Note

Synthesis of some sugar nitrates

Silvia R. Leicach and Jorge F. Sproviero*

Departamento de Química Orgánica, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Ciudad Universitaria, Pabellón II, 1428 Buenos Aires (Argentina)

(Received August 29th, 1989; accepted for publication in revised form December 24th, 1989)

The syntheses of three selectively benzoylated derivatives of β -L-arabinopyranose were undertaken for use in a study of the migratory aptitudes of O-benzoyl groups of perbenzoylated monosaccharides when treated with ammonia in methanol¹. The free



hydroxyl groups were converted into nitrate by esters using fuming nitric acid in acetic anhydride²⁻⁵.

Benzyl 2-O-benzoyl- β -L-arabinopyranoside⁶ 1, treated with fuming nitric acid in acetic anhydride at -20° , gave benzyl 2-O-benzoyl-3,4-di-O-nitro- β -L-arabinopyranoside 2 (58%) and benzyl 2-O-benzoyl-4-O-nitro- β -L-arabinopyranoside 3 (3.2%). The isolation of 3, although in low yield, suggests that the axial OH-4 group in 1 is more reactive than the equatorial OH-3.

This behavior may be due, as has been pointed out^{7-9} , to intramolecular hydrogen-bonding between OH-4 and O-5, which would enhance the nucleophilic character of OH-4.

Treatment of **2** with sodium iodide in acetone^{10,11} afforded partial selective denitration¹⁰⁻¹² at O-3, with retention of configuration and without rearrangement, to give **3**. The structure of **3** was confirmed by its transformation into benzyl 2,3-di-*O*-benzoyl-4-*O*-nitro- β -L-arabinopyranoside **4** and the subsequent denitration of **4** to give benzyl 2,3-di-O-benzoyl- β -L-arabinopyranoside **5**, which was identical with the product previously described⁶. The structure of **5** was confirmed by its reaction with methanesulfonyl chloride to give benzyl 2,3-di-*O*-benzoyl-4-*O*-methylsulfonyl- β -L-arabinopyranoside⁶.

^{*} To whom correspondence should be addressed.

EXPERIMENTAL

General methods. — Melting points were determined with a Fisher–Johns apparatus and are uncorrected. T.1.c. was conducted on silica gel (Merck) with 5:5:0.1 (v/v) C_6H_6 –CHCl₃–Me₂CHOH. Column chromatography was performed on dry-packed silica gel (Davison) grade 923 (100–200 mesh) using the following developing solvents: 99:1 C_6H_6 –cyclohexane (A); $C_6H_6(B)$; 19:1 C_6H_6 –EtOAc (C) and 41:4 C_6H_6 –EtOAc (D). Optical rotations were measured with a Perkin–Elmer 141 polarimeter. I.r. spectra were recorded for Nujol mulls with a Perkin–Elmer 137-B Infracord spectrophotometer. ¹H-n.m.r. spectra (60 MHz) were recorded at 25° for solutions in pyridine- d_5 with a Varian A-60 spectrometer (internal Me₄Si).

Benzyl 2-O-benzoyl-3,4-di-O-nitro- β -L-arabinopyranoside (2). — A mixture of fuming HNO₃ (d 1.5, 3.2 mL) and Ac₂O (18 mL) was added dropwise to a suspension of benzyl 2-O-benzoyl- β -L-arabinopyranoside⁶ 1 (5 g) in Ac₂O (24 mL) at -20° . The mixture was kept at that temperature for 10 min. On pouring into cold water, a solid (6.1 g) separated. T.l.c. showed it to be a complex mixture, which was chromatographed on a column of dry silica gel. Fractions 9–12 (solvent A) and 13–43 (solvent B), R_F 0.80), were evaporated to dryness. The solid residue, recrystallized from EtOH, gave 2 (3.7 g, 58%); m.p. 123–124°, $[a]_p^{25} + 201^{\circ}$ (c 0.6, CHCl₃); ν_{max} 1700 (C=O), 1630, and 1275 cm⁻¹ (ONO₂); ¹H-n.m.r.: δ 6.4 (q, 1 H, $J_{3,4}$ 3, $J_{2,3}$ 10.5 Hz, H-3), 6.22 (m, 1 H, H-4), 5.76 (q, 1 H, H-2), 5.66 (d, 1 H, $J_{1,2}$ 3Hz, H-1), 4.88–4.67 (PhCH₂, $J_{A,B}$ 12 Hz), 4.38 (q, 1 H, $J_{5,5}$ 13.5, $J_{4,5}$ 1.5 Hz, H-5), and 4.34 (q, 1 H, $J_{4,5}$ 1.5 Hz, H-5').

Anal. Calc. for C₁₉H₁₈N₂O₁₀: C, 52.30; H, 4.30; N, 6.20. Found: C, 52.54; H, 4.18; N, 6.46.

Fractions 57–60 (solvent *C*) (R_F 0.50) were evaporated to a crystalline residue. Recrystallization from EtOH gave benzyl 2-*O*-benzoyl-4-*O*-nitro-β-L-arabinopyranoside 3 (0.18 g, 3.2%), m.p. 120–121°, $[a]_{D}^{25}$ + 191.0° (*c* 0.5, CHCl₃); v_{max} 3300 (O-H), 1720 (C=O), 1620, and 1280 cm⁻¹ (ONO₂); ¹H-n.m.r.: δ 5.93 (m, 1 H, H-4), 5.82 (q, 1 H, $J_{2,3}$ 10, $J_{1,2}$ 3.5 Hz, H-2), 5.58 (d, 1 H, H-1), 5.02 (q, 1 H, $J_{3,4}$ 3 Hz, H-3), 4.87–4.56 (PhC H_2 , $J_{A,B}$ 12 Hz), 4.26 (q, 1 H, $J_{5,5'}$ 13, $J_{4,5}$ 2 Hz, H-5), and 4.22 (q, 1 H, $J_{4,5'}$ 2 Hz, H-5').

Anal. Calc. for C₁₉H₁₉NO₈: C, 58.61; H, 4.92; N, 3.60. Found: C, 58.57; H, 5.04; N, 3.69.

Benzyl-2-O-benzoyl-4-O-nitro- β -L-arabinopyranoside (3). — A solution of 2 (2.5 g) in acetone (25 mL) containing NaI (5 g) was heated for 24 h at 100° in a sealed tube, and the residue obtained by evaporation extracted with CHCl₃ (3x10 mL). The extract, washed with aq. Na₂S₂O₃ and water, dried (Na₂SO₄), and evaporated afforded a solid which contained a main component (R_F 0.50). The solid was submitted to chromatography on a column of dry silica gel, (elution with C₆H₆-EtOAc mixtures of increasing polarity). The crystalline residue obtained by evaporation of fractions 11–15 (solvent *D*) was recrystallized from 90% EtOH to give 3 (1.2 g, 53.5%); [a]_D²⁵ + 190.7° (c 0.5, CHCl₃); m.p. and m.m.p. with 3 (previously obtained by nitration of 1) 120–121°. I.r. and ¹H-n.m.r. data confirmed that both products were identical.

Benzyl 2,3-di-O-benzoyl-4-O-nitro- β -L-arabinopyranoside (4). — To a solution of

3 (1.04 g) in pyridine (3.4 mL) cooled to -15° , BzCl (0.7 mL) was added dropwise. The mixture was kept for 2 h at 10°, and poured into ice–water whereupon the product crystallized slowly. Recrystallization from MeOH yielded 4 (1.19 g, 90%), m.p. 95–96°, $[a]_{D}^{25} + 211^{\circ}$ (*c* 0.6, CHCl₃); v_{max} 1705 (C = O), 1620, and 1270 cm⁻¹ (ONO₂); ¹H-n.m.r.: δ 6.51 (q, 1 H, $J_{3,4}$ 3.4, $J_{2,3}$ 10.5 Hz, H-3), 6.19 (m, 1 H, H-4), 6.03 (q, 1 H, H-2), 5.7 (d, 1 H $J_{1,2}$ 3.5 Hz, H-1), 4.93–4.65 (PhC H_2 , J_{AB} 12 Hz), 4.38 (q, 1 H, $J_{5,5}$ 13.5, $J_{4,5}$ 2 Hz, H-5), and 4.34 (q, 1 H, $J_{4,5'}$ 2 Hz, H-5').

Anal. Calc. for C₂₆H₂₃NO₉: C, 63.28; H, 4.70; N, 2.84. Found: C, 63.53; H, 4.98; N, 3.06.

Benzyl 2,3-di-O-benzoyl-β-L-arabinopyranoside (5). — To a solution of 4 (1.7 g) in AcOH (50 mL) a 1:1 iron–zinc mixture (5 g) was added with shaking until a reaction¹³ for nitrate was negative. The insoluble material was filtered off and washed with CHCl₃. The AcOH–CHCl₃ filtrate was successively washed with saturated NaHCO₃ and water, dried (Na₂SO₄) and evaporated to an oil, from which abs. EtOH was repeatedly evaporated until it crystallized. Recrystallization from the same solvent afforded 5 (1.0 g, 67%), m.p. 122–123°, $[a]_{D}^{25}$ + 205.7° (c 0.6, CHCl₃), lit.⁶ m.p. 122–123.5°, $[a]_{D}^{25}$ + 204° (c 0.55, CHCl₃). The 4-methanesulfonate was then obtained and its physical constants were coincident with those given in the literature⁶.

ACKNOWLEDGMENT

We thank Dr. E. G. Gros for helpful discussions of 'H-n.m.r. spectra.

REFERENCES

- 1 E. G. Gros, M. A. Ondetti, J. F. Sproviero, V. Deulofeu, and J. O. Deferrari, J. Org. Chem., 27 (1962) 924–929.
- 2 E. S. Bertiche, Thesis 1969, Departamento de Química Orgánica, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires.
- 3 J. Honeyman and J. W. W. Morgan, Adv. Carbohydr. Chem., 12 (1957) 117-135.
- 4 J. Honeyman and J. W. W. Morgan, Chem. & Ind., (1953) 1035.
- 5 G. O. Aspinall and G. Zweifel, J. Chem. Soc., (1957) 2271-2278.
- 6 T. Sivakumaran and J. K. N. Jones, Can. J. Chem., 45 (1967) 2493-2500.
- 7 K. W. Buck, A. B. Foster, A. R. Perry, and J. M. Webber, J. Chem. Soc., (1963) 4171-4177.
- 8 E. Lee and J. O. Wood, Carbohydr. Res., 89 (1981) 329-333.
- 9 Y. Kondo, Carbohydr. Res., 128 (1984) 175-181.
- 10 J. Honeyman and J. W. W. Morgan, J. Chem. Soc., (1955) 3660-3674.
- 11 H. Finkelstein, Ber., 43 (1910) 1528-1532.
- 12 A. H. Haines, Adv. Carbohydr. Chem. Biochem., 39 (1981) 13-70.
- 13 F. Feigl, Spot Tests in Organic Analysis, Elsevier Publishing Company, Amsterdam, 1966, pp. 302.