CCXXXIX.—*Synthesis of Glucosides. Part II. The Preparation of Some Galactosides.*

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TETRA-ACETYLGALACTOSIDYL bromide was obtained by Fischer and Armstrong (*Ber.*, 1902, **35**, 833; compare Helferich, *Ber.*, 1926, **59**, 2655) by the action of liquid hydrogen bromide on penta-acetyl galactose. Since this method is not convenient, attempts were made to prepare the bromide by a procedure similar to that described by Fischer (*Ber.*, 1916, **49**, 584) for the preparation of tetra-acetylglucosidyl bromide, but the products could not be induced to crystallise. When the method was modified, however, by allowing penta-acetyl galactose to interact with a mixture of acetyl bromide and hydrogen bromide in glacial acetic acid solution, tetra-acetylgalactosidyl bromide, identical with that prepared by Fischer and Armstrong (*loc. cit.*), was obtained in good yield.

O-*Tetra-acetyl*-β-p-*hydroxyphenylgalactoside* * was prepared by the interaction of quinol and tetra-acetylgalactosidyl bromide in acetone solution in the presence of aqueous potassium hydroxide. On deacetylation, β-p-*hydroxyphenylgalactoside*, analogous to the natural glucoside arbutin, was obtained. In a similar way, β-p-*anisylgalactoside*, the analogue of methyl arbutin, was prepared.

Tetra-acetyl-β-l-*menthylgalactoside*, obtained by the interaction of tetra-acetylgalactosidyl bromide and *l*-menthol in benzene solution with the help of silver oxide, on deacetylation yielded β-l-*menthylgalactoside*; and β-d-*bornylgalactoside* was similarly prepared.

EXPERIMENTAL.

O-*Tetra-acetylgalactosidyl Bromide*.—Powdered penta-acetyl galactose, m. p. 142° (40 g.), was added to a mixture of acetic anhydride (40 c.c.) and glacial acetic acid saturated at 0° with hydrogen bromide (100 g.), and the solid dissolved during the course of 30 mins. The reaction mixture, after remaining at room temperature for 2 hours, was poured on ice (300 g.) in water (300 c.c.). The semi-solid bromide thus precipitated was immediately dissolved in chloroform (300 c.c.), and the solution washed three times with ice water (200 c.c.) and dried over calcium chloride. After removal of the solvent in a vacuum, the bromide remained as a straw-coloured syrup, which, on trituration with ligroin, gradually solidified. It was recrystallised from dry ether–ligroin (1 in 5), from

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* In conformity with the nomenclature established in J., 1926, 1714, these compounds would be, *e.g.*, 4-hydroxy-1-*O*-tetra-acetyl-*β*-galactosidoxybenzene, but it seems undesirable to use this for the simpler galactosides here described.

which it separated in colourless elongated prisms, m. p. 82—83° (yield, 35 g.). Owing to the decomposition of the bromide in moist air it was kept in a vacuum desiccator over soda-lime.

O-*Tetra-acetyl*-β-p-*hydroxyphenylgalactoside*.—A solution of potassium hydroxide (2·4 g.) in water (15 c.c.) was gradually added to one of quinol (6 g.) and tetra-acetylgalactosidyl bromide (16 g.) in acetone (90 c.c.) maintained below 10° in an atmosphere of nitrogen. The dark brown solution, after remaining at room temperature for 6 hours, was acidified with dilute acetic acid, and the acetone removed under diminished pressure. The *tetra-acetylgalactoside*, which remained as a syrup, solidified on trituration with cold water, and after recrystallisation from ethyl alcohol was obtained in colourless, elongated prisms, m. p. 202—203° (yield, 3·2 g.) (Found : C, 54·3; H, 5·7. $C_{20}H_{24}O_{11}$ requires C, 54·5; H, 5·5%). It is sparingly soluble in cold methyl or ethyl alcohol, and very soluble in hot alcohol.

β-p-*Hydroxyphenylgalactoside*.—The acetylgalactoside (3 g.) was deacetylated by treatment with methyl-alcoholic ammonia at 0° during 24 hours; the methyl alcohol and ammonia were then removed under diminished pressure. The colourless residual solid was washed with alcohol to remove acetamide, and, on recrystallisation from 75% methyl alcohol, was obtained in prismatic needles, m. p. 246—247°, which contained $1{\cdot}5H_2O$. This *hydrate* is practically insoluble in warm absolute ethyl or methyl alcohol, but is very soluble in warm water, from which it separates on cooling in glistening, elongated, blunt prisms of the *dihydrate*, m. p. 246—247°, $[\alpha]_D^{20^\circ}$ − 53·2° (in water) (Found, in specimen crystallised from water and air-dried : C, 46·6; H, 6·4. $C_{12}H_{16}O_7,2H_2O$ requires C, 46·7; H, 6·5%. Found, in specimen from 75% methyl alcohol : C, 48·0; H, 6·5. $C_{12}H_{16}O_7,1{\cdot}5H_2O$ requires C, 48·1; H, 6·4%). The anhydrous galactoside could not be obtained in a state of purity. It reduces ammoniacal silver oxide solution.

O-*Tetra-acetyl*-β-p-*anisylgalactoside*.—A solution of potassium hydroxide (2·4 g.) in water (20 c.c.) cooled to 0° was gradually added to one of quinol monomethyl ether (10 g.) and tetra-acetylgalactosidyl bromide (16·4 g.) in acetone (90 c.c.) cooled below 5° in ice water. The homogeneous solution was allowed to remain at room temperature for 5 hours, and then rendered acid by addition of dilute acetic acid. On the addition of water (200 c.c.) the *tetra-acetylgalactoside* was precipitated as a thick syrup which gradually solidified, and on recrystallisation from 90% methyl alcohol was obtained in glistening elongated prisms, m. p. 104° (yield 9 g.) (Found : C, 55·4; H, 5·9. $C_{21}H_{26}O_{11}$ requires C, 55·5; H, 5·7%).

β-p-*Anisylgalactoside*.—The acetylgalactoside was deacetylated by means of methyl-alcoholic ammonia at 0° for 18 hours. After removal of the ammonia and alcohol in a vacuum and washing with ethyl alcohol to remove acetamide, the solid residue on recrystallisation gave the *galactoside* in the anhydrous state as prismatic needles, m. p. 161° (Found : C, 54·4; H, 6·6. $C_{13}H_{18}O_7$ requires C, 54·5; H, 6·3%). It is readily soluble in warm water, from which it separates on cooling in elongated prisms containing $1H_2O$, $[\alpha]_D^{20^\circ}$ −40° (in water) (Found : C, 51·2; H, 6·9. $C_{13}H_{18}O_7,H_2O$ requires C, 51·3; H, 6·6%). On heating, this *hydrate* becomes semi-solid at 88°, gradually solidifies again above 100°, and finally melts at 161°.

O-*Tetra-acetyl-*β-l-*menthylgalactoside.*—Dry activated silver oxide (Helferich, *Annalen*, 1926, **450**, 225) (10 g.) was added to a solution of tetra-acetylgalactosidyl bromide (12 g.) and *l*-menthol (20 g.) in dry benzene. The mixture was heated to 35° for 30 mins. (with shaking) and then under reflux for 15 mins. After separation of the silver salts, the benzene and excess of menthol were removed in a current of steam, and the residual syrup crystallised on cooling. Crystallisation from 50% alcohol gave the *tetra-acetyl-*β-l-*menthylgalactoside* in colourless glistening prisms, m. p. 100—101°, $[\alpha]_D^{20^\circ}$ −48·6° (in chloroform), yield 9·4 g. (Found : C, 59·3; H, 8·0. $C_{24}H_{38}O_{10}$ requires C, 59·3; H, 7·8%).

l-*Menthylgalactoside.*—The acetylgalactoside was deacetylated with methyl-alcoholic ammonia during 24 hours at 0°. After removal of the ammonia and methyl alcohol in a vacuum, the syrupy residue on solution in warm water deposited β-l-*menthylgalactoside* in rectangular plates containing $2H_2O$, m. p. 40—41°, $[\alpha]_D^{20^\circ}$ −74·2° in alcohol (Found, in air-dried material : C, 53·7; H, 9·6. $C_{16}H_{30}O_6,2H_2O$ requires C, 54·2; H, 9·7%. Found, in specimen dried in high vacuum over phosphoric oxide : C, 58·5; H, 9·5. $C_{16}H_{30}O_6,\frac{1}{2}H_2O$ requires C, 58·7; H, 9·5%). The galactoside could not be obtained in the anhydrous state as it decomposes on heating in a vacuum. It is readily soluble in ethyl and methyl alcohols.

O-*Tetra-acetyl-*d-*bornylgalactoside.*—Active silver oxide (5 g.) was added to a vigorously agitated solution of tetra-acetylgalactosidyl bromide (6 g.) and *d*-borneol (10 g.) in dry benzene (25 c.c.) at 35°. The reaction proceeded quickly during 30 mins. with a slight rise in temperature, and was completed by a further 15 minutes' heating under reflux. Benzene and excess of borneol were removed by a current of steam from the filtered solution, and the residual oil quickly crystallised. *Tetra-acetyl-*d-*bornylgalactoside* was recrystallised from 70% alcohol, from which it separated in colourless needles, m. p. 140°, $[\alpha]_D^{20^\circ}$ + 1·3° (in chloroform).

β-d-*Bornylgalactoside.*—Deacetylation of the tetra-acetylgalactoside was effected by means of saturated methyl-alcoholic ammonia at 0° during 24 hours, the ammonia and methyl alcohol being then removed under diminished pressure. The residue on solution in boiling benzene deposited β-d-*bornylgalactoside* as hair-fine needles, which on exposure to moist air liberated benzene of crystallisation and liquefied. On crystallisation from warm water, the *monohydrate* separated in hexagonal plates, m. p. 123°, $[\alpha]_D^{20°}$ —6·5° (in alcohol); m. p. of *anhydrous* galactoside, 137—138° (Found, in an air-dried specimen: C, 57·3; H, 9·1. $C_{16}H_{28}O_6,H_2O$ requires C, 57·5; H, 9·0%. Found, in specimen dried at 100—105° in a vacuum: C, 60·5; H, 9·0. $C_{16}H_{28}O_6$ requires C, 60·8; H, 8·9%). This galactoside is easily soluble in alcohol and warm water. On prolonged boiling of an aqueous solution hydrolysis occurs.

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