286. *The Condensation of α-Methylgalactoside with Benzaldehyde.*

By GEORGE J. ROBERTSON and ROBERT A. LAMB.

THE condensation of α-methylgalactoside with benzaldehyde has been investigated for the purpose of comparing the reaction with the analogous cases of α-methylglucoside and α-methylmannoside, and in order to obtain new standard reference compounds of galactose. The importance of the latter objective is enhanced by the fact that the interconversion of isomeric sugars by chemical means may now be effected.

The condensation affords crystalline 4 : 6-*benzylidene α-methylgalactoside*, and no trace of a dibenzylidene derivative has been detected. Methylation with the Purdie reagents converts the benzylidene derivative into crystalline 4 : 6-*benzylidene* 2 : 3-*dimethyl α-methylgalactoside*, which, on graded hydrolysis with dilute hydrochloric acid, yields first 2 : 3-*dimethyl α-methylgalactoside* and finally 2 : 3-*dimethyl galactose*. The constitution assigned to the new sugar is supported by the following evidence. The free sugar condenses with phenylhydrazine to give a monomethyl galactosazone, which proves that one methyl group is situated in position 2. Moreover, the sugar reacts with methyl alcohol containing hydrogen chloride at room temperature to give a non-reducing product which is lævorotatory, from which it is inferred that position 4 is unsubstituted. It therefore seems probable that the benzylidene residue in benzylidene α-methylgalactoside is attached in positions 4 and 6, as in the corresponding derivatives of glucose and mannose. Crystalline 2 : 3-*dimethyl α-methylgalactoside* 4 : 6-*dinitrate*, and a crystalline *anilide* of 2 : 3-dimethyl galactose have also been prepared.

EXPERIMENTAL.

Preparation of α-Methylgalactoside.—Galactose (50 g.) was dissolved in methyl alcohol (400 c.c.) containing dry hydrogen chloride (4 g.), and the solution boiled until a constant rotation was observed (10 hrs.). After neutralisation with silver carbonate, and treatment of the filtered solution with charcoal to remove colloidal silver, the solution was evaporated to dryness. The resulting syrup was dissolved in hot absolute alcohol, and on cooling, α-methylgalactoside separated in shining prisms, m. p. 110—111°; $[\alpha]_D^{15°}$ + 178·5° in water; yield (pure), 29·1 g., 54%.

Condensation of α-Methylgalactoside with Benzaldehyde.—Condensation was effected (*a*) by a modification of Irvine and Scott's method (J., 1913, **103**, 585), and (*b*) by Freudenberg's method (*Ber.*, 1928, **61**, 1758). (*a*) Finely powdered α-methylgalactoside (20 g.) was heated with freshly distilled benzaldehyde (100 c.c.) under *ca.* 330 mm. pressure in a current of carbon dioxide at 145°. The sugar dissolved rapidly, and after 3 hours, the benzaldehyde was distilled as completely as possible at the same temperature by further diminution of the pressure. The residue, a clear syrup, was poured while hot into a mortar containing light petroleum (b. p. 60—80°); it solidified, and was ground to a fine powder. Purification of the crude material was best carried out by crystallisation from a mixture of light petroleum (b. p. 60—80°) and absolute alcohol (2 : 1). The yield of pure monobenzylidene α-methylgalactoside was 15 g., 51·7%. (*b*) This method afforded a product identical with that obtained above, but in 73% yield.

4 : 6-*Benzylidene α-methylgalactoside* crystallised in very fine needles, m. p. 170—172°, $[\alpha]_D^{15°}$ + 166·5° in chloroform (c = 1·384). It is practically insoluble in light petroleum (b. p. 40—60°), fairly soluble in cold water, and easily soluble in hot water, ether, chloroform, and benzene (Found: OMe, 10·4; C, 59·5; H, 6·4. $C_{14}H_{18}O_6$ requires OMe, 11·0; C, 59·6; H, 6·4%).

Methylation of 4 : 6-*Benzylidene α-Methylgalactoside.*—Methylation was carried out with methyl iodide and silver oxide with the addition of acetone to effect complete solution. The product, isolated in the usual way after one methylation, solidified completely on the removal of the solvent, and one crystallisation from ether gave pure 4 : 6-*benzylidene* 2 : 3-*dimethyl α-methylgalactoside* in 77% yield. The substance crystallised in long, shining prisms, m. p. 123—124°, $[\alpha]_D^{15°}$ + 173·7° in chloroform (c = 2·026) (Found: OMe, 29·8; C, 61·9; H, 7·3. $C_{16}H_{22}O_6$ requires OMe, 30·0; C, 61·9; H, 7·1%). Methylation may also be effected with methyl sulphate and sodium hydroxide solution with the addition of acetone as before.

Partial Hydrolysis of 4 : 6-*Benzylidene* 2 : 3-*Dimethyl α-Methylgalactoside.*—The material

(10 g.) was dissolved in a mixture of acetone (200 c.c.), water (100 c.c.), and *N*-hydrochloric acid (8 c.c.), and the solution boiled until the rotation become constant; it was then neutralised with barium carbonate, the acetone evaporated, and the aqueous residue extracted with chloroform to remove benzaldehyde. The aqueous solution was evaporated to dryness under diminished pressure, the residue extracted with acetone, and the product obtained on removal of the solvent was distilled in a vacuum. 2 : 3-*Dimethyl* α-*methylgalactoside* was thus obtained as a clear syrup which could not be crystallised; yield 5·8 g., 80%; $n_{\mathrm{D}}^{15^\circ}$ 1·4720, $[\alpha]_{\mathrm{D}}^{15^\circ}$ + 173·7° in chloroform (c = 1·129) (Found : OMe, 40·1; C, 48·4; H, 8·2. $C_9H_{18}O_6$ requires OMe, 41·9; C, 48·65; H, 8·1%). The 4 : 6-*dinitrate* was prepared by treating the galactoside with fuming nitric acid in chloroform solution (cf. Oldham, J., 1925, **127**, 2840); it crystallised from alcohol in large prisms, m. p. 88—90°, $[\alpha]_{\mathrm{D}}^{15^\circ}$ + 100·3° in chloroform (c = 1·096), yield 79% (Found : OMe, 29·1. $C_9H_{16}O_{10}N_2$ requires OMe, 29·8%). The substance may also be prepared by the direct action of fuming nitric acid on 4 : 6-benzylidene 2 : 3-dimethyl α-methylgalactoside in chloroform solution, but the yield is reduced to 67%.

Hydrolysis of 2 : 3-*Dimethyl* α-*Methylgalactoside*.—The material (6·1 g.) was dissolved in 8% hydrochloric acid (90 c.c.), and the solution boiled until of constant rotation. The acid was neutralised with barium carbonate, and the filtered solution evaporated under diminished pressure. The dry residue was extracted with chloroform, and the evaporated extract yielded 2 : 3-*dimethyl galactose* as a hard colourless glass, which could not be crystallised; $[\alpha]_{\mathrm{D}}^{15^\circ}$ + 11·3° in chloroform (c = 1·151) (Found : OMe, 27·8; C, 45·9; H, 7·7. $C_8H_{16}O_6$ requires OMe, 29·8; C, 46·1; H, 7·7%).

Action of Phenylhydrazine on 2 : 3-*Dimethyl Galactose*.—When the sugar was treated with phenylhydrazine acetate in the usual manner, considerable decomposition took place, and the solid product which separated was contaminated with a red tar. It was purified by precipitation of an ethereal solution with light petroleum (b. p. 60—80°) and thus obtained as a bright yellow powder; yield 44%. This proved to be 3-*methyl galactosazone*, m. p. 176—179° (Found : OMe, 7·9; N, 15·6. $C_{19}H_{24}O_4N_4$ requires OMe, 8·3; N, 15·0%).

Condensation of 2 : 3-*Dimethyl Galactose with Acid Methyl Alcohol*.—The sugar (0·4 g.) was dissolved in methyl alcohol (40 c.c.) containing 0·3% dry hydrogen chloride, and the solution kept at room temperature. Condensation took place very slowly, but after 7 days the solution had no reducing action on Fehling's solution :

Time (days)	0	1	2	3	4	5	6	7	8
$[\alpha]_{\mathrm{D}}^{15^\circ}$	+ 38°	+ 21°	+ 3°	− 6°	− 10°	− 12°	− 15°	− 24°	− 24°

Anilide of 2 : 3-*Dimethyl Galactose*.—This *compound*, obtained in the usual way, consisted of a mixture of syrup and crystals. After being pressed on porous tile and crystallised from alcohol, it formed small prisms, m. p. 130—131°, $[\alpha]_{\mathrm{D}}^{15^\circ}$ + 119·4° in ethyl alcohol (c = 0·67); yield (pure) 48% (Found : OMe, 20·9. $C_{14}H_{21}O_5N$ requires OMe, 21·9%). The oxime of 2 : 3-dimethyl galactose was a syrup which could not be crystallised.

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THE UNIVERSITY, ST. ANDREWS.

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