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p-Tolyl 3-amino-3-*N*,4-*O*-carbonyl-2,3,6-trideoxy-1-thio-α-L-*lyxo*-hexopyranoside

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Key indicators

Single-crystal X-ray study
T = 193 K
Mean σ(C–C) = 0.003 Å
R factor = 0.031
wR factor = 0.098
Data-to-parameter ratio = 16.5

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

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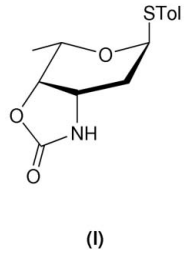
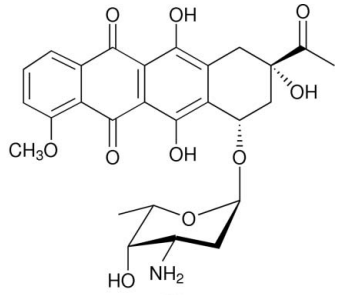
In the title compound, $C_{14}H_{17}NO_3S$, the pyranoside ring adopts a ^2S_O skew-boat conformation, owing to the presence of the fused oxazolidinone ring, which distorts the six-membered ring away from the normally observed chair form. In this conformation, each of the methyl and *p*-thiotolyl substituents of the pyranoside ring are oriented pseudo-equatorially.

Comment

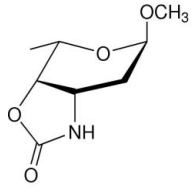
In the course of an investigation (Mendlik, Tao *et al.*, 2006) on the synthesis of glycosides of daunosamine, a sugar residue found in the anticancer agent daunorubicin, (II) (Arcamone & Cassinelli 1998), we reacted methyl glycoside (III) with *p*-thiocresol and boron trifluoride etherate. This reaction provided a thioglycoside product in 99% yield as a chromatographically indistinguishable (>10:1) mixture of anomers. Using NMR spectroscopy it was impossible to determine unambiguously whether the major product was (I) or its β-anomer (IV). As the product obtained after chromatography was crystalline, we selectively recrystallized the major isomer from the mixture to allow structure determination.



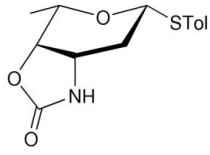
(I)



(II)



(III)



(IV)

The structure of (I) (Fig. 1 and Table 1) clearly establishes that the *p*-thiotolyl group at C1 is *trans* to the oxazolidinone group. In addition, similar to the corresponding methyl glycoside (III) (Mendlik, Coleman *et al.*, 2006), the pyranoside ring in (I) adopts a ^2S_O skew-boat conformer, owing to the fusion of the oxazolidinone ring, which deviates slightly from the preferred planar geometry [N—C3—C4—O2 = 7.77 (18)°]. The polar coordinates for the pyranoside ring, as

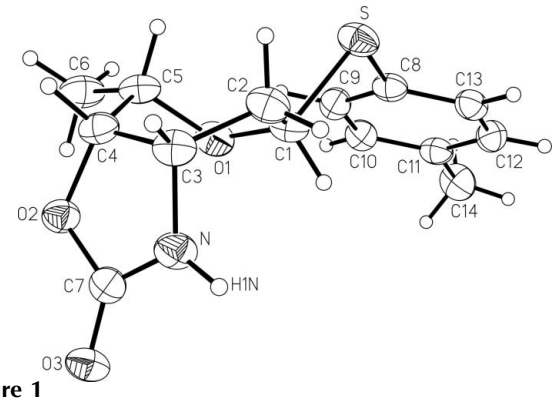


Figure 1
Perspective view of (I), showing the atom-labeling scheme and with displacement ellipsoids drawn at the 50% probability level.

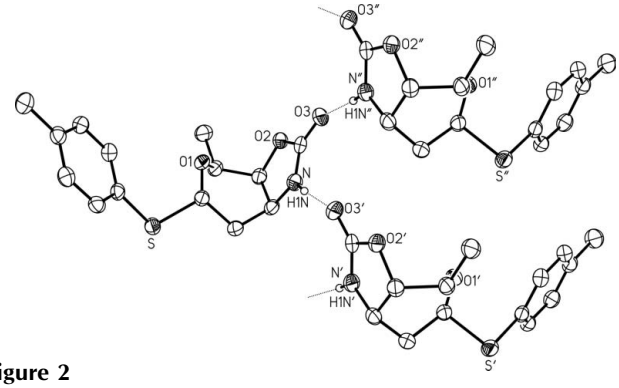


Figure 2
Illustration of the hydrogen-bonding interactions between adjacent molecules in (I). The chain propagates parallel to the *a* axis *via* the 2_1 screw operation. Single-primed atoms are related to unprimed ones by $(\frac{1}{2} + x, \frac{1}{2} - y, -z)$; double-primed atoms by $(-\frac{1}{2} + x, \frac{1}{2} - y, -z)$.

defined by Berces *et al.* (2001), are $d = 1.15$, $\Phi = 261°$, $\theta = 80°$. With the pyranoside ring in this conformation, the C5 methyl group and *p*-thiotolyl group at C1 adopt the sterically most favorable pseudo-equatorial positions. For the *p*-thiotolyl group, the pseudo-equatorial orientation also provides stabilization *via* the *endo*-anomeric effect (Lemieux & Koto, 1974). Finally, regarding the orientation about the C1—S bond, the S atom is *anti* to C2 and *gauche* to the O atom of the pyranoside ring; this is the rotamer favored by the *exo*-anomeric effect (Lemieux & Koto, 1974). The solid-state structure is stabilized by hydrogen-bonding interactions between the NH group and the carbonyl O atom of an oxazolidone group of an adjacent molecule, resulting in the formation of helical chains propagating parallel to the *a* axis (Fig. 2 and Table 2).

Experimental

Methyl 3-amino-3-*N*,4-*O*-carbonyl-2,3,6-trideoxy-α-L-*lyxo*-hexopyranoside, (III) (Mendlik, Coleman *et al.* 2006) (0.890 g, 4.75 mmol), and *p*-thiocresol (0.709 g, 5.71 mmol) were dissolved in CH_2Cl_2 (40 ml). Boron trifluoride diethyl etherate (1.51 ml, 11.9 mmol) was added dropwise at room temperature, and the solution was stirred for 2 h. The reaction mixture was poured on to a saturated aqueous solution of $NaHCO_3$ (60 ml) and the layers were separated. The aqueous layer was back-extracted with CH_2Cl_2 (3 × 10 ml), and the organic layers were combined, dried ($MgSO_4$) and concentrated. The resulting solid was purified by column chromatography (6 × 15 cm silica, 1:1, toluene/EtOAc) to afford (I) as white crystalline plates (1.314 g, 99%, >10:1 α/β mixture). The solid was recrystallized from 2:1 EtOAc:hexane to yield the pure α-isomer (m.p. 428–430 K): R_F 0.59 (6:1, $CHCl_3/CH_3OH$); $[\alpha]^{23}_D$ −174.3 (c 1/2, $CHCl_3$); IR 2986, 2305, 1759, 1421, 1265 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$, see Fig. 1 for numbering scheme): δ 7.38 (*d*, 2H, *J* = 8.1 Hz, ArH), 7.10 (*d*, 2H, *J* = 7.9 Hz, ArH), 6.39 (*s* 1H, NH), 5.48 (*dd*, 1H, *J* = 6.2 and 9.1 Hz, C1—H), 4.48 (*dd*, 1H, *J* = 1.7 and 9.1 Hz, C4—H), 4.23 (app. *dt*, 1H, *J* = 4.0 and 9.1 Hz, C3—H), 4.17 (*dq*, 1H, *J* = 1.7 and 6.5 Hz, C5—H), 2.32 (*s*, 3H, $ArCH_3$), 2.22 (*ddd*, 1H, *J* = 4.0, 6.2 and 15.2 Hz, C2—H_β), 1.87 (*ddd*, 1H, *J* = 4.0, 9.1 and 15.2 Hz, C2—H_α), 1.30 (*d*, 3H, *J* = 6.5 Hz, C6—H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 159.6 (C═O), 137.5 (aryl C), 132.6 (2C, aryl), 130.0 (aryl C), 129.7 (2C, aryl), 81.0 (C-1), 76.2 (C-4), 64.3 (C-5), 48.5 (C-3), 29.9 (C-2), 21.1 ($ArCH_3$), 15.8 (C-6); HRMS (ESI) *m*/*z* calculated for $C_{14}H_{17}NO_3S$+Na: 302.0821; found: 302.0810.

Crystal data

$C_{14}H_{17}NO_3S$	$Z = 4$
$M_r = 279.35$	$D_x = 1.335$ Mg m^{-3}
Orthorhombic, $P2_12_12_1$	Mo $K\alpha$ radiation
$a = 5.9331$ (6) Å	$\mu = 0.24$ mm^{-1}
$b = 6.0141$ (6) Å	$T = 193$ (2) K
$c = 38.941$ (4) Å	Plate, colorless
$V = 1389.5$ (2) $Å^3$	0.61 × 0.54 × 0.09 mm

Data collection

Bruker PLATFORM/SMART 1000 CCD diffractometer	10756 measured reflections
ω scans	2862 independent reflections
Absorption correction: multi-scan (*SADABS*; Sheldrick, 2003)	2761 reflections with $I > 2\sigma(I)$
$T_{min} = 0.869$, $T_{max} = 0.979$	$R_{int} = 0.022$
	$\theta_{max} = 26.4°$

Refinement

Refinement on F^2	$w = 1/[\sigma^2(F_o^2) + (0.0577P)^2 + 0.2797P]$ where $P = (F_o^2 + 2F_c^2)/3$
$R[F^2 > 2\sigma(F^2)] = 0.031$	$(\Delta/\sigma)_{max} = 0.001$
$wR(F^2) = 0.098$	$\Delta\rho_{max} = 0.33$ e $Å^{-3}$
$S = 1.17$	$\Delta\rho_{min} = -0.25$ e $Å^{-3}$
2862 reflections	Absolute structure: Flack (1983), 1140 Friedel pairs
173 parameters	Flack parameter: 0.02 (8)
H-atom parameters constrained	

Table 1
Selected geometric parameters (Å, °).

S—C8	1.7775 (19)	N—C7	1.334 (2)
S—C1	1.8322 (18)	N—C3	1.446 (2)
O1—C1	1.415 (2)	C1—C2	1.534 (2)
O1—C5	1.436 (2)	C2—C3	1.520 (3)
O2—C7	1.357 (2)	C3—C4	1.548 (3)
O2—C4	1.450 (2)	C4—C5	1.521 (3)
O3—C7	1.215 (2)	C5—C6	1.513 (3)
C8—S—C1	100.90 (8)	C2—C3—C4	112.56 (15)
C1—O1—C5	113.91 (14)	O2—C4—C5	109.42 (15)
C7—O2—C4	109.79 (15)	O2—C4—C3	105.04 (14)
C7—N—C3	113.50 (16)	C5—C4—C3	111.93 (16)
O1—C1—C2	113.46 (16)	O1—C5—C6	107.40 (16)
O1—C1—S	113.37 (12)	O1—C5—C4	107.82 (15)
C2—C1—S	106.84 (12)	C6—C5—C4	114.65 (18)
C3—C2—C1	112.72 (15)	O3—C7—N	129.11 (18)
N—C3—C2	113.19 (16)	O3—C7—O2	120.78 (17)
N—C3—C4	100.89 (15)	N—C7—O2	110.11 (16)

Table 2
Hydrogen-bond geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
N—H1N···O3^{i}	0.88	1.97	2.846 (2)	173

Symmetry code: (i) $x+\frac{1}{2}, -y+\frac{1}{2}, -z$.

H atoms were included in the riding-model approximation, with C—H = 0.95–1.00 Å and N—H = 0.88 Å, and with U_{iso}(H) = 1.2U_{eq}(C,N).

Data collection: *SMART* (Bruker, 1997); cell refinement: *SAINT* (Bruker, 1997); data reduction: *SAINT*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1990); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997*a*); molecular graphics: *SHELXTL* (Sheldrick, 1997*b*); software used to prepare material for publication: *SHELXTL*.

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References

Arcamone, F. & Cassinelli, G. (1998). *Curr. Med. Chem.* **5**, 391–419.
Berces, A., Nukada, T. & Whitfield, D. M. (2001). *Tetrahedron*, **57**, 477–491.
Bruker (1997). *SMART* (Version 5.0) and *SAINT* (Version 6.45A). Bruker AXS Inc., Madison, Wisconsin, USA.
Flack, H. D. (1983). *Acta Cryst.* A**39**, 876–881.
Lemieux, R. U. & Koto, S. (1974). *Tetrahedron*, **30**, 1933–1944.
Mendlik, M. T., Coleman, R. S., Qi, G., Lowary, T. L. & McDonald, R. (2006). *Acta Cryst.* E**62**, o2490–o2492.
Mendlik, M. T., Tao, P., Hadad, C. M., Coleman, R. S. & Lowary, T. L. (2006). *J. Org. Chem.*
Sheldrick, G. M. (1990). *Acta Cryst.* A**46**, 467–473.
Sheldrick, G. M. (1997*a*). *SHELXL97*. University of Göttingen, Germany.
Sheldrick, G. M. (1997*b*). *SHELXTL*. Version 5.1. Bruker AXS Inc., Madison, Wisconsin, USA.
Sheldrick, G. M. (2003). *SADABS*. Version 2.10. University of Göttingen, Germany.