586. *The Conversion of Mannitol and Sorbitol into Dulcitol.*

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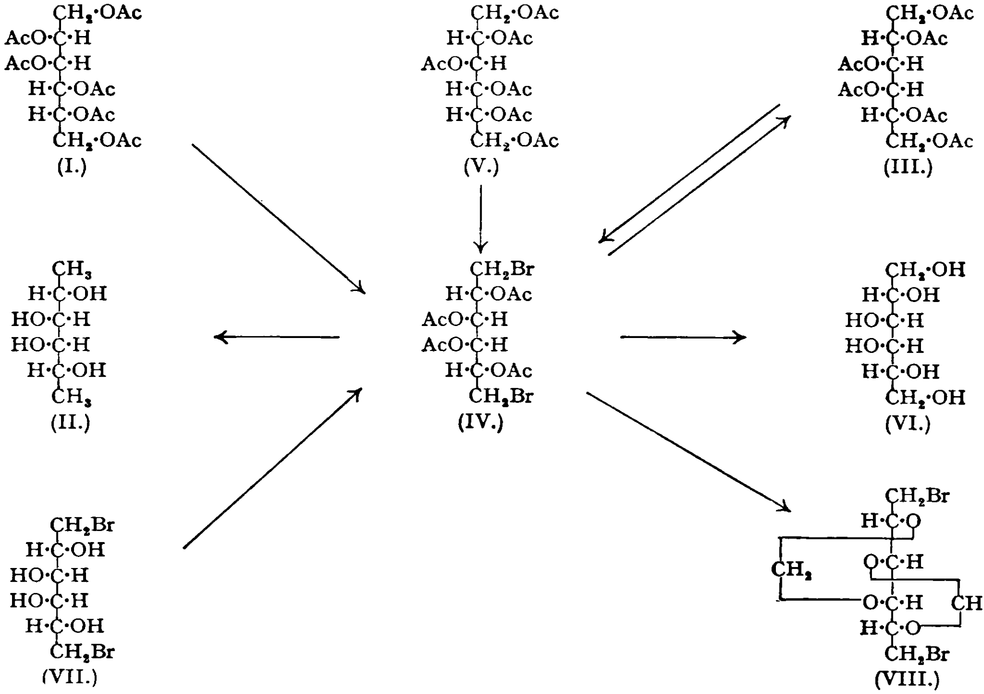
The compound described by Vogel (*Ber.*, 1938, **71**, 1272) as 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dibromo-1 : 6-dideoxymannitol, obtained by the action of hydrogen bromide in acetic acid on hexa-acetyl mannitol, is shown to be 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dibromo-1 : 6-dideoxydulcitol; the same product is obtained, under similar conditions, from hexa-acetyl sorbitol and from hexa-acetyl dulcitol. The 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dichloro-1 : 6-dideoxymannitol of Fischer and Armstrong (*Ber.*, 1902, **35**, 842), prepared by treatment of hexa-acetyl mannitol with hydrogen chloride, is 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dichloro-1 : 6-dideoxydulcitol. Vogel's dibromide is also obtained from dulcitol by transformation into 1 : 6-dibromo-1 : 6-dideoxydulcitol followed by acetylation under mild conditions. Further confirmation of its formulation as a dulcitol derivative is obtained by hydrolysis with dilute hydrobromic acid, dulcitol itself being formed.

By the action of hydrogen bromide in acetic acid on hexa-acetyl mannitol for several months at room temperature, Vogel (*loc. cit.*) obtained a crystalline compound, m. p. 201°, $[\alpha]_D^{20}$ $+10{\cdot}26°$ (in chloroform), to which he assigned the structure 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dibromo-1 : 6-dideoxymannitol. Evans, Fraser, and Owen (*J.*, 1949, 248), by reaction of this dibromide with potassium thiolacetate, obtained a product, m. p. 188°, which was accordingly formulated as hexa-acetyl 1 : 6-dithiomannitol; on deacetylation, the corresponding dithiohexitol, m. p. 172°, was formed. Subsequently (Bladon and Owen, *J.*, 1950, 585) 1 : 6-dithiomannitol was synthesised by a different route, and was found to have m. p. 155—157°, $[\alpha]_D$ $+15°$ (in 2·9% aqueous borax); its hexa-acetyl derivative had m. p. 109—111°, $[\alpha]_D$ $+85°$. Re-examination of the earlier specimens of dithiol and hexa-acetyl derivative confirmed their melting-points and also showed that they were optically inactive. It followed that they could not have the structures originally assigned to them. Since it was unlikely that any abnormal reaction had occurred in the replacement of bromine atoms by acetylthio-groups, it was evident that Vogel's dibromide could not be a mannitol derivative.

The dibromide was prepared both by Vogel's method and also by the more convenient process in which a mixture of hexa-acetyl mannitol (I) and 50% hydrogen bromide in acetic acid is warmed for several hours (compare Evans, Fraser, and Owen, *loc. cit.*). When hydrogenated over Raney nickel it gave, after re-acetylation (some deacetylation having occurred during the hydrogenation), a tetra-acetyl 1 : 6-dideoxyhexitol, m. p. 182—184°, and thence, by deacetylation, a 1 : 6-dideoxyhexitol, m. p. 179—180°, which gave a di*iso*propylidene derivative, m. p. 61°. All these compounds were optically inactive, and the properties of the last two were in good agreement with those recorded by Ness, Hann, and Hudson (*J. Amer. Chem. Soc.*, 1942, **64**, 984) for 1 : 6-dideoxydulcitol (II) and its di*iso*propylidene derivative (m. p.s 183—184° and 63—64° respectively). Furthermore, on reaction with potassium acetate in acetic acid–acetic anhydride solution, the dibromide gave hexa-acetyl dulcitol (III) in excellent yield. Vogel's compound is therefore 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dibromo-1 : 6-dideoxydulcitol (IV) and must be identical with the substance, m. p. 197—198°, obtained by Wolfrom, Burke, and Waisbrot (*ibid.*, 1939, **61**, 1827) by the action of hydrogen bromide in acetic acid on 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-bistriphenylmethyl dulcitol. The optical rotation recorded by Vogel is erroneous; the dibromide, and all the compounds derived from it, are optically inactive, in conformity with the possession of the dulcitol structure.

It follows that the original thio-compounds, derived from this dibromide, are 1 : 6-dithiodulcitol and its hexa-acetyl derivative. De-sulphurisation of the dithiol in aqueous solution with Raney nickel (compare Mozingo *et al.*, *J. Biol. Chem.*, 1942, **146**, 475; *J. Amer. Chem. Soc.*, 1943, **65**, 1013), and acetylation of the product, gave tetra-acetyl 1 : 6-dideoxydulcitol identical with that obtained by hydrogenation of the dibromide.



In order to eliminate the very unlikely possibility that the commercial mannitol used in these experiments contained any appreciable quantity of dulcitol, a specimen of mannitol was rigorously purified by conversion into, and regeneration from, its tri*iso*propylidene derivative. The pure hexa-acetyl mannitol derived from this material gave, with hydrogen bromide in acetic acid, the same dulcitol derivative (IV), characterised by conversion into hexa-acetyl dulcitol. There can therefore be no doubt that a change of configuration occurs during the reaction.

As a consequence of these surprising results, it appeared that the compound, m. p. 196°, obtained by the action of hydrogen bromide in acetic acid on hexa-acetyl sorbitol (V) (Evans, Fraser, and Owen, *loc. cit.*), was probably identical with (IV). The preparation was repeated, and the identity was confirmed by conversion of the product into hexa-acetyl dulcitol. The same dibromide was also obtained by similar means from hexa-acetyl dulcitol itself. Evans, Fraser, and Owen (*loc. cit.*) showed that the liquid portion of the reaction product from hexa-acetyl mannitol and hydrogen bromide in acetic acid contained a higher proportion of bromine, and by carrying out the reaction at 100° isolated a pentabromo-acetoxy-hexane, m. p. 138°, probably identical with that of Perkin and Simonsen (*J.*, 1905, **87**, 862). It has now been shown that the same, optically inactive, product is obtained when (IV) is similarly treated, though this, of course, does not prove that the pentabromide also has the dulcitol configuration.

By reaction of liquid hydrogen chloride on hexa-acetyl mannitol, Fischer and Armstrong (*loc. cit.*) obtained a compound, m. p. 214°, which was formulated as 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dichloro-1 : 6-dideoxymannitol. A compound having this structure, but with m. p. 128—130°, was prepared by Griner (*Ann. Chim.*, 1892, [vi], **26**, 380) by acetylation of 1 : 6-dichloro-1 : 6-dideoxymannitol, the structure of which has been well established (Haworth, Heath, and Wiggins, *J.*, 1944, 155) as a true mannitol derivative. In view of the results of the investigation of the dibromide, it appeared that Fischer and Armstrong's compound was probably 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dichloro-1 : 6-dideoxydulcitol; this proved to be so, since it gave hexa-acetyl dulcitol on treatment with potassium acetate.

The above investigations were carried out by two of us (Bladon and Owen), but similar conclusions with regard to the allocation of the structure 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dibromo-1 : 6-dideoxydulcitol to Vogel's dibromide have been reached independently (Overend and Wiggins). It was found that both bromine atoms were readily replaced by iodine, through the reaction of the compound with sodium iodide in acetone or acetic anhydride solution, with the formation of a di-iodo-dideoxyhexitol tetra-acetate (*A*). Thus, the indication that the bromine atoms are attached to primary carbon atoms is given. The acetyl groups could also be replaced by two methylene residues by treatment with paraformaldehyde and sulphuric acid, a dimethylene dibromodideoxyhexitol (*B*), m. p. 144—145°, being isolated. Both this and the Vogel dibromide itself were different from the dimethylene 1 : 6-dibromo-1 : 6-dideoxymannitol, m. p. 178—179°, and the tetra-acetyl 1 : 6-dibromo-1 : 6-dideoxymannitol, m. p. 125—126°, respectively, which had been prepared from 1 : 4-3 : 6-dianhydromannitol (Overend, Montgomery, and Wiggins, *J.*, 1948, 2201). Proof that the Vogel dibromide was a derivative of dulcitol was provided by the fact that hydrolysis with dilute hydrobromic acid effected the replacement of all the bromine and acetyl groups by hydroxyl, with the formation of dulcitol itself (VI). Further proof was furnished as follows : 1 : 6-dibromo-1 : 6-dideoxydulcitol (VII) was prepared by heating dulcitol with fuming hydrobromic acid, as described by Maquenne (" Les Sucres," Carré and Naud, Paris, 1900, p. 110). On acetylation, it gave 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dibromo-1 : 6-dideoxydulcitol identical in all respects with Vogel's compound. Hence (*A*) must be 1 : 6-di-iodo-1 : 6-dideoxydulcitol tetra-acetate, and (*B*) 2 : 3 : 4 : 5-di-methylene 1 : 6-dibromo-1 : 6-dideoxydulcitol; the position of the methylene groups cannot be allocated precisely at this stage, but by analogy with similar compounds in the mannitol and sorbitol series (Haworth and Wiggins *J.*, 1944, 58; Jones and Wiggins, *J.*, 1944, 364) they are probably in the 2 : 4-3 : 5-conformation (VIII).

When the 1 : 6-dibromide of tetra-acetyl dulcitol was treated with sodium methoxide a very small amount of a crystalline material, which appeared to contain bromine, was obtained. This had m. p. 141—143° and was at first believed to be identical with the monobromoanhydrodulcitol of Maquenne (*loc. cit.*) (see *Nature*, 1949, **164**, 567). Difficulty has been experienced, however, in repeating the isolation of this substance, but further purification of such small amounts as were isolable effectively removed the bromine (which must have been present as impurity only) and gave rise to a compound of sharper melting point. From preliminary experiments it would appear that this substance is a dianhydrohexitol, but more extensive investigations are being carried out.

The formation of a dulcitol derivative from both mannitol and sorbitol indicates the occurrence of profound stereochemical changes, and it would appear that a succession of Walden inversions occurs, perhaps involving all the asymmetric carbon atoms, so that a mixture of hexitol derivatives is formed from which the dulcitol compound readily separates by virtue of its low solubility. It is of interest that a somewhat similar reaction is known to occur with *meso-*

inositol, which, when treated under vigorous conditions with hydrogen chloride in acetic acid, is partly converted into racemic inositol; the latter is also formed similarly from scyllitol (Muller, *J.*, 1912, **101**, 2383; Fletcher and Findlay, *J. Amer. Chem. Soc.*, 1948, **70**, 4050; Posternak, *Helv. Chim. Acta*, 1948, **31**, 2242). These two changes involve, respectively, one and two asymmetric centres.

EXPERIMENTAL.

(Rotations were determined in chloroform, unless otherwise stated.)

Hexitol Hexa-acetates.—Acetylation, with acetic anhydride and pyridine, of commercial mannitol, sorbitol, and dulcitol gave the corresponding hexa-acetates. m. p.s 122—123°, 98—100°, 168—169°, and $[\alpha]_D$ +24·8°, +9·9°, ±0°, respectively.

A specimen of the commercial mannitol was converted into the tri*iso*propylidene derivative, m. p. 68—70°, $[\alpha]_D^{17}$ +12·3° (*c*, 2 in ethanol) (compare Fischer, *Ber.*, 1895, **28**, 1167), which was hydrolysed by being heated with aqueous-methanolic 0·2N-sulphuric acid on the steam-bath for 4 hours. The recovered mannitol, m. p. 163—166°, was treated with acetic anhydride and pyridine and gave the pure hexa-acetate, which after two recrystallisations from ethanol had m. p. 122—124°, $[\alpha]_D^{20}$ +24·6°.

2 : 3 : 4 : 5-*Tetra-acetyl* 1 : 6-*Dibromo*-1 : 6-*dideoxydulcitol*.—(a) *From hexa-acetyl mannitol.* The finely powdered hexa-acetate (150 g.; from commercial mannitol) was stirred at 35—40° with 50% w/v hydrogen bromide in acetic acid (500 g.). Dissolution was complete in 2½ hours, and a solid product then began to be precipitated. After a total of 8 hours the mixture was allowed to cool to room temperature, and the solid was collected, washed with a little acetic acid, and dried *in vacuo* over potassium hydroxide. One recrystallisation from acetic acid gave the dibromide (28·3 g.), m. p. 198—199°, $[\alpha]_D$ ±0° (Found: Br, 33·4. Calc. for $C_{14}H_{20}O_8Br_2$: Br, 33·6%). After a further 4 weeks at room temperature, the reaction mixture had deposited more solid, recrystallisation of which from acetic acid gave the same dibromide (11·4 g.), m. p. 197—199°, $[\alpha]_D$ ±0° (total yield, 23·5%). Similar treatment of hexa-acetyl mannitol (20 g., from the specially-purified mannitol) gave 5·1 g. of dibromide, m. p. 195—196°, which on recrystallisation from acetic acid gave 4·5 g., m. p. 196—198°, $[\alpha]_D^{15}$ ±0° (Found: Br, 33·3%).

(b) *From hexa-acetyl sorbitol.* The hexa-acetate (50 g.) was stirred at 35—40° with 50% hydrogen bromide in acetic acid (167 g.) and gave a clear solution in 1 hour. After a further 3 hours, solid began to be precipitated and after a total of 9 hours the solution was cooled to room temperature. The solid was collected, washed with acetic acid, dried, and recrystallised from acetic acid to give the dibromide (12 g., 22%), m. p. 197—198°, $[\alpha]_D^{15}$ ±0° (Found: Br, 33·6%).

(c) *From hexa-acetyl dulcitol.* The hexa-acetate (25 g.) was stirred at 35—45° with 50% hydrogen bromide in acetic acid (83 g.) for 10 hours; at no time was a clear solution obtained. The mixture was cooled, and the solid was collected, washed with acetic acid, and dried, to give 16·6 g., m. p. 160—183°; it probably contained unchanged hexa-acetate, which is much less soluble in acetic acid than the hexa-acetates of mannitol and sorbitol. Six recrystallisations from acetic acid, followed by three from dioxan, gave the dibromide, m. p. 196—198° (Found: C, 35·7; H, 4·5; Br, 33·55. Calc. for $C_{14}H_{20}O_8Br_2$: C, 35·3; H, 4·3; Br, 33·6%).

2 : 3 : 4 : 5-*Tetra-acetyl* 1 : 6-*Di-iodo*-1 : 6-*dideoxydulcitol*.—(*a*) The dibromide (9·5 g.; from commercial mannitol) was heated under reflux with sodium iodide (18 g.) in acetone (120 c.c.) for 24 hours. The solid (7·8 g.) was filtered off from the cooled solution and washed with acetone. The filtrate and washings were evaporated to small bulk, diluted with water, decolorised by the addition of some sodium thiosulphate, and extracted with chloroform. The extracts were dried (Na_2SO_4) and concentrated until crystals began to separate; methanol was then added, and the solid was collected, washed with methanol, and dried (yield, 1·4 g.; m. p. 185°). The solid (7·8 g.) which had been removed from the original reaction mixture was washed with water, which extracted sodium bromide (4·2 g.); the residue (3·6 g.), m. p. 188—190°, was combined with the material of m. p. 185° and recrystallised from dioxan to give the *di-iodide*, m. p. 188—190° (decomp.), $[\alpha]_D^{16}$ ±0° (Found: C, 29·4; H, 3·8. $C_{14}H_{20}O_8I_2$ requires C, 29·5; H, 3·5%).

(*b*) The dibromide (1 g.) was dissolved in freshly-distilled acetic anhydride (50 c.c.), dry sodium iodide (2 g.) added, and the mixture heated under reflux for 95 minutes. A solid separated. The mixture was poured into ice-water, and the precipitate was collected and recrystallised from ethanol; it formed colourless plates of the di-iodide, m. p. 188—189°, $[\alpha]_D$ ±0°.

Hydrogenation of 2 : 3 : 4 : 5-*Tetra-acetyl* 1 : 6-*Dibromo*-1 : 6-*dideoxydulcitol*.—The dibromide (10 g.; prepared from commercial mannitol) was hydrogenated in the presence of magnesium oxide (5 g.) and Raney nickel (*ca.* 10 g.) in ethanol (250 c.c.) for 16 hours at 110°/125 atm. The cooled and filtered solution was concentrated to small bulk and diluted with water, which precipitated a solid (2·3 g.), m. p. 180—190°, which still contained bromine and was rejected. Chloroform extraction of the aqueous-alcoholic solution gave only 0·8 g. of a crude product, and it was concluded that deacetylation had occurred. The catalyst was therefore washed with hot water, the washings were combined with the aqueous alcoholic solution, and the whole was evaporated to dryness under reduced pressure. The residue was heated on the steam-bath for 12 hours with acetic anhydride (50 c.c.) and fused sodium acetate (3 g.); pouring of the reaction mixture into cold water then gave a solid (1·45 g.) which on recrystallisation from methanol gave 2 : 3 : 4 : 5-tetra-acetyl 1 : 6-dideoxydulcitol (1·0 g.), m. p. 182—184°, $[\alpha]_D^{17}$ ±0°, identical with a specimen obtained from 1 : 6-dithiodulcitol (see below).

This tetra-acetate (0·9 g.) was dissolved in dry methanol (70 c.c.) and N-methanolic barium methoxide (1·5 c.c.) was added. After 12 hours at room temperature, the alkali was neutralised with carbon dioxide and the solution was evaporated to dryness. The residue was taken up in warm ethanol, filtered, and evaporated, and finally recrystallised from methanol to give 1 : 6-dideoxydulcitol, m. p. 179—180°, $[\alpha]_D^{16}$ ±0° (*c*, 2·6 in water) (Found : C, 48·5; H, 9·5. Calc. for $C_6H_{14}O_4$: C, 48·0; H, 9·4%).

Treatment of 1 : 6-dideoxydulcitol (0·2 g.) with dry acetone (10 c.c.) and pure sulphuric acid (0·1 g.) for 12 hours at room temperature, followed by neutralisation with potassium carbonate, filtration, and evaporation, gave the di*iso*propylidene derivative (0·25 g.), m. p. 61°, $[\alpha]_D^{16}$ ±0°, which formed small prisms on sublimation at 100°/760 mm.

Hexa-acetyl Dulcitol from the Dibromides.—(*a*) The dibromide (1·9 g.; from commercial mannitol), fused potassium acetate (2·5 g.), acetic anhydride (5 c.c.), and acetic acid (15 c.c.) were heated under reflux on a sand-bath for 16 hours; a crystalline precipitate of potassium bromide appeared during this time. The cooled mixture was stirred with water (25 c.c.) and the precipitated hexa-acetyl dulcitol (1·6 g.), m. p. 167—169°, was collected. Recrystallisation from ethanol gave a colourless solid, m. p. 168—169°, $[\alpha]_D^{21}$ ±0°; the m. p. was not depressed on admixture with an authentic specimen.

(*b*) The dibromide from pure mannitol similarly gave hexa-acetyl dulcitol (93%), m. p. 168—169°, $[\alpha]_D^{17}$ ±0° (Found : C, 50·2; H, 6·2. Calc. for $C_{18}H_{26}O_{12}$: C, 49·8; H, 6·0%).

(*c*) The dibromide from sorbitol gave hexa-acetyl dulcitol (95%), m. p. 168—169°, $[\alpha]_D^{17}$ ±0° (Found : C, 50·1; H, 6·2%).

The hexa-acetate [1 g., from (*b*)] was heated under reflux with ethanol (35 c.c.) and concentrated hydrochloric acid (1 c.c.) for 5½ hours. Evaporation to dryness then gave dulcitol (0·38 g.), m. p. 182—184°, raised on recrystallisation from ethanol to 185—187°, undepressed on admixture with an authentic sample. The hexa-acetate from (*c*) gave an identical product.

Hydrolysis of 2 : 3 : 4 : 5-*Tetra-acetyl* 1 : 6-*Dibromo*-1 : 6-*dideoxydulcitol wtih Hydrobromic Acid.*—The bromide (1·54 g.) and 5% aqueous hydrogen bromide (72 c.c.) were heated together at 100° until complete dissolution was effected (4 days). The solution was filtered, neutralised with silver carbonate, and refiltered. The filtrate was evaporated to dryness and the product extracted with hot ethanol. The insoluble residue was dissolved in water, and the solution acidified with hydrochloric acid and evaporated to small volume; it was then neutralised with silver oxide, filtered, and treated with hydrogen sulphide. After the removal of the silver sulphide the solution was evaporated to dryness and the residue recrystallised from ethanol–water; it formed white cubes (0·15 g., 27%) having m. p. 188—189° alone or when admixed with authentic dulcitol, $[\alpha]_D^{20}$ ±0° (Found : C, 38·9; H, 7·4. Calc. for $C_6H_{14}O_6$: C, 39·5; H, 7·7%). The hydrolysis product (0·1 g.), dry pyridine (2 c.c.), and freshly distilled acetic anhydride (2 c.c.) were mixed. After being warmed slightly, the solution was kept at room temperature for 4 hours and then boiled under reflux for 20 minutes. The acetylation product was isolated in the usual manner. Dulcitol hexa-acetate (0·1 g.) was obtained as colourless needles (from ethanol), m. p. 169—170°.

Desulphurisation of 1 : 6-*Dithiodulcitol.*—The dithiol (previously described as " 1 : 6-dithiomannitol " by Evans, Fraser, and Owen, *loc. cit.*) (1·5 g.) was suspended in water (50 c.c.), and Raney nickel (*ca.* 14 g.) was added; vigorous effervescence occurred. The mixture was heated on the steam-bath for 5 hours, and was then filtered and evaporated to dryness. The residue was acetylated by being heated on the steam-bath for 8 hours with acetic anhydride (10 c.c.) and fused sodium acetate (0·5 g.); addition of water, followed by chloroform-extraction and evaporation of the washed ($NaHCO_3$) and dried (Na_2SO_4) extracts, gave a syrup (1·5 g.) which slowly crystallised. Recrystallisation from methanol gave 2 : 3 : 4 : 5-*tetra-acetyl* 1 : 6-*dideoxydulcitol*, m. p. 182—184°, $[\alpha]_D^{19}$ ±0° (Found : C, 52·8; H, 7·2. $C_{14}H_{22}O_8$ requires C, 52·8; H, 7·0%).

Pentabromo-acetoxyhexane.—2 : 3 : 4 : 5-Tetra-acetyl 1 : 6-dibromo-1 : 6-dideoxydulcitol (2 g.; from commercial mannitol) was heated with 50% hydrogen bromide in acetic acid (20 c.c.) in a sealed tube at 100° for 18 hours. The mixture was then poured into water and extracted with chloroform, and gave a syrup (2 g.) from which a small amount of solid (0·1 g.) was obtained by treatment with methanol and light petroleum (b. p. 40—60°). Two recrystallisations from ethanol gave needles, m. p. 138—140°, $[\alpha]_D^{18}$ ±0° (Found : Br, 73·7. Calc. for $C_8H_{11}O_2Br_5$: Br, 74·2%). The m. p. was not depressed on admixture with a specimen prepared directly from hexa-acetyl mannitol (compare Evans, Fraser, and Owen, *loc. cit.*).

2 : 3 : 4 : 5-*Tetra-acetyl* 1 : 6-*Dichloro*-1 : 6-*dideoxydulcitol.*—Finely powdered hexa-acetyl mannitol (10 g.), contained in a Carius tube cooled in liquid nitrogen, was covered with liquid hydrogen chloride (5—10 c.c.) by allowing the dried gas to condense in the tube. The tube was then sealed and set aside at room temperature for 6 weeks. After being cooled in liquid nitrogen, the tube was opened and the hydrogen chloride was allowed to evaporate. The solid residue from three such experiments was triturated with ether at 0° and gave 2·3 g. of the dichloride, m. p. 207—212°, raised on recrystallisation from dioxan to 215—216°, $[\alpha]_D^{19}$ ±0° (Found : C, 43·8; H, 5·15; Cl, 18·5. Calc. for $C_{14}H_{20}O_8Cl_2$: C, 43·4; H, 5·2; Cl, 18·3%). Fischer and Armstrong (*loc. cit.*) for " tetra-acetyl 1 : 6-dichloro-1 : 6-dideoxymannitol " give m. p. 214°.

Proof of structure. The dichloride (0·77 g.) was heated under reflux with fused potassium acetate (1·25 g.) in acetic acid (7·5 c.c.) and acetic anhydride (2·5 c.c.) for 40 hours. After addition of water, the precipitated hexa-acetyl dulcitol was collected and recrystallised from ethanol; it had m. p. and mixed m. p. 167—169°, $[\alpha]_D^{19}$ ±0° (Found : C, 49·4; H, 6·4. Calc. for $C_{18}H_{26}O_{12}$: C, 49·8; H, 6·0%).

*Di*iso*propylidene* 1 : 6-*Dithiodulcitol.*—1 : 6-Dithiodulcitol (0·5 g.) was treated with dry acetone (10 c.c.) and pure sulphuric acid (0·1 g.) for 12 hours at room temperature. The acid was then neutralised with potassium carbonate and the solution was filtered and evaporated to an oil (0·7 g.) which was dissolved in ethyl acetate. Addition of light petroleum (b. p. 40—60°) gave a precipitate (0·06 g.), m. p. 156—157°, which on recrystallisation from the same solvents gave the *di*iso*propylidene* derivative as clusters of needles, m. p. 158—160° (Found : S, 21·6. $C_{12}H_{22}O_4S_2$ requires S, 21·8%), soluble in chloroform, insoluble in water.

2 : 4-3 : 5-*Dimethylene* 1 : 6-*Dibromo*-1 : 6-*dideoxydulcitol*.—The dibromodideoxydulcitol tetra-acetate (1 g.) was intimately mixed with paraformaldehyde (1 g.) and concentrated sulphuric acid (1 c.c.). The mixture was gently warmed and continuously stirred. The mass became pasty and then quite fluids After being heated for about 20 minutes it was cooled and extracted several times with chloroform. The extracts were combined and washed with water, dilute aqueous ammonia, and again with water, dried ($MgSO_4$), and evaporated. The residue (0·6 g.) was partly crystalline and when recrystallised from alcohol formed needles (0·1 g.) of *dimethylene* 1 : 6-*dibromo*-1 : 6-*dideoxydulcitol*, m. p. 144—145°, $[\alpha]_D$ ±0° (Found : C, 29·4; H, 3·7. $C_8H_{12}O_4Br_2$ requires C, 28·9; H, 3·6%). A small amount (0·07 g.) of unchanged starting material was recovered.

1 : 6-*Dibromo*-1 : 6-*dideoxydulcitol*.—Dulcitol (6·4 g.) was heated under reflux with fuming hydrobromic acid (80 c.c.) for 5 hours. A small amount of black carbonaceous matter separated which was filtered off on sintered glass. The clear brown filtrate was evaporated under reduced pressure, and the residual thick syrup was triturated with ice-water, whereupon partial crystallisation ensued. The solid was separated, and when recrystallised from alcohol (charcoal) formed tiny white plates (0·25 g.) of 1 : 6-*dibromo*-1 : 6-*dideoxydulcitol*, m. p. 172—174° (decomp.) (Found : C, 23·9; H, 3·82. $C_6H_{12}O_4Br_2$ requires C, 23·4; H, 3·9%). Maquenne (*op. cit.*) describes the preparation of this substance, but no physical constants have been recorded.

Conversion of 1 : 6-*Dibromo*-1 : 6-*dideoxydulcitol into Vogel's Tetra-acetyl Dibromodideoxyhexitol*.—The dibromide of dulcitol (0·045 g.) was dissolved in pyridine (5 c.c.); acetic anhydride (1 c.c.) was added and the mixture was kept at room temperature for 24 hours. Thereafter, it was poured into ice-water, a crystalline precipitate then separating. This was collected, washed with water, and recrystallised from acetic acid to give 1 : 6-dibromo-1 : 6-dideoxydulcitol tetra-acetate (0·02 g.), m. p. 196—198°, alone or in admixture with the material obtained from mannitol hexa-acetate according to Vogel (*loc. cit.*).

One of us (P. B.) is grateful to the Department of Scientific and Industrial Research for a maintenance grant and two of us (W. G. O. and L. F. W.) express their thanks to the Colonial Products Research Council for their support.

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[*Received, July 5th,* 1950.]