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## Note

# The solid state and solution conformation of 3,4,6-tri-*O*-acetyl-1,2-*O*-isopropylidene-α-D-galactopyranose

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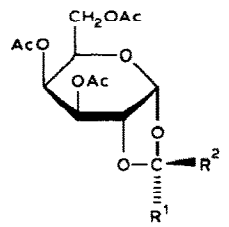
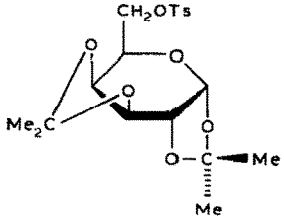
The solid state and solution conformation of 1,2-*O*-alkylidene-pyranoses depends on a series of factors[1–6]. The conformation of the pyranoid ring has been investigated conventionally by using $^1$H-n.m.r. spectroscopy[1–6], and that of the dioxolane ring on the basis of $^3J_{C,H}$ coupling constants[3–5] with the help of data on model compounds[7]. For 1,2-*O*-ethylidene derivatives in which the conformation of the pyranoid ring is $^4C_1$, the $^3J_{C,H}$ values indicated a $^{O2}T_{C2}$ conformation of the dioxolane ring when the 2′-methyl substituent was *exo* and a $^{C1}E$ conformation when that substituent was *endo*[8]. We now report on the solid state and solution conformation of the title isopropylidene derivative **1**, which has both *exo* and *endo* 2′-substituents.




**1** $R^1 = R^2 = Me$
**2** $R^1 = CN, R^2 = Me$
**3** $R^1 = Me, R^2 = {}^tBuO$




**4**

The crystal data for **1** are given in Table I and an ORTEP view is given in Fig. 1. Two independent molecules were present in the unit cell. The torsion angles are gathered in Table II. Both independent molecules of **1** compare well with each other, and have a $^4C_1$ conformation for the pyranoid ring. The main differences

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TABLE I

CRYSTAL ANALYSIS PARAMETERS

| | |
|---|---|
| *Crystal data* | |
| Formula | $C_{15}H_{22}O_9$ |
| Crystal habit | prismatic, transparent, colourless |
| Crystal size (mm) | 0.30 × 0.27 × 0.13 |
| Symmetry | monoclinic, $P2_1$ |
| Unit-cell determination: | least-squares fit from 83 reflexions ($\theta$ <45°) |
| Unit-cell dimensions | 11.3472(4), 18.6054(8), 9.5957(3) Å<br>90, 114.289(2), 90° |
| Packing: $V$(Å$^3$), $Z$ | 1846.5(1), 4 |
| $D_c$ (g.cm$^{-3}$), $M$, $F$(000) | 1.246, 346.33, 736 |
| $\mu$ (cm$^{-1}$) | 8.48 |
| *Experimental data* | |
| Technique | four-circle diffractometer:<br>Philips PW1100, bisecting geometry<br>graphite-oriented monochromator: Cu$K_\alpha$<br>w/2$\theta$ scans, scan width: 1.5°<br>detector apertures 1 × 1°, up $\theta_{max}$ 65°<br>1 min/reflex. |
| Number of reflexions: | |
| Independent | 3210 |
| Observed | 2233 [3 $\sigma(I)$ criterion] |
| Standard reflexions: | 2 reflexions every 90 min<br>0.5% maximum variation |
| *Solution and refinement* | |
| Solution | Patterson search and direct difference methods |
| Refinement | least-squares on $F_{obs}$ with 3 blocks |
| Parameters: | |
| Number of variables | 608 |
| Degrees of freedom | 1625 |
| Ratio of freedom | 3.7 |
| H atoms | difference synthesis |
| Final shift/error | 0.29 |
| w-scheme | empirical as to give no trends in<br>$\langle w\Delta^2F\rangle$ *vs.* $\langle\lvert F_{obs}\rvert\rangle$ or $\langle\sin\theta/\lambda\rangle$ |
| Max. thermal value | U33(07′) = 0.81(5) Å$^2$ |
| Final $\Delta F$ peaks | 0.26 eÅ$^{-3}$ |
| Final $R$ and $R_w$ | 0.062, 0.071 |
| Computer and programs | VAX 11/750, X-RAY-76[17], DIRDIF[18] |
| Scattering factors | International Tables for X-Ray Crystallography[19] |

with data reported[1,9] for **2** and **3** concern the conformation ($^{C1}E$) of the dioxolane ring. However, the conformation of the pyranoid ring in the tricyclic compound 1,2:3,4-di-*O*-isopropylidene-6-*O*-toluene-*p*-sulphonyl-α-D-galactopyranose (**4**) is skew[10]. Tricyclic 1,2:3,4-di-*O*-alkylidene-α-D-galacto- and -β-L-arabino-pyranose derivatives show boat-like conformations[11].

The observed $J$ values for **1** (Table III) agree reasonably well with those calculated according to Altona's equation[12] from the vicinal torsion angles observed

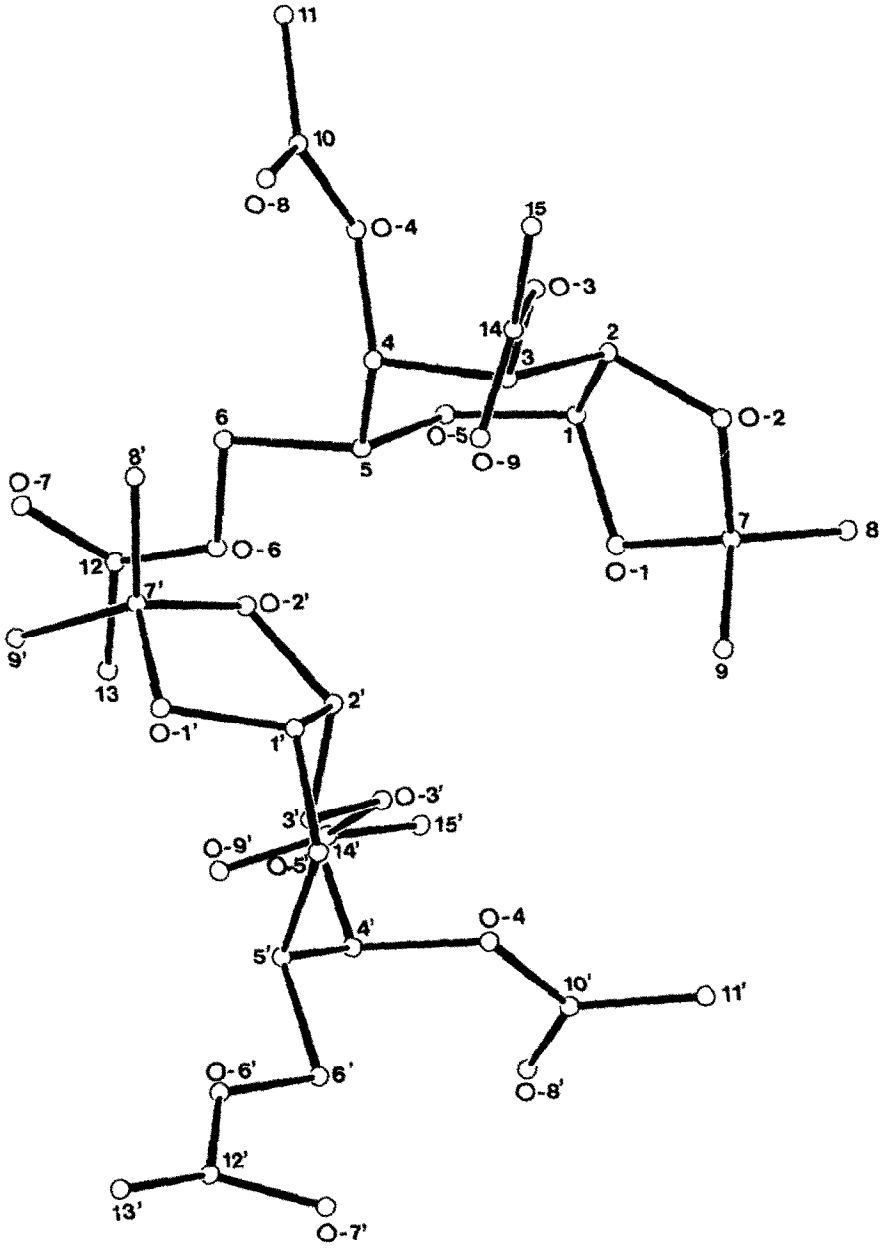


Fig. 1. ORTEP[16] view of the two independent molecules of compound **1**, showing the atomic numbering.

TABLE II

TORSION ANGLES[a] (DEGREES) FOR **1** FROM X-RAY DIFFRACTION DATA

| *Angle* | **1** | **1'** |
|---|---|---|
| C-2–C-1–O-5–C-5 | −43.8(8) | −45.2(9) |
| O-5–C-1–C-2–C-3 | 36.5(9) | 35.7(9) |
| C-1–C-2–C-3–C-4 | −43.3(9) | −41.8(9) |
| C-2–C-3–C-4–C-5 | 55.2(8) | 56.0(9) |
| C-3–C-4–C-5–O-5 | −62.6(8) | −63.9(8) |
| C-4–C-5–O-5–C-1 | 58.7(8) | 60.1(8) |
| O-1–C-1–C-2–O-2 | 35.8(7) | 33.5(7) |
| C-2–C-1–O-1–C-7 | −36.0(7) | −35.4(8) |
| C-1–O-1–C-7–O-2 | 22.1(8) | 23.6(8) |
| C-2–O-2–C-7–O-1 | 2.1(9) | −0.9(8) |
| C-1–C-2–O-2–C-7 | −22.9(8) | −19.7(8) |
| H-1–C-1–C-2–H-2 | 27(8) | 33(8) |
| H-2–C-2–C-3–H-3 | −154(8) | −157(8) |
| H-3–C-3–C-4–H-4 | 56(7) | 62(7) |
| H-4–C-4–C-5–H-5 | −56(6) | −61(8) |
| C-3–C-2–C-1–H-1 | 150(5) | 150(4) |
| C-1–C-2–C-3–H-3 | 74(5) | 78(5) |
| C-4–C-3–C-2–H-2 | 88(6) | 84(6) |
| C-2–C-3–C-4–H-4 | 163(5) | −175(6) |
| C-5–C-4–C-3–H-3 | −72(5) | −67(4) |
| C-6–C-5–C-4–H-4 | 59(5) | 57(7) |
| C-3–C-4–C-5–H-5 | 61(4) | 59(4) |

[a]Estimated standard deviations in brackets.

in the crystal, and from molecular mechanics calculations (MM2)[13], and accord with a $^4C_1$ conformation for the pyranoid ring. Additional support is provided by n.O.e. experiments. Irradiation of the signal corresponding to the *endo*-methyl group induced a 6% increase in the intensity of the signal assigned to H-3, in agreement with enhancements previously reported for $^4C_1$ conformers[1,9]. The long-range couplings $^3J_{C\text{-}7,H\text{-}1}$ 2.0, $^3J_{C\text{-}7,H\text{-}2}$ 3.8 Hz, for **1** measured through selective 2D heteronuclear *J*-resolved experiments[14] indicate[15] a *gauche*-type dihedral angle between the acetal carbon and H-1, and a larger angle with H-2. Molecular mechanics calculations for the possible conformers of the dioxolane ring, maintaining a $^4C_1$ conformation for the pyranoid ring, showed that $^3J_{C,H}$ values could be accounted for by a $^{C1}E$ conformation with torsion angles $\phi_{C\text{-}7,H\text{-}1}$ 77° and $\phi_{C\text{-}7,H\text{-}2}$ −142°, in agreement with the solid state conformation. Nevertheless, relative steric energy values show that the envelope could be distorted towards the $^{C1}T_{O1}$ conformation (only 0.85 kcal/mol less stable than the envelope form).

## EXPERIMENTAL

3,4,6-Tri-*O*-acetyl-1,2-*O*-isopropylidene-α-D-galactopyranose (**1**), prepared as for the D-glucopyranose analogue[20], had m.p. 70–72°, $[\alpha]_D$ +104° (*c* 0.7,

TABLE III

OBSERVED AND CALCULATED[a] $^3J_{H,H}$ VALUES (Hz) FOR **1**

| | *Observed* | *Calc.* | |
|---|---|---|---|
| | | *From X-Ray* | *From MM2* |
| $J_{1,2}$ | 4.4 | 5.5 | 4.4 |
| $J_{2,3}$ | 7.0 | 7.4 | 8.5 |
| $J_{3,4}$ | 3.0 | 2.0 | 2.9 |
| $J_{4,5}$ | 2.3 | 0.8 | 0.5 |

[a]From vicinal proton torsion angles according to Altona's equation.

chloroform). N.m.r. data ($CDCl_3$): $^1H$ (300 MHz), $\delta$ 5.646 (H-1), 4.156 (H-2), 5.083 (H-3), 5.416 (H-4), 4.380 (H-5), 4.162 (H-6,6'); $J_{1,2}$ 4.4, $J_{1,5}$ −0.5, $J_{2,3}$ 7.0, $J_{3,4}$ 3.0, $J_{4,5}$ 2.3, $J_{5,6}$ 6.3, $J_{5,6'}$ 6.9, $J_{6,6'}$ −11.5 Hz; $^{13}C$ (75 MHz), $\delta$ 97.1 (C-1), 72.6 (C-2), 71.5 (C-3), 66.1 (C-4), 68.8 (C-5), 61.2 (C-6), 108.9 (C-7); $J_{C\text{-}7,H\text{-}1}$ 2.0, $J_{C\text{-}7,H\text{-}2}$ 3.8 Hz.

The selective 2D heteronuclear *J*-resolved experiments were accomplished by using a length of 10 ms for the soft 90° pulse. The coupled spectrum was finally computer-assisted analysed by using a PANIC programme.

Crystal and experimental data and refinement parameters are given in Table I. A non-crystallography two-fold symmetry across, approximately, *x* 0.125, *y* 0.055, and parallel to *c* relates the two crystallographically independent molecules **1** and **1'**.

*Supplementary material.* — The final atomic co-ordinates, thermal parameters, bond distances and bond angles, hydrogen co-ordinates, structure factor tables, and relative steric energy values have been deposited with, and can be obtained from, Elsevier Science Publishers, B.V., BBA Data Deposition, P.O. Box 1527, Amsterdam, The Netherlands. Reference should be made to No. BBA/DD/000/*Carbohydr. Res.*, 000 (1987) 000–000.

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