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Benzyl 2-deoxy-2-(3,5-di-*tert*-butylsalicylamino)-α-D-glucopyranoside

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The title compound, $C_{28}H_{41}NO_6$, was obtained by reduction of benzyl 2-deoxy-2-(3,5-di-*tert*-butylsalicylideneamino)-α-D-glucopyranoside. The benzyl substituent is in an axial position, whereas the 3,5-di-*tert*-butylsalicylamino substituent and the hydroxyl groups are in equatorial positions. The enantiomerically pure title compound is a potential *O*,*N*,*O*-chelate ligand suitable as a precursor for chiral transition metal complexes. The absolute configuration was determined by NMR experiments.

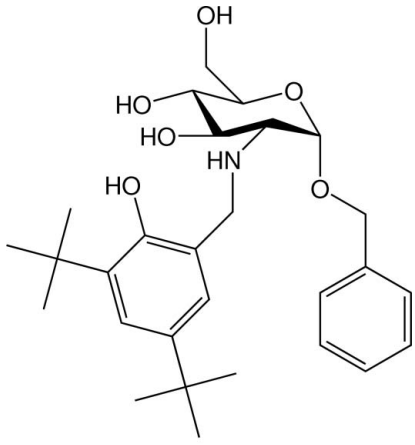
Key indicators

Single-crystal X-ray study
T = 183 K
Mean σ(C–C) = 0.005 Å
R factor = 0.046
wR factor = 0.154
Data-to-parameter ratio = 10.7

For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

Comment

Related imino-functionalized carbohydrates containing an unprotected anomeric hydroxyl group are known as chiral chelate ligands. The *cis*-VO_2^+, *cis*-MoO_2^{2+} and *trans*-UO_2^{2+} complexes are effective catalysts in asymmetric olefin epoxidation (Zhao *et al.*, 2003; Sah *et al.*, 2001) or sulfide oxidation (Cucciolito *et al.*, 2005). Tc and Re complexes have been developed for molecular imaging and radiotherapy (Duatti *et al.*, 1987; Bayly *et al.*, 2004). The reduced amino-derived compounds are stable towards hydrolysis. The title compound, (I), has been synthesized as part of our efforts to utilize sugar-modified Schiff base ligands (Burkhardt *et al.*, 2007*a*,*b*) as precursors for chiral catalysts (Becher *et al.*, 2006) and chiral polynuclear complexes of paramagnetic metal centers (Burkhardt *et al.*, 2006; Roth *et al.*, 2006).



(I)

The hydroxyl group of the anomeric atom C1 is blocked *via* a benzyl ether. The benzyl substituent is in an axial position, corresponding to the exclusive presence of the α-anomer as confirmed by ^{1}H NMR data. H1 leads to a doublet with $^3J_{1,2}$ = 3.7 Hz associated with the *cis* configuration of the atoms H1

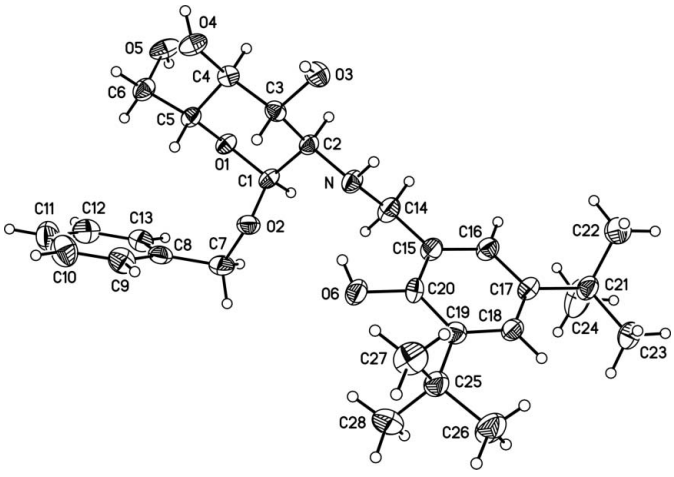


Figure 1
A view of the molecular structure of the title compound. Displacement ellipsoids are drawn at the 50% probability level.

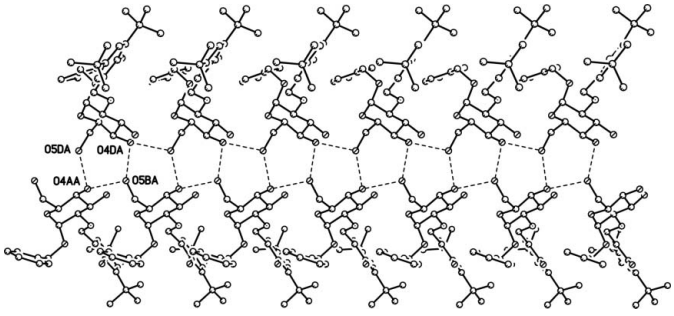


Figure 2
Supramolecular double-chain of $C_{28}H_{41}NO_6$. Hydrogen bonds are shown as dashed lines and H atoms have been omitted.

and H2. All other substituents at C2–C5 are in equatorial positions.

The 3,5-di-*tert*-butylsalicylamino group at C2 was introduced *via* a three-step-synthesis into the sugar backbone. Alkaline hydrolysis of 2-acetamido-2-deoxy-α-D-glucopyranoside yielded the amino sugar and, by reaction with 3,5-di-*tert*-butyl-salicylaldehyde, the Schiff base was formed. The imine was finally reduced with $NaBH_4$ to the title compound, which is soluble in $CHCl_3$ and several alcohols.

The sugar ring in (I) adopts the more stable $^4C_1$ chair conformation (see Fig. 1). The benzyl group at C1 is directed towards the hydroxyl group at C6. The mean plane of the anomeric substituent (defined by C8–C13) and the mean sugar plane (defined by C1, C3, C4 and O1) subtend an angle of 57.03 (12)°. The mean plane of the 3,5-di-*tert*-butyl-salicylamino substituent at C2 (defined by C15–C20) and the mean sugar plane subtend an angle of 81.68 (11)° accompanied with the nearly perpendicular orientation of the substituent's aromatic ring towards the carbohydrate chair.

The individual $C_{28}H_{41}NO_6$ units are linked *via* intermolecular hydrogen bonding, forming one-dimensional double chains with a twofold screw symmetry along the crystallographic *a* axis (see Fig. 2). The hydroxyl groups at C4 and C6 of the monosaccharide groups are involved in the hydrogen-bonding network.

The title compound is suitable as an *O*,*N*,*O*-chelate ligand. Complexation in protic solvents should work better than with the corresponding Schiff base ligands because of the hydrolysis stability of the secondary amine in comparison with imine in the Schiff base.

Experimental

All substances were purchased from commercial suppliers and used without further purification. Benzyl 2-acetamido-2-deoxy-α-D-glucopyranoside was prepared from *N*-acetyl-α-D-glucoseamine according to Györgydéak (1991).

Compound (I) was obtained by reduction of benzyl 2-deoxy-2-(3,5-di-*tert*-butylsalicylideneamino)-α-D-glucopyranoside.

For the preparation of benzyl 2-deoxy-2-(3,5-di-*tert*-butylsalicylideneamino)-α-D-glucopyranoside, a solution of benzyl 2-acetamido-2-deoxy-α-D-glucopyranoside (2.00 g, 0.006 mol) and KOH (14.00 g, 0.250 mol) in 50 ml of ethanol (96%) was refluxed overnight. After cooling to 298 K, the orange mixture was diluted with 100 ml of ethanol (96%) and neutralized with HCl. The precipitated KCl was separated by centrifugation and the filtrate volume was reduced *in vacuo* to 10 ml. Addition of $NaHCO_3$ (700 mg, 8.33 mmol) and 3,5-di-*tert*-butyl-salicylaldehyde (1.52 g, 0.006 mol) afforded an intensely yellow mixture. After 2.5 h of stirring at 298 K, a pale-yellow precipitate was obtained. The amorphous solid was collected by filtration and washed successively with 100 ml of water and 100 ml of *n*-hexane with vigorous stirring for 12 h each. After filtration the product was dried *in vacuo* at 333 K. Yield 2.09 g (67%). M.p. 498–500 K (water). IR (KBr): 3494, 3401, 3276 (ν O—H), 3066, 3027 (ν C—H arom.), 2962 (ν_{as} CH_3), 2870 (ν_s CH_2), 1628 (ν CH═N), 1597, 1498 (ν C═C), 1469, 1455, 1441 (δ_{as} CH_3, δ CH_2), 1392, 1362 (δ_s CH_3), 1335, 1307, 1271, 1251, 1207, 1158, 1135, 1083, 1043, 1024, 1007, 983 (ν C—O), 880, 850, 827, 806, 772, 739, 731, 712, 696, 645, 530, 514 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6, 298 K): 1.27 and 1.43 (2*s*, each 9H, H methyl), 3.22–3.28 (*m*, 1H, H4), 3.26 (*dd*, $^3J_{21}$ = 3.6 Hz, $^3J_{23}$ = 9.5 Hz, 1H, H2), 3.54–3.64 (*m*, 2H, H5 and H6*A*), 3.69–3.71 (*m*, 2H, H3 and H6*B*), 4.51 and 4.74 (2*d*, $^2J_{7A7B}$ = 12.4 Hz, each 1H, H7*A* and H7*B*), 4.60 (*dd*, $^3J_{av}$ = 5.9 Hz, 1H, OH6), 4.86 (d, $^3J_{12}$ = 3.7 Hz, 1H, H1), 5.05 (*d*, $^3J_{4OH4}$ = 5.9 Hz, 1H, OH4), 5.11 (*d*, $^3J_{3OH3}$ = 5.9 Hz, 1H, OH3), 7.25–7.32 (*m*, 3H, H ph), 7.41–7.43 (*m*, 2H, H ph), 8.49 (*s*, 1H, H14), 14.70 (*s*, 1H, OH20) p.p.m; ^{13}C NMR (60 MHz, DMSO-d_6, 298 K): 29.2 and 31.3 (C22–C24 and C26–C28), 33.8 and 34.6 (C21 and C25), 60.9 (C6), 67.9 (C7), 70.2 and 71.4 (C2, C3 and C4), 73.4 (C5), 97.5 (C1), 117.6, 126.1, 126.2, 127.4, 128.0, 135.8, 137.9 and 139.0 (C ph), 158.6 (C20) 168.1 (C14) p.p.m. ESI–MS: *m*/*z* (%) = 486 $[M+H]^+$ (3), 508 $[M+Na]^+$ (100). $C_{28}H_{39}NO_6$ (485.61 g mol^{-1}): calculated C 69.25, H 8.09, N 2.88%; found C 69.10, H 8.17, N 2.68%.

For the preparation of benzyl 2-deoxy-2-(3,5-di-*tert*-butylsalicylamino)-α-D-glucopyranoside, with ice-cooling, a solution of benzyl 2-deoxy-2-(3,5-di-*tert*-butylsalicylideneamino)-α-D-glucopyranoside (0.50 g, 0.001 mol) in 25 ml of ethanol (100%) was slowly poured into a suspension of $NaBH_4$ (0.20 g, 0.005 mol) in 10 ml of ethanol (100%). The slightly yellow solution was stirred for 5 h at 298 K. The reaction was quenched by addition of 1 *M* HCl until pH 5 was achieved. After complete removal of the solvent, the pale-brown semi-solid residue was taken up in 70 ml of $CHCl_3$. The organic layer was washed once with an $NaHCO_3$ solution (pH 8) and four times with water, and finally dried over Na_2SO_4. Filtration and complete

removal of the solvent yielded the raw product as a colourless amorphous solid which was dried *in vacuo* at 333 K. Single crystals suitable for X-ray determination were obtained by slow evaporation of a solution of the crude product in 15 ml of methanol over a period of six weeks. Yield 320 mg (64%). M.p. 465–467 K (methanol). IR (KBr): 3513 (ν O—H), 3324 (ν N—H), 3031, 3000 (ν C—H arom.), 2954 (ν_{as} CH_3), 2909 (ν_{as} CH_2), 2870 (ν_s CH_2), 2835 (ν_s CH_3), 1481, 1456 (δ_{as} CH_3, δ CH_2), 1360 (δ_s CH_3), 1238, 1127, 1096, 1063, 987 (ν C–O), 763, 702 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6, 298 K): 1.22 and 1.35 (2*s*, 18H, H methyl), 2.49–2.53 (*m*, 1H, H2), 2.73 (*d*, ^3J = 5.4 Hz, 1H, N—H), 3.13 (*dd*, $^3J_{43}$ = $^3J_{45}$ = 9.3 Hz, 1H, H4), 3.41–3.50 (*m*, 3H, H3, H5 and H6), 3.66 (*dd*, $^3J_{65}$ = $^2J_{6a6e}$ = 11.3 Hz, 1H, H6), 3.81–3.86 (*m*, 2H, H14), 4.46 and 4.67 (2*d*, $^2J_{7a7b}$ = 11.7 Hz, each 1H, H7*A* and H7*B*), 4.53 (*s*, 1H, OH6), 4.95 (*s*, 1H, OH4), 4.98 (*d*, $^3J_{12}$ = 3.7 Hz, 1H, H1), 5.02 (*s*, 1H, OH3), 6.80 (*d*, *J* = 2.2 Hz, 1H, H ph), 7.07 (*d*, *J* = 2.2 Hz, 1H, H ph), 7.28–7.36 (*m*, 3H, H ph), 7.45–7.47 (*m*, 2H, H ph) p.p.m.; ^{13}C NMR (100 MHz, DMSO-d_6, 298 K): 29.5 and 31.5 (C22–C24 and C26–C28), 33.7 and 34.4 (C21 and C25), 50.8 (C14), 60.9 (C6), 61.1 (C2), 68.2 (C7), 70.5 (C4), 72.2 and 73.1 (C3 and C5), 95.4 (C1), 121.6, 122.9, 123.0, 127.5, 128.1, 128.2, 134.6, 137.7 and 139.3 (C ph), 154.4 (C20) p.p.m. ESI–MS: *m*/*z* (%) = $[M+H]^+$ (4), $[M+Na]^+$ (40). $C_{28}H_{41}NO_6$ (487.63 g mol^{-1}): calculated: C 68.97, H 8.47, N 2.87%; found: C 69.09, H 8.40, N 2.72%.

Crystal data

$C_{28}H_{41}NO_6$	V = 2700.0 (9) Å^3
M_r = 487.62	Z = 4
Orthorhombic, $P2_12_12_1$	Mo $K\alpha$ radiation
a = 5.9940 (12) Å	μ = 0.08 mm^{-1}
b = 15.342 (3) Å	T = 183 (2) K
c = 29.361 (6) Å	0.7 × 0.7 × 0.4 mm

Data collection

Nonius KappaCCD diffractometer	3554 independent reflections
Absorption correction: none	2415 reflections with $I > 2\sigma(I)$
18295 measured reflections	R_{int} = 0.072

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.046	H atoms treated by a mixture of independent and constrained refinement
$wR(F^2)$ = 0.154	$\Delta\rho_{max}$ = 0.32 e Å^{-3}
S = 1.09	$\Delta\rho_{min}$ = −0.47 e Å^{-3}
3554 reflections	
331 parameters	

C-bound H atoms were positioned geometrically [C—H = 0.95 (Csp^2), 0.98 (methyl), 0.99 (methylene) and 1.00 Å (methine), and O—H = 0.84 Å] and treated as riding atoms with fixed displacement parameters [U_{iso}(H) = xU_{eq}(C), where x = 1.5 for methyl and OH groups and 1.2 for all others]. The H atom on the N atom was located and refined with an isotropic displacement parameter. In the absence of significant anomalous scattering effects, Friedel equivalents were merged prior to the final refinement. The absolute configuration was assigned by reference to the chiral starting material and the evidence provided by NMR spectroscopy.

Data collection: *COLLECT* (Nonius 1998); cell refinement: *DENZO* (Otwinowski & Minor, 1997); data reduction: *DENZO*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *XP* (Siemens, 1990); software used to prepare material for publication: *XP* and *SHELXL97*.

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