Introduction, Substitution, and Elimination of Bromine at C-5 of Aldopyranose Peresters

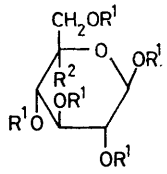
By ROBERT J. FERRIER* and PETER C. TYLER
(*Department of Chemistry, Victoria University, Private Bag, Wellington, New Zealand*)

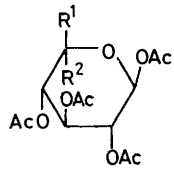
Summary Photochemical bromination of penta-*O*-benzoyl-β-D-glucopyranose and tetra-*O*-acetyl-β-D-xylopyranose gives crystalline products with bromine in the axial site at C-5; substitution and elimination products derived from these are reported.

FOLLOWING the observation[1] that treatment of pyranuronic acid derivatives with *N*-bromosuccinimide (NBS) in carbon tetrachloride under bright visible light leads to the introduction of bromine at C-5, we report that similar substitution occurs with some aldopyranose peresters. Bromine, in some instances, can be used with advantage as a brominating agent; it permits the isolated yield of methyl tetra-*O*-acetyl-5-*C*-bromo-β-D-glucopyranuronate to be increased from 68[1] to 90%.

Penta-*O*-acetyl-β-D-glucopyranose (**1**), in refluxing carbon tetrachloride containing bromine (2·5 mol equiv.) over a 275 W heat lamp for 1 h, was converted completely into a product which was more mobile on t.l.c. plates. ^{1}H n.m.r. spectroscopy indicated that substitution had occurred at C-5, and this was confirmed by conversion of the crude product into the known alkene[2] (**9**; 33% isolated) by stirring in acetic acid in the presence of zinc dust with copper(II) sulphate as catalyst. The corresponding pentabenzoate (**2**), under similar conditions, gave the bromo-derivative {**3**; m.p. 171—172 °C, $[\alpha]_D$ −12° (*c* 2, $CHCl_3$)}† in 77% yield. Absence of a resonance for H-5 in the ^{1}H n.m.r. spectrum and deshielding of C-5 and C-6 by *ca.* 20 and 4 p.p.m., respectively, in the ^{13}C n.m.r. spectrum revealed the site of substitution, the configuration at C-5 being assigned following the observation that the conformation of the ring remains $^4C_1$ ($J_{1,2}$ = 8 Hz), and this would not be expected to be so[3] had bromine entered at C-5 by a process which involved configurational inversion.

† All new compounds gave satisfactory elemental analyses.





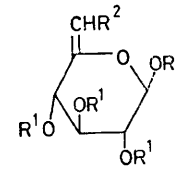
	R^1	R^2
(**1**);	Ac	H
(**2**);	Bz	H
(**3**);	Bz	Br

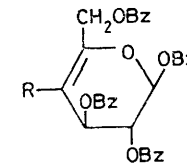
	R^1	R^2
(**4**);	H	H
(**5**);	H	Br
(**6**);	OMe	H
(**7**);	OAc	H
(**8**);	SAc	H

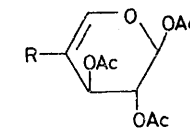
Applied to tetra-*O*-acetyl-β-D-xylopyranose (**4**), the reaction with NBS gave the crystalline bromo-compound {**5**; m.p. 135—140 °C, $[\alpha]_D$ −117° (*c* 1·8, $CHCl_3$)} in 46% yield. The ring conformation is again $^4C_1$ ($J_{1,2} = J_{2,3} = 8{\cdot}5$; $J_{3,4} = 9{\cdot}5$; $J_{4,5} = 4{\cdot}5$ Hz), and the configuration at C-5 follows from this last coupling constant. Consistent with the introduction of a second 'β-D' (*S*) anomeric centre, the product (**5**) is more levorotatory than its precursor (**4**). Likewise, the bromo-derivative (**3**) is more levorotatory than compound (**2**).

As derivatives of glycopyranosyl halides (also of aldulose and dialdose cyclic hydrates) the halogenated compounds (**3**) and (**5**) readily undergo displacement of bromine. Methanolysis of the latter in the presence of silver oxide gave the 'glycoside' {**6**; m.p. 117—119 °C, $[\alpha]_D$ + 16° (*c* 2, $CHCl_3$), 60%; $J_{1,2} = 6{\cdot}5$, $J_{4,5} = 5{\cdot}5$ Hz}, acetolysis gave the achiral penta-acetate (**7**; m.p. 155—157 °C, 58%), and treatment with potassium thioacetate, the thiosugar peracetate {**8**; m.p. 146—147 °C, $[\alpha]_D$ −13·5°, (*c* 2, $CHCl_3$), 23%}. Substitution reactions with the hexose compound (**3**) were complex, the methanolysis product being a mixture of three main components. Hydrolysis in the presence of silver oxide, however, proceeded smoothly to give the cyclic hydrate of 2,3,4,6-tetra-*O*-benzoyl-D-*xylo*-hexos-5-ulose which could be ring-opened to the dicarbonyl compound by heating in refluxing benzene for 8 h with removal of the liberated water.

Attempts to introduce iodide and thioacetate groups by treating the bromide (**3**) with sodium iodide in refluxing acetone and sodium thioacetate in *NN*-dimethylformamide led to the alkene {**10**; m.p. 227—228 °C, $[\alpha]_D$ + 79° (*c* 2·4, $CHCl_3$), 11 and 22%, respectively} as the only isolated product. The other alkenes derivable from compound (**3**) were obtained by orthodox methods. Treatment with 1,5-diazabicyclo[5.4.0]undec-5-ene (DBU) gave the endocyclic compound {**12**; m.p. 72—74 °C, $[\alpha]_D$ + 29° (*c* 2, $CHCl_3$), 65%}, whereas stirring with zinc in acetic acid gave directly the exocyclic alkene {**11**; m.p. 129—131 °C, $[\alpha]_D$ −8° (*c* 4, $CHCl_3$), 67%}, with the syrupy isomer {**13**; $[\alpha]_D$ −34° (*c* 3, $CHCl_3$), 11%} being isolated by preparative t.l.c. From the xylose product (**5**), the glycal derivatives {**14**; m.p. 113—114 °C, $[\alpha]_D$ + 7° (*c* 2, $CHCl_3$), 45%} and {**15**; m.p. 97—98 °C, $[\alpha]_D$ + 18° (*c* 2, $CHCl_3$), 46%} were obtained on treatment with DBU and with zinc-acetic acid, respectively.







	R^1	R^2
(**9**);	Ac	H
(**10**);	Bz	OBz
(**11**);	Bz	H

	R
(**12**);	OBz
(**13**);	H

	R
(**14**);	OAc
(**15**);	H

Penta-*O*-benzoyl-α-D-glucopyranose and -β-D-galactopyranose do not readily give discrete products of photobromination; the applicability of the bromination reaction, and further aspects of compounds derived by its use are under investigation.

We thank the N.Z. University Grants Committee for the award of a Postgraduate Scholarship (to P.C.T.) and Dr. R. H. Furneaux for assistance at the commencement of this work.

(*Received*, 30*th August* 1978; *Com.* 936.)

[1] R. J. Ferrier and R. H. Furneaux, *J.C.S. Perkin I*, 1977, 1996.
[2] B. Helferich and E. Himmen, *Ber.*, 1928, **61**, 1825.
[3] H. Paulsen, H. Köster, and K. Heyns, *Chem. Ber.*, 1967, **100**, 2669.