Acta Crystallographica Section C
Crystal Structure Communications
ISSN 0108-2701

Methyl {1-[2,3-*O*-isopropylidene-5-*O*-(4-nitrobenzoyl)-α-D-ribofuranosyl]-4-methoxycarbonyl-1*H*-1,2,3-triazol-5-yl}acetate

Ivan Leban,[a]* Anton Štimac,[b] Jože Kobe[b] and Gerald Giester[c]

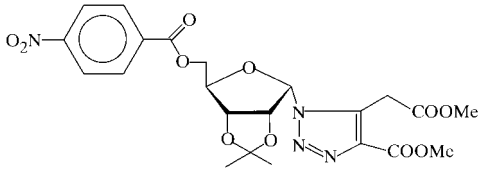
[a]Faculty of Chemistry and Chemical Technology, University of Ljubljana, Aškerčeva 5, PO Box 537, SI-1001 Ljubljana, Slovenia, [b]Laboratory for Organic and Medicinal Chemistry, National Institute of Chemistry, Hajdrihova 19, SI-1115 Ljubljana, Slovenia, and [c]Institut für Mineralogie und Kristallographie, Geozentrum, Universität Wien, Althanstr. 14, A-1090 Wien, Austria
Correspondence e-mail: ivan.leban@uni-lj.si

Received 6 December 1999
Accepted 7 April 2000

In the title compound, $C_{22}H_{24}N_4O_{11}$, the *N*-glycosidic torsion angles O′—C′—N—C and O′—C′—N—N are −34.1 (6) and 148.8 (3)°, respectively. The molecule displays an α-D configuration with the ribofuranose moiety in an O′-*exo*–C′-*endo* pucker. There are only weak C—H···O and C—H···N intra- and intermolecular interactions.

Comment

The Dimroth reaction of glycosyl azides with dimethyl-3-oxoglutarate (DOG) was recently used to produce the intermediates for further cyclizations to various 8-aza-3-deazaguanine nucleosides. The stereochemistry followed a favourable path even with 1,2-*cis* glycosyl azides, in sharp contrast to the condensations with cyanoacetamide, which were reported to yield 1,2-*trans* nucleosides exclusively (Štimac *et al.*, 1999). Herein, we report the crystal structure of



(I)

the only product, (I), between 2,3-*O*-isopropylidene-5-*O*-(4-nitrobenzoyl)-α-D-ribofuranosyl azide and DOG, which revealed the glycosidation site N1 of the 4-methoxycarbonyl-1,2,3-triazol-5-yl acetate and the α-anomeric configuration of the nucleoside. The molecule with the atomic numbering scheme is depicted in Fig. 1. Selected geometric parameters are presented in Table 1. The absolute configuration was assigned to agree with the known chirality of the sugar moiety (α-D-ribofuranose).

A survey of the Cambridge Structural Database (Allen & Kennard, 1993) revealed 18 entries where the aglycon moiety of the nucleoside was either the 1,2,4-triazole derivative alone (13 entries), or the 1,2,4-triazole derivative as part of the bicyclic system (5 entries). Only in the structure determination of 2-β-D-ribofuranosyl-1,2,3-triazole-4,5-dicarboxamide dihydrate was the 1,2,3-triazole derivative an aglycon to ribofuranose (Sanghvi *et al.*, 1990).

The orientation of the heterocyclic base relative to the sugar moiety (defined as *anti* or *syn*) is determined by the torsion angle about the *N*-glycosidic bond, explicitly, for purines and pyrimidines. In the case of modified nucleosides with *e.g.* a five-membered base ring system, the sequence of atoms is chosen as far as possible to correspond closely with the normal substrates (Sundaralingham, 1975; IUPAC-IUB Joint Commission on Biochemical Nomenclature, 1983). The appropriate torsion angles O4′—C1′—N1—C5 and O4′—C1′—N1—N2 in this study are −34.1 (6) and 148.8 (3)°,

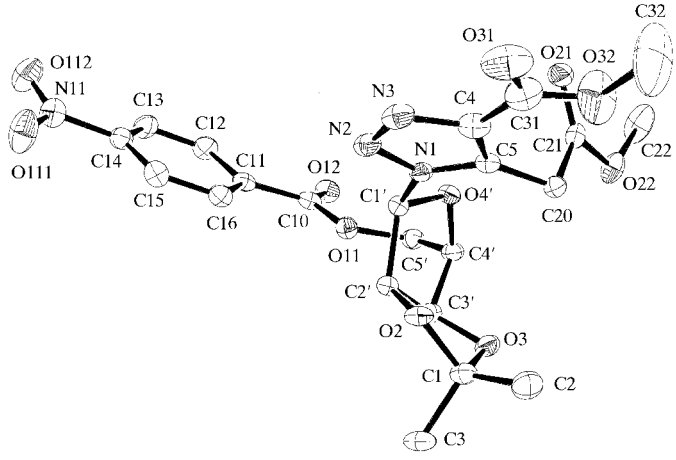


Figure 1
*ORTEP*II (Johnson, 1971) view of the molecule with atomic numbering. Anisotropic displacement ellipsoids are drawn at the 30% probability level. H atoms are omitted for clarity.

respectively, suggesting high *anti*-configuration. The conformation about the C4′—C5′ bond [O4′—C4′—C5′—O11 −59.6 (4)°] is in the *gauche* range. The ribofuranose moiety exists in an O4′-*exo*–C4′-*endo* pucker. The corresponding Cremer–Pople (Cremer & Pople, 1975) puckering parameters q_2 and φ_2 are 0.246 (4) Å and 161.7 (10)° (Spek, 1998; Farrugia, 2000), respectively, suggesting the twisted form around the C4′—O4′ bond. The bond lengths and angles are normal and in agreement with the values for the related compounds. The bond lengths N1—C5 1.341 (5), N1—N2 1.354 (4), N2—N3 1.289 (5), N3—C4 1.360 (6) and C4—C5 1.399 (6) Å in the 1,2,3-triazole ring suggest considerable delocalization of electrons and the prevalent double bond character of N2—N3 bonds. The triazole moiety is planar to within 0.005 (3) Å, and the phenyl part of the *para*-nitrobenzoyl group to within 0.011 (3) Å. The dihedral angles between the *para*-nitro group NO_2 (N11, O111, O112) and the carboxylate group COO (C10, O11, O12), and the phenyl ring (C11–C16) are 10.8 (4) and 5.8 (3)°, respectively.

Because the OH groups of the molecule are protected with either the *para*-nitrobenzoate or the isopropylidene group, the molecule is essentially hydrophobic. There are only weak C—H···O and C—H···N intra- and intermolecular interactions (Table 1), which control the packing. Although the data were collected at 150 K, there is still appreciable thermal motion of the terminal C32 atom.

Experimental

The title compound was the only product isolated from the reaction between a solution of 2,3-*O*-isopropylidene-5-*O*-(4-nitrobenzoyl)-α-D-ribofuranosyl azide (4 mmol) in dimethyl sulfoxide (5 ml) and dimethyl-3-oxoglutarate (8 mmol) together with finely ground K_2CO_3 (4 mmol). The heterogenous mixture was stirred at 318 K for 72 h. The precipitate was washed with water, dried in air and dissolved in $CHCl_3$ (30 ml). The solution was washed with 1 *M* Na_2CO_3 (2 × 16 ml), 0.1 *M* HCl (16 ml) and brine (16 ml) and finally dried with Na_2SO_4. Solvent was removed and the residue was purified by chromatography on silica gel, first with 0.2% ethanol in CH_2Cl_2, followed by CH_2Cl_2–ether mixture. The fragile, plate-like, elongated crystals with melting point 477–479 K were obtained after several recrystallizations from ethyl acetate. Details are given by Štimac *et al.* (1999).

Crystal data

$C_{22}H_{24}N_4O_{11}$
M_r = 520.45
Orthorhombic, $P2_12_12_1$
a = 8.845 (2) Å
b = 9.931 (2) Å
c = 27.325 (5) Å
V = 2400.2 (8) Å^3
Z = 4
D_x = 1.440 Mg m^{-3}
D_m = 1.42 (5) Mg m^{-3}
D_m measured by flotation
Mo $K\alpha$ radiation
Cell parameters from 28 700 reflections
θ = 3–25°
μ = 0.117 mm^{-1}
T = 150 (2) K
Needle, colourless
0.35 × 0.13 × 0.13 mm

Data collection

Nonius KappaCCD diffractometer
301 frames in 5 sets of ω scans
24 551 measured reflections
2358 independent reflections
2111 reflections with $I > 2\sigma(I)$
R_{int} = 0.057
θ_{max} = 25°
$h = -10 \rightarrow 10$
$k = -11 \rightarrow 11$
$l = -32 \rightarrow 31$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.049
$wR(F^2)$ = 0.122
S = 1.088
2358 reflections
335 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.0546P)^2 + 1.5179P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = 0.038
$\Delta\rho_{max}$ = 0.54 e Å^{-3}
$\Delta\rho_{min}$ = −0.24 e Å^{-3}
Extinction correction: *SHELXL*97
Extinction coefficient: 0.0067 (16)

All H atoms were found in the difference electron-density map and were placed at calculated positions with isotropic displacement parameters taken from those of the attached heavy atoms and multiplied by 1.5. With the absence of suitable anomalous scatterers for Mo $K\alpha$ radiation, the determination of the absolute configuration was not possible. The absolute configuration was assigned to agree with the known chirality of the ribofuranose moiety and the Friedel diffraction data were merged accordingly. Three strong reflections, 131, 109 and 0,0,14, were omitted from the refinement in the final stage due to inaccuracy in measurement.

Data collection: *KappaCCD Reference Manual* (Nonius, 1998); cell refinement: *DENZO* and *SCALEPACK* (Otwinowski & Minor, 1997); data reduction: *DENZO* and *SCALEPACK*; program(s) used to solve structure: *SHELXS*86 (Sheldrick, 1986); program(s) used to refine structure: *SHELXL*97 (Sheldrick, 1997); molecular graphics: *ORTEP*II (Johnson, 1971), *PLATON* (Spek, 1998) and *ORTEP*-3 (Farrugia, 1999); software used to prepare material for publication: *SHELXL*97.

Table 1
Selected geometric parameters (Å, °).

C1′—O4′	1.406 (5)	C14—N11	1.481 (6)
C1′—N1	1.454 (5)	N11—O111	1.203 (5)
C1′—C2′	1.546 (5)	N11—O112	1.212 (5)
C2′—C3′	1.533 (6)	N1—C5	1.341 (5)
C3′—C4′	1.513 (5)	N1—N2	1.354 (4)
C4′—O4′	1.446 (5)	N2—N3	1.289 (5)
C4′—C5′	1.505 (6)	N3—C4	1.360 (6)
C5′—O11	1.441 (4)	C4—C5	1.399 (6)
O4′—C1′—C2′—C3′	−8.6 (4)	O4′—C4′—C5′—O11	−59.6 (4)
C1′—C2′—C3′—C4′	−8.0 (4)	C3′—C4′—C5′—O11	60.1 (4)
C2′—C3′—C4′—O4′	21.4 (4)	O4′—C1′—N1—C5	−34.1 (5)
C2′—C1′—O4′—C4′	23.1 (4)	O4′—C1′—N1—N2	148.8 (3)
C3′—C4′—O4′—C1′	−28.1 (4)		

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

D—H···A	D—H	H···A	D···A	D—H···A
C1′—H1···O11	1.00	2.54	2.925 (5)	102
C20—H18···O32	0.99	2.47	3.036 (5)	116
C4′—H4···O31^{i}	1.00	2.30	3.073 (6)	133
C3—H10···O12^{ii}	0.98	2.50	3.342 (6)	144
C2′—H2···N3^{iii}	1.00	2.60	3.573 (6)	164

Symmetry codes: (i) $x, 1+y, z$; (ii) $-1-x, y-\frac{1}{2}, -\frac{1}{2}-z$; (iii) $-1-x, \frac{1}{2}+y, -\frac{1}{2}-z$.

Financial support by the Ministry for Science and Technology, Republic of Slovenia, through grants L1-1491 and PS-511, is gratefully acknowledged.

Supplementary data for this paper are available from the IUCr electronic archives (Reference: JZ1388). Services for accessing these data are described at the back of the journal.

References

Allen, F. H. & Kennard, O. (1993). *Chem. Design Autom. News*, **8**, 31–37.
Cremer, D. & Pople, J. A. (1975). *J. Am. Chem. Soc.* **97**, 1354–1358.
Farrugia, L. J. (1999). *ORTEP-3 for Windows*. Version 1.05. University of Glasgow, Scotland.
Farrugia, L. J. (2000). Implementation of *PLATON* for 32-bit Windows. University of Glasgow, Scotland.
Nonius (1998). *KappaCCD Reference Manual.* Nonius BV, Delft, The Netherlands.
IUPAC-IUB Joint Commission on Biochemical Nomenclature (1983). *Eur. J. Biochem.* **131**, 9–15.
Johnson, C. K. (1971). *ORTEP*II. Report ORNL-3794, revised. Oak Ridge National Laboratory, Tennessee, USA.
Otwinowski, Z. & Minor, W. (1997). *Methods Enzymol.* **276**, 307–326.
Sanghvi, Y. S., Bhattacharya, B. K., Kini, G. D., Matsumoto, S. S, Larson, S. B, Jolley, W. B., Robins, G. R. & Revankar, G. R. (1990). *J. Med. Chem.* **33**, 336–344.
Sheldrick, G. M. (1986). *SHELXS*86. University of Göttingen, Germany.
Sheldrick, G. M. (1997). *SHELXL*97. University of Göttingen, Germany.
Spek, A. L. (1998). *PLATON*. University of Utrecht, The Netherlands.
Štimac, A., Leban, I. & Kobe, J. (1999). *Synlett*, pp. 1069–1073.
Sundaralingham, M. (1975). *Ann. N. Y. Acad. Sci.* **255**, 3–42.