Acta Crystallographica Section E
Structure Reports Online
ISSN 1600-5368

3-*epi*-Casuarine monohydrate

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Key indicators

Single-crystal X-ray study
T = 150 K
Mean σ(C–C) = 0.003 Å
Disorder in main residue
R factor = 0.047
wR factor = 0.072
Data-to-parameter ratio = 6.9

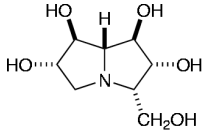
For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

Received 18 June 2004
Accepted 29 July 2004
Online 7 August 2004

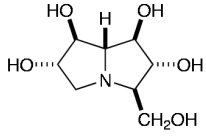
The title compound [systematic name: (1*R*,2*R*,3*S*,6*S*,7*S*,7a*R*)-3-hydroxymethyl-1,2,6,7-tetrahydroxypyrrolizidine monohydrate or (2*S*,3*R*,4*R*,5*R*,6*S*,7*S*)-2-hydroxymethyl-1-azabicyclo-[3.3.0]octan-3,4,6,7-tetraol monohydrate], $C_8H_{15}NO_5\cdot H_2O$, was formed in a synthetic sequence in which there were several ambiguities in the stereochemistry of the reactions. Its crystal structure was determined to resolve these ambiguities.

Comment

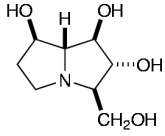
3-*epi*-Casuarine, (1), is a synthetic epimer of the natural product casuarine, (2) (Nash *et al.*, 1994), the most heavily oxygenated of the polyhydroxylated alkaloids which can be viewed as sugar mimics. Although the 6-α-D-glucoside of (2) is also a natural product (Wormald *et al.*, 1996), as yet no other diastereomers of casuarine have been isolated as natural products. In contrast, since the initial isolation of alexine (3) (without a hydroxyl group at C6) (Fellows *et al.*, 1988), a number of stereoisomers have been isolated (Asano *et al.*, 2000).



(1)



(2)



(3)

A combination of crystal structures and NMR studies have firmly established solid-state and solution conformations of a number of stereoisomers of alexine (Wormald *et al.*, 1998; Kato *et al.*, 2003), which may be used to rationalize their biological activity. Studies on the epimers of casuarine at

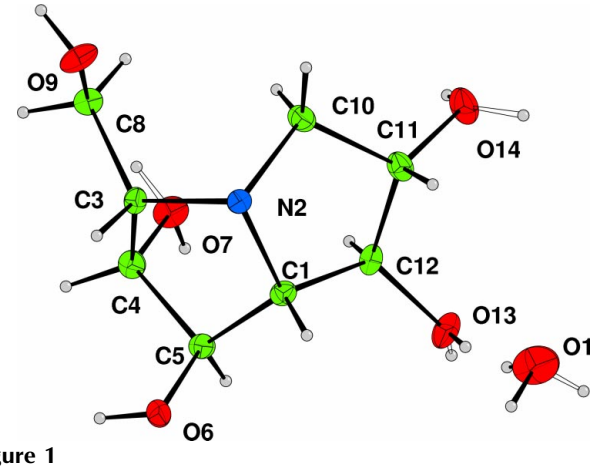


Figure 1
The asymmetric unit of (1), with displacement ellipsoids drawn at the 50% probability level. H-atom radii are arbitary. Unfilled O—H bonds indicate one of each pair of disordered H-atom positions.

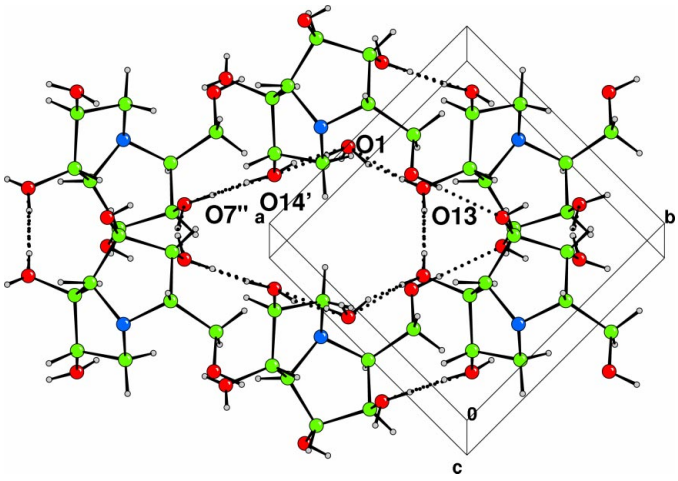


Figure 2
Partial packing diagram showing how the disorder in the hydrogen-bonded network results from the crystallographic twofold axis lying horizontally across the figure. The molecule containing atom O14′ is generated by the symmetry code $(2-y, -x, \frac{1}{2}-z)$ and that containing atom O7″ by $(1+x, 2-y, z)$. Hydrogen bonds are shown as dotted lines.

present are scant (Bell *et al.*, 1997). Since coupling constants are notoriously unreliable in assigning the relative configuration at stereogenic centres in five-membered ring systems, a crystal structure was necessary to firmly establish the structure of the title compound, (1), and to allow comparison of the solution and solid-state conformation; this may allow the development of rationales for the glycosidase inhibition of casuarines.

Fig. 1 shows the asymmetric unit of (1). The open O—H bonds shown are to one of each pair of disordered H atoms. The crystal structure consists of a three-dimensional hydrogen-bonded network. Of particular interest is the hydrogen-bonded ring shown in Fig. 2. Because this ring straddles a twofold rotation axis, the hydrogen bonds in it are necessarily disordered and the H atoms have occupancy factors of exactly one-half.

Experimental

The title compound (Nash *et al.*, 2004) was recrystallized from 1,4-dioxane to give colourless prismatic crystals.

Crystal data

$C_8H_{15}NO_5\cdot H_2O$
$M_r = 223.23$
Tetragonal, $P4_12_12$
$a = 7.6230\ (2)$ Å
$c = 33.8174\ (10)$ Å
$V = 1965.13\ (9)$ Å^3
$Z = 8$
$D_x = 1.509$ Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 1241 reflections
$\theta = 5$–$27°$
$\mu = 0.13$ mm^{-1}
$T = 150$ K
Prism, colourless
0.40 × 0.20 × 0.20 mm

Data collection

Nonius KappaCCD diffractometer
ω scans
Absorption correction: multi-scan *DENZO/SCALEPACK* (Otwinowski & Minor, 1997)
$T_{min} = 0.96$, $T_{max} = 0.97$
9161 measured reflections
1372 independent reflections
1372 reflections with $I > -3\sigma(I)$
$R_{int} = 0.021$
$\theta_{max} = 27.5°$
$h = -9 \rightarrow 9$
$k = -6 \rightarrow 7$
$l = -42 \rightarrow 43$

Refinement

Refinement on F^2
$R[F^2>2\sigma(F^2)] = 0.047$
$wR(F^2) = 0.072$
$S = 1.01$
1372 reflections
199 parameters
H atoms: only coordinates refined
$w = 1/[\sigma^2(F) + (0.029P)^2 + 0.165P]$, where $P = [\max(F_o^2,0) + 2F_c^2]/3$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max} = 0.35$ e Å^{-3}
$\Delta\rho_{min} = -0.34$ e Å^{-3}

Table 1
Selected geometric parameters (Å, °).

C1—C5	1.528 (3)	C5—O6	1.428 (2)
C1—C12	1.530 (3)	C8—O9	1.433 (2)
C1—N2	1.509 (2)	C10—C11	1.524 (3)
C3—C4	1.531 (3)	C10—N2	1.494 (2)
C3—C8	1.511 (3)	C11—C12	1.517 (3)
C3—N2	1.494 (3)	C11—O14	1.418 (2)
C4—C5	1.526 (3)	C12—O13	1.420 (2)
C4—O7	1.431 (2)		
C5—C1—C12	116.88 (16)	C3—C8—O9	109.04 (16)
C5—C1—N2	106.92 (15)	C11—C10—N2	103.10 (16)
C12—C1—N2	105.52 (15)	C10—C11—C12	101.71 (17)
C4—C3—C8	115.05 (17)	C10—C11—O14	112.16 (18)
C4—C3—N2	105.52 (15)	C12—C11—O14	114.32 (16)
C8—C3—N2	116.31 (16)	C1—C12—C11	102.10 (16)
C3—C4—C5	101.50 (16)	C1—C12—O13	113.73 (16)
C3—C4—O7	109.85 (17)	C11—C12—O13	114.58 (17)
C5—C4—O7	109.04 (15)	C1—N2—C3	106.05 (15)
C1—C5—C4	103.35 (16)	C1—N2—C10	107.10 (14)
C1—C5—O6	107.24 (16)	C3—N2—C10	117.00 (16)
C4—C5—O6	111.76 (15)		

H atoms were found in difference maps and refined with $U_{iso} = 0.02$ Å^2. In the absence of significant anomalous dispersion effects, Friedel pairs were averaged.

Data collection: *COLLECT* (Nonius, 1997); cell refinement: *DENZO/SCALEPACK*; data reduction: *DENZO/SCALEPACK* (Otwinowski & Minor, 1997); structure solution: *SIR92* (Altomare *et al.*, 1994); structure refinement: *CRYSTALS* (Betteridge *et al.*, 2003); molecular graphics: *CAMERON* (Watkin *et al.*, 1996).

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