Reactions of Sugar 1-Carbonates with Sugar Derivatives Bearing a Hydroxy-group; Novel Method for Preparation of Orthoesters Combining Two Monosaccharide Units, and Disaccharides[1]

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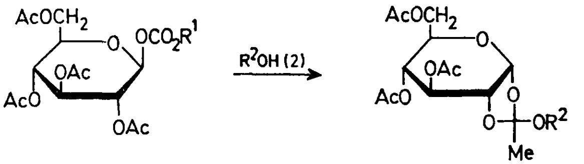
Summary 2,3,4,6-Tetra-*O*-acetyl-β-D-glucopyranose 1-carbonates (**1**) and (**4**) react with 1,2,3,4-tetra-*O*-acetyl-β-D-glucopyranose (**2**) to give 3,4,6-tri-*O*-acetyl-α-D-glucopyranose 1,2-(1,2,3,4-tetra-*O*-acetyl-6-deoxy-β-D-glucopyranos-6-anyl)orthoacetate whereas 2,3 : 5,6-di-*O*-isopropylidene-α-D-mannofuranose 1-carbonates (**7**) and (**8**) react with (**2**) to afford 1,2,3,4-tetra-*O*-acetyl-6-*O*-(2,3 : 5,6-di-*O*-isopropylidene-α-D-mannofuranosyl)-β-D-glucopyranose (**9**).

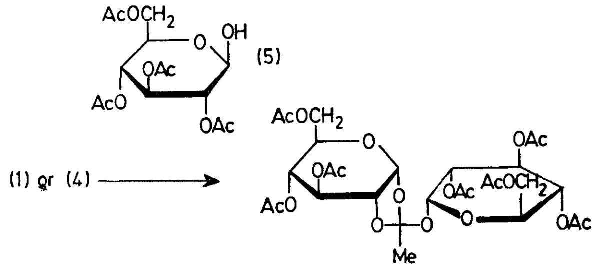
ORTHOESTERS combining two monosaccharide units have been prepared by the reaction of polyacylglycosyl halides with sugar derivatives bearing a hydroxy-group, in the presence of silver salts such as silver salicylate,[2a] and/or the acid-catalysed transformation of sugar 1,2-alkylorthoacylates.[2b] Now we describe a novel method for the preparation of monosaccharide orthoesters involving the fusion of sugar 1-carbonates with sugar derivatives bearing a hydroxy-group; this is an extension of the new glycosylation reaction[3] which involves autocatalytic reaction of sugar



(1) R^1 = Ph

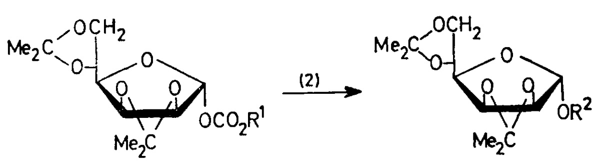
(4) R^1 = CH_2CCl_3

(3)



(5)

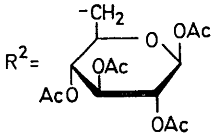
(6)



(7) R^1 = Ph

(8) R^1 = CH_2CCl_3

(9)



1-*O*-aryloxycarbonyl derivatives with a variety of nucleophiles.

Fusion of the carbonate[3] (**1**) (2·0 mmol) with the glucopyranose (**2**) (2·2 mmol) at 160—170 °C for 90 min *in vacuo*, followed by chromatography on a silica gel column (with $CHCl_3$ as eluant), gave a syrup of the orthoacetate (**3**); 65% yield after recrystallization from EtOH, m.p. 133—134 °C, $[\alpha]_D^{22}$ + 30° (*c* 1·0, $CHCl_3$) {lit.,[2b] m.p. 137—138 °C, $[\alpha]_D$ +39° (*c* 1, $CHCl_3$)}; ^{1}H n.m.r.: δ 1·67 (3H, CMe). When the reaction was performed in phenol (6 mmol) at 110—115 °C under atmospheric pressure for 2 h (**3**) was obtained in 78% yield.

In view of the stereochemical bulkiness and pK_a value (*ca.* 12) of 2,2,2-trichloroethyl alcohol we also studied the reaction of the carbonate (**4**)† with (**2**) (1·15 mmol) at 175 °C for 40 min *in vacuo*; chromatography of the resulting mixture gave (**3**) in 80% yield. Similarly, fusion of (**1**) with the glucopyranose (**5**) at 175—180 °C for 50 min *in vacuo* and fusion of (**4**) (0·5 mmol) with (**5**) (0·63 mmol) at 130 °C for 3 h *in vacuo* gave the orthoacetate (**6**)‡ {$[\alpha]_D^{22}$ +79° (*c* 1·0, $CHCl_3$)} in 38 and 24% yields, respectively; the reaction of (**4**) and (**5**) also gave the corresponding β-D-glucopyranosylorthoacetate‡§ {$[\alpha]_D^{22}$ +12° (*c* 1·2, $CHCl_3$)} (35% yield) and 2,2,2-trichloroethylorthoacetate‡§ (13% yield).

Furthermore, the reactions of compounds (**7**)† and (**8**)† with (**2**) were similarly studied since they should exert no anchimeric effect on their anomeric centre. Compound (**7**), in contrast with the previous reactions, gave as expected the disaccharide (**9**) (48% yield) as well as phenyl 2,3:5,6-di-*O*-isopropylidene-α-D-mannofuranoside (23%), while (**8**) gave (**9**) in 59% yield.¶

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† These were prepared by the reaction of the corresponding 1-OH sugar derivatives [*cf.* R. U. Lemieux, 'Methods in Carbohydrate Chemistry,' eds. R. L. Whistler and M. L. Wolfrom, Academic Press, New York and London, 1963, vol. 2, pp. 221—222, and P. Z. Allen, *ibid.*, 1962, vol. 1, pp. 372–373 for (**1**) and (**4**); O. Th. Schmidt, *ibid.*, 1963, vol. 2, p. 319 for (**7**) and (**8**)] with phenyl or 2,2,2-trichloroethyl chloroformate-pyridine: (**1**) (54% yield from D-glucose in 3 steps); (**4**) (54% yield from D-glucose in 3 steps) {m.p. 130 °C, $[\alpha]_D^{22}$ −3 ° (*c* 1·0, $CHCl_3$)}; (**7**) (78% yield from D-mannose in 2 steps) {m.p. 84–86 °C, $[\alpha]_D^{22}$ +79° (*c* 1·0, $CHCl_3$)}; (**8**) (82% yield from D-mannose in 2 steps) {m.p. 114—115 °C, $[\alpha]_D^{22}$ +48 °C (*c* 1·0, $CHCl_3$)}.

‡ Satisfactory elemental analyses, and ^{1}H and ^{13}C n.m.r. spectra were obtained.

§ The differences between the reactions of (**1**) and (**4**) with (**5**) are now under investigation. Detailed results will be reported elsewhere.

¶ Reactions of sugar derivatives with non-participating protecting groups other than isopropylidene groups are also under investigation.

[1] The present work was partly presented at the VIIIth International Symposium on Carbohydrate Chemistry (Aug. 1976, Kyoto, Japan). See also Y. Ishido, H. Tsutsumi, and S. Inaba, *J.C.S. Perkin I*, in the press.

[2] (a) G. Wulff and W. Krüger, *Carbohydrate Res.*, 1971, **19**, 139; (b) N. K. Kochetkov, A. J. Khorin, and A. F. Bochkov, *Tetrahedron*, 1967, **23**, 693.

[3] S. Inaba, M. Yamada, T. Yoshino, and Y. Ishido, *J. Amer. Chem. Soc.*, 1973, **95**, 2062.