

OBSERVATIONS ON SOME CARBOHYDRATE BENZYLIDENE DERIVATIVES

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THE formation of the new asymmetric carbon atom in the reaction of benzaldehyde (and other aldehydes except formaldehyde) with sugar derivatives to yield 5- and 6- membered cyclic acetals might be expected to yield diastereoisomers. Apparently, and as predicted,¹ only one diastereoisomer is formed in most benzylidenation reactions which afford a 6-membered cyclic acetal (1:3-dioxan derivative). The expected² diastereoisomer would have the phenyl group equatorial³ to the 1:3-dioxan ring. However, in certain cases two products have been isolated and these are frequently cited as examples of distereoisomers. Thus glycero-gulo-heptitol ("α-glucoheptitol") yields⁴ a mono-O-benzylidene derivative (m.p. 155-156°) which is converted to 3:5-O-benzylidene-glycero-gulo-heptitol⁵ (m.p. 216°) on recrystallisation from ethanol.⁴ Similarly D-perseitol (D-glycero-D-gala-heptitol) yields⁶ two 1:3-5:7-di-O-benzylidene derivatives

¹ Angyal and Mills, Rev. Pure Appl. Chem. 2, 185 (1952); Mills, Adv. Carbohydrate Chem. 10, 1 (1956).

² Barton and Cookson, Quart. Rev. 10, 44 (1956).

³ Barton, Hassel, Pitzer and Prelog, Nature, Lond. 172, 1096 (1953).

⁴ Fischer, Ann. 270, 64 (1892); Ber. 27, 1524 (1894).

⁵ Hann, Ness and Hudson, J. Amer. Chem. Soc. 68, 1769 (1946).

⁶ Ness, Hann and Hudson, J. Amer. Chem. Soc. 70, 765 (1948).

(A, m.p. 153-155° [α]_D - 58.2° (pyridine); B, m.p. 280°, [α]_D -58.1°). Identical derivatives were obtained on methylation or benzylation of A and B and A was converted into B by repeated recrystallisation from ethanol-pyridine. Parallel results were obtained in the L-perseitol series.⁶ The facile "rearrangement" of the labile forms and the [α]_D values suggests polymorphism.

Through the courtesy of Dr. N.K. Richtmyer samples ⁶ of the 1:3-5:7-di-O-benzylidene derivatives of D- and L-perseitol were made available; the m.p.s. of these compounds were as recorded.⁶ All four compounds gave indistinguishable infra-red spectra both in Nujol mulls and KBr disks. This is compelling evidence that the substances comprise two pairs of polymorphic forms not diastereoisomers. It is noteworthy that both cis- and trans-1:3-O-benzylidene glyceritol ⁷ were unaffected by treatment with hot ethanol-pyridine.

From the reaction ⁸ of magnesium diphenyl with methyl 2:3-anhydro-4:6-O-benzylidene- α -D-allopranoside three forms of methyl 4:6-O-benzylidene-2-deoxy-2-C-phenyl- α -D-glucopyranoside were isolated (C, m.p. 163.5°, [α]_D + 143° (CHCl₃); D, m.p. 194.5°, [α]_D + 126°; E, m.p. 144.5°, [α]_D + 132°) C and D were considered to be diastereoisomeric at the acetal carbon atom and E to be a mixture of C and D. Benzylation of C and saponification of the product gave D; recrystallisation of crude E (m.p. 139-145°) from ethanol gave a product with an even wider m.p. range.

Although the pattern of behaviour of these compounds resembles that of the di-O-benzylidene-perseitols the [α]_D values suggests that they are not polymorphs. Specimens of C, D and E were kindly provided for

⁷ Baggett, Foster and Stacey, Chem. & Ind. 1229 (1958).

⁸ Richards, J. Chem. Soc. 2013 (1955).

examination by Dr. G.N. Richards; the m.p.s. of C and D had not changed on storage but that of E had become more diffuse (150-160°). The infra-red spectra of C, D and E in KCl disks suggested C and D to be different compounds and E to be a mixture of C and D. If, as seems probable, methyl 2:3-anhydro-4:6-O-benzylidene- α -D-allopyranoside is a pure diastereoisomer then any stereochemical difference between C and D must arise in the reaction of the epoxide compound with magnesium diphenyl.

The reaction of benzaldehyde with glyceritol ⁹ represents a unique case since the relevant products, cis- and trans- 1:3-O-benzylidene-glyceritol, may be considered diastereoisomeric at either C₂ or the acetal carbon and further, intra-molecular hydrogen bonding ¹⁰ may significantly influence the amount of each isomer formed in the reaction. Similar considerations apply to the reaction of p-nitrobenzaldehyde and glyceritol.¹¹

The reaction of benzaldehyde with sugar derivatives to yield diastereoisomeric 5-membered cyclic acetals (1:3-dioxolan derivatives) is well substantiated; thus methyl β -D-arabopyranoside yields ¹² two 3:4-O-benzylidene derivatives isolated as the benzoates (m.p. 126-127°, $[\alpha]_D + 174^\circ$ (CHCl₃); m.p. 100-102°, $[\alpha]_D + 214^\circ$). Methyl α -D-mannopyranoside yields ¹³ two di-O-benzylidene derivatives (m.p. 181-182°, $[\alpha]_D + 0.9^\circ$ (CHCl₃); m.p. 97-98°, $[\alpha]_D - 61.3^\circ$) as does 1:5-anhydro-D-mannitol (stryacitol) ¹⁴ (m.p. 165°, $[\alpha]_D - 148^\circ$ (CHCl₃);

⁹ Irvine, Macdonald and Souter, J. Chem. Soc. 107, 344 (1915).

¹⁰ Brimacombe, Foster and Stacey, Chem. & Ind. 1228 (1958).

¹¹ Hibbert and Carter, J. Amer. Chem. Soc. 50, 3376 (1928).

¹² Oldham and Honeyman, J. Chem. Soc. 986 (1946).

¹³ Robertson, J. Chem. Soc. 330 (1934).

¹⁴ Asahina and Takimoto, Ber. 64, 1803 (1931).

m.p. 192-195°, $[\alpha]_D - 80^\circ$). If as seems likely,¹ these compounds are 2:3-4:6-di-O-benzylidene derivatives then the differences may well be due to stereochemical variations at the acetal carbons in the 1:3-dioxolan rings.

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