

## Action of Strong Acids on Acetylated Glycosides

### I. Transformation of some Aliphatic Tetraacetyl- $\beta$ -Glucosides to the $\alpha$ -Form

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While  $\beta$ -glycosides are relatively easy to prepare, there are few good methods for preparation of the corresponding  $\alpha$ -glycosides. One of the best is due to Pacsu, who found that acetylated  $\beta$ -glycosides, when treated with stannic chloride<sup>1</sup> or titanium tetrachloride<sup>2</sup> in absolute chloroform, are transformed into  $\alpha$ -glycosides. With these reagents, especially with titanium tetrachloride, acetylated  $\beta$ -glycosides of primary and secondary alcohols are easily converted into the  $\alpha$ -form.

Glycosides of tertiary alcohols, however, yield acetochlorosugars whilst phenolic glycosides and polysaccharides do not react. Similar transformations have been performed with hydrogen bromide+mercuric bromide in benzene<sup>3</sup> and with concentrated sulfuric acid in acetic anhydride<sup>4</sup>. All the catalysts mentioned are strong acids. It was of interest therefore, to investigate the action of boron trifluoride on acetylated  $\beta$ -glycosides, this being a stronger acid than those mentioned above. Another advantage is its very slight tendency to give up its halogen and consequently it ought to be a more general catalyst for the transformation of  $\beta$ -glycosides than, for example, titanium tetrachloride.

This paper deals with some experiments on aliphatic tetraacetyl-glycosides. Tetraacetyl- $\alpha$ -glucosides of methyl-, ethyl-, isopropyl-, allyl- and benzyl-alcohol have been prepared by treatment of the corresponding  $\beta$ -glucosides with boron trifluoride. Each  $\alpha$ -glucoside was also prepared by the action of titanium tetrachloride on the  $\beta$ -glucoside and the resulting products compared and proved identical. Attempts to prepare tetraacetyl- $\alpha$ -tertiary-butylglucoside have not been successful but are being continued.

Absolute chloroform solutions of the  $\beta$ -glucosides were saturated with boron trifluoride and allowed to stand at room-temperature for some time. The time necessary for complete reaction differed considerably. With tetraacetyl- $\beta$ -isopropylglucoside only 30 minutes was necessary, while the methyl derivative required 24 hours. The reactivity of the different glucosides decreases in the series: isopropyl > ethyl > methyl  $\approx$  allyl  $\approx$  benzyl. An electron repelling group seems to facilitate the reaction. Preliminary experiments with tetraacetyl- $\beta$ ( $\beta$ -chloroethyl)glucoside showed that in this case the reaction proceeds at a slower rate than with the methylglucoside. This is consistent with the observation of the effect of the agluconic group, the inductive effect of chlorine making this group electron attracting.

Table 1. Tetraacetyl- $\alpha$ -glucosides prepared.

Alkyl group	Reaction time in hours with BF <sub>3</sub>	M. p.	$[\alpha]_D^{20}$
Methyl	24	100—101°	+ 131°
Ethyl	4	61—61.5°	+ 132°
Isopropyl *	0.5	85.5—86.5°	+ 143°
Allyl *	24	51 —52°	+ 130°
Benzyl	24	109.5—110°.5	+ 142.5°

## EXPERIMENTAL PART

### Tetraacetyl- $\alpha$ -methylglucoside

A solution of 1 g tetraacetyl- $\beta$ -methylglucoside (dried over phosphorus pentoxide in a vacuum) in absolute chloroform was saturated with boron trifluoride at room temperature. A slight yellow gelatinous precipitate was formed. The mixture was allowed to stand for 24 hours at room temperature and then shaken with bicarbonate solution. The precipitate disappeared and both phases became colourless.

The chloroform solution was washed with water, dried with calcium chloride, and concentrated under reduced pressure. The residue, 0.98 g, solidified to a white crystalline mass of m. p. 97—98° and  $[\alpha]_D^{20} + 121^\circ$  \*\*. After one recrystallization from ethanol the substance had m. p. 100—101° and  $[\alpha]_D^{20} + 130^\circ$ .

Tetraacetyl- $\alpha$ -methylglucoside was also prepared by Pacsu's method with titanium tetrachloride \*. M. p. 100—101°.  $[\alpha]_D^{20} + 131^\circ$ . Mixed m. p. of the two preparations was 100—101°.

\* These substances are new.

\*\* All m. p. uncorrected. All rotations in about 2 % chloroform solution.

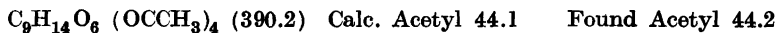
Tetraacetyl- $\alpha$ -ethylglucoside

With boron trifluoride: 1 g tetraacetyl- $\beta$ -ethylglucoside was treated analogously but the solution was allowed to stand for 4 hours only. Yield 0.91 g crystals of m. p. 60.5—61.5° and  $[\alpha]_D^{20} + 128^\circ$ .

With titanium tetrachloride: 5 g tetraacetyl- $\beta$ -ethylglucoside, 2.5 g titanium tetrachloride and 150 ml absolute chloroform were boiled for 90 minutes on the steam bath. When cold the mixture was shaken with bicarbonate solution, washed with water, dried over calcium chloride and concentrated in a vacuum. The residue was recrystallized from ethanol. Yield 4 g. M. p. 60.5—61°.  $[\alpha]_D^{20} + 130^\circ$  Mixed m. p. of the two preparations 60.5—61.5°.

Tetraacetyl- $\alpha$ -isopropylglucoside

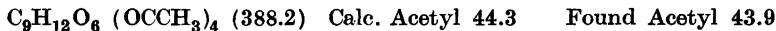
With boron trifluoride: 1 g tetraacetyl- $\beta$ -isopropylglucoside was treated as above. Time 30 minutes. Yield 0.99 g. M. p. 83—84°.  $[\alpha]_D^{20} + 122^\circ$ . After two recrystallizations from ethanol its m. p. was 85.5—86.5° and  $[\alpha]_D^{20} + 142^\circ$ . The acetyl content was determined according to Clark <sup>5</sup>.



With titanium tetrachloride: 5 g tetraacetyl- $\beta$ -isopropylglucoside, 2.5 g titanium tetrachloride and 150 ml absolute chloroform were boiled for 60 minutes on the steam bath and the glucoside isolated as above. Yield 3.9 g. M. p. 84—85°.  $[\alpha]_D^{20} + 135^\circ$ . After a further recrystallization from ethanol: M. p. 85—86°.  $[\alpha]_D^{20} + 140^\circ$ . Mixed m. p. of the two preparations 85—86°.

Tetraacetyl- $\alpha$ -allylglucoside

With boron trifluoride: 2 g tetraacetyl- $\beta$ -allylglucoside was treated as above. Time 24 hours. Yield 1.6 g of an oil which was dissolved in a small amount of ethanol and allowed to stand in the refrigerator for several days. 1.4 g colourless crystals separated. M. p. 48—50°.  $[\alpha]_D^{20} + 123^\circ$ . Recrystallized from ethanol. M. p. 51—52°.  $[\alpha]_D^{20} + 130^\circ$ .



With titanium tetrachloride: 5 g tetraacetyl- $\beta$ -allylglucoside, 2.5 g titanium tetrachloride and 150 ml absolute chloroform were heated on the steam bath for 5 hours. The mixture was worked up in the usual way. Yield 3.5 g. M. p. 49—51°.  $[\alpha]_D^{20} + 124^\circ$ . Mixed m. p. of the two preparations 49.5—51°.

Tetraacetyl- $\alpha$ -benzylglucoside

With boron trifluoride: 2 g tetraacetyl- $\beta$ -benzylglucoside in 25 ml absolute chloroform was saturated with boron trifluoride and allowed to stand for 24 hours. The solution was washed with bicarbonate and water, dried over calcium chloride and concentrated

under reduced pressure. The viscous residue which slowly solidified, was only partly soluble in ethanol. After extraction with boiling ethanol a brownish-yellow, amorphous, almost optically inactive powder remained. When the ethanol solution was poured into water 0.7 g white crystals of m. p. 99—102° separated. Recrystallized twice from ethanol. M. p. 108.5—109.5°  $[\alpha]_D^{20} + 140^\circ$ .

With titanium tetrachloride: 5 g tetraacetyl- $\beta$ -benzylglucoside, 2.7 g titanium tetrachloride and 70 ml absolute chloroform were heated for 5 hours on the steam bath. The substance was worked up in the usual way. One recrystallization from 75 % ethanol afforded 4.2 g crystals of m. p. 98—99° and  $[\alpha]_D^{20} + 142^\circ$ . The substance contained chlorine. Two further recrystallizations removed the chlorine and the substance now had m. p. 109.5—110.5° and  $[\alpha]_D^{20} + 142.5^\circ$  Mixed m. p. of the two preparations 108.5—109.5°.

$C_{13}H_{14}O_6 (OCCH_3)_4$  (438.2) Calc. Acetyl 39.3 Found Acetyl 39.0

#### SUMMARY

Five tetraacetyl- $\alpha$ -glucosides, two of which are new, have been prepared from the corresponding  $\beta$ -glucosides by a new method, using boron trifluoride as a catalyst. The glucosides were also prepared with titanium tetrachloride, and the substances prepared by the two methods were shown to be identical.

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