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Note

Syntheses of α-D-linked disaccharides

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In the preceding paper[1], the mechanism of, and the solvent effects in, the Koenigs–Knorr reactions of glucosyl chlorides having a non-participating group at C-2, using silver perchlorate as a main catalyst, were investigated. For the preparation of α-D-glucopyranosides, it was concluded that anhydrous ether is a preferable solvent; silver perchlorate and *sym*-collidine are superior catalysts to silver perchlorate and silver carbonate in the presence of Drierite; β-D-glucosyl chloride is preferred to the α-D anomer; the solvent and reagents should be as dry as possible. This paper describes the preparation of β-isomaltose (**3**), β-maltose (**6**), β-nigerose (**8**), and α-kojibiose octa-acetates (**10**) on the basis of the above conclusions.

When 3,4,6-tri-*O*-acetyl-2-*O*-benzyl-β-D-glucopyranosyl chloride[2] (**1**) was reacted with 1 molar equivalent of each of the tetra-*O*-acetyl-D-glucopyranoses in anhydrous ether at 0° for 1–4 h, using 1 molar equivalent each of silver perchlorate and *sym*-collidine as catalysts, and the products were hydrogenated over palladium–carbon and reacetylated, the corresponding α-D-glucopyranosyl-D-glucopyranose octa-acetates were obtained in much better yields than those reported for other synthetic methods.

β-Isomaltose octa-acetate (**3**) was obtained in 75% yield from **1** and 1,2,3,4-tetra-*O*-acetyl-β-D-glucopyranose[3] (**2**). Wolfrom and co-workers[4,5] reported that **3** was obtained in 20–55% yields when 3,4,6-tri-*O*-acetyl-2-*O*-nitro-β-D-glucopyranosyl chloride was reacted with **2** in ether, using silver perchlorate and silver carbonate as catalysts in the presence of Drierite, and the product was hydrogenated and reacetylated. A 74.5% yield of **3** was obtained when **1** was treated with 1,2,3,4-tetra-*O*-acetyl-6-*O*-trityl-β-D-glucopyranose[6] (**4**) in anhydrous ether at 0° for 3 h, using silver perchlorate as a catalyst. Bredereck and co-workers[7] have reported that an anomeric mixture of 6-*O*-D-glucopyranosyl-D-glucopyranose derivatives was obtained when 3,4,6-tri-*O*-acetyl-2-*O*-trichloroacetyl-β-D-glucopyranosyl chloride was reacted with **4** in nitromethane, using silver perchlorate as catalyst, but the yields were not given.

β-Maltose octa-acetate (**6**) was obtained in 43.6% yield from **1** and 1,2,3,6-tetra-*O*-acetyl-β-D-glucopyranose[8] (**5**). Lemieux[9] obtained **6** in 8.7% yield when **5**

was heated with 3,4,6-tri-*O*-acetyl-1,2-anhydro-α-D-glucopyranose at 120° for 13 h and the product was acetylated.

β-Nigerose octa-acetate (**8**) was obtained in 57% yield from **1** and 1,2,4,6-tetra-*O*-acetyl-β-D-glucopyranose[10] (**7**). Haq and Whelan[11] obtained a derivative of nigerose in 1.8% yield by boiling a solution of 3,4,6-tri-*O*-acetyl-β-D-glucopyranosyl chloride with 1,2:5,6-di-*O*-isopropyridene-3-*O*-sodio-α-D-glucofuranose in toluene.

α-Kojibiose octa-acetate (**10**) was obtained in 47% yield from **1** and 1,3,4,6-tetra-*O*-acetyl-α-D-glucopyranose[12] (**9**). Wolfrom and co-workers[13] obtained **10** in 1.5% yield by the reaction of 3,4,6-tri-*O*-acetyl-2-*O*-nitro-β-D-glucopyranosyl chloride with **9** in ether, using silver perchlorate and silver carbonate in the presence of Drierite. Helferich and Zinner[12] obtained **10** in 21% yield by the reaction of 1,2,3,4-tetra-*O*-acetyl-α-D-glucopyranosyl bromide with **9** in acetonitrile, using mercuric cyanide and mercuric bromide as catalysts.

EXPERIMENTAL

The general methods were as described in the preceding paper[1]. Benzene–ether (1:1) was used for p.l.c. Specific rotations were measured in chloroform.

General procedure for the preparation of α-D-glucopyranosyl-D-glucopyranose octa-acetates (**3**, **6**, **8**, *and* **10**). — Preparations of the disaccharide octa-acetates were carried out in the same manner as here described for β-isomaltose octa-acetate (**3**), except for the reaction period. The reaction period for the preparation of the β-isomaltose derivative was 1 h, and those for others were 4 h.

To a mixture of 1,2,3,4-tetra-*O*-acetyl-β-D-glucopyranose[3] (**2**) (169 mg, 0.482 mmole) in anhydrous ether (9.6 ml), 80mM ethereal silver perchlorate (6.05 ml, 0.482 mmole), and 371mM ethereal *sym*-collidine (1.30 ml, 0.482 mmole) was added, with stirring at 0°, 3,4,6-tri-*O*-acetyl-2-*O*-benzyl-β-D-glucopyranosyl chloride[2] (**1**) (200 mg, 0.482 mmole). After 1 h, the insoluble materials were filtered off and washed with dichloromethane. The combined filtrate and washings were successively washed with water, dilute hydrochloric acid, water, aqueous sodium hydrogen carbonate, and water, dried (Na_2SO_4), and evaporated. The residue (348 mg) was dissolved in methanol (10 ml) and hydrogenated in an atmosphere of hydrogen over 10% palladium–carbon (150 mg). After the hydrogenation was finished (2 h), the catalyst was removed by filtration and washed with methanol. The combined filtrate and washings were evaporated to a syrup, which was acetylated by refluxing with acetic anhydride (4 ml) and sodium acetate (200 mg). The cooled reaction mixture was poured onto ice and, after decomposition of the excess acetic anhydride, the mixture was extracted with dichloromethane. The extract was washed with water, aqueous sodium hydrogen carbonate, and water, dried, and evaporated. The residue (310 mg) was purified by preparative t.l.c., and a zone at R_F 0.22 was collected and extracted with ether–dichloromethane (8:2). After evaporation of the solvent, the residue was crystallized from ethanol to give β-isomaltose octa-acetate (262 mg, 80%), m.p. 142–146°. Recrystallization from the same solvent gave **3** as colourless prisms (246 mg, 75%),

m.p. 148–149°, $[\alpha]_D^{23.5}$ +93.8 ±1.4° (*c* 0.984); lit.[4] m.p. 144–146°, $[\alpha]_D^{22}$ +95° (chloroform).

Anal. Calc. for $C_{28}H_{38}O_{19}$: C, 49.56; H, 5.64. Found: C, 49.34; H, 5.65.

β-Maltose octa-acetate (**6**). — **6** (183 mg, 55.8%), m.p. 152–157°, was obtained from 1,2,3,6-tetra-*O*-acetyl-β-D-glucopyranose[8] (**5**) (169 mg) and **1** (200 mg). Recrystallization from ether gave colourless needles (143 mg, 43.6%), m.p. 163–164°, $[\alpha]_D^{24.5}$ +62.9 ±1.0° (*c* 1.038); lit.[8] m.p. 159–161°, $[\alpha]_D^{20}$ +63° (chloroform).

Anal. Calc. for $C_{28}H_{38}O_{19}$: C, 49.56; H, 5.64. Found: C, 49.47; H, 5.69.

β-Nigerose octa-acetate (**8**). — **8** (220 mg, 67%), m.p. 140–145°, was obtained from 1,2,4,6-tetra-*O*-acetyl-β-D-glucopyranose[10] (**7**) (169 mg) and **1** (200 mg). Recrystallization from ether gave colourless needles (187 mg, 57%), m.p. 152–153°, $[\alpha]_D^{25}$ +77.2 ±1.0° (*c* 1.275); lit.[11] m.p. 151–152°, $[\alpha]_D$ +84° (chloroform).

Anal. Calc. for $C_{28}H_{38}O_{19}$: C, 49.56; H, 5.64. Found: C, 49.60; H, 5.82.

α-Kojibiose octa-acetate (**10**). — **10** (210 mg, 64%), m.p. 155–158°, was obtained from 1,3,4,6-tetra-*O*-acetyl-α-D-glucopyranose[12] (**9**) (169 mg) and **1** (200 mg). Recrystallization from ether gave colourless prisms (154 mg, 47%), m.p. 171–172°, $[\alpha]_D^{25}$ +145.6 ±1.9° (*c* 1.027); lit.[12] m.p. 168–168.5°, $[\alpha]_D^{18}$ +152.5° (chloroform).

Anal. Calc. for $C_{28}H_{38}O_{19}$: C, 49.56; H, 5.64. Found: C, 49.72; H, 5.66.

Preparation of β-isomaltose octa-acetate (**3**) *from 1,2,3,4-tetra-O-acetyl-6-O-trityl-β-D-glucopyranose* (**4**) *and* **1**. — To a mixture of **4**[6] (286 mg) in anhydrous ether (10.9 ml) and 80mM ethereal silver perchlorate (6.05 ml) was added, with stirring at 0°, **1** (200 mg). After 3 h, the insoluble materials were filtered off and washed with anhydrous ether. The combined filtrate and washings were washed with water, dried, and evaporated. The residue was hydrogenated, reacetylated, and purified as described above to give **3** (260 mg, 79.4%), m.p. 141–145°. Recrystallization from ethanol gave colourless prisms (243 mg, 74.5%), m.p. 148–149°. This was identical with **3** obtained above by mixture m.p. determination and comparison of their n.m.r. spectra.

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