Note

1',4': 3',6'-Dianhydrosucrose

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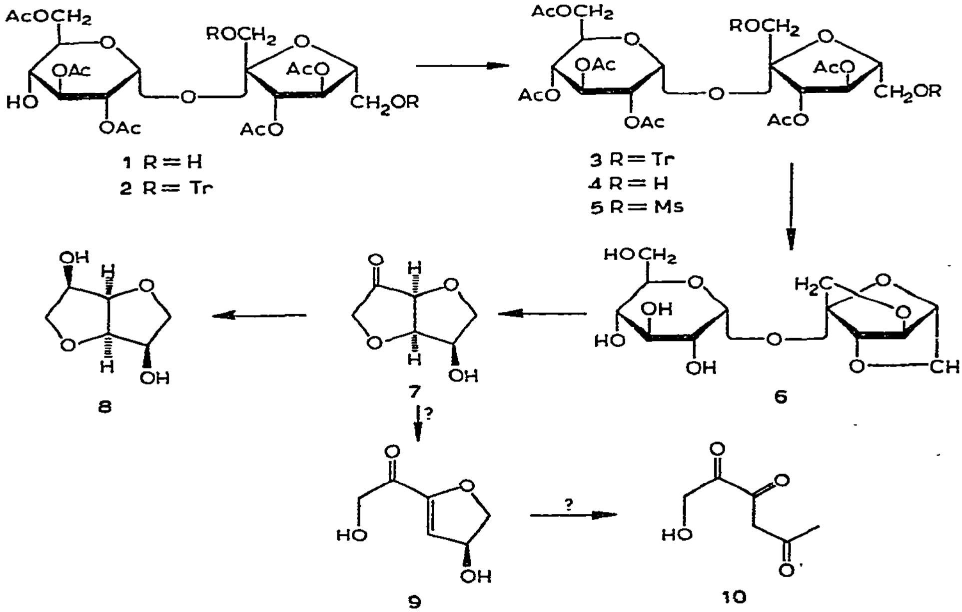
During a study of the chemical synthesis of sucrose 6'-phosphate[1], we examined the tritylation of the sucrose penta-acetate[2] **1** by means of triphenylmethyl chloride in pyridine. Monomolar tritylation was shown to yield preferentially a 6'-trityl ether[1]. Bredereck and his co-workers[3] showed that dimolar tritylation gave a crystalline ditrityl ether, presumably **2**. When we repeated this reaction under similar conditions, and added acetic anhydride to the reaction mixture after tritylation, we isolated the crystalline hexa-acetate **3** in 55% yield. Detritylation by means of aqueous acetic acid afforded the crystalline hexa-acetate **4**, which may have value as an intermediate for the preparation of sucrose derivatives of known structure.

In order to prove the structure of **4**, it was treated with methanesulphonyl chloride in pyridine. The resulting syrupy product, presumably **5**, was treated directly



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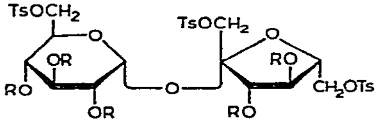
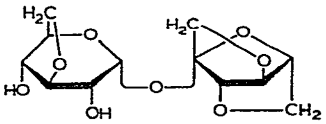
with sodium methoxide in methanol to yield the crystalline dianhydride **6** (49% from **4**). When **6** was subjected to acid hydrolysis, and the product examined by paper chromatography, glucose and an unknown sugar of high R_F value could be detected, but no fructose. Reduction of the hydrolysate with sodium borohydride yielded mainly D-glucitol and 1,4:3,6-dianhydro-D-mannitol (**8**), identified as crystalline derivatives after purification by preparative, paper chromatography. Lemieux has pointed out[4] that the 1′,4′:3′,6′-dianhydrofructofuranose ring, as in **6**, is highly strained. Consequently, **6** is very labile towards acid and the dianhydrofructose produced is likely to be in the bicyclic form **7**, rather than tricyclic. Reduction of **7** with borohydride would be expected to proceed from the *exo* direction to yield the *manno*-dianhydride **8**; none of the isomeric 1,4:3,6-dianhydro-D-glucitol was detected by chromatography. Two minor, unidentified products were observed in the borohydride-reduction product. These may have been derived from compounds, *e.g.* **9** and **10**, arising by alkaline degradation of the dianhydrofructose **7**.

There has been renewed interest in the chemistry of anhydro derivatives of sucrose, with the preparation of 3,6:1′,4′:3′,6′-trianhydrosucrose (**13**) by alkaline treatment of the tritoluene-*p*-sulphonate[5] **11**, a result in keeping with the formation of **6** from **5**. The structure of **13** was determined by X-ray crystallography. On the other hand, the unacetylated sulphonate **12** yields the trianhydride **14** on similar treatment[6,7]. Of the two possible explanations offered by the Australian workers, the first, that the trianhydride **14** arose from an isomer of **12**, is apparently ruled out by Lemieux's later evidence[7]. Before accepting the second, that the *O*-acetyl groups exert a conformational influence on the course of the reaction, we feel that further experimental work is required.



11 R = Ac
12 R = H



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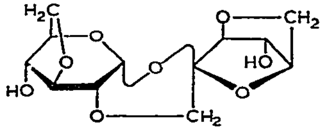

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EXPERIMENTAL

General procedures are described in Ref. 1. Paper chromatography was carried out with butyl alcohol–pyridine–water (3:1:1, v/v) as irrigant.

2,3,4,6,3′,4′-Hexa-O-acetyl-1′,6′-di-O-tritylsucrose (**3**). — The sucrose pentaacetate[1,2] **1** (890 mg) and chlorotriphenylmethane (860 mg, 1.9 molar equiv.) were dissolved in dry pyridine (7 ml), and the solution was heated at 100° for 20 h. When the mixture had cooled to room temperature, a mixture of acetic anhydride (10 ml) and pyridine (5 ml) was added, and the whole was kept at 4° overnight. Water (0.5 ml) was added, with cooling, and after 30 min the mixture was poured into iced water (100 ml). The precipitated solid was filtered off, washed with water, and dried *in vacuo*.

A benzene solution of the product (2 g) was chromatographed on neutral silica gel (100 g). Benzene–ether (97:3) eluted a compound which was possibly a tritrityl ether. Benzene–ether (94:6) eluted material which was crystallised from ethanol to give the ditrityl ether **3** (939 mg, 55%), m.p. 95–98°, $[\alpha]_D$ +65.3° (*c* 0.53, chloroform) (Found: C, 69.1; H, 6.1. $C_{62}H_{62}O_{17}$ calc.: C, 69.0; H, 5.8%). It was homogeneous on t.l.c. in benzene–ether (1:1).

*2,3,4,6,3′,4′-Hexa-*O*-acetylsucrose* (**4**). — The trityl ether **3** (765 mg) was dissolved in aqueous acetic acid (80% v/v, 25 ml) and kept at 65° for 3 h. The solvent was evaporated to dryness at 50° and the residue crystallised from ether. T.l.c. (ether) showed that the product contained triphenylmethanol, which was removed by virtue of its insolubility in hot water. The pure hexa-acetate **4** crystallised from water and had m.p. 103–104°. Recrystallisation from ether gave a higher-melting form, m.p. 132°, and all subsequent preparations had this m.p. The yield of **4** was 300 mg (71%), $[\alpha]_D$ +40.1° (*c* 2.07, chloroform) Found: C, 48.7; H, 5.7. $C_{24}H_{34}O_{17}$ calc.: C, 48.5; H, 5.7%).

1′,4′:3′,6′-Dianhydrosucrose (**6**). — The sucrose hexa-acetate **4** (200 mg) was dissolved in pyridine (4 ml), and methanesulphonyl chloride (0.5 ml) was added. The solution was kept at −15° for 5 h. More acid chloride (0.5 ml) was added, and after a further 1 h, the product was isolated by using chloroform. The resulting syrup, presumably the impure sulphonate **5**, was immediately dissolved in methanol (25 ml) containing sodium methoxide (from 100 mg of sodium) and heated under reflux for 2 h. The solution was cooled, neutralised (CO_2), and evaporated to dryness. The residue was dissolved in water, and the solution was passed through a column of Dowex-50 (NH_4^+) resin. Ammonia was removed by concentration of the eluate and washings. The resulting solution was passed through a column of Dowex-2 (HCO_3^-) resin, and the eluate was evaporated to dryness. The solid residue was recrystallised from ethanol to give the dianhydride **6** (88 mg, 49%), m.p. 184–185° (Found: C, 46.7; H, 6.2. $C_{12}H_{18}O_9$ calc.: C, 47.1; H, 5.9%). Paper chromatography, using periodate–Schiff's reagent[8] for detection, showed only one spot, R_F 0.17 (*cf.* sucrose, R_F 0.07). Examination of the crystallisation mother-liquors by paper chromatography showed only the presence of **6**.

Acid hydrolysis of 1′,4′:3′,6′-dianhydrosucrose (**6**). — The dianhydride **6** (85 mg) was dissolved in 10mM hydrochloric acid (8 ml) and kept at room temperature for 6 h. Paper chromatography, using aniline hydrogen phthalate[9] as spray reagent, showed the presence of glucose and a compound of much higher R_F value, which streaked on the chromatogram. Sodium borohydride (100 mg) was added slowly to the solution (final pH, alkaline), and the mixture was left at room temperature overnight. After neutralisation with acetic acid, the solution was evaporated to dryness and the residue dissolved in water. The solution was passed through a column of Dowex-50 (NH_4^+) resin, and the eluate evaporated to dryness. Borate was removed as methyl borate by distillation several times with methanol. The residue was dissolved in water and the solution passed through a column of Dowex-2 (HCO_3^-) resin. The eluate was evaporated to dryness, leaving a residue (90 mg) which was examined by paper chromatography. Periodate and Schiff's reagent[8] showed the presence of D-glucitol and two minor products. Acid permanganate[10] showed the same three compounds, together with 1,4:3,6-dianhydro-D-mannitol (**8**). No 1,4:3,6-dianhydro-D-glucitol, the R_F value of which is greater than that of **8**, could be detected.

The reduced hydrolysate above was subjected to preparative, paper chromatography on Whatman 3MM paper. The bands were located by means of acid permanganate[10]; the appropriate areas of paper were cut out, and the compounds were eluted with water. D-Glucitol was obtained as a syrup (25 mg) and identified as the hexa-acetate, m.p. 98–100°, indistinguishable from an authentic sample (mixed m.p., i.r. spectrum). 1,4:3,6-Dianhydro-D-mannitol (**8**) was isolated as a syrup (18 mg) which was converted, by means of toluene-*p*-sulphonyl chloride and pyridine, into the 2,5-ditoluene-*p*-sulphonate, m.p. 89–90°. It was identical (mixed m.p., i.r. spectrum) with an authentic sample[11].

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