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# Note

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## On the preparation of carbohydrate sulfates by displacement of trifluoromethanesulfonates

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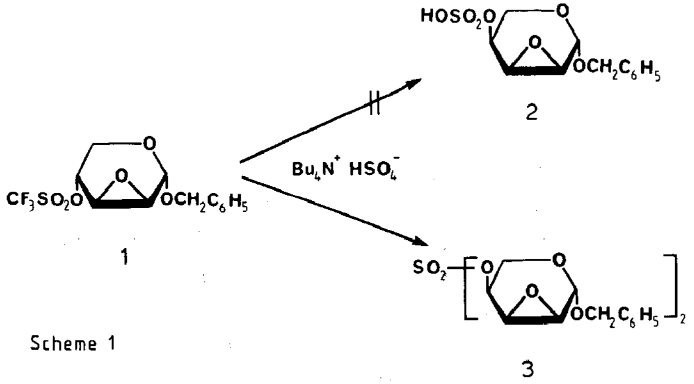
A recent paper by Latif *et.al.*[1] described the reaction of certain carbohydrate trifluoromethanesulfonates (triflates) with tetrabutylammonium hydrogensulfate in acetonitrile solution to produce hydrogensulfates. In a particular example, benzyl 2,3-anhydro-4-*O*-(trifluoromethanesulfonyl)-α-D-lyxopyranoside (**1**) was reported to undergo displacement of the triflate group by the hydrogensulfate ion to produce in 59% yield the product benzyl 2,3-anhydro-*β*-L-ribopyranoside 4-hydrogensulfate (**2**, Scheme 1).

Compound **2** was reported to be a stable, crystalline solid that could be chromatographed on silica gel with ethyl acetate–hexane elution. $^1$H- and $^{13}$C-n.m.r. spectra in support of structure **2** were provided; mass and infrared spectra were not reported[1].

In connection with some studies underway in these laboratories, there was a need for a secondary carbohydrate sulfate, and we repeated the process for preparing **2** from **1**. From this reaction a compound was obtained whose physical properties ($R_F$, m.p., and $^1$H- and $^{13}$C-n.m.r. spectra) were in excellent accord with those reported[1] for **2**.



2

1

3

Scheme 1

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However, further investigation proved that this substance was a neutral compound, rather than the acidic substance expected for structure **2**. The stability of this alleged monosulfate, together with its mobility on silica gel under ethyl acetate–hexane elution, also argue against the proposed structure **2**.

We propose that the product of reaction of triflate **1** with tetrabutylammonium hydrogensulfate is in fact the bis-sulfate **3** rather than monosulfate **2**. Compound **3** could be formed under the reaction conditions (excess hydrogensulfate salt) by proton transfer from initially formed **2** to the hydrogensulfate salt, followed by reaction with additional **1**. Compound **3** should have $^1$H- and $^{13}$C-n.m.r. spectra very close to those expected for **2**, but it would be a neutral, relatively nonpolar substance. In support of structure **3** we noted the absence of O-H absorption in the infrared spectrum, and the definitive evidence of the mass spectrum: fast-atom bombardment spectroscopy from a potassium-containing matrix gave an $m/z$ value of 545 (calc. for **3** + K, 545), and ammonia c.i. spectroscopy gave an $m/z$ value of 524 (calc. for **3** + $NH_4$, 524). An accurate mass correct to 5 p.p.m. was obtained using the l.s.i.-m.s. technique.

## EXPERIMENTAL

*General methods.* — N.m.r. spectra were obtained on a Varian Gemini 300 instrument using chloroform-*d* solvent. Chemical-ionization (c.i.) mass spectra were taken with a Finnigan TSQ-70 using a direct exposure probe at $1.3 \times 10^{-5}$ torr of ammonia, 150° source, positive-ion mode, 1000-V multiplier, and 10 KV dynode voltage. The d.c.i. probe was heated from 30 to 650 mA in 1 min. The l.s.i-m.s. accurate mass spectra were obtained with a VG 7070SEQ instrument; the sample matrix was *m*-nitrobenzyl alcohol containing potassium acetate as previously described[3]. A small amount of a 5% solution of polypropylene glycol monomethyl ether was added as internal standard. F.a.b. mass spectra were taken with the TSQ-70 in the positive-ion mode using the f.a.b. gun and the same *m*-nitrobenzyl alcohol–potassium acetate matrix. The i.r. spectra were taken on a Nicolet 5DX F.t. instrument.

*Bis(benzyl 2,3-anhydro-β-L-ribopyranoside) 4,4'-sulfate* (**3**). — A solution of benzyl 2,3-anhydro-α-D-lyxopyranoside[2] (0.222 g, 1 mmol) in dry dichloromethane (10 mL) was protected from moisture and cooled in an ice bath. Addition of dry pyridine (0.15 mL) was followed by dropwise addition of a solution of trifluoromethanesulfonic anhydride (0.16 mL, 0.27 g, 0.96 mmol) in dichloromethane (5.0 mL). After stirring for 45 min at ice-bath temperature, the solution was washed sequentially with water, 5% aq. HCl, and 5% aq. sodium hydrogencarbonate, brine, and it was dried over sodium sulfate. Evaporation of solvent at 30° provided benzyl 2,3-anhydro-4-*O*-trifluoromethanesulfonyl-α-D-lyxopyranoside (**1**) as a syrup which was used without further purification. Compound **1** was dissolved in dry acetonitrile (15 mL) and treated with dry tetrabutylammonium hydrogensulfate (0.70 g). After stirring under argon overnight, the solvent was evaporated from the reaction mixture at 30°, and the residue was extracted with ethyl acetate (5 mL). The crude product solution was flash-chromatographed on silica gel (4:1 hexane–ethyl acetate) to give **3** (0.143 g, 28%) as a homogeneous syrup. A sample crystallized from ether–hexane had m.p. 87–90° (lit.[1] for **2**, 92–3°). Compound **3** could not be extracted into aq. sodium hydrogencarbonate from ethyl acetate solution. Compound **3** had $^{13}$C- and $^{1}$H-n.m.r. spectra identical to those reported for **2**[1]. M.s.: ammonia c.i., *m/z* 524 (calc. for **3** + $NH_4$, 524). Positive-ion f.a.b., *m/z* 545 (calc. for **3** + K, 545). L.s.i.-m.s. accurate mass: calc. 545.0884, found, 545.0910. I.r. (neat film): 1198, 1140, 1096, 1055, 970, 927, 907, 861, and 700 $cm^{-1}$.

*Anal.:* Calc. for $C_{24}H_{26}O_{10}S$: C, 56.91; H, 5.17; S, 6.33. Found: C, 56.77; H, 5.33; S, 6.60.

## REFERENCES

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