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Note

Derivatives of methyl 2-*O*-methyl-D-xylofuranosides

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Treatment of 1,2-*O*-isopropylidene-5-seleno-D-xylofuranose with methanolic hydrogen chloride did not give the desired methyl D-xyloside with selenium as the hetero-atom of the pyranoside ring. Instead, dehydration between C-2 and C-5 occurred, resulting in D-*threo*-2,3,4,5-tetrahydro-3,4-dihydroxy-2-selenophene-dimethyl acetal[1]. Similar treatment of a compound having the hydroxyl group at C-2 substituted may lead to a selenium-containing pyranose and thus 2-*O*-methyl-D-xylofuranosides were selected as the starting materials.

A recent preparation[2] of these compounds involved a chromatographic separation of the anomers and is unsuitable for large scale preparation. However, a modification of the method of methylation, by Robertson[3], of the mixture of methyl 3,5-*O*-isopropylidene-α- and β-D-xylofuranosides, led to a convenient preparation of the desired furanosides.

Methyl 3,5-*O*-isopropylidene-α- and -β-D-xylofuranosides were prepared by the method of Baker *et al.*[4], and methylation of each compound gave the corresponding 2-*O*-methyl derivatives. The isopropylidene group was removed with dilute acetic acid to give methyl 2-*O*-methyl-α- and -β-D-xylofuranosides. The α-D anomer crystallized readily, whereas, the β-D anomer was a syrup but gave a crystalline di-*O*-*p*-nitrobenzoate, in agreement with the reported data[2].

5-*p*-Toluenesulfonate derivatives were prepared from both anomers. The tosyl ester of the α-D anomer was treated with the benzylselenolate ion to give the corresponding 5-selenobenzyl compound. Reduction of this compound with sodium in ammonia, followed by treatment with methanolic hydrogen chloride[1] gave 5,5-diselenobis(methyl 2-*O*-methyl-D-xylofuranoside). Attempts to prevent the oxidation to the diselenides by conducting the reaction in the presence of hypophosphorous acid were unsuccesful.

EXPERIMENTAL

General. — Melting points were determined on a Fisher–Johns apparatus and are uncorrected. Column chromatography was carried out on silica gel (60–200 mesh) with 5% methanol in benzene. Infrared spectra were determined on a Perkin–Elmer 700 spectrophotometer. Nuclear magnetic resonance spectra were recorded with a

Varian T-60 spectrometer. Chemical shifts are quoted in p.p.m. units and tetramethylsilane is the internal standard.

Methyl 3,5-O-isopropylidene-2-O-methyl-α-D-xylofuranoside. — Methyl 3,5-*O*-isopropylidene-α-D-xylofuranoside[4] (20.0 g) was dissolved in *N*,*N*-dimethylformamide (45 ml). Barium oxide (20.0 g) and methyl iodide (20 ml) were added and the mixture was stirred overnight at room temperature. The suspension was filtered and the solid was washed repeatedly with chloroform. The combined filtrates were washed successively with water, ice-cold dilute hydrochloric acid, sodium hydrogen carbonate solution, sodium thiosulfate solution, and water, dried with sodium sulfate, and evaporated. The syrupy residue was distilled to give the product, (15.7 g, 73%) b.p. 60–62° (0.07 torr); $[\alpha]_D^{25}$ +81° (*c* 8.06, chloroform); n.m.r. (chloroform-*d*): δ 1.29 (d, 6 p, *J* 1.5 Hz, CMe_2), 3.36 (s, 6 p, OMe), 3.54–3.74 (m, 3 p), 3.90–4.13 (m, 2 p), and 4.86 (d, 1 p, *J* 4.0 Hz, H-1).

Anal. Calc. for $C_{10}H_{18}O_5$: C, 55.05; H, 8.26. Found: C, 55.14; H, 8.23.

The corresponding β-D anomer was prepared by the same procedure (17.0 g, 80%), b.p. 69–70° (0.07 torr); $[\alpha]_D^{25}$ −65° (*c* 8.6, chloroform); n.m.r. (chloroform-*d*): δ 1.39 (s, 6 p, CMe_2), 3.44 (s, 6 p, OMe), 3.70–4.23 (m, 5 p), and 4.90 (s, 1 p, H-1).

Anal. Calc. for $C_{10}H_{18}O_5$: C, 55.05; H, 8.26. Found: C, 55.18; H, 8.29.

Methyl 2-O-methyl-α-D-xylofuranoside. — The syrupy isopropylidene α-D anomer just described (10.0 g) was treated with 25% aqueous acetic acid (150 ml) overnight at room temperature. The solution was evaporated at room temperature under diminished pressure and the residue was crystallized from ethyl acetate–petroleum ether (40–60°) (7.8 g, 95%), m.p. 73° $[\alpha]_D^{25}$ +195° (*c* 1.09, chloroform) (lit.[1]: m.p. 72–73°); n.m.r. (chloroform-*d*): δ 3.50 (s, 3 p, OMe), 3.55 (s, 3 p, OMe), 3.62–4.58 (m, 7 p), and 5.02 (d, 1 p, *J* 4.0 Hz, H-1).

The β-D anomer was obtained by the same procedure as a syrup (7.1 g, 87%), b.p. 93–94° (0.07 torr), $[\alpha]_D^{25}$ −78° (*c* 2.08, chloroform); n.m.r. (chloroform-*d*): δ 3.48 (s, 6 p, OMe), 3.70–4.41 (m, 7 p), and 4.90 (s, 1 p, H-1). It was characterized by a crystalline 3,5-di-*O*-*p*-nitrobenzoate, m.p. 91° (from methanol); lit.[1]: m.p. 91–93°.

Methyl 2-O-methyl-5-O-p-tolylsulfonyl-α-D-xylofuranoside. — A solution of methyl 2-*O*-methyl-α-D-xylofuranoside (1.28 g) in pyridine (10 ml) was cooled to −10°. *p*-Toluenesulfonyl chloride (1.60 g) was added in small portions while the temperature was kept at −10°. The mixture was kept for 2 h at −10° and then overnight at room temperature. The mixture was treated with chloroform and water, and the chloroform layer was washed with ice-cold dilute hydrochloric acid, sodium hydrogen carbonate solution, and water, dried with sodium sulfate, and evaporated to give a semi-solid (2.5 g). The product was crystallized from ethyl acetate-petroleum ether (40–60°) (1.3 g, 55%), m.p. 74–75°; $[\alpha]_D^{25}$ −24° (*c* 2.26, chloroform); i.r. data: $\nu_{max}^{CHCl_3}$ 3450 (OH) and 1601 cm^{-1} (aromatic); n.m.r. (chloroform-*d*): δ 2.45 (s, 3 p, Me) 2.62–2.95 (m, 1 p), 3.40 (s, 3 p, OMe), 3.46 (s, 3 p, OMe), 3.58–3.74 (m, 1 p), 4.18–4.50 (m,4 p), 4.88 .(d, 1 p, *J* 4.0 Hz, H-1), 7.39 and 7.85 (2 d of 2 p, *J* 8.0 Hz, C_6H_4).

Anal. Calc. for $C_{14}H_{20}O_7S$: C, 50.60; H, 6.02. Found: C, 50.43, H, 6.00.

The β-D anomer was prepared in the same manner. The crude product was

separated by column chromatography from the 3,5-di-*O*-tosyl derivative to give the desired compound as a syrup (2.2 g, 92%), $[\alpha]_D^{25}$ −30° (*c* 3.3. chloroform); i.r. data: $\nu_{max}^{CHCl_3}$ 3450 (OH) and 1601 cm^{-1} (aromatic); n.m.r. (chloroform-*d*): δ 2.44 (s, 3 p, Me), 2.52–2.84 (m, 1 p), 3.26 (s, 3 p, OMe), 3.37 (s, 3 p, OMe), 3.60 (s, 1 p), 3.90–4.33 (m, 4 p), 4.87 (s, 1 p, H-1), 7.31 and 7.78 (2 d of 2 p, *J* 8.0 Hz, C_6H_4).

Anal. Calc. for $C_{14}H_{20}O_7S$: C, 50.60; H, 6.02. Found: C, 50.65; H, 6.04.

Methyl 5-deoxy-2-O-methyl-5-selenobenzyl-α-D-xylofuranoside. — Methyl 2-*O*-methyl-5-*O*-*p*-tolylsulfonyl-α-D-xylofuranoside (1.0 g) was added to a solution of sodium (0.10 g) and benzylselenol (0.50 ml) in methanol (15 ml). The solution was heated under reflux and under nitrogen for 2 h. The solvent was evaporated and the residue extracted with chloroform and water. The chloroform extract was evaporated to a syrup which was chromatographed (10% methanol in benzene) to give the title compound as a syrup (0.96 g); n.m.r. (chloroform-*d*): δ 2.60–2.80 (m, 3 p), 3.43, 3.47 (2 s of 3 p, OMe), 3.60–3.84 (m, 1 p), 3.84 (s, 2 p, $CH_2C_6H_5$), 4.6–4.66 (m, 2 p), 4.90 (d, 1 p, *J* 4.0 Hz, H-1), and 7.30 (s, 5 p, Ph).

Anal. Calc. for $C_{14}H_{20}O_4Se$: C, 50.80; H, 6.04. Found: C, 50.63; H, 6.00.

Reduction of methyl 5-deoxy-2-O-methyl-5-selenobenzyl-α-D-xylofuranoside. — The just described compound (0.91 g) was reduced in ammonia with sodium and the residue treated with 1% hydrogen chloride in methanol (25 m), as described previously[1]. The methanolic solution was neutralized with Dowex 45 (OH^-) ion-exchange resin and evaporated to a syrup, which was applied to a column of silica gel. Elution with 1:19 methanol–benzene gave 5,5′-diselenobis(methyl 2-*O*-methyl-D-xylofuranoside) (0.70 g) as a syrup.

Anal. Calc. for $C_{14}H_{26}O_8Se_2$: C, 34.89; H, 5.40; mol. wt., 482. Found: C, 34.78; H, 5.51; mol. wt., 482 (m. s.).

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