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Note

Synthesis of 1,6-anhydro-2-*O*-benzoyl-3,4-dideoxy-β-D-*erythro*-hex-3-enopyranose

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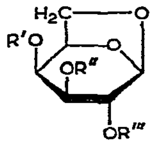
A number of hex-3-enopyranose derivatives are known[1-7], as well as some hex-3-enopyranos-2-uloses[7-9]. Synthesis of 1,6-anhydro-2-*O*-benzoyl-3,4-dideoxy-β-D-*erythro*-hex-3-enopyranose (**6**) from 1,6-anhydro-β-D-galactose(**1**) has now been achieved *via* compounds **2**–**5**. Compound **6** is of interest, as the rigid conformation imposed by the combination of the two ring systems and the double bond is likely to affect the stereochemistry of addition to the double bond.

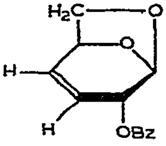
The 100-MHz, n.m.r. spectrum (see Fig. 1) of **6** is interesting, in that complete assignment of all the proton signals is possible (see Table I). The two protons on C-6 have virtually identical δ values, in contrast to those in **5**; this was to be expected, as **6** has no axial substituent on C-3 to deshield the *endo* proton on C-6 relative to the *exo* proton[10].

EXPERIMENTAL

General methods. — Melting points were determined with a Kofler hot-stage apparatus and are uncorrected. Microanalyses were performed in the Chemistry School, The University of New South Wales and by the Australian Microanalytical Service, CSIRO, Melbourne. Bis(imidazol-1-yl)thione was purchased from Sefochem Fine Chemicals Ltd., Israel.



1 $R' = R'' = R''' = H$
2 $R', R'' = Me_2C, R''' = H$
3 $R', R'' = Me_2C, R''' = Bz$
4 $R' = R'' = H, R''' = Bz$
5 $R', R'' = {>}C{=}S, R''' = Bz$



6

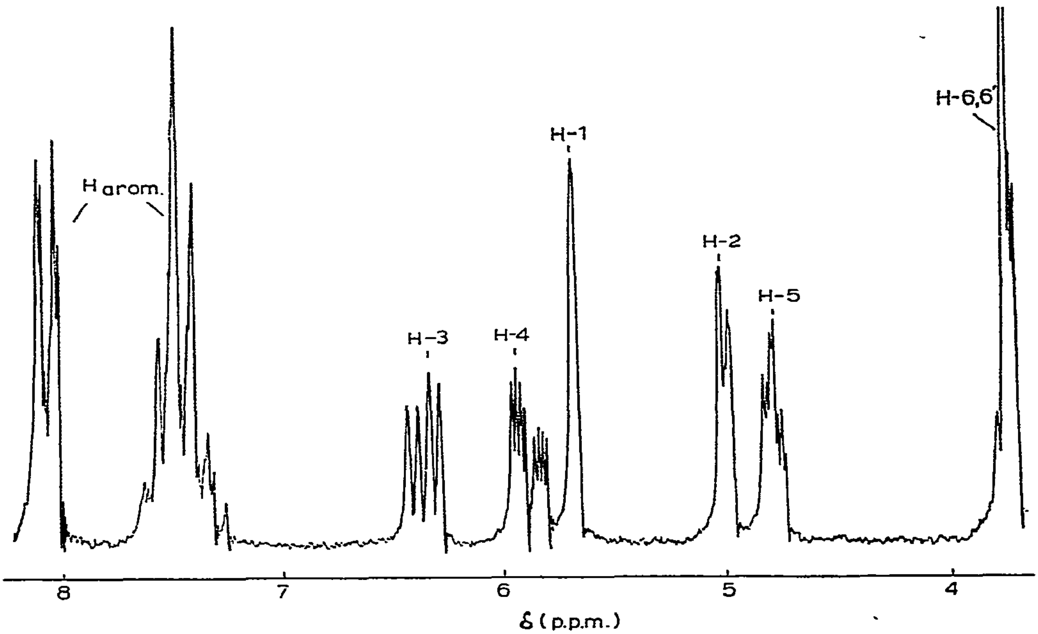


Fig. 1. N.m.r. spectrum (10-Hz) of *6* in chloroform-*d*. (δ in p.p.m. from internal Me_4Si.)

TABLE I

CHEMICAL SHIFTS (FROM INTERNAL Me_4Si) AND COUPLING CONSTANTS (Hz) FOR THE 100-MHz N.M.R. SPECTRUM OF COMPOUND *6* IN CHLOROFORM-*d*

Proton	δ	$J_{H,H}$ *(Hz)*
H-1	5.66	1,2 = 1.1
H-2	5.00	1,2 = 1.1; 2,3 = 4
H-3	6.35	3,4 = 10; 2,3 = 4
H-4	5.89	3,4 = 10; 4,5 = 1.8; 2,4 = 1.8
H-5	4.80	5,6 = 3; 4,5 = 1.8; 3,5 < 1
H-6[a]	3.74	5,6 = 3

[a] Two protons, having virtually identical δ values.

The following materials and instruments were used where appropriate. Optical rotations were measured with a Bendix NPZ Automatic Polarimeter Model 143C; t.l.c. on precoated plates of Merck Silica Gel 60 F_{254}; i.r. spectra were recorded, for KBr discs, with a Hitachi EPIG 2 double-beam spectrophotometer; n.m.r. spectra were recorded with a JEOL-4H-100 spectrometer; chemical ionization mass spectra were recorded with a GEC-AEI M.S. 902 instrument equipped with an SRIC-CIS-2 chemical ionization source with ammonia as the ionizing gas, and the following operating conditions: source pressure 133.3 Pa (1 torr); source temperature 170°;

probe temperature 130°; electron energy 500 eV; filament emission 0.5 mA; accelerating voltage 8 kV.

1,6-Anhydro-β-D-galactopyranose (**1**). — Compound **1** was synthesized *via* penta-*O*-acetyl-β-D-galactopyranose[11], phenyl 2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranoside[12,13], and phenyl β-D-galactopyranoside[14]. The n.m.r. spectrum in D_2O and the m.p. (220°) were in agreement with published data[10,14] for **1**.

Compounds **2** *and* **3**. — 1,6-Anhydro-3,4-*O*-isopropylidene-β-D-galactopyranose (**2**), 1,6-anhydro-2-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranose, and 1,6-anhydro-2-*O*-benzoyl-β-D-galactopyranose (**3**) were synthesized as described by Hann and Hudson[15]. All had physical data, elemental analyses, and n.m.r. spectra consistent with the structures proposed.

*1,6-Anhydro-2-*O*-benzoyl-β-D-galactopyranose 2,3-thionocarbonate* (**5**). — To a solution of **3** (2.1 g, 7.9 mmol) in dry acetone (40 mL) was added bis(imidazol-1-yl)-thione (1.7 g, 9.5 mmol), and the mixture was boiled under reflux, with a slow stream of nitrogen, for 80 min. T.l.c. on silica gel with 19:1 (v/v) chloroform–acetone showed a major spot having R_F 0.92 (**5**) and minor spots at 0.77 (unknown) and 0.17 (**3**). The clear, brown solution was partly decolorized (to a pale yellow) with activated charcoal, and evaporated to a syrup that crystallized on trituration with ether; the yield of crude product was 2.12 g (87%). Recrystallization from diethyl ether–light petroleum (b.p. 30–60°) afforded pure **5** (1.9 g) as very small, fine needles, m.p. 131–132°, $[\alpha]_D^{22}$ +120.5° (*c* 1.5, chloroform); ν_{max}^{KBr} 1740 (benzoyl CO) and 1330 cm^{-1} (thionocarbonate); n.m.r. data ($CDCl_3$, δ from internal Me_4Si): 3.80 (2 d, 1 H, H-6), 4.08 (d, 1 H, H-6′), 4.75 (m, 2 H, H-2,5), 5.30 (m, 2 H, H-3,4), 5.62 (s, 1 H, H-1), and 7.5 and 8.0 (5 H, aromatic); *m/e* 326 $[M + NH_4^+]$ and 309 $[M + H^+]$.

Anal. Calc. for $C_{14}H_{12}O_6S$: C, 54.54; H, 3.90; S, 10.39. Found: C, 54.47; H, 3.74; S, 10.1.

*1,6-Anhydro-2-*O*-benzoyl-3,4-dideoxy-β-D-*erythro*-hex-3-enopyranose* (**6**). — Compound **5** (1.8 g, 5.8 mmol) in freshly distilled trimethyl phosphite (15 mL) was refluxed under nitrogen for 60 h at 135–140° (bath temp.). The mixture was poured into M sodium hydroxide solution (125 mL), stirred for 20 min at room temperature, and extracted with chloroform (4 × 50 mL). The extracts were combined, washed with water (2 × 30 mL), dried (anhydrous magnesium sulfate), and evaporated to a syrup (0.9 g, 66%) that crystallized on trituration with light petroleum. T.l.c. with 19:1 (v/v) chloroform–acetone showed a major spot, R_F 0.95 (**6**), and a faint spot, R_F 0.92 (**5**). Recrystallization from light petroleum afforded cubic crystals, m.p. 66–68°, $[\alpha]_D^{22}$ −237° (*c* 1.72, chloroform); n.m.r. data: see Table I; *m/e* 250 $[M + NH_4^+]$ and 233 $[M + H^+]$.

Anal. Calc. for $C_{13}H_{12}O_4$: C, 67.24; H, 5.17. Found: C, 66.97; H, 5.24.

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