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Note

Synthesis of 2-amino-2,6-dideoxy-D-glucopyranose-6-sulphonic acid

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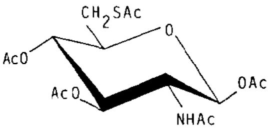
A 2-amino-2,3-dideoxyhexose-3-sulphonic acid has been identified in hydrolysates of sulphite-treated glycoproteins[1,2] and a 2-amino-2,6-dideoxyhexose-6-sulphonic acid has been found[3] in cell-wall hydrolysates of *Halococcus* sp., strain 24, although the configuration of neither compound has been established. We now report the synthesis of 2-amino-2,6-dideoxy-D-glucopyranose-6-sulphonic acid (**2**) as part of a programme on the synthesis of anionic surfactants from sugars[4].

Oxidation of 2-acetamido-1,3,4-tri-*O*-acetyl-6-*S*-acetyl-2-deoxy-6-thio-β-D-glucopyranose[5] (**1**) with 30% hydrogen peroxide in acetic acid[6] gave a mixture of **2** and its 3,4-diacetate **3**. Deacetylation of **3** gave **2**. The structures and the $^4C_1$(D) conformations of **2** and **3** were indicated by ^{1}H-n.m.r. data (Table I), and the structure of **2** was proved by an X-ray crystallography study[7].

The ^{1}H-n.m.r. data for **2** showed that, at equilibrium in D_2O, the α,β-ratio was 68:32; furanose forms were not detected. D-Glucose[8] and 2-amino-2-deoxy-D-glucose[9] show an α,β-ratio of 36:64, whereas that for 2-amino-2-deoxy-D-glucose hydrochloride[9] is 63:37 because the anomeric effect is accentuated by amino protonation[9,10]. Therefore, the amino group of **2** is protonated in solution.

Three staggered rotamers (gg, gt, and tg) are possible[11] about the C-5–C-6 bond in **2**, and the $J_{5,6}$ and $J_{5,6'}$ values indicate[12–14] that the preferred conformation is gt (**4**) as found for the hydroxymethyl group of hexopyranoses in aqueous solutions[15]. The relative shift positions of the signals for H-6 and H-6′ accord with the *syn*-upfield rule[13].



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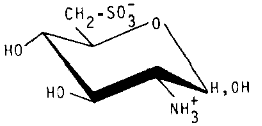

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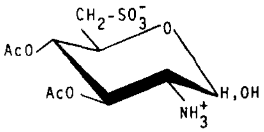

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TABLE I

^{1}H-N.M.R. DATA[a] FOR **2** AND **3** IN DEUTERIUM OXIDE

Compound	*H-1*	*H-2*	*H-3*	*H-4*	*H-5*	*H-6*	*H-6'*	*OAc*	$J_{1,2}$	$J_{2,3}$	$J_{3,4}$	$J_{4,5}$	$J_{5,6}$	$J_{5,6'}$	$J_{6,6'}$
α-**2**	5.41d	3.31dd	3.89dd	3.35dd	4.27td	3.41dd	3.09dd		3.6	10.5	8.8	9.7	1.8	9.6	−14.9
β-**2**	4.95d	3.03dd	3.68dd	3.36dd	3.83td	3.41dd	3.10dd		8.4	10.5	8.8	9.5	1.8	9.4	−14.9
α-**3**	5.50d	3.73dd	5.48dd	4.99dd	4.60td	← 3.14m →		2.12s 2.11s	3.6	10.7	9.0	9.0	—	—	—
β-**3**	5.08d	3.44dd	5.38dd	5.00dd	4.19td	← 3.14m →		2.12s 2.11s	8.4	10.7	9.0	9.0	—	—	—

[a] Assignments were confirmed by spin-decoupling experiments.

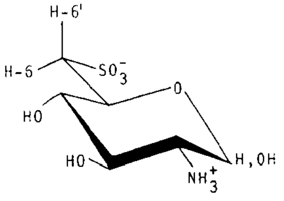

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TABLE II

^{13}C-N M R DATA FOR **2** AND **3** IN DEUTERIUM OXIDE[a]

Compound	*C-1*	*C-2*	*C-3*	*C-4*	*C-5*	*C-6*	*CO*	*CH_3*
α-**2**	89.9	55.0	70.3	73.3	68.7	52.8	—	—
β-**2**	93.6	57.4	72.6	73.3	73.3	52.8	—	—
α-**3**	89.8	52.9	70.9	72.1	66.1	52.2	174.0 173.7	21.0
β-**3**	93.5	55.3	72.1	72.1	70.8	52.4	174.0 173.7	21.0

[a] Internal 1,4-dioxane (δ 67.4).

The α,β-ratio for **3**, in deuterium oxide solution, was 76:24 and the 3,4-positions of the OAc groups are supported by an increase of ~1.6 p.p.m. in the values of the chemical shifts of the signals for H-3 and H-4 relative to the values observed for **2**.

The ^{13}C-n.m.r. data for **2** and **3** are shown in Table II, and the assignments were based on selective proton decoupling. The data resemble those for 2-amino-2-deoxy-D-glucose hydrochloride[16,17], except that replacement of HO-6 by a sulphonic acid group causes upfield shifts of ~9 and ~4 p.p.m., respectively, in the signals for C-6 and C-5, and a downfield shift of ~3 p.p.m. in the signal for C-4.

The mobility of **2** in paper chromatography (see Experimental) was quite different from that reported[3] for the naturally occurring 2-amino-2,6-dideoxyhexose-6-sulphonic acid.

EXPERIMENTAL

General. — Melting points are uncorrected. I.r. spectra were recorded for KBr discs with a Perkin–Elmer 299 spectrophotometer. ^{1}H-N.m.r. spectra (200 MHz) were recorded with a Varian XL-200 spectrometer at 20° (internal sodium 4,4-dimethyl-4-silapentane-1-sulphonate). The coupling constants were measured directly from the spectra. ^{13}C-N.m.r. spectra (50.2 MHz) were recorded with a Varian XL-200 spectrometer (internal 1,4-dioxane: δ 67.4). Optical rotations were measured immediately and after 20 h at room temperature. An automatic amino acid analyser was used with a column (31 × 1 cm) of Aminex A-9 (BioRad Laboratories) at 60° with citrate buffer (pH 6.40) and an *o*-phthalaldehyde system[18] for detection. P.c. (horizontal) was performed at 20° on Whatman No. 1 paper with *A*, 1-butanol–pyridine–water (1:1:1), and p.c. (descending) with *B*, 1-pentanol–pyridine–water (7:7:6), and *C*, ethyl acetate–pyridine–water–acetic acid (5:5:3:1). Alkaline silver nitrate and ninhydrin were used for detection.

*2-Amino-2,6-dideoxy-*D*-glucopyranose-6-sulphonic acid* (**2**) *and 3,4-di-*O*-acetyl-2-amino-2,6-dideoxy-*D*-glucopyranose-6-sulphonic acid* (**3**). — To a solution of **1** (2 g, 4 mmol) in acetic acid (10 mL) was added aqueous 30% hydrogen peroxide (3.6 mL, 36 mmol). The mixture was kept at 80° for 1 h (white precipitate), and then cooled to room temperature. The precipitate (fraction *A*, 0.35 g) was collected and the filtrate was concentrated at 0.1mm Hg to give fraction *B* (1.23 g).

Fraction *A* was recrystallised from aqueous methanol to give **3** (0.34 g, 20%), m.p. ~270° (dec.), $[\alpha]_D^{26}$ +117° (*c* 1, water), R_F 0.56 (solvent *A*); ν_{max} 1735 (C=O), 1615 and 1520 (NH_3^+), 1240 (C–O–C), 1210 and 1150 cm^{-1} (SO_3^-).

Anal. Calc. for $C_{10}H_{17}NO_9S$: C, 36.69; H, 5.23; N, 4.27; S, 9.79. Found: C, 36.84; H, 5.28; N, 4.37; S, 10.00.

A solution of fraction *B* (1.23 g) in water (30 mL) was stirred and boiled with Amberlite IR-120 (H^+) resin (14 g) for ~6 h, then filtered, and concentrated, and the residue was crystallised from aqueous methanol to yield **2** (0.37 g, 31%), m.p. ~250° (dec.), $[\alpha]_D^{22}$ +85 → +73° (*c* 1, water), R_F 0.40 (solvent *A*), R_{GlcN} 0.36 (solvent *B*) and 0.65 (solvent *C*) [*cf.* R_{GlcN} 0.49 (solvent *B*) and 0.47 (solvent *C*) reported[3] for 2-amino-2,6-dideoxyhexose-6-sulphonic acid]; mobility (relative to that of GlcN) in the amino acid analyser, 2.3; ν_{max} 1610 and 1520 (NH_3^+), 1210 and 1150 cm^{-1} (SO_3^-).

Anal. Calc. for $C_6H_{13}NO_7S$: C, 29.62; H, 5.38; N, 5.75; S, 13.18. Found: C, 29.33; H, 5.50; N, 5.71; S, 12.75.

Treatment of **3** (0.34 g) with Amberlite IR-120 (H^+) resin (4 g), using the above procedure, gave **2** (0.21 g, 80%).

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