New branched carbohydrate building block from a tandem elimination-Farvorski rearrangement

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3-Methoxycarbonyl-1,5-anhydro-β-D-*erythro*-pentofuranose 1 was obtained when 2,3,4-tri-*O*-tosyl-1,6-anhydro-β-D-glucopyranose 2 was treated with NaOMe.

Carbohydrates are a rich and cheap source of chiral compounds for use in stereospecific synthesis.[1] One such popular chiral starting material is 1,6-anhydroglucose **3** (levoglucosan),[2] and its decendants the Cerny epoxides **4** and **5**.[3] Compound **4** is routinely obtained from **3** in two steps: conversion of **3** to 1,6-anhydro-2,4-di-*O*-tosyl-β-D-glucopyranose **6** followed by epoxidation of **6** *via* treatment with NaOMe.[4,5] The tritosylate **2** is sometimes obtained as a byproduct in the tosylation of **3**, but can also be converted to **4** in high yield by treatment with base (Scheme 1).[6]

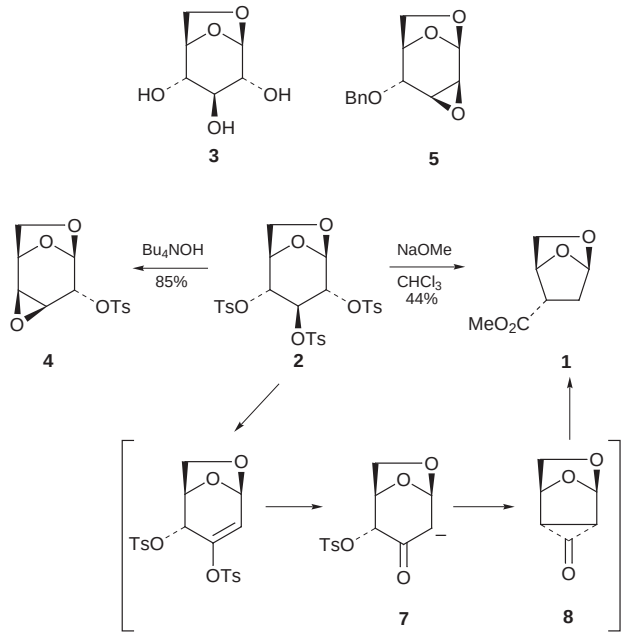
When recently requiring some **4** we tried to obtain it from **2** using NaOMe as base. However, to our surprise, inspection of the reaction product revealed besides small quantities of **2** and **4** a large amount of another compound. After purification the compound could be isolated in 44% yield and identified by ^{1}H, ^{13}C and COSY NMR and EI mass spectroscopy:[7] a mass peak at *m/z* 159 (M+1) corresponded to $C_7H_{10}O_4$; ^{13}C NMR peaks at δ 52 and 178 identified a methyl ester; ^{13}C NMR peaks at δ 38 and 43 and ^{1}H NMR peaks at δ 2.0 and 2.7 were consistent with deoxygenated CH and CH_2 moieties; and COSY correlations showed anomeric C next to CH_2 next to CH. All were consistent with structure **1**. The stereochemistry at C-3 could be determined by comparison with spectra of the four isomeric acetylated 1,5-anhydropentosides. Only the isomers with the 3 substituent *exo* had a J_{45} value of 0 Hz.

The compound **1** was not formed from epoxide **4**, as **4** was completely stable to prolonged treatment with NaOMe. Formation of compound **1** can be explained by a Farvorski rearrangement of an intermediate ketone **7** (or its regioisomer) as outlined in Scheme 1. The ketone can be formed by elimination of a tosylate. Attack by methoxide and ring opening of the intermediate cyclopropanone **8** apparently occur with high regioselectivity.

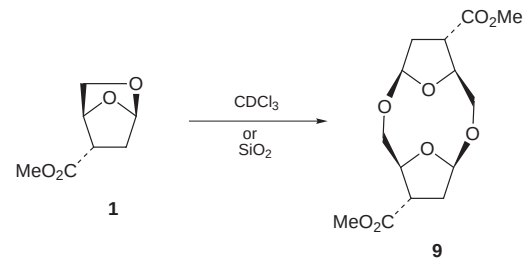
Compound **1** is a highly strained compound. On standing in $CDCl_3$ or when subjected to silica gel chromatography under non-basic conditions, **1** was spontaneously and quantitatively transformed to a new crystalline compound. X-Ray crystallographic structure determination revealed it to be the dimer **9** (Scheme 2). This structure determination also confirmed the structure and stereochemistry of **1**. To avoid the conversion of **1** to **9**, chromatography of the former was carried out with 1% Et_3N present.[8]

The tandem elimination-Farvorski rearrangement of a tritosylate is to the best of our knowledge unprecedented. To investigate its generality we also subjected tritosylarabinoside **10** and methyl 2,3,4-tri-*O*-tosyl-α-L-rhamnopyranoside to reaction with NaOMe. From the reaction of **10** Farvorski products **11** and **12** were isolated in 8 and 5% yield, respectively, together with 22% of epoxides **13** (Scheme 3). From the reaction of the tritosylrhamnoside, 29% of a mixture of Farvorski products was formed. Thus the reaction is apparently general but much less favored in these other cases.

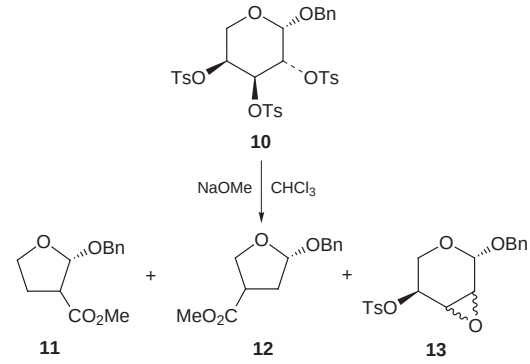
Farvorski product **1** is a useful chiral building block. Although the yield of its formation, as is common for many Farvorski rearrangements, is relatively low this is compensated



Scheme 1



Scheme 2



Scheme 3

for by the fact that branched carbohydrate chains are usually synthesised *via* multistep procedures.

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Notes and References

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7 *Selected data* for **1**: $\delta_H(CDCl_3)$ 5.65 (d, 1H, $J_{1,2exo}$ 2.0, H-1), 5.0 (d, 1H, $J_{4,5}$ 2.7, H-4), 3.6 (s, 3H, OMe), 3.5 (m, 2H, H-5a and H-5b), 2.7 (dd, 1H, $J_{2endo,3}$ 8.5, $J_{2exo,3}$ 4.5, H-3), 2.1 (ddd, 1H, $J_{2exo,2endo}$ 12.0, H-2*exo*), 2.0 (dd, 1H, H-2*endo*); $\delta_H(CDCl_3)$ 172.6 (C-3'), 100.4 (C-1), 78.1 (C-4), 68.6 (C-5), 52.2 (OMe), 44.7 (C-3), 36.6 (C-2).
8 *Typical procedure*: To tritosylate **2** (2.35 g) in $CHCl_3$ (25 ml) was added a solution of Na (400 mg) in MeOH (3 ml). The strongly exothermic reaction was left for 30 min. and then water (15 ml) and sat. aq. NH_4Cl (3 ml) was added. The phases were separated and the organic layer dried ($MgSO_4$), concentrated and the content chromatographed in EtOAc–pentane (1:4) with 1% Et_3N to give **1** (261 mg, 44%). In another identical experiment no Et_3N was added to the mobile phase during chromatography. This gave **9** in 49% yield (291 mg).

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