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Preliminary communication

Synthesis of 1,2-*O*-(1-cyanoalkylidene) sugar derivatives

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In a recent synthesis of gentiobiose octa-acetate[1], the cyanoethylidene derivative **1a** was used as a β-glucosylating agent. Tritylated cyanoethylidene derivatives of D-glucose[2] and maltose[3] have been subjected to stereo- and regio-specific polycondensations. Few cyanoethylidene derivatives have been described.

Treatment of tetra-*O*-acetyl-α-D-glucopyranosyl or hepta-*O*-acetyl-α-maltosyl bromide with silver cyanide in boiling xylene for 1 h afforded peracetylated derivatives of 1,2-*O*-(1-cyanoethylidene)-α-D-glucose[4] and -α-maltose[5] in yields of 53 and 35%, respectively, but up to 20% of glycosyl isocyanides were formed simultaneously[6]. The reaction of benzoylated D-arabinofuranosyl halides with sodium cyanide in nitromethane at room temperature for 3 days gave 32–36% of 3,5-di-*O*-benzoyl-1,2-*O*-(1-cyanobenzylidene)-β-D-arabinofuranose[7].

We now report a convenient procedure for the synthesis of the title compounds by treatment of acylated 1,2-*cis*- and 1,2-*trans*-glycosyl bromides with potassium cyanide in acetonitrile at room temperature for 12–24 h.

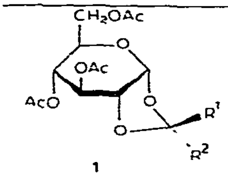
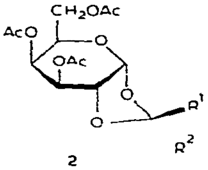
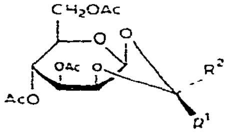
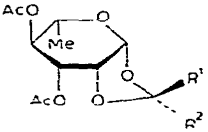
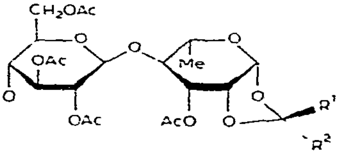
In a typical experiment, for a glycosyl bromide in which the substituents at positions 1 and 2 are *cis*, a solution of tetra-*O*-acetyl-α-D-galactopyranosyl bromide (2.05 g, 5 mmol) in dry acetonitrile (15 ml, freshly distilled from CaH_2) was stirred with dry potassium cyanide (1.63 g, 25 mmol) and tetrabutylammonium bromide (750 mg, 2.5 mmol) for 15 h. The mixture was then diluted with ethyl acetate (150 ml), washed with water (7 X 50 ml), and concentrated to dryness. A solution of the residue in chloroform–light petroleum (1:2, 100 ml) was passed through a bed of silica gel to yield **2ab** [1.69 g, 95%; *endo,exo* ratio 2.8 : 1, determined by p.m.r. spectroscopy (intensities of C-Me signals)], which was fractionated by chromatography on silica gel (elution with benzene→ether). The use of tetrabutylammonium iodide, instead of the bromide, gave 91% of **2ab**.

In a similar manner, tetra-*O*-acetyl-α-D-glucopyranosyl bromide gave 91% of **1ab** (*endo,exo* ratio 1.9 : 1) and hepta-*O*-acetyl-α-maltosyl bromide afforded 73% of 3,6-di-*O*-acetyl-1,2-*O*-(1-cyanoethylidene)-4-*O*-(2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosyl)-α-D-glucopyranose[5].

For the synthesis of 1,2-*O*-cyanoalkylidene derivatives from glycosyl bromides with the substituents at positions 1 and 2 *trans*, the quaternary ammonium salt was omitted.

TABLE I

1,2-O-(1-CYANOALKYLIDENE) SUGAR DERIVATIVES

Compound		R^1	R^2	M.p. (degrees)	$[\alpha]_D^{20}$ (degrees)[a]	P.m.r. data ($CDCl_3$: δ scale)		
						H-1 ($J_{1,2}$ Hz)	OAc	$>C(CN)Me$
 1	a	CN	Me	77 78	+13 6	5 76 (5)	2.07(×2), 2.10	1.90
	b	Me	CN	74–75	+108	5.68 (5)	2.06(×3)	1.75
 2	a	CN	Me	syrup	+92 7	5.88 (5)	2 06(×2), 2 11	1 85
	b	Me	CN	116–118	+114	5.72 (5)	2 06(×2), 2 09	1 76
 3	a	CN	Me	154–155	+2.7	5.42 (2)	2 00(×2), 2 06	1.86
	b	Me	CN	161–162	−74	5.58 (2)	2.07,2.10, 2.13	1 82
 4	a	CN	Me	147–149	+7	5.44 (2)	2 06,2.10	1.90
	b	Me	CN	125–127	+88 5	5 58 (2)	2 07,2 10	1 80
 5	a	CN	Me	230 232	+31.7	5.42 (2)	2 02(×2), 2.04,2 08, 2 24	1 90
	b	Me	CN	190–192	−11.4	5 54 (2)	2 02(×2), 2 06(×2), 2.10	1.80

[a] In chloroform

In a typical procedure, tetra-*O*-acetyl-D-mannopyranosyl bromide [from D-mannose penta-acetate (1.95 g, 5 mmol) by conventional treatment with HBr–HOAc–Ac_2O] was treated with potassium cyanide (1.63 g, 25 mmol) in acetonitrile (15 ml) for 20 h. The mixture was then diluted with chloroform (100 ml), washed with water (5 × 50 ml), passed through a bed of silica gel, and concentrated to yield a syrupy mixture (1.8 g) of **3ab** (*endo,exo* ratio of C-Me groups, 4 : 1). Crystallisation from methanol (20 ml) afforded 63% of the *endo*-isomer **3a**, and the *exo*-isomer **3b** was isolated by chromatography of the material in the mother liquor.

In a similar manner, L-rhamnose tetra-acetate was converted into a 6 : 1 mixture of the *endo* and *exo* isomers (**4a** and **4b**), from which **4a** (62%) was isolated by crystallisation and **4b** by chromatography, and scillabiose hepta-acetate[8] was converted into a 2.5 : 1 mixture of *endo* and *exo* isomers (**5a** and **5b**) that were isolated by crystallisation and chromatography. Methyl 2,3,5-tri-*O*-benzoyl-α-L-arabinofuranoside was converted[9] into the glycosyl bromide, which, without purification, was treated with potassium cyanide in acetonitrile for 12 h to yield 49% of 3,5-di-*O*-benzoyl-1,2-*O*-(1-cyanobenzylidene)-β-L-arabinofuranose, m.p. 150–152° (from ethanol), $[\alpha]_D^{20}$ +16.8° (*c* 1.32, chloroform); *cf* m.p. 151°, $[\alpha]_D^{23}$ −20.3° for the D isomer[7].

The Raman spectra of all the derivatives in Table I exhibited absorptions for nitrile at 2230–2240 cm^{-1}, their intensities being higher than those of carbonyl groups. Assignment of the C-Me groups to *exo* or *endo* positions was based on the relative chemical shifts, by analogy with the corresponding 1,2-alkoxyethylidene derivatives[10,11].

REFERENCES

1 A. F Bochkov and N. K. Kochetkov, *Carbohydr. Res.*, 39 (1975) 355–357.

2 A. F. Bochkov, I. V. Obruchnikov, V. M. Kalinevich, and N K. Kochetkov, *Tetrahedron Lett* , (1975) 3403–3407.

3 I. V. Obruchnikov and N. K. Kochetkov, *Izv Akad Nauk SSSR, Ser Khim* , (1977) 2574–2578

4 B Coxon and H. G Fletcher, Jr , *J. Am Chem Soc.*, 85 (1963) 2637–2642.

5 I. V. Obruchnikov and N. K. Kochetkov, *Izv. Akad Nauk SSSR, Ser. Khim* , (1977) 2571–2573

6 M Martin-Lomas and M E. Chacon-Fuertes, *Carbohydr. Res* , 59 (1977) 604–606.

7 G. Barnathan, T. H. Dinh, A. Kolb, and J. Igolen, *Eur. J Med Chem Chim Ther.*, 11 (1976) 67–72.

8 V. I. Torgov and A. Ya. Chernyak, *Izv Akad. Nauk SSSR, Ser. Khim* , (1975) 455–458

9 H G. Fletcher, Jr , *Methods Carbohydr. Chem.*, 2 (1963) 228–230.

10 N K Kochetkov and A. F. Bochkov, *Recent Developments in the Chemistry of Natural Carbon Compounds*, Vol 4, Akademia Kiado, Budapest, 1972, pp. 113–114

11 J. A. Heitman, G. F. Richards, and L R Schoeder, *Acta Crystallogr , Sect B*, 30 (1974) 2322–2328.