Preliminary communication

Systematic, sequential synthesis of $(1 \rightarrow 4)$ - β -D-xylo-ligosaccharides and their methyl β -glycosides

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 $(1\rightarrow 4)$ - β -D-Xylo-oligosaccharides are found in partial hydrolysates of various natural xylans and they can be isolated, albeit rather laboriously and in low yields, by chromatography¹⁻⁴. Of this homologous series of oligosaccharides, only xylobiose has been chemically synthesised⁵⁻⁷. Stepwise construction of the higher oligosaccharides by the Koenigs-Knorr reaction requires a D-xylosyl halide conventionally blocked at positions 2 and 3, but having a protecting group at position 4 that can be selectively removed. Condensation of such a halide with, for example, 1,2,3-tri-O-acetyl- β -D-xylopyranose (1), followed by selective removal of the 4-substituent, would yield a product suitable for another condensation with the same halide. The limitation of this approach lies in the yields of the desired products and the availability of methods for their isolation.



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2,3-Di-*O*-acetyl-4-*O*-chloroacetyl- α -D-xylopyranosyl bromide⁸ (2) satisfies these requirements, but its large-scale preparation requires the isolation of several of its precursors by chromatography. We now report on the use of 1,2,3-tri-*O*-acetyl-4-*O*-benzyl- β -D-xylopyranose (3; m.p. 103–104°, $[\alpha]_D - 28°$)* in a stepwise synthesis of $(1\rightarrow 4)$ - β -D-xylo-oligosaccharides. Compound 3 was obtained by acetylation of 4-*O*-benzyl-D-xylose {m.p. 167–169°, $[\alpha]_D + 10°$ (c 0.6, water)}, which was obtained from methyl 4-*O*-benzyl- β -D-xylopyranoside⁹ by acid hydrolysis. Hydrogenolysis (5% Pd/C; methanol-acetone, 1:1) of 3 gave 1 (m.p. 112–113°; lit.¹⁰ m.p. 112°), and treatment of 3 with hydrogen bromide in toluene-dichloromethane gave the reactive, amorphous glycosyl bromide 4. Compounds 1, 3, and 4 can be obtained on the centigram scale in excellent yields without recourse to chromatography.

To test the suitability of 4 for the sequential synthesis of $(1\rightarrow 4)\beta$ -D-xylo-oligosaccharides, its reactions with 1 and⁹ 5 were investigated. Thus, condensation** of 4 with 1 gave 6 (m.p. 132.5–133.5°, $[\alpha]_D$ –64°), hydrogenolysis of which gave 7 (m.p. 180–181°, $[\alpha]_D$ –76°). Likewise, reaction of 7 with 1 gave 8 (m.p. 104–109°, $[\alpha]_D$ –82°), and thence 9 (m.p. 216–218°, $[\alpha]_D$ –90°). Reaction of 9 with 1 gave 10 (m.p. 188.5–191°, $[\alpha]_D$ –91.5°), and hydrogenolysis of 10 gave 11 (m.p. 221–222°, $[\alpha]_D$ –101°). Acetylation of 7, 9, and 11 afforded known² products, and subsequent deacetylation (Zemplén) gave the corresponding β -D-xylo-oligosaccharides, the physical constants of which were in accord with literature data¹⁻⁴.

In a second series of reactions, the glycosyl bromide 4 was treated with 5, to give 12 (m.p. 137–138°, $[\alpha]_D$ -85°), and subsequent hydrogenolysis afforded 13 (m.p. 121–123°, $[\alpha]_D$ -104°). Condensation of 13 with 4 gave 14 (m.p. 155–157°, $[\alpha]_D$ -98°), and subsequent hydrogenolysis yielded 15 (amorphous solid, $[\alpha]_D$ -107°). Reaction of 15 with 4 gave 16 (m.p. 198–199°, $[\alpha]_D$ -106°). Removal of the protecting groups from 12, 14, and 16 gave the known^{11–13} methyl β -glycosides of xylobiose and xylotriose, and the hitherto unknown methyl β -glycoside (17) of xylotetraose {m.p. 238–239°, $[\alpha]_D$ -88° (c 1, water)}, the structure of which was confirmed by mass spectrometry of its deca-O-methyl derivative 18 (m.p. 122–123°, $[\alpha]_D$ -87°), and by ¹³C-n.m.r. spectroscopy.

Work is in progress on the synthesis of higher members of the two homologous series using the above approach.

^{*}Crystalline compounds gave correct microanalyses; $[\alpha]_D^{22}$ values were determined on chloroform solutions (c 1) unless stated otherwise. All monosaccharide derivatives exhibited 80-MHz, p.m.r. spectral characteristics consistent with their structures.

^{**}In acetonitrile in the presence of mercuric cyanide, using 2-3 molar proportions of 4. Chromatography on silica gel 60 gave both α and β products. Only those with a β -linked, terminal D-xylosyl group are noted in the text. The configuration at the newly formed, inter-sugar linkage, tentatively assigned on the basis of specific optical rotation, was confirmed by ¹³C-n.m.r. spectroscopy.

REFERENCES

- 1 R. L. Whistler and C. C. Tu, J. Am. Chem. Soc., 74 (1952) 3609-3612.
- 2 T. E. Timell, Sven. Papperstidn., 65 (1962) 435-447.
- 3 J. K. N. Jones and L. E. Wise, J. Chem. Soc., (1952) 2750-2756.
- 4 C. T. Bishop, Can. J. Chem., 33 (1955) 1073-1078.
- 5 D. W. Myhre and F. Smith, J. Org. Chem., 26 (1961) 4609-4612.
- 6 G. O. Aspinall and K. M. Ross, J. Chem. Soc., (1961) 3674-3677.
- 7 P. Kováč, Chem. Zvesti, 33 (1979) 365-370.
- 8 J. P. Utille and P. J. Vottero, Carbohydr. Res., 52 (1976) 241-245.
- 9 P. Kováč and J. Alföldi, Chem. Zvesti, 32 (1978) 519-523.
- 10 P. J. Utille and P. J. Vottero, Carbohydr. Res., 53 (1977) 259-262.
- 11 P. Kováč, Chem. Zvesti, 32 (1978) 514-518.
- 12 P. Kováč, Chem. Zvesti, 34 (1980) 234-240.
- 13 P. Kováč, Collect. Czech. Chem. Commun., 45 (1980) 892-900.