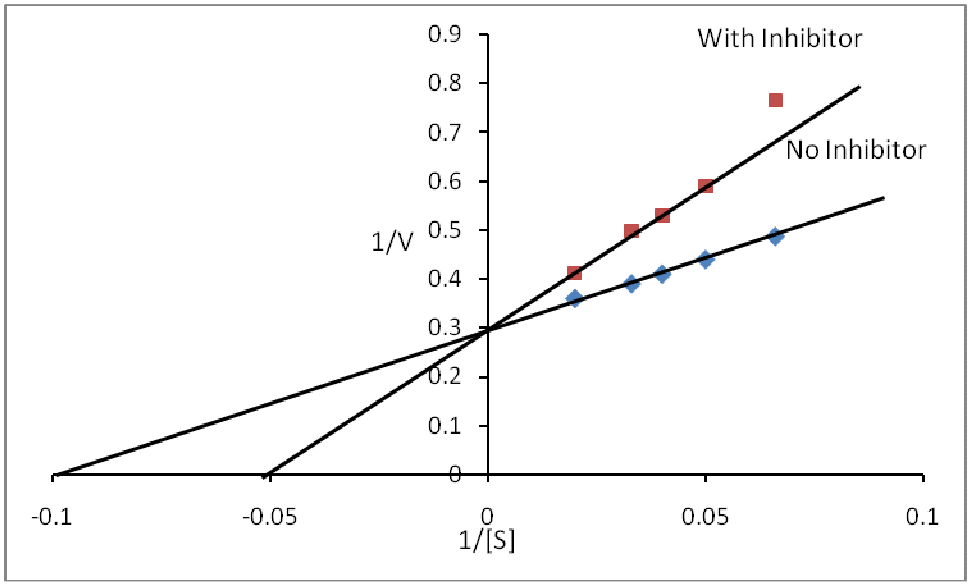
K_i= 40µM

Lineweaver Burk plot of D-*Gluco*-deoxynojirimycin with α-glucosidase from Bakers yeast



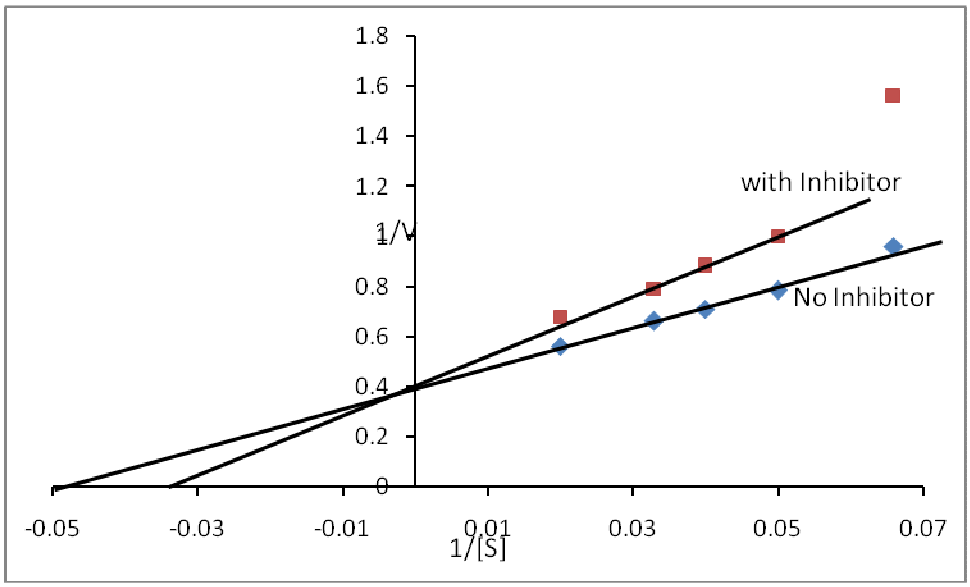
K_i= 22 µM

Lineweaver Burk plot of **2b** with α-glucosidase from Bakers yeast



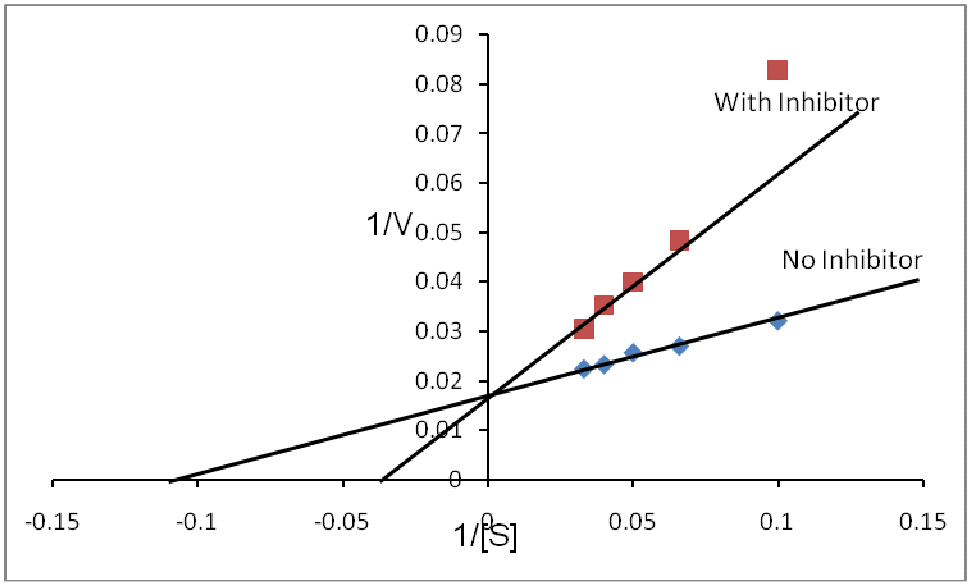
K_i= 20 µM

Lineweaver Burk plot of **1b** with α-glucosidase from Bakers yeast



K_i= 25 µM

Lineweaver Burk plot of **2a** with *β*-galactosidase from bovine liver



K_i= 25 µM

5. Molecular docking Studies:

Table 3: The total energy (E_{total}), Van der Waals energy (E_{vdw}) and electrostatic energy (E_{ele}) in kcal mol^{-1} between active site residues of rice *α*-glucosidase and tested ligands

Ligand	E_{total}	E_{vdw}	E_{ele}	Intercting residues
DNJ	-81.4958	-48.9341	-32.5617	LEU-699, LEU-773, TYR-774, ASP-775, PHE-776, SER-777, THR-796, VAL-797, ASN-798, VAL-799, HIS-800
2a	-83.9167	-48.6397	-35.277	HIS-159, ARG-161, THR-163, GLU-171, VAL-172, PRO-173, ILE-177, PRO-178, ARG-179, PRO-180, LEU-316, VAL-338, ASP-340, TYR-342
2b	-89.7871	-47.4847	-42.3023	HIS-159, ARG-161, THR-163,GLU-171, VAL-172, PRO-173,ILE-177, PRO-178, ARG-179, PRO-180, LEU-316, VAL-338, ASP-340, TYR-342
2c	-87.3137	-44.4827	-42.831	HIS-159, ARG-161, THR-163, GLU-171, VAL-172, PRO-173, ILE-177, PRO-178, ARG-179, PRO-180, LEU-316, VAL-338, ASP-340, TYR-342
1b	-79.2897	-58.9851	-20.3046	GLY-462, MET-463, GLN-465, ASP-466, ILE-467, PHE-468, LEU-469, LYS-470, TRP-471, TYR-486, ASP-489, ASP-775
1c	-75.728	-37.583	-38.145	HIS-159, ARG-161, THR-163, GLU-171, VAL-172, PRO-173, ILE-177, PRO-178, ARG-179, PRO-180, LEU-316, VAL-338, ASP-340, TYR-342

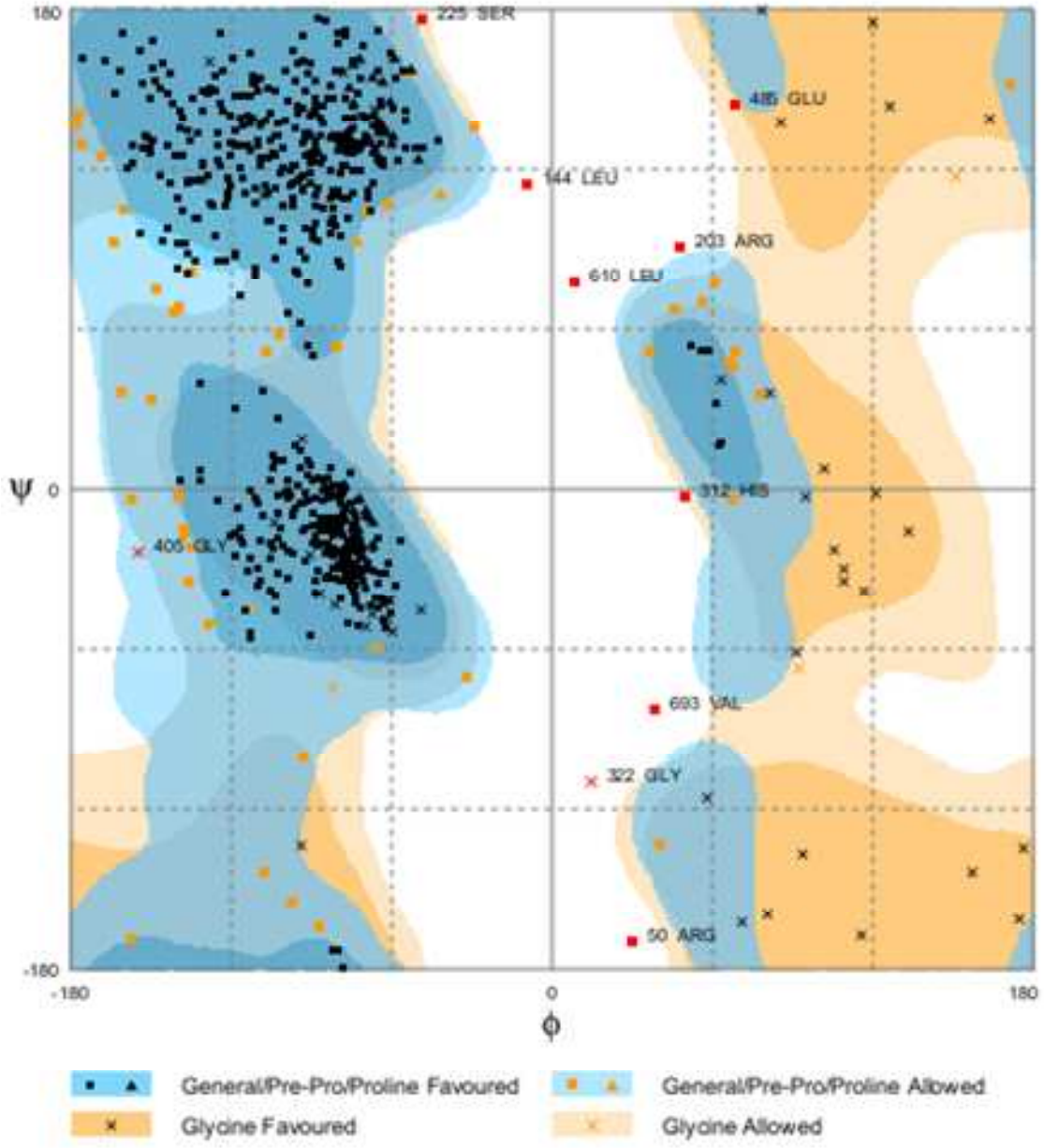
Table 4: The total energy (E_{total}), Van der Waals energy (E_{vdw}) and electrostatic energy (E_{ele}) in kcal mol^{-1} between active site residues of Yeast *α*-glucosidase and tested ligands

Ligand	E_{total}	E_{vdw}	E_{ele}	Interacting Residues
DNJ	-59.4979	-42.933	-16.5649	ARG-222, ASN-241, TRP-242, SER-244, HIS245, ASN-246,GLY-247, PRO-248
2a	-56.6534	-43.5307	-13.1227	ASP-68, MET-69, TYR-71, HIS-111,PHE-158, PHE-177, GLN-181, ARG-212,ASP-214,THR-215, GLU-276, PHE-300, HIS-348, ASP-349, VAL-407, ARG-439,ARG-443
2b	-63.0606	-30.3637	-32.6969	SER-30, LEU-38, LYS-39, PRO-81, THR-82, TYR-83, GLY-84, THR-85
2c	-52.5725	-32.8415	-19.731	TRP-14, HIS-258, ILE-271,ALA-289,VAL-294, SER-295, GLU-270, MET-272,THR-273, SER-288, ALA-290, TYR-292,GLU-293
1b	-55.0016	-39.6788	-15.3228	HIS-258, LYS-262, ARG-269, ILE-271,LEU-257, ARG-259, PHE-260, MET-261,VAL-265, GLY-268, GLU-270, MET-272,THR-273, TYR-292
1c	-63.9244	-45.8175	-18.1068	ASP-68, TYR-71, HIS-111,PHE-158,PHE-177, GLN-181,ARG-212, ASP-214,THR-215,GLU-276, PHE-300, ASP-349,ARG-439, HIS-348, VAL-407,ARG-443

Table 5: The total energy (E_{total}), Van der Waals energy (E_{vdw}) and electrostatic energy (E_{ele}) in kcal mol^{-1} between active site residues of Geobacillus *α*-galactosidase and tested ligands

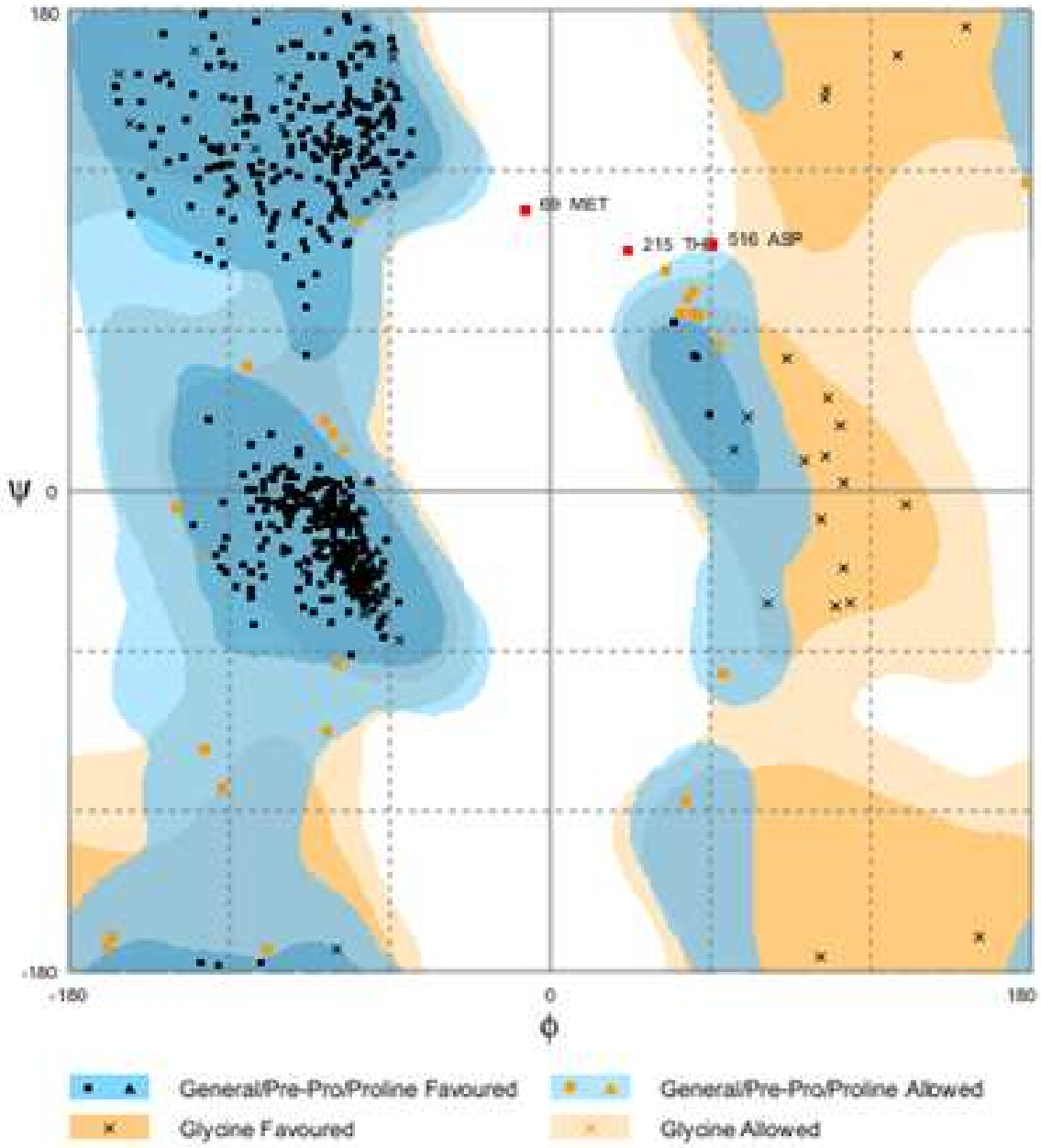
Ligand	E_{total}	E_{vdw}	E_{ele}	Interacting Residues
DNJ	-63.6648	-32.93	-30.7348	TRP-192, PRO-209, VAL-211, THR-212, GLY-213, GLN-215, ILE-261, ARG-208, LEU-210, VAL-214, SER-216, GLU-262, VAL-263
2a	-62.8266	-39.9326	-22.8939	TRP-192, ARG-208, PRO-209, VAL-211, GLY-213, GLN-215, ILE-261, LEU-210, THR-212, VAL-214, SER-216, GLU-262, VAL-263
2b	-71.5287	-42.9741	-28.5545	ASN-334, ASP-366, TRP-411,LYS-476, ASP-478, ASN-480, CYS-526, TRP-545, ASP-548,GLU-604, TRP-199, TRP-336,GLU-337, ASP-367, SER-527, GLY-528, GLY-529, SER-547,THR-550, HIS-574
2c	-67.805	-43.7417	-24.0632	GLY-646, ASN-647, GLU-648, ARG-667, LEU-669, GLU-671, PRO-675, SER-677, VAL-668, ALA-670, ASN-673, ALA-674, LEU-676, VAL-711, GLN-713
1b	-64.0811	-39.1639	-24.9172	ASP-366, TRP-411, ARG-443, LYS-476, ASP-478, ASN-480, CYS-526, GLY-528, ASP-548, TRP-336, ASP-367, SER-527, GLY-529, TRP-545
1c	-70.065	-45.3084	-24.7567	TRP-192, PRO-209, VAL-211, GLY-213, GLN-215, ILE-261, VAL-263, ARG-208, LEU-210, THR-212, VAL-214, GLU-262

Fig. 1A: Ramchandran plot analysis for Rice alpha glucosidase



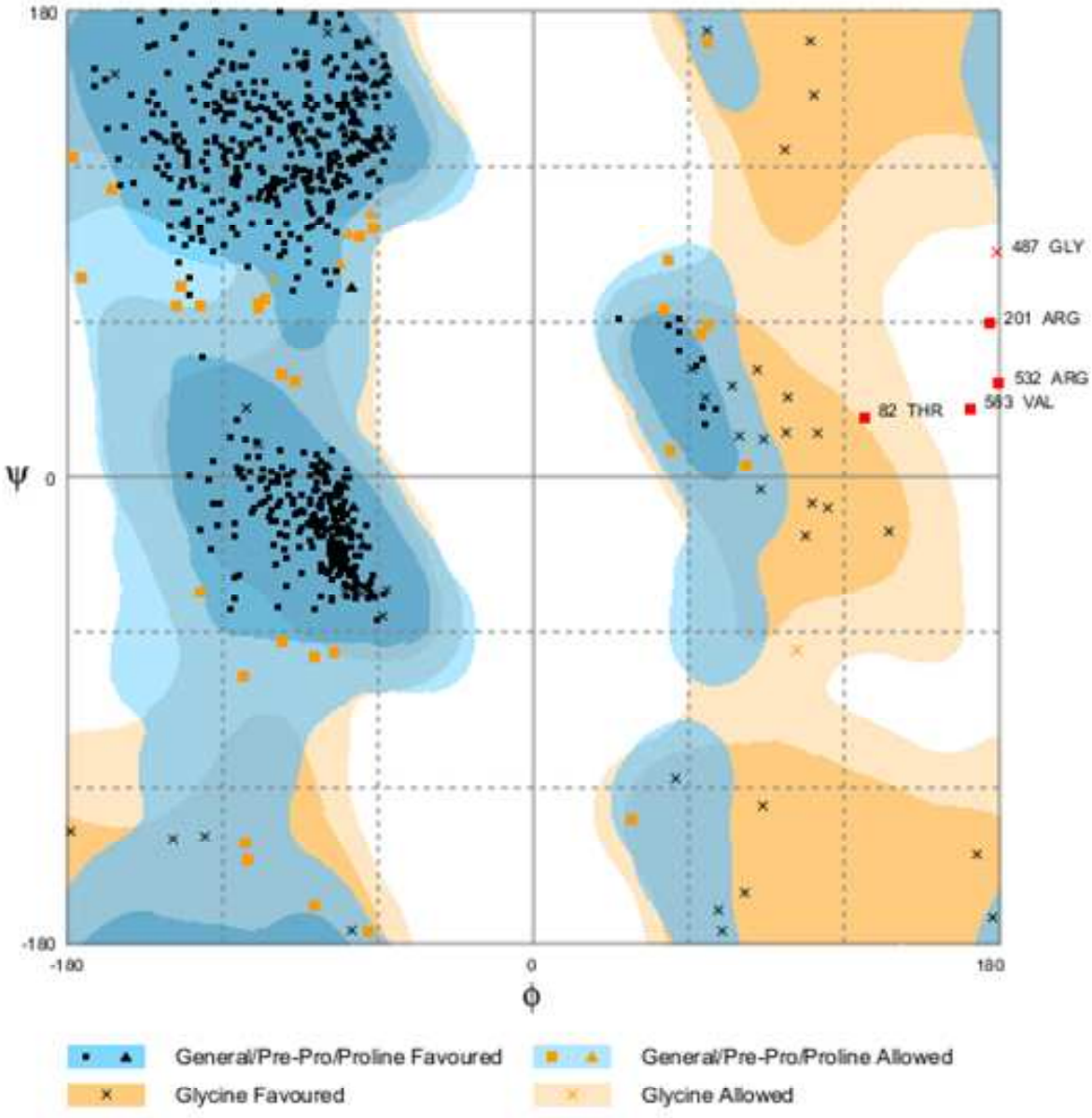
Number of residues in favoured region (~98.0% expected)	: 638 (91.3%)
Number of residues in allowed region (~2.0% expected)	: 51 (7.3%)
Number of residues in outlier region	: 10 (1.4%)

Fig. 1B: Ramchandran plot analysis for Yeast alpha glucosidase



Number of residues in favoured region (~98.0% expected)	: 550 (95.3%)
Number of residues in allowed region (~2.0% expected)	: 24 (4.2%)
Number of residues in outlier region	: 3 (0.5%)

Fig. 1C: Ramchandran plot analysis for Geobacillus alpha galactosidase



Number of residues in favoured region (~98.0% expected)	: 683 (94.5%)
Number of residues in allowed region (~2.0% expected)	: 35 (4.8%)
Number of residues in outlier region	: 5 (0.7%)

6. X-ray Crystal Structure Analysis of compound 5a

Crystal Data: Single crystals of the complex were grown by slow evaporation of the solution of ethyl acetate. Data was collected on SMART APEX-II CCD using Mo-Kα radiation (λ = 0.7107 Å) to a maximum θ range of 25.00°. Colourless plate like crystal of approximate size 0.33 x 0.32 x 0.20 mm^3, was used for data collection. Crystal to detector distance 5.00 cm, 512 x 512 pixels / frame, Oscillation / frame -0.5º, maximum detector swing angle = –30.0º, beam center = (260.2, 252.5), in plane spot width = 1.24, Multi run data acquisition. Total scans = 3, total frames = 1059, exposure / frame = 50.0 sec / frame, θ range = 2.06 to 24.00º, completeness to θ of 24.00 º, is 99.8 %. C_{24} H_{28} Cl_2 O_6, M = 483.36. Crystals belong to Monoclinic, space group $P2_1$, a = 6.299(1) Å, b = 39.634(8) Å, c = 9.864(2) Å, V = 2337.7(9) $Å^3$, β= 108.327(14)°. Z = 4, D_c = 1.373 g/cc, μ (Mo–Kα) = 0.316 mm-1, 15488 reflections measured, 7150 unique [I>2σ(I)], R1 = 0.0840, wR2 = 0.1689 . Largest diff. peak and hole 0.364 and -0.371 e.Å-3. All the data were corrected for Lorentzian, polarisation and absorption effects. SHELX-97 (ShelxTL)[ref] was used for structure solution and full matrix least squares refinement on F^2. Hydrogen atoms were included in the refinement as per the riding model. Data collection and refinement parameters are listed in table 1.

There are two molecules in the asymmetric unit with slight change in conformation of the molecules. The conformation of the molecules was established by single crystal X-ray analysis, which shows that **C1** to **C5** have S configuration for both the molecules of **5a**. The angle between two benzene rings in **5a** for the two molecules is 55.51º and 62.27º respectively. These two molecules in the asymmetric unit with slight change in conformation of the molecules as shown in **figure 35**. The benzene rings of two molecules in the asymmetric unit are oriented at 6.03º.

Reference

G. M. Sheldrick, SHELX-97 program for crystal structure solution and refinement, University of Gottingen, Germany, 1997; 2008

Figure 35.: Overlap of two molecules from the asymmetric Unit

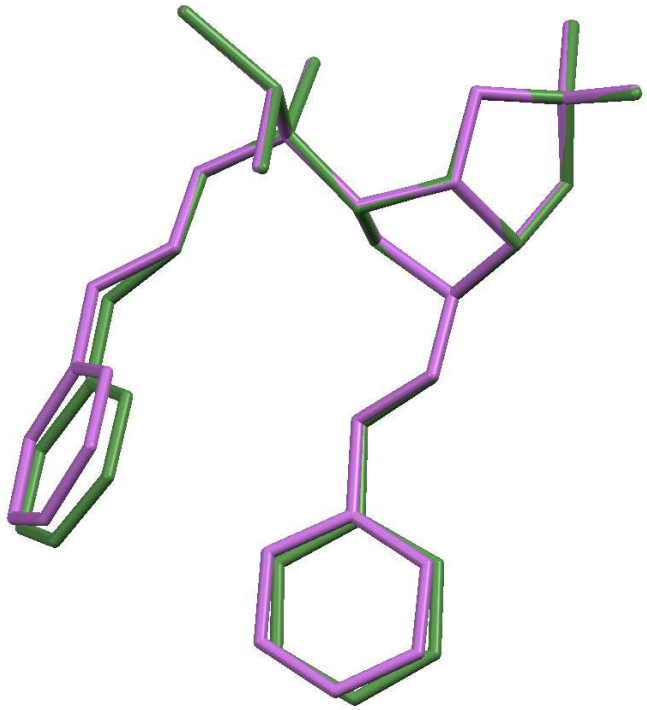


Figure 36: ORTEP diagram of molecule **5a**. Ellipsoids are drawn at 40% probability.

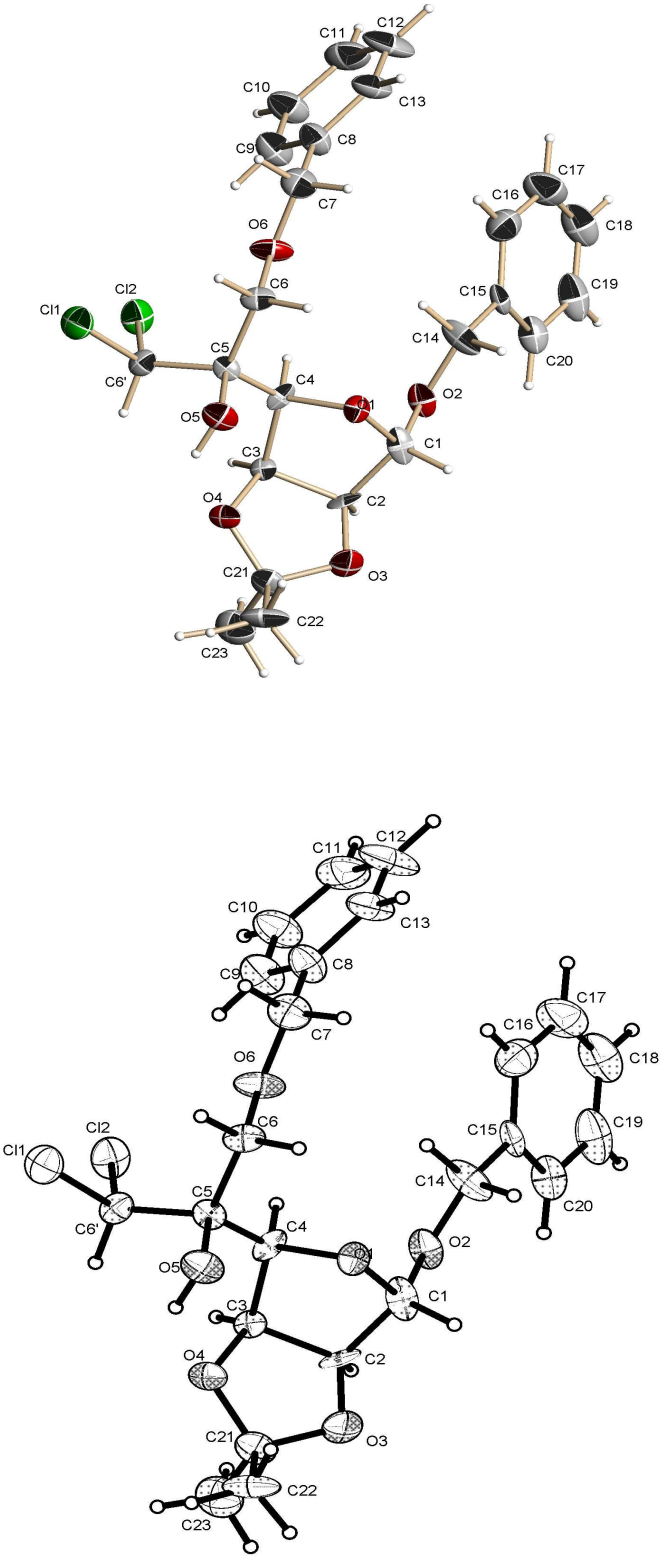


Table 1. Crystal data and structure refinement for **5a**.

Empirical formula	$C_{24}H_{28}Cl_2O_6$	
Formula weight	483.36	
Temperature	173(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	$P2_1$	
Unit cell dimensions	a = 6.299(1) Å	α= 90°.
	b = 39.634(8) Å	β= 108.327(14)°.
	c = 9.864(2) Å	γ = 90°.
Volume	2337.7(9) $Å^3$	
Z	4	
Density (calculated)	1.373 g/cc	
Absorption coefficient	0.316 mm^{-1}	
F(000)	1016	
Crystal size	0.33 x 0.25 x 0.05 mm^3	
Theta range for data collection	2.06 to 24.00°.	
Index ranges	-7<=h<=7, -45<=k<=45, -11<=l<=11	
Reflections collected	15488	
Independent reflections	7150 [R(int) = 0.0652]	
Completeness to theta = 24.00°	99.8 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.9844 and 0.9036	

Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	7150 / 1 / 583
Goodness-of-fit on F^2	1.185
Final R indices [I>2sigma(I)]	R1 = 0.0841, wR2 = 0.1676
R indices (all data)	R1 = 0.0956, wR2 = 0.1729
Absolute structure parameter	0.09(10)
Largest diff. peak and hole	0.364 and -0.371 e.$Å^{-3}$

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for **5a**. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
O(1)	2820(8)	1055(1)	-194(5)	22(1)
O(2)	-333(9)	1317(1)	96(6)	29(1)
O(3)	-543(10)	736(1)	-2688(5)	31(1)
O(4)	1429(8)	339(1)	-1157(5)	25(1)
O(5)	5782(9)	509(1)	136(6)	31(1)
O(6)	5861(9)	999(1)	3202(6)	34(1)
C(1)	578(13)	1158(2)	-865(9)	28(2)
C(3)	638(11)	569(2)	-303(7)	18(2)
C(4)	2647(12)	771(2)	684(8)	21(2)
C(5)	4928(12)	611(2)	1255(8)	17(2)
C(6)	6670(12)	864(2)	2138(8)	25(2)

C(7)	7319(14)	1229(2)	4115(9)	35(2)
C(8)	6214(15)	1363(2)	5127(9)	34(2)
C(9)	4676(15)	1176(2)	5533(10)	39(2)
C(10)	3677(16)	1298(2)	6489(10)	44(2)
C(11)	4174(17)	1625(3)	7011(10)	49(3)
C(12)	5646(17)	1817(3)	6651(10)	53(3)
C(13)	6696(15)	1682(2)	5691(9)	39(2)
C(14)	1085(14)	1588(2)	832(11)	37(2)
C(15)	-192(13)	1803(2)	1577(8)	24(2)
C(16)	997(17)	1948(2)	2866(10)	42(2)
C(17)	-70(20)	2171(2)	3515(11)	56(3)
C(18)	-2296(19)	2238(2)	2920(12)	47(3)
C(19)	-3477(18)	2085(2)	1683(12)	48(3)
C(20)	-2437(14)	1864(2)	1007(10)	32(2)
C(21)	24(14)	393(2)	-2597(9)	31(2)
C(22)	1409(15)	324(3)	-3576(9)	44(2)
C(23)	-2032(16)	176(2)	-2885(10)	47(2)
C(6')	4738(12)	285(2)	2061(8)	23(2)
Cl(1)	7405(4)	103(1)	2890(2)	39(1)
Cl(2)	3308(4)	335(1)	3342(2)	36(1)
O(1A)	8825(8)	3609(1)	2082(6)	23(1)
O(2A)	5415(9)	3326(1)	1703(6)	28(1)
O(3A)	7878(9)	3859(1)	4684(5)	31(1)

O(4A)	8394(9)	4290(1)	3349(5)	26(1)
O(5A)	11440(8)	4179(1)	1999(5)	25(1)
O(6A)	8522(10)	3740(1)	-1244(6)	36(1)
C(1A)	7279(12)	3476(2)	2735(8)	20(2)
C(2A)	6386(14)	3788(2)	3315(9)	28(2)
C(3A)	6778(13)	4080(2)	2376(8)	23(2)
C(4A)	7751(12)	3902(2)	1327(7)	17(2)
C(5A)	9509(12)	4097(2)	831(8)	23(2)
C(6A)	10354(13)	3866(2)	-116(9)	29(2)
C(7A)	9062(16)	3477(2)	-2017(9)	38(2)
C(8A)	7024(14)	3336(2)	-3059(8)	27(2)
C(9A)	4956(15)	3495(2)	-3357(9)	36(2)
C(10A)	3075(16)	3351(2)	-4357(10)	43(2)
C(11A)	3220(17)	3066(2)	-5069(10)	44(2)
C(12A)	5320(20)	2901(2)	-4723(11)	57(3)
C(13A)	7142(17)	3034(2)	-3754(10)	41(2)
C(14A)	6080(15)	3077(2)	912(9)	32(2)
C(15A)	4081(13)	2859(2)	136(8)	26(2)
C(16A)	3988(15)	2718(2)	-1146(10)	35(2)
C(17A)	2284(17)	2498(2)	-1792(9)	44(2)
C(18A)	636(18)	2420(2)	-1182(12)	57(3)
C(19A)	708(15)	2572(2)	74(10)	39(2)
C(20A)	2472(14)	2783(2)	765(9)	34(2)

C(2)	-721(12)	833(2)	-1328(7)	22(2)
C(21A)	8368(14)	4208(2)	4796(8)	29(2)
C(22A)	10667(15)	4270(2)	5774(10)	44(2)
C(23A)	6503(17)	4403(2)	5089(10)	52(3)
C(6A')	8462(13)	4433(2)	167(8)	30(2)
Cl(1A)	5745(3)	4396(1)	-1115(2)	34(1)
Cl(2A)	10254(4)	4649(1)	-617(2)	39(1)

Table 3. Bond lengths [Å] and angles [°] for **5a**.

O(1)-C(1)	1.419(9)
O(1)-C(4)	1.444(8)
O(2)-C(1)	1.404(8)
O(2)-C(14)	1.438(9)
O(3)-C(21)	1.403(9)
O(3)-C(2)	1.433(8)
O(4)-C(3)	1.434(8)
O(4)-C(21)	1.434(10)
O(5)-C(5)	1.431(8)
O(5)-H(5)	0.8400
O(6)-C(7)	1.402(9)
O(6)-C(6)	1.408(8)

C(1)-C(2)	1.516(10)
C(1)-H(1)	1.0000
C(3)-C(2)	1.519(10)
C(3)-C(4)	1.555(10)
C(3)-H(3)	1.0000
C(4)-C(5)	1.507(10)
C(4)-H(4)	1.0000
C(5)-C(6)	1.539(10)
C(5)-C(6')	1.543(10)
C(6)-H(6A)	0.9900
C(6)-H(6B)	0.9900
C(7)-C(8)	1.483(11)
C(7)-H(7A)	0.9900
C(7)-H(7B)	0.9900
C(8)-C(13)	1.376(11)
C(8)-C(9)	1.376(11)
C(9)-C(10)	1.376(11)
C(9)-H(9)	0.9500
C(10)-C(11)	1.394(13)
C(10)-H(10)	0.9500
C(11)-C(12)	1.332(13)
C(11)-H(11)	0.9500
C(12)-C(13)	1.419(12)

C(12)-H(12)	0.9500
C(13)-H(13)	0.9500
C(14)-C(15)	1.511(10)
C(14)-H(14A)	0.9900
C(14)-H(14B)	0.9900
C(15)-C(20)	1.369(11)
C(15)-C(16)	1.382(12)
C(16)-C(17)	1.384(13)
C(16)-H(16)	0.9500
C(17)-C(18)	1.365(15)
C(17)-H(17)	0.9500
C(18)-C(19)	1.355(14)
C(18)-H(18)	0.9500
C(19)-C(20)	1.385(12)
C(19)-H(19)	0.9500
C(20)-H(20)	0.9500
C(21)-C(23)	1.504(12)
C(21)-C(22)	1.516(10)
C(22)-H(22A)	0.9800
C(22)-H(22B)	0.9800
C(22)-H(22C)	0.9800
C(23)-H(23A)	0.9800
C(23)-H(23B)	0.9800

C(23)-H(23C)	0.9800
C(6')-Cl(1)	1.773(7)
C(6')-Cl(2)	1.779(7)
C(6')-H(6')	1.0000
O(1A)-C(1A)	1.427(8)
O(1A)-C(4A)	1.430(8)
O(2A)-C(14A)	1.404(9)
O(2A)-C(1A)	1.419(9)
O(3A)-C(2A)	1.410(10)
O(3A)-C(21A)	1.413(9)
O(4A)-C(3A)	1.426(9)
O(4A)-C(21A)	1.468(9)
O(5A)-C(5A)	1.426(9)
O(5A)-H(5A)	0.8400
O(6A)-C(7A)	1.396(9)
O(6A)-C(6A)	1.417(10)
C(1A)-C(2A)	1.544(10)
C(1A)-H(1A)	1.0000
C(2A)-C(3A)	1.548(10)
C(2A)-H(2A)	1.0000
C(3A)-C(4A)	1.530(9)
C(3A)-H(3A)	1.0000
C(4A)-C(5A)	1.549(10)

C(4A)-H(4A)	1.0000
C(5A)-C(6A)	1.518(10)
C(5A)-C(6A')	1.541(10)
C(6A)-H(6A1)	0.9900
C(6A)-H(6A2)	0.9900
C(7A)-C(8A)	1.479(12)
C(7A)-H(7A1)	0.9900
C(7A)-H(7A2)	0.9900
C(8A)-C(13A)	1.391(11)
C(8A)-C(9A)	1.392(11)
C(9A)-C(10A)	1.402(13)
C(9A)-H(9A)	0.9500
C(10A)-C(11A)	1.350(12)
C(10A)-H(10A)	0.9500
C(11A)-C(12A)	1.416(14)
C(11A)-H(11A)	0.9500
C(12A)-C(13A)	1.351(14)
C(12A)-H(12A)	0.9500
C(13A)-H(13A)	0.9500
C(14A)-C(15A)	1.518(11)
C(14A)-H(14C)	0.9900
C(14A)-H(14D)	0.9900
C(15A)-C(16A)	1.368(11)

C(15A)-C(20A)	1.378(11)
C(16A)-C(17A)	1.374(13)
C(16A)-H(16A)	0.9500
C(17A)-C(18A)	1.389(14)
C(17A)-H(17A)	0.9500
C(18A)-C(19A)	1.365(14)
C(18A)-H(18A)	0.9500
C(19A)-C(20A)	1.387(12)
C(19A)-H(19A)	0.9500
C(20A)-H(20A)	0.9500
C(2)-H(2)	1.0000
C(21A)-C(22A)	1.487(12)
C(21A)-C(23A)	1.509(11)
C(22A)-H(22G)	0.9800
C(22A)-H(22H)	0.9800
C(22A)-H(22I)	0.9800
C(23A)-H(23D)	0.9800
C(23A)-H(23E)	0.9800
C(23A)-H(23F)	0.9800
C(6A')-Cl(2A)	1.775(7)
C(6A')-Cl(1A)	1.785(9)
C(6A')-H(6A')	1.0000

C(1)-O(1)-C(4)	104.6(5)
C(1)-O(2)-C(14)	110.9(5)
C(21)-O(3)-C(2)	107.1(6)
C(3)-O(4)-C(21)	105.5(5)
C(5)-O(5)-H(5)	109.5
C(7)-O(6)-C(6)	114.0(5)
O(2)-C(1)-O(1)	111.9(7)
O(2)-C(1)-C(2)	106.8(5)
O(1)-C(1)-C(2)	105.1(6)
O(2)-C(1)-H(1)	110.9
O(1)-C(1)-H(1)	110.9
C(2)-C(1)-H(1)	110.9
O(4)-C(3)-C(2)	105.9(5)
O(4)-C(3)-C(4)	109.4(5)
C(2)-C(3)-C(4)	103.8(5)
O(4)-C(3)-H(3)	112.4
C(2)-C(3)-H(3)	112.4
C(4)-C(3)-H(3)	112.4
O(1)-C(4)-C(5)	107.9(5)
O(1)-C(4)-C(3)	103.1(5)
C(5)-C(4)-C(3)	120.6(6)
O(1)-C(4)-H(4)	108.2
C(5)-C(4)-H(4)	108.2

C(3)-C(4)-H(4)	108.2
O(5)-C(5)-C(4)	112.1(6)
O(5)-C(5)-C(6)	104.3(5)
C(4)-C(5)-C(6)	111.4(6)
O(5)-C(5)-C(6')	105.5(5)
C(4)-C(5)-C(6')	109.0(5)
C(6)-C(5)-C(6')	114.3(6)
O(6)-C(6)-C(5)	107.9(5)
O(6)-C(6)-H(6A)	110.1
C(5)-C(6)-H(6A)	110.1
O(6)-C(6)-H(6B)	110.1
C(5)-C(6)-H(6B)	110.1
H(6A)-C(6)-H(6B)	108.4
O(6)-C(7)-C(8)	108.3(6)
O(6)-C(7)-H(7A)	110.0
C(8)-C(7)-H(7A)	110.0
O(6)-C(7)-H(7B)	110.0
C(8)-C(7)-H(7B)	110.0
H(7A)-C(7)-H(7B)	108.4
C(13)-C(8)-C(9)	117.6(7)
C(13)-C(8)-C(7)	120.8(7)
C(9)-C(8)-C(7)	121.6(7)
C(10)-C(9)-C(8)	121.7(8)

C(10)-C(9)-H(9)	119.2
C(8)-C(9)-H(9)	119.2
C(9)-C(10)-C(11)	118.8(8)
C(9)-C(10)-H(10)	120.6
C(11)-C(10)-H(10)	120.6
C(12)-C(11)-C(10)	121.9(9)
C(12)-C(11)-H(11)	119.1
C(10)-C(11)-H(11)	119.1
C(11)-C(12)-C(13)	118.1(8)
C(11)-C(12)-H(12)	120.9
C(13)-C(12)-H(12)	120.9
C(8)-C(13)-C(12)	121.8(8)
C(8)-C(13)-H(13)	119.1
C(12)-C(13)-H(13)	119.1
O(2)-C(14)-C(15)	108.9(6)
O(2)-C(14)-H(14A)	109.9
C(15)-C(14)-H(14A)	109.9
O(2)-C(14)-H(14B)	109.9
C(15)-C(14)-H(14B)	109.9
H(14A)-C(14)-H(14B)	108.3
C(20)-C(15)-C(16)	119.7(7)
C(20)-C(15)-C(14)	122.7(8)
C(16)-C(15)-C(14)	117.6(8)

C(15)-C(16)-C(17)	119.3(9)
C(15)-C(16)-H(16)	120.3
C(17)-C(16)-H(16)	120.3
C(18)-C(17)-C(16)	120.5(10)
C(18)-C(17)-H(17)	119.8
C(16)-C(17)-H(17)	119.8
C(19)-C(18)-C(17)	120.0(9)
C(19)-C(18)-H(18)	120.0
C(17)-C(18)-H(18)	120.0
C(18)-C(19)-C(20)	120.4(10)
C(18)-C(19)-H(19)	119.8
C(20)-C(19)-H(19)	119.8
C(15)-C(20)-C(19)	119.9(9)
C(15)-C(20)-H(20)	120.0
C(19)-C(20)-H(20)	120.0
O(3)-C(21)-O(4)	105.9(6)
O(3)-C(21)-C(23)	110.7(7)
O(4)-C(21)-C(23)	109.2(7)
O(3)-C(21)-C(22)	108.6(7)
O(4)-C(21)-C(22)	107.7(7)
C(23)-C(21)-C(22)	114.3(7)
C(21)-C(22)-H(22A)	109.5
C(21)-C(22)-H(22B)	109.5

H(22A)-C(22)-H(22B)	109.5
C(21)-C(22)-H(22C)	109.5
H(22A)-C(22)-H(22C)	109.5
H(22B)-C(22)-H(22C)	109.5
C(21)-C(23)-H(23A)	109.5
C(21)-C(23)-H(23B)	109.5
H(23A)-C(23)-H(23B)	109.5
C(21)-C(23)-H(23C)	109.5
H(23A)-C(23)-H(23C)	109.5
H(23B)-C(23)-H(23C)	109.5
C(5)-C(6')-Cl(1)	111.3(5)
C(5)-C(6')-Cl(2)	114.2(5)
Cl(1)-C(6')-Cl(2)	109.6(4)
C(5)-C(6')-H(6')	107.1
Cl(1)-C(6')-H(6')	107.1
Cl(2)-C(6')-H(6')	107.1
C(1A)-O(1A)-C(4A)	104.9(5)
C(14A)-O(2A)-C(1A)	111.6(6)
C(2A)-O(3A)-C(21A)	109.4(6)
C(3A)-O(4A)-C(21A)	107.6(5)
C(5A)-O(5A)-H(5A)	109.5
C(7A)-O(6A)-C(6A)	114.4(6)
O(2A)-C(1A)-O(1A)	111.0(6)

O(2A)-C(1A)-C(2A)	106.5(6)
O(1A)-C(1A)-C(2A)	104.5(5)
O(2A)-C(1A)-H(1A)	111.5
O(1A)-C(1A)-H(1A)	111.5
C(2A)-C(1A)-H(1A)	111.5
O(3A)-C(2A)-C(1A)	107.7(6)
O(3A)-C(2A)-C(3A)	104.0(6)
C(1A)-C(2A)-C(3A)	103.4(5)
O(3A)-C(2A)-H(2A)	113.6
C(1A)-C(2A)-H(2A)	113.6
C(3A)-C(2A)-H(2A)	113.6
O(4A)-C(3A)-C(4A)	111.8(6)
O(4A)-C(3A)-C(2A)	104.3(6)
C(4A)-C(3A)-C(2A)	103.6(5)
O(4A)-C(3A)-H(3A)	112.2
C(4A)-C(3A)-H(3A)	112.2
C(2A)-C(3A)-H(3A)	112.2
O(1A)-C(4A)-C(3A)	104.3(5)
O(1A)-C(4A)-C(5A)	107.5(5)
C(3A)-C(4A)-C(5A)	117.5(6)
O(1A)-C(4A)-H(4A)	109.1
C(3A)-C(4A)-H(4A)	109.1
C(5A)-C(4A)-H(4A)	109.1

O(5A)-C(5A)-C(6A)	105.1(6)
O(5A)-C(5A)-C(6A')	106.7(6)
C(6A)-C(5A)-C(6A')	116.5(6)
O(5A)-C(5A)-C(4A)	111.8(6)
C(6A)-C(5A)-C(4A)	108.6(6)
C(6A')-C(5A)-C(4A)	108.3(6)
O(6A)-C(6A)-C(5A)	109.7(6)
O(6A)-C(6A)-H(6A1)	109.7
C(5A)-C(6A)-H(6A1)	109.7
O(6A)-C(6A)-H(6A2)	109.7
C(5A)-C(6A)-H(6A2)	109.7
H(6A1)-C(6A)-H(6A2)	108.2
O(6A)-C(7A)-C(8A)	110.8(7)
O(6A)-C(7A)-H(7A1)	109.5
C(8A)-C(7A)-H(7A1)	109.5
O(6A)-C(7A)-H(7A2)	109.5
C(8A)-C(7A)-H(7A2)	109.5
H(7A1)-C(7A)-H(7A2)	108.1
C(13A)-C(8A)-C(9A)	118.4(8)
C(13A)-C(8A)-C(7A)	119.9(8)
C(9A)-C(8A)-C(7A)	121.7(7)
C(8A)-C(9A)-C(10A)	119.5(7)
C(8A)-C(9A)-H(9A)	120.2

C(10A)-C(9A)-H(9A)	120.2
C(11A)-C(10A)-C(9A)	121.7(9)
C(11A)-C(10A)-H(10A)	119.1
C(9A)-C(10A)-H(10A)	119.1
C(10A)-C(11A)-C(12A)	118.2(9)
C(10A)-C(11A)-H(11A)	120.9
C(12A)-C(11A)-H(11A)	120.9
C(13A)-C(12A)-C(11A)	120.8(8)
C(13A)-C(12A)-H(12A)	119.6
C(11A)-C(12A)-H(12A)	119.6
C(12A)-C(13A)-C(8A)	121.3(9)
C(12A)-C(13A)-H(13A)	119.3
C(8A)-C(13A)-H(13A)	119.3
O(2A)-C(14A)-C(15A)	109.5(6)
O(2A)-C(14A)-H(14C)	109.8
C(15A)-C(14A)-H(14C)	109.8
O(2A)-C(14A)-H(14D)	109.8
C(15A)-C(14A)-H(14D)	109.8
H(14C)-C(14A)-H(14D)	108.2
C(16A)-C(15A)-C(20A)	120.2(8)
C(16A)-C(15A)-C(14A)	119.0(7)
C(20A)-C(15A)-C(14A)	120.6(7)
C(15A)-C(16A)-C(17A)	119.2(8)

C(15A)-C(16A)-H(16A)	120.4
C(17A)-C(16A)-H(16A)	120.4
C(16A)-C(17A)-C(18A)	121.5(8)
C(16A)-C(17A)-H(17A)	119.3
C(18A)-C(17A)-H(17A)	119.3
C(19A)-C(18A)-C(17A)	118.6(9)
C(19A)-C(18A)-H(18A)	120.7
C(17A)-C(18A)-H(18A)	120.7
C(18A)-C(19A)-C(20A)	120.3(9)
C(18A)-C(19A)-H(19A)	119.8
C(20A)-C(19A)-H(19A)	119.8
C(15A)-C(20A)-C(19A)	120.0(8)
C(15A)-C(20A)-H(20A)	120.0
C(19A)-C(20A)-H(20A)	120.0
O(3)-C(2)-C(1)	108.4(6)
O(3)-C(2)-C(3)	104.2(5)
C(1)-C(2)-C(3)	104.3(6)
O(3)-C(2)-H(2)	113.1
C(1)-C(2)-H(2)	113.1
C(3)-C(2)-H(2)	113.1
O(3A)-C(21A)-O(4A)	102.0(6)
O(3A)-C(21A)-C(22A)	110.8(7)
O(4A)-C(21A)-C(22A)	106.8(7)

O(3A)-C(21A)-C(23A)	110.7(7)
O(4A)-C(21A)-C(23A)	108.7(7)
C(22A)-C(21A)-C(23A)	116.7(7)
C(21A)-C(22A)-H(22G)	109.5
C(21A)-C(22A)-H(22H)	109.5
H(22G)-C(22A)-H(22H)	109.5
C(21A)-C(22A)-H(22I)	109.5
H(22G)-C(22A)-H(22I)	109.5
H(22H)-C(22A)-H(22I)	109.5
C(21A)-C(23A)-H(23D)	109.5
C(21A)-C(23A)-H(23E)	109.5
H(23D)-C(23A)-H(23E)	109.5
C(21A)-C(23A)-H(23F)	109.5
H(23D)-C(23A)-H(23F)	109.5
H(23E)-C(23A)-H(23F)	109.5
C(5A)-C(6A')-Cl(2A)	110.9(5)
C(5A)-C(6A')-Cl(1A)	114.6(5)
Cl(2A)-C(6A')-Cl(1A)	109.3(4)
C(5A)-C(6A')-H(6A')	107.2
Cl(2A)-C(6A')-H(6A')	107.2
Cl(1A)-C(6A')-H(6A')	107.2

Table 4. Anisotropic displacement parameters ($Å^2 x\ 10^3$) for **5a**. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2\ a^{*2}U^{11} + ...\ + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
O(1)	19(3)	24(3)	26(3)	4(2)	12(2)	-3(2)
O(2)	32(3)	23(3)	40(3)	0(2)	25(3)	6(2)
O(3)	42(4)	38(3)	19(3)	0(2)	17(3)	4(3)
O(4)	17(3)	30(3)	26(3)	-9(2)	5(2)	8(2)
O(5)	34(3)	36(3)	30(3)	-8(3)	20(3)	-3(3)
O(6)	30(3)	50(3)	24(3)	-16(3)	15(3)	-13(3)
C(1)	31(5)	23(4)	45(5)	5(4)	34(5)	2(3)
C(3)	13(4)	22(4)	19(4)	-1(3)	7(3)	2(3)
C(4)	20(4)	34(4)	13(4)	9(3)	13(3)	3(3)
C(5)	12(4)	22(3)	23(4)	-2(3)	13(3)	0(3)
C(6)	12(4)	38(4)	24(4)	-5(3)	6(4)	-2(3)
C(7)	26(5)	39(5)	41(5)	-4(4)	10(4)	-6(4)
C(8)	40(5)	26(4)	41(6)	-5(4)	21(5)	-1(4)
C(9)	48(6)	36(5)	45(6)	-6(4)	29(5)	-7(4)
C(10)	53(6)	42(5)	44(6)	-14(4)	28(5)	-11(5)
C(11)	56(7)	61(6)	32(6)	-16(5)	16(5)	5(5)
C(12)	57(7)	57(6)	49(6)	-33(5)	24(6)	-32(5)
C(13)	45(6)	41(5)	31(5)	-14(4)	12(4)	-16(4)
C(14)	24(5)	31(4)	65(7)	-21(4)	25(5)	-1(4)

C(15)	36(5)	11(3)	32(5)	2(3)	22(4)	0(3)
C(16)	45(6)	45(5)	35(6)	4(4)	10(5)	2(4)
C(17)	92(10)	50(6)	39(6)	-11(5)	37(6)	-15(6)
C(18)	60(7)	35(5)	65(7)	-5(5)	46(6)	0(5)
C(19)	57(7)	30(5)	77(8)	11(5)	50(6)	3(5)
C(20)	29(5)	28(4)	49(5)	6(4)	26(4)	2(4)
C(21)	36(5)	32(4)	29(5)	-9(4)	17(4)	4(4)
C(22)	38(5)	68(6)	24(5)	-25(5)	7(4)	-4(5)
C(23)	50(6)	46(5)	49(6)	-8(5)	19(5)	4(5)
C(6')	19(4)	28(4)	23(4)	2(3)	8(4)	7(3)
Cl(1)	29(1)	36(1)	47(1)	-1(1)	3(1)	12(1)
Cl(2)	44(1)	35(1)	38(1)	6(1)	26(1)	0(1)
O(1A)	17(3)	20(2)	33(3)	8(2)	11(3)	1(2)
O(2A)	23(3)	31(3)	30(3)	-9(2)	12(3)	0(2)
O(3A)	39(3)	33(3)	21(3)	-4(2)	11(3)	-9(3)
O(4A)	35(3)	20(2)	31(3)	-5(2)	21(3)	-11(2)
O(5A)	16(3)	38(3)	19(3)	2(2)	3(2)	1(2)
O(6A)	36(4)	44(3)	30(3)	-11(3)	14(3)	12(3)
C(1A)	20(4)	19(4)	22(4)	4(3)	7(4)	-3(3)
C(2A)	33(5)	22(4)	36(5)	4(3)	24(4)	0(3)
C(3A)	25(4)	21(4)	29(5)	0(3)	14(4)	1(3)
C(4A)	21(4)	18(3)	12(4)	-3(3)	4(3)	1(3)
C(5A)	19(4)	28(4)	22(4)	1(3)	9(4)	2(3)

C(6A)	25(4)	32(4)	37(5)	-6(4)	18(4)	-3(4)
C(7A)	47(6)	43(5)	29(5)	1(4)	19(5)	15(4)
C(8A)	37(5)	26(4)	20(4)	-3(3)	11(4)	-2(4)
C(9A)	43(6)	29(4)	43(6)	-7(4)	26(5)	0(4)
C(10A)	37(6)	47(5)	47(6)	-11(5)	15(5)	-3(4)
C(11A)	44(6)	48(5)	42(6)	-12(5)	15(5)	-7(5)
C(12A)	86(9)	39(5)	54(7)	-24(5)	36(7)	1(6)
C(13A)	56(6)	36(5)	44(6)	-4(4)	36(6)	15(5)
C(14A)	42(5)	17(4)	42(5)	-10(4)	22(5)	-8(4)
C(15A)	25(4)	19(4)	32(5)	0(3)	5(4)	8(3)
C(16A)	37(5)	30(4)	44(6)	-2(4)	24(5)	5(4)
C(17A)	63(7)	46(5)	20(5)	-7(4)	9(5)	0(5)
C(18A)	45(6)	40(6)	69(8)	-12(5)	-6(6)	-8(5)
C(19A)	43(6)	25(4)	47(6)	13(4)	9(5)	8(4)
C(20A)	29(5)	40(5)	34(5)	-7(4)	13(4)	-6(4)
C(2)	8(4)	42(4)	11(4)	-2(3)	-5(3)	2(3)
C(21A)	40(5)	23(4)	23(5)	2(3)	9(4)	-6(4)
C(22A)	38(6)	44(5)	44(6)	-8(4)	4(5)	-7(4)
C(23A)	67(7)	49(5)	59(7)	-21(5)	46(6)	-2(5)
C(6A')	38(5)	27(4)	33(5)	5(4)	24(4)	-3(4)
Cl(1A)	29(1)	37(1)	33(1)	11(1)	8(1)	7(1)
Cl(2A)	43(1)	36(1)	49(1)	10(1)	30(1)	-4(1)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$x 10^3) for **5a**.

	x	y	z	U(eq)
H(5)	5029	345	-308	46
H(1)	463	1306	-1706	34
H(3)	-247	453	243	21
H(4)	2215	858	1512	25
H(6A)	8118	749	2582	30
H(6B)	6902	1047	1516	30
H(7A)	7668	1416	3553	42
H(7B)	8734	1115	4647	42
H(9)	4294	957	5143	47
H(10)	2666	1162	6788	52
H(11)	3442	1714	7641	59
H(12)	5985	2039	7026	63
H(13)	7759	1816	5430	46
H(14A)	1554	1727	143	45
H(14B)	2443	1495	1541	45
H(16)	2532	1895	3303	51
H(17)	754	2279	4381	68
H(18)	-3017	2391	3373	56

H(19)	-5030	2131	1277	58
H(20)	-3280	1755	149	39
H(22A)	549	386	-4557	67
H(22B)	1787	83	-3541	67
H(22C)	2787	458	-3265	67
H(23A)	-2869	242	-2240	71
H(23B)	-1591	-61	-2725	71
H(23C)	-2977	207	-3877	71
H(6')	3862	119	1333	28
H(5A)	11067	4210	2736	37
H(1A)	8022	3313	3518	24
H(2A)	4794	3766	3292	33
H(3A)	5368	4204	1878	28
H(4A)	6499	3830	469	21
H(6A1)	11377	3992	-514	35
H(6A2)	11196	3675	455	35
H(7A1)	9852	3297	-1352	46
H(7A2)	10079	3562	-2528	46
H(9A)	4821	3699	-2885	43
H(10A)	1662	3458	-4538	52
H(11A)	1949	2978	-5782	53
H(12A)	5441	2694	-5179	68
H(13A)	8534	2920	-3543	49

H(14C)	7262	2934	1558	38
H(14D)	6700	3184	211	38
H(16A)	5090	2771	-1586	42
H(17A)	2232	2397	-2675	53
H(18A)	-518	2264	-1629	68
H(19A)	-456	2533	477	47
H(20A)	2571	2876	1672	40
H(2)	-2303	848	-1323	27
H(22G)	10712	4225	6761	66
H(22H)	11087	4505	5687	66
H(22I)	11719	4119	5522	66
H(23D)	5138	4382	4272	78
H(23E)	6926	4642	5240	78
H(23F)	6235	4313	5946	78
H(6A')	8311	4578	962	36

Table 6. Torsion angles [°] for **5a**.

C(14)-O(2)-C(1)-O(1)	52.9(8)
C(14)-O(2)-C(1)-C(2)	167.4(6)
C(4)-O(1)-C(1)-O(2)	72.4(7)
C(4)-O(1)-C(1)-C(2)	-43.2(7)
C(21)-O(4)-C(3)-C(2)	-18.5(7)
C(21)-O(4)-C(3)-C(4)	-129.8(6)
C(1)-O(1)-C(4)-C(5)	171.1(6)
C(1)-O(1)-C(4)-C(3)	42.4(6)
O(4)-C(3)-C(4)-O(1)	87.6(6)
C(2)-C(3)-C(4)-O(1)	-25.1(6)
O(4)-C(3)-C(4)-C(5)	-32.7(8)
C(2)-C(3)-C(4)-C(5)	-145.4(6)
O(1)-C(4)-C(5)-O(5)	-57.4(7)
C(3)-C(4)-C(5)-O(5)	60.5(8)
O(1)-C(4)-C(5)-C(6)	59.1(7)
C(3)-C(4)-C(5)-C(6)	177.0(6)
O(1)-C(4)-C(5)-C(6')	-173.8(5)
C(3)-C(4)-C(5)-C(6')	-55.9(8)
C(7)-O(6)-C(6)-C(5)	178.5(6)
O(5)-C(5)-C(6)-O(6)	175.4(6)
C(4)-C(5)-C(6)-O(6)	54.2(8)

C(6')-C(5)-C(6)-O(6)	-69.9(7)
C(6)-O(6)-C(7)-C(8)	177.0(7)
O(6)-C(7)-C(8)-C(13)	-150.9(8)
O(6)-C(7)-C(8)-C(9)	28.9(12)
C(13)-C(8)-C(9)-C(10)	-1.2(14)
C(7)-C(8)-C(9)-C(10)	178.9(9)
C(8)-C(9)-C(10)-C(11)	2.6(15)
C(9)-C(10)-C(11)-C(12)	-2.5(16)
C(10)-C(11)-C(12)-C(13)	0.9(16)
C(9)-C(8)-C(13)-C(12)	-0.4(14)
C(7)-C(8)-C(13)-C(12)	179.4(9)
C(11)-C(12)-C(13)-C(8)	0.5(16)
C(1)-O(2)-C(14)-C(15)	166.6(7)
O(2)-C(14)-C(15)-C(20)	-35.7(10)
O(2)-C(14)-C(15)-C(16)	146.1(7)
C(20)-C(15)-C(16)-C(17)	-4.3(12)
C(14)-C(15)-C(16)-C(17)	174.0(8)
C(15)-C(16)-C(17)-C(18)	2.6(13)
C(16)-C(17)-C(18)-C(19)	-0.1(14)
C(17)-C(18)-C(19)-C(20)	-0.7(13)
C(16)-C(15)-C(20)-C(19)	3.5(11)
C(14)-C(15)-C(20)-C(19)	-174.7(7)
C(18)-C(19)-C(20)-C(15)	-1.1(12)

C(2)-O(3)-C(21)-O(4)	-34.1(7)
C(2)-O(3)-C(21)-C(23)	84.2(8)
C(2)-O(3)-C(21)-C(22)	-149.5(6)
C(3)-O(4)-C(21)-O(3)	32.5(7)
C(3)-O(4)-C(21)-C(23)	-86.7(7)
C(3)-O(4)-C(21)-C(22)	148.6(6)
O(5)-C(5)-C(6')-Cl(1)	64.4(7)
C(4)-C(5)-C(6')-Cl(1)	-175.0(5)
C(6)-C(5)-C(6')-Cl(1)	-49.7(7)
O(5)-C(5)-C(6')-Cl(2)	-170.9(5)
C(4)-C(5)-C(6')-Cl(2)	-50.2(7)
C(6)-C(5)-C(6')-Cl(2)	75.1(7)
C(14A)-O(2A)-C(1A)-O(1A)	55.8(7)
C(14A)-O(2A)-C(1A)-C(2A)	168.9(6)
C(4A)-O(1A)-C(1A)-O(2A)	72.1(6)
C(4A)-O(1A)-C(1A)-C(2A)	-42.3(7)
C(21A)-O(3A)-C(2A)-C(1A)	133.4(6)
C(21A)-O(3A)-C(2A)-C(3A)	24.1(7)
O(2A)-C(1A)-C(2A)-O(3A)	156.2(5)
O(1A)-C(1A)-C(2A)-O(3A)	-86.2(6)
O(2A)-C(1A)-C(2A)-C(3A)	-94.1(7)
O(1A)-C(1A)-C(2A)-C(3A)	23.4(8)
C(21A)-O(4A)-C(3A)-C(4A)	-130.3(6)

C(21A)-O(4A)-C(3A)-C(2A)	-19.1(7)
O(3A)-C(2A)-C(3A)-O(4A)	-2.4(7)
C(1A)-C(2A)-C(3A)-O(4A)	-114.7(6)
O(3A)-C(2A)-C(3A)-C(4A)	114.7(6)
C(1A)-C(2A)-C(3A)-C(4A)	2.3(8)
C(1A)-O(1A)-C(4A)-C(3A)	44.0(7)
C(1A)-O(1A)-C(4A)-C(5A)	169.5(6)
O(4A)-C(3A)-C(4A)-O(1A)	84.3(6)
C(2A)-C(3A)-C(4A)-O(1A)	-27.3(7)
O(4A)-C(3A)-C(4A)-C(5A)	-34.5(9)
C(2A)-C(3A)-C(4A)-C(5A)	-146.2(6)
O(1A)-C(4A)-C(5A)-O(5A)	-56.3(7)
C(3A)-C(4A)-C(5A)-O(5A)	60.8(8)
O(1A)-C(4A)-C(5A)-C(6A)	59.1(8)
C(3A)-C(4A)-C(5A)-C(6A)	176.2(7)
O(1A)-C(4A)-C(5A)-C(6A')	-173.6(6)
C(3A)-C(4A)-C(5A)-C(6A')	-56.5(8)
C(7A)-O(6A)-C(6A)-C(5A)	-168.3(6)
O(5A)-C(5A)-C(6A)-O(6A)	174.1(6)
C(6A')-C(5A)-C(6A)-O(6A)	-68.1(8)
C(4A)-C(5A)-C(6A)-O(6A)	54.3(8)
C(6A)-O(6A)-C(7A)-C(8A)	173.5(6)
O(6A)-C(7A)-C(8A)-C(13A)	-168.5(7)

O(6A)-C(7A)-C(8A)-C(9A)	10.7(11)
C(13A)-C(8A)-C(9A)-C(10A)	-1.1(12)
C(7A)-C(8A)-C(9A)-C(10A)	179.8(8)
C(8A)-C(9A)-C(10A)-C(11A)	-1.5(13)
C(9A)-C(10A)-C(11A)-C(12A)	3.5(14)
C(10A)-C(11A)-C(12A)-C(13A)	-2.9(15)
C(11A)-C(12A)-C(13A)-C(8A)	0.4(15)
C(9A)-C(8A)-C(13A)-C(12A)	1.6(13)
C(7A)-C(8A)-C(13A)-C(12A)	-179.2(8)
C(1A)-O(2A)-C(14A)-C(15A)	164.1(6)
O(2A)-C(14A)-C(15A)-C(16A)	149.2(7)
O(2A)-C(14A)-C(15A)-C(20A)	-36.0(10)
C(20A)-C(15A)-C(16A)-C(17A)	-0.4(12)
C(14A)-C(15A)-C(16A)-C(17A)	174.4(8)
C(15A)-C(16A)-C(17A)-C(18A)	1.0(14)
C(16A)-C(17A)-C(18A)-C(19A)	1.2(15)
C(17A)-C(18A)-C(19A)-C(20A)	-3.9(14)
C(16A)-C(15A)-C(20A)-C(19A)	-2.3(12)
C(14A)-C(15A)-C(20A)-C(19A)	-177.0(7)
C(18A)-C(19A)-C(20A)-C(15A)	4.5(13)
C(21)-O(3)-C(2)-C(1)	132.2(6)
C(21)-O(3)-C(2)-C(3)	21.6(7)
O(2)-C(1)-C(2)-O(3)	156.1(6)

O(1)-C(1)-C(2)-O(3)	-84.9(7)
O(2)-C(1)-C(2)-C(3)	-93.4(7)
O(1)-C(1)-C(2)-C(3)	25.7(7)
O(4)-C(3)-C(2)-O(3)	-1.5(7)
C(4)-C(3)-C(2)-O(3)	113.7(6)
O(4)-C(3)-C(2)-C(1)	-115.1(6)
C(4)-C(3)-C(2)-C(1)	0.1(7)
C(2A)-O(3A)-C(21A)-O(4A)	-35.7(7)
C(2A)-O(3A)-C(21A)-C(22A)	-149.1(7)
C(2A)-O(3A)-C(21A)-C(23A)	79.8(8)
C(3A)-O(4A)-C(21A)-O(3A)	33.4(7)
C(3A)-O(4A)-C(21A)-C(22A)	149.8(6)
C(3A)-O(4A)-C(21A)-C(23A)	-83.5(7)
O(5A)-C(5A)-C(6A')-Cl(2A)	66.4(6)
C(6A)-C(5A)-C(6A')-Cl(2A)	-50.6(8)
C(4A)-C(5A)-C(6A')-Cl(2A)	-173.2(5)
O(5A)-C(5A)-C(6A')-Cl(1A)	-169.3(4)
C(6A)-C(5A)-C(6A')-Cl(1A)	73.8(7)
C(4A)-C(5A)-C(6A')-Cl(1A)	-48.8(7)

7. X-ray Crystal Structure Analysis of compound 8a

Crystal Data: Single crystals of the compound were grown by slow evaporation of the solution in ethyl acetate. Colourless plate crystal of approximate size 0.46 x 0.44 x 0.05 mm, was used for data collection on *Bruker SMART APEX* CCD diffractometer using Mo K_α radiation with fine focus tube with 50kV and 30mA. Crystal to detector distance 6.05 cm, 512 x 512 pixels / frame, multirun data acquisition. Total frames = 1041, Oscillation / frame -0.3º, exposure / frame = 5.0 sec / frame, maximum detector swing angle = –30.0º, beam center = (260.2, 252.5), in plane spot width = 1.24, SAINT integration, θ range = 2.65 to 24.99 º, completeness to θ of 24.99 º is 70.5 %. SADABS correction applied , C_{21} H_{25} N_3 O_6, M = 415.44. Crystals belong to Monoclinic, space group $P2_1$, a = 8.4484(9) Å, b = 5.7765(7) Å, c = 20.541(3) Å, V = 1001.6(2) $Å^3$, Z = 2, D_c = 1.378 g/cc, μ (MoK_α) = 0.102 mm-1, T = 90(2) K, 2384 reflections measured, 2251 unique [I>2σ(I)], R1 value = 0.0668, wR2 = 0.1806. Largest diff. peak and hole 0.448 and -0.537 e.Å-3. All the data were corrected for Lorentzian, polarisation and absorption effects. SHELX-97 (ShelxTL)[ref] was used for structure solution and full matrix least squares refinement on F^2. Hydrogen atoms were included in the refinement as per the riding model. Data collection and refinement parameters are listed in table 1.

The conformation of the molecule was established by single crystal X-ray analysis and shows that C1 to C5 have S S R R and R respectively for **8a**. The angle between two benzene rings is 73.23º.

Reference:

G. M. Sheldrick, SHELX-97 program for crystal structure solution and refinement, University of Gottingen, Germany, 1997; 2008

Figure 37: ORTEP diagram of molecule **8a**. Ellipsoids are drawn at 40% probability.

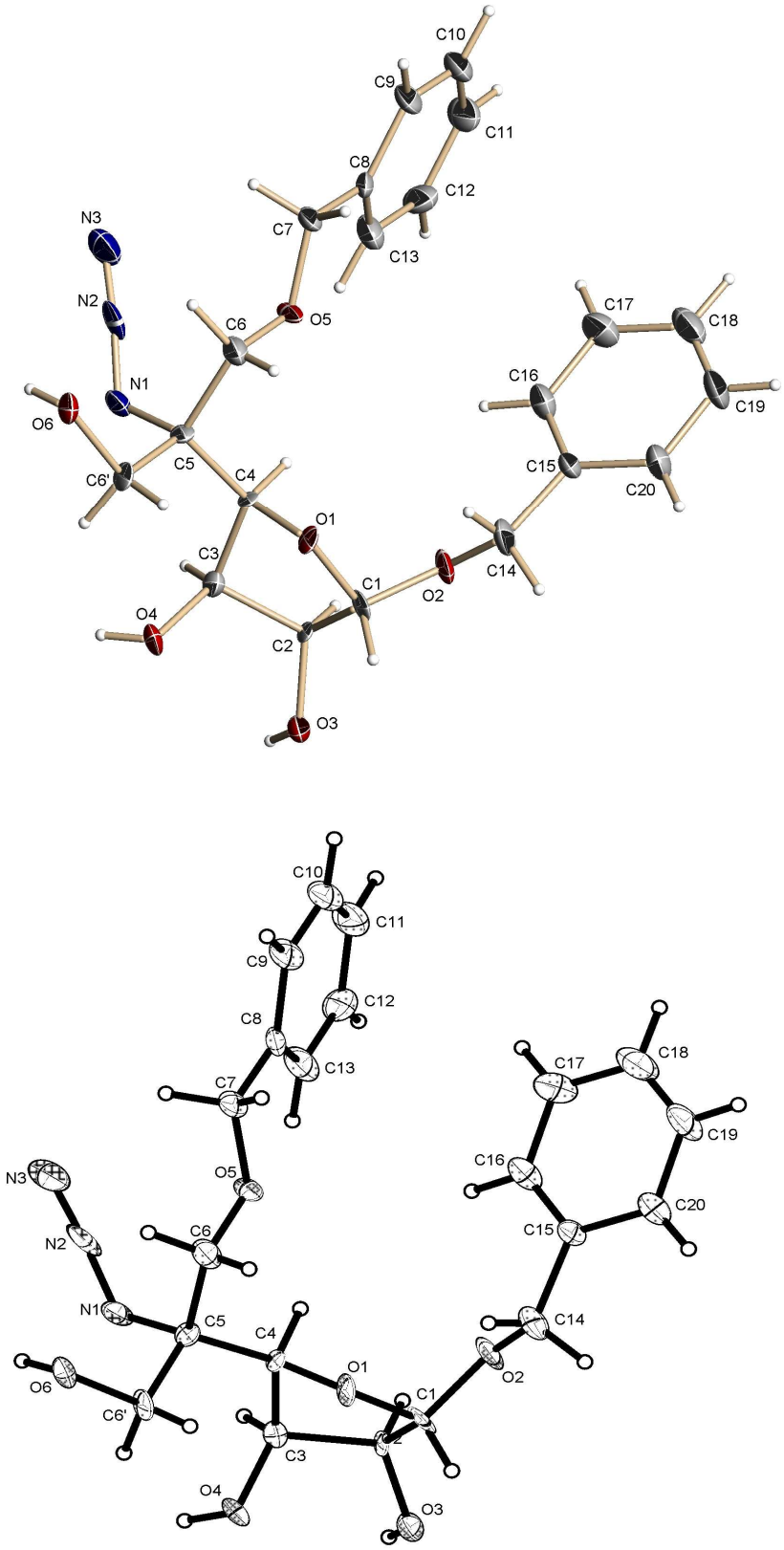


Table 1. Crystal data and structure refinement for **8a**.

Empirical formula	$C_{21}H_{25}N_3O_6$	
Formula weight	415.44	
Temperature	90(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	$P2_1$	
Unit cell dimensions	a = 8.4484(9) Å	α= 90°.
	b = 5.7765(7) Å	β= 92.337(3)°.
	c = 20.541(3) Å	γ = 90°.
Volume	1001.6(2) $Å^3$	
Z	2	
Density (calculated)	1.378 g/cc	
Absorption coefficient	0.102 mm^{-1}	
F(000)	440	
Crystal size	0.45 x 0.44 x 0.05 mm^3	
Theta range for data collection	2.65 to 24.99°.	
Index ranges	-5<=h<=6, -6<=k<=6, -5<=l<=24	
Reflections collected	2384	
Independent reflections	2251 [R(int) = 0.0442]	
Completeness to theta = 24.99°	70.5 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.9949 and 0.9554	

Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	2251 / 1 / 275
Goodness-of-fit on F^2	1.004
Final R indices [I>2sigma(I)]	R1 = 0.0668, wR2 = 0.1806
R indices (all data)	R1 = 0.0758, wR2 = 0.1899
Absolute structure parameter	8(2)
Largest diff. peak and hole	0.448 and -0.537 e.$Å^{-3}$

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for **8a**. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
O(1)	8531(6)	6804(7)	6352(2)	20(1)
O(2)	10801(5)	7944(7)	6967(2)	25(1)
O(3)	11395(6)	9391(7)	5440(2)	21(1)
O(4)	8292(6)	8694(6)	5067(2)	22(1)
O(5)	5839(5)	9266(7)	7321(1)	24(1)
O(6)	3731(6)	6286(7)	5671(2)	22(1)
N(1)	5180(7)	10734(8)	5988(2)	21(1)
N(2)	4214(8)	11560(9)	6354(2)	25(2)
N(3)	3325(8)	12471(9)	6649(2)	33(2)
C(1)	10154(9)	7363(10)	6334(2)	21(2)
C(2)	10260(8)	9603(10)	5925(2)	17(2)

C(3)	8565(8)	9944(9)	5657(2)	20(2)
C(4)	7669(8)	8897(9)	6230(2)	16(2)
C(5)	5914(9)	8458(9)	6178(2)	17(2)
C(6)	5324(9)	7634(11)	6842(2)	25(2)
C(6')	5385(9)	6707(10)	5655(2)	22(2)
C(7)	4860(8)	9294(11)	7869(2)	24(2)
C(8)	5459(8)	11120(11)	8330(2)	24(2)
C(9)	4890(9)	11189(12)	8965(2)	32(2)
C(10)	5429(9)	12872(13)	9393(2)	33(2)
C(11)	6443(9)	14498(12)	9213(2)	33(2)
C(12)	7020(8)	14513(12)	8584(3)	32(2)
C(13)	6494(9)	12834(12)	8152(3)	33(2)
C(14)	10779(9)	6065(11)	7414(2)	30(2)
C(15)	10826(8)	6962(10)	8106(2)	23(2)
C(16)	10062(9)	8938(10)	8267(2)	29(2)
C(17)	9985(9)	9656(12)	8915(2)	35(2)
C(18)	10758(10)	8319(12)	9399(3)	36(2)
C(19)	11533(10)	6382(14)	9244(3)	41(2)
C(20)	11618(8)	5651(11)	8591(2)	30(2)

Table 3. Bond lengths [Å] and angles [°] for **8a**.

O(1)-C(1)	1.411(8)
O(1)-C(4)	1.428(7)
O(2)-C(14)	1.421(7)
O(2)-C(1)	1.430(5)
O(3)-C(2)	1.415(8)
O(3)-H(3)	0.8200
O(4)-C(3)	1.420(5)
O(4)-H(4)	0.8200
O(5)-C(6)	1.419(6)
O(5)-C(7)	1.423(7)
O(6)-C(6')	1.420(8)
O(6)-H(6)	0.8200
N(1)-N(2)	1.228(8)
N(1)-C(5)	1.499(7)
N(2)-N(3)	1.117(8)
C(1)-C(2)	1.547(8)
C(1)-H(1)	0.9800
C(2)-C(3)	1.526(9)
C(2)-H(2)	0.9800
C(3)-C(4)	1.549(8)
C(3)-H(3A)	0.9800

C(4)-C(5)	1.504(9)
C(4)-H(4A)	0.9800
C(5)-C(6')	1.530(7)
C(5)-C(6)	1.546(8)
C(6)-H(6A)	0.9700
C(6)-H(6B)	0.9700
C(6')-H(6'1)	0.9700
C(6')-H(6'2)	0.9700
C(7)-C(8)	1.493(8)
C(7)-H(7A)	0.9700
C(7)-H(7B)	0.9700
C(8)-C(13)	1.381(9)
C(8)-C(9)	1.408(8)
C(9)-C(10)	1.376(9)
C(9)-H(9)	0.9300
C(10)-C(11)	1.333(10)
C(10)-H(10)	0.9300
C(11)-C(12)	1.400(8)
C(11)-H(11)	0.9300
C(12)-C(13)	1.376(9)
C(12)-H(12)	0.9300
C(13)-H(13)	0.9300
C(14)-C(15)	1.512(7)

C(14)-H(14A)	0.9700
C(14)-H(14B)	0.9700
C(15)-C(16)	1.359(9)
C(15)-C(20)	1.400(7)
C(16)-C(17)	1.398(7)
C(16)-H(16)	0.9300
C(17)-C(18)	1.400(9)
C(17)-H(17)	0.9300
C(18)-C(19)	1.342(10)
C(18)-H(18)	0.9300
C(19)-C(20)	1.410(8)
C(19)-H(19)	0.9300
C(20)-H(20)	0.9300

C(1)-O(1)-C(4)	106.9(4)
C(14)-O(2)-C(1)	113.1(4)
C(2)-O(3)-H(3)	109.5
C(3)-O(4)-H(4)	109.5
C(6)-O(5)-C(7)	112.6(5)
C(6')-O(6)-H(6)	109.5
N(2)-N(1)-C(5)	117.4(5)
N(3)-N(2)-N(1)	173.9(5)
O(1)-C(1)-O(2)	111.5(5)

O(1)-C(1)-C(2)	106.5(5)
O(2)-C(1)-C(2)	105.6(4)
O(1)-C(1)-H(1)	111.0
O(2)-C(1)-H(1)	111.0
C(2)-C(1)-H(1)	111.0
O(3)-C(2)-C(3)	114.2(4)
O(3)-C(2)-C(1)	111.5(5)
C(3)-C(2)-C(1)	103.3(5)
O(3)-C(2)-H(2)	109.2
C(3)-C(2)-H(2)	109.2
C(1)-C(2)-H(2)	109.2
O(4)-C(3)-C(2)	111.0(5)
O(4)-C(3)-C(4)	112.5(5)
C(2)-C(3)-C(4)	99.0(4)
O(4)-C(3)-H(3A)	111.3
C(2)-C(3)-H(3A)	111.3
C(4)-C(3)-H(3A)	111.3
O(1)-C(4)-C(5)	111.3(5)
O(1)-C(4)-C(3)	101.7(5)
C(5)-C(4)-C(3)	121.5(4)
O(1)-C(4)-H(4A)	107.2
C(5)-C(4)-H(4A)	107.2
C(3)-C(4)-H(4A)	107.2

N(1)-C(5)-C(4)	105.5(5)
N(1)-C(5)-C(6')	106.9(4)
C(4)-C(5)-C(6')	114.9(5)
N(1)-C(5)-C(6)	110.8(5)
C(4)-C(5)-C(6)	110.0(4)
C(6')-C(5)-C(6)	108.7(5)
O(5)-C(6)-C(5)	107.9(5)
O(5)-C(6)-H(6A)	110.1
C(5)-C(6)-H(6A)	110.1
O(5)-C(6)-H(6B)	110.1
C(5)-C(6)-H(6B)	110.1
H(6A)-C(6)-H(6B)	108.4
O(6)-C(6')-C(5)	110.9(5)
O(6)-C(6')-H(6'1)	109.5
C(5)-C(6')-H(6'1)	109.5
O(6)-C(6')-H(6'2)	109.5
C(5)-C(6')-H(6'2)	109.5
H(6'1)-C(6')-H(6'2)	108.0
O(5)-C(7)-C(8)	108.5(5)
O(5)-C(7)-H(7A)	110.0
C(8)-C(7)-H(7A)	110.0
O(5)-C(7)-H(7B)	110.0
C(8)-C(7)-H(7B)	110.0

H(7A)-C(7)-H(7B)	108.4
C(13)-C(8)-C(9)	118.0(6)
C(13)-C(8)-C(7)	122.7(5)
C(9)-C(8)-C(7)	119.2(6)
C(10)-C(9)-C(8)	119.6(7)
C(10)-C(9)-H(9)	120.2
C(8)-C(9)-H(9)	120.2
C(11)-C(10)-C(9)	121.4(6)
C(11)-C(10)-H(10)	119.3
C(9)-C(10)-H(10)	119.3
C(10)-C(11)-C(12)	120.8(6)
C(10)-C(11)-H(11)	119.6
C(12)-C(11)-H(11)	119.6
C(13)-C(12)-C(11)	118.4(7)
C(13)-C(12)-H(12)	120.8
C(11)-C(12)-H(12)	120.8
C(12)-C(13)-C(8)	121.7(6)
C(12)-C(13)-H(13)	119.2
C(8)-C(13)-H(13)	119.2
O(2)-C(14)-C(15)	110.2(5)
O(2)-C(14)-H(14A)	109.6
C(15)-C(14)-H(14A)	109.6
O(2)-C(14)-H(14B)	109.6

C(15)-C(14)-H(14B)	109.6
H(14A)-C(14)-H(14B)	108.1
C(16)-C(15)-C(20)	119.9(5)
C(16)-C(15)-C(14)	121.5(5)
C(20)-C(15)-C(14)	118.5(5)
C(15)-C(16)-C(17)	121.5(5)
C(15)-C(16)-H(16)	119.3
C(17)-C(16)-H(16)	119.3
C(16)-C(17)-C(18)	118.3(6)
C(16)-C(17)-H(17)	120.8
C(18)-C(17)-H(17)	120.8
C(19)-C(18)-C(17)	120.6(5)
C(19)-C(18)-H(18)	119.7
C(17)-C(18)-H(18)	119.7
C(18)-C(19)-C(20)	121.4(6)
C(18)-C(19)-H(19)	119.3
C(20)-C(19)-H(19)	119.3
C(15)-C(20)-C(19)	118.2(6)
C(15)-C(20)-H(20)	120.9
C(19)-C(20)-H(20)	120.9

Table 4. Anisotropic displacement parameters ($Å^2 x\ 10^3$) for **8a**. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2\ a^{*2}U^{11} + ...\ + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
O(1)	4(4)	38(2)	18(2)	3(2)	-4(2)	-4(2)
O(2)	21(4)	44(2)	10(2)	2(2)	-8(2)	-4(2)
O(3)	15(4)	36(2)	13(2)	4(2)	-1(2)	1(2)
O(4)	23(4)	33(2)	9(2)	-1(1)	-6(2)	4(2)
O(5)	8(4)	53(2)	9(2)	-4(2)	2(2)	-8(2)
O(6)	15(4)	37(2)	15(2)	-1(2)	-6(2)	1(2)
N(1)	20(5)	34(3)	9(2)	-3(2)	0(2)	-2(2)
N(2)	35(6)	30(3)	9(2)	-3(2)	-10(3)	-1(3)
N(3)	41(6)	40(3)	17(2)	-5(2)	-3(3)	4(3)
C(1)	20(7)	37(3)	7(2)	-5(2)	-7(3)	-2(3)
C(2)	3(5)	36(3)	11(2)	1(2)	-2(3)	0(3)
C(3)	13(6)	32(3)	14(2)	-3(2)	-3(3)	3(3)
C(4)	3(6)	35(3)	10(2)	1(2)	2(3)	0(3)
C(5)	7(6)	31(3)	13(3)	1(2)	3(3)	-2(3)
C(6)	18(6)	44(3)	14(3)	1(2)	-1(3)	-1(3)
C(6')	7(7)	41(3)	16(3)	-2(2)	-5(3)	-4(3)
C(7)	15(5)	46(3)	10(2)	4(2)	2(2)	0(3)
C(8)	11(5)	48(3)	11(2)	4(2)	-3(3)	5(3)
C(9)	25(6)	60(4)	12(2)	8(3)	2(3)	3(4)

C(10)	26(6)	62(4)	13(3)	1(3)	1(3)	1(4)
C(11)	23(6)	53(4)	23(3)	-9(3)	-3(3)	-8(4)
C(12)	16(6)	51(4)	29(3)	-8(3)	3(3)	0(4)
C(13)	29(6)	53(4)	16(3)	3(3)	-4(3)	-1(4)
C(14)	33(6)	42(3)	14(2)	4(2)	-7(3)	12(3)
C(15)	18(6)	40(3)	10(2)	2(2)	0(3)	4(3)
C(16)	30(6)	41(3)	15(2)	-1(2)	-6(3)	2(3)
C(17)	38(6)	46(4)	21(3)	-9(3)	2(3)	2(4)
C(18)	35(7)	59(4)	15(3)	-2(3)	-1(3)	-10(4)
C(19)	36(6)	73(5)	13(3)	7(3)	-6(3)	3(4)
C(20)	31(6)	45(4)	15(2)	1(2)	-5(3)	7(3)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$x 10^3) for **8a**.

	x	y	z	U(eq)
H(3)	11445	10610	5238	32
H(4)	7741	9471	4813	33
H(6)	3246	7462	5561	34
H(1)	10753	6103	6141	26
H(2)	10553	10899	6213	0(11)

H(3A)	8316	11590	5599	24
H(4A)	7870	9907	6608	19
H(6A)	4177	7530	6825	30
H(6B)	5753	6116	6947	30
H(6'1)	5637	7295	5229	26
H(6'2)	5955	5265	5726	26
H(7A)	4888	7796	8082	29
H(7B)	3773	9624	7729	29
H(9)	4153	10103	9094	39
H(10)	5080	12877	9816	40
H(11)	6772	15635	9509	40
H(12)	7740	15632	8460	38
H(13)	6846	12854	7729	39
H(14A)	11685	5070	7351	36
H(14B)	9825	5157	7333	36
H(16)	9579	9832	7939	34
H(17)	9434	10988	9021	42
H(18)	10735	8778	9833	44
H(19)	12024	5503	9573	49
H(20)	12185	4332	8486	36

Table 6. Torsion angles [°] for **8a**.

C(5)-N(1)-N(2)-N(3)	179(100)
C(4)-O(1)-C(1)-O(2)	91.8(5)
C(4)-O(1)-C(1)-C(2)	-23.0(5)
C(14)-O(2)-C(1)-O(1)	64.1(6)
C(14)-O(2)-C(1)-C(2)	179.3(5)
O(1)-C(1)-C(2)-O(3)	-130.7(5)
O(2)-C(1)-C(2)-O(3)	110.7(5)
O(1)-C(1)-C(2)-C(3)	-7.6(5)
O(2)-C(1)-C(2)-C(3)	-126.3(5)
O(3)-C(2)-C(3)-O(4)	34.7(6)
C(1)-C(2)-C(3)-O(4)	-86.5(5)
O(3)-C(2)-C(3)-C(4)	153.1(4)
C(1)-C(2)-C(3)-C(4)	31.9(5)
C(1)-O(1)-C(4)-C(5)	174.9(4)
C(1)-O(1)-C(4)-C(3)	44.0(4)
O(4)-C(3)-C(4)-O(1)	71.0(5)
C(2)-C(3)-C(4)-O(1)	-46.3(5)
O(4)-C(3)-C(4)-C(5)	-53.2(6)
C(2)-C(3)-C(4)-C(5)	-170.5(5)
N(2)-N(1)-C(5)-C(4)	-121.4(6)
N(2)-N(1)-C(5)-C(6')	115.8(6)

N(2)-N(1)-C(5)-C(6)	-2.4(7)
O(1)-C(4)-C(5)-N(1)	-174.7(4)
C(3)-C(4)-C(5)-N(1)	-55.1(6)
O(1)-C(4)-C(5)-C(6')	-57.2(5)
C(3)-C(4)-C(5)-C(6')	62.4(6)
O(1)-C(4)-C(5)-C(6)	65.8(5)
C(3)-C(4)-C(5)-C(6)	-174.6(5)
C(7)-O(5)-C(6)-C(5)	154.7(5)
N(1)-C(5)-C(6)-O(5)	-63.4(7)
C(4)-C(5)-C(6)-O(5)	52.9(6)
C(6')-C(5)-C(6)-O(5)	179.4(5)
N(1)-C(5)-C(6')-O(6)	-67.3(6)
C(4)-C(5)-C(6')-O(6)	176.0(4)
C(6)-C(5)-C(6')-O(6)	52.4(6)
C(6)-O(5)-C(7)-C(8)	-177.8(4)
O(5)-C(7)-C(8)-C(13)	15.9(8)
O(5)-C(7)-C(8)-C(9)	-167.6(5)
C(13)-C(8)-C(9)-C(10)	-3.0(9)
C(7)-C(8)-C(9)-C(10)	-179.7(6)
C(8)-C(9)-C(10)-C(11)	2.3(10)
C(9)-C(10)-C(11)-C(12)	-1.4(11)
C(10)-C(11)-C(12)-C(13)	1.1(10)
C(11)-C(12)-C(13)-C(8)	-1.8(10)

C(9)-C(8)-C(13)-C(12)	2.8(10)
C(7)-C(8)-C(13)-C(12)	179.4(6)
C(1)-O(2)-C(14)-C(15)	-157.0(6)
O(2)-C(14)-C(15)-C(16)	36.4(8)
O(2)-C(14)-C(15)-C(20)	-146.7(6)
C(20)-C(15)-C(16)-C(17)	-2.8(10)
C(14)-C(15)-C(16)-C(17)	174.1(7)
C(15)-C(16)-C(17)-C(18)	1.8(11)
C(16)-C(17)-C(18)-C(19)	-0.9(12)
C(17)-C(18)-C(19)-C(20)	1.1(12)
C(16)-C(15)-C(20)-C(19)	2.8(10)
C(14)-C(15)-C(20)-C(19)	-174.2(6)
C(18)-C(19)-C(20)-C(15)	-2.0(11)