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Sucrose Chemistry. 6. Synthesis of Amino Derivatives of Sucrose

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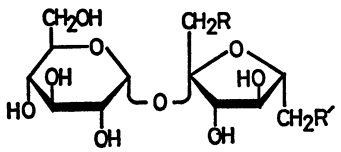
Synopsis. 6′-Amino-6′-deoxy- and 1′,6′-diamino-1′,-6′-dideoxysucrose have been prepared by azidolysis of the corresponding tosylates, followed by catalytic hydrogenation.

In connection with the preceding papers on sucrose chemistry,[1a-e] we have attempted to prepare amino derivatives of sucrose. Two triamino-trideoxysucroses[2,3] and 6-amino-6-deoxysucrose[4] have been described in the literature. In the present paper, we wish to report the synthesis of 6′-amino-6′-deoxy- (**3**) and 1′,6′-diamino-1,′-6′dideoxysucrose (**9**).



	R	R′
3 :	OH	NH_2
9 :	NH_2	NH_2

2,3,4,6,1′,3′,4′-Hepta-*O*-acetylsucrose[5-7] was treated with tosyl chloride in pyridine to give 2,3,4,6,1′,3′,4′-hepta-*O*-acetyl-6′-*O*-tosylsucrose (**1**). Nucleophilic replacement of **1** with an azide ion gave 6′-azido-6′-deoxysucrose heptaacetate (**2**). Catalytic hydrogenation of **2**, followed by de-*O*-acetylation afforded **3**.

2,3,4,6,3′,4′-Hexa-*O*-acetyl-1′,6′-di-*O*-tosylsucrose (**7**) was prepared by tosylation of 2,3,4,6,3′,4′-hexa-*O*-acetylsucrose (**6**).[8] 1′,6′-Diazido-1′,6′-dideoxysucrose hexaacetate (**8**) was obtained by azidolysis of **7**. Compound **8** was de-*O*-acetylated and subsequently hydrogenated to afford **9**. Compounds **3** and **9** showed faint astringent taste.

PMR spectra of the acetyl derivatives of **3** and **9** were determined and the methyl group signals at highest field (δ 2.00 and 2.02) were assigned definitively to those of the acetamido methyl groups on C-6′ and C-1′ by the specific deuteration technique.[11-13]

Experimental

General. Melting points were determined in capillary tubes, and are uncorrected. Solutions were evaporated under diminished pressure below 40 °C. Optical rotations were measured on a Japan Spectroscopic DIP-SL polarimeter. PMR spectra were determined at 60 MHz on a Varian A-60D spectrometer in chloroform-*d* or deuterium oxide with tetramethylsilane or sodium 4,4-dimethyl-4-silapentane-1-sulfonate as an internal standard. The peak position is given in δ-value. Tlc was performed on a silica gel (Wakogel B-10) plate, and silica gel (Wakogel C-200) was used for column chromatography.

*2,3,4,6,1′,3′,4′-Hepta-*O*-acetyl-6′-*O*-tosylsucrose (**1**).* To a solution of 2,3,4,6,1′,3′,4′-hepta-*O*-acetylsucrose[5-7] (790 mg, 1.2 mmol) in dry pyridine (20 ml), tosyl chloride (1.22 g, 6.4 mmol) was added and the mixture was agitated for 72 hr. The mixture was poured into ice cold water and extracted with chloroform repeatedly. The combined extracts were evaporated and the residue was crystallized from aqueous methanol to give **1** (780 mg, 80%), mp 120—122 °C. $[\alpha]_D^{24}$ +62.0° (*c* 1.0, chloroform). PMR data ($CDCl_3$): δ 1.99 (s, 3H, OAc), 2.02 (s, 3H, OAc), 2.06 (s, 12H, 4 OAc), 2.12 (s, 3H, OAc) and 2.45 (s, 3H, aryl-CH_3).

Found: C, 50.37; H, 5.27; S, 3.67%. Calcd for $C_{33}H_{42}O_{20}S$: C, 50.13; H, 5.35; S, 4.06%.

*2,3,4,6,1′,3′,4′-Hepta-*O*-acetyl-6′-azido-6′-deoxysucrose (**2**).* A mixture of **1** (696 mg, 0.9 mmol) and sodium azide (350 mg, 5.4 mmol) in *N*,*N*-dimethylformamide (14 ml) was heated at 130—133 °C for 24 hr under agitation. The mixture was filtered and the filtrate was evaporated. The residue was acetylated with acetic anhydride in pyridine in the usual manner to a product (515 mg). The product was subjected to chromatography on a silica gel column and the fractions which showed a single spot at R_f 0.58 in butanone–toluene(2 : 5, v/v) were collected. The solution was evaporated to give **2** (411 mg, 71%) as a glassy solid. $[\alpha]_D^{21}$ +52.4° (*c* 8.6, chloroform). PMR data ($CDCl_3$): δ 2.03 (s, 3H, OAc), 2.06 (s, 3H, OAc), 211 (s, 12H, 4 OAc), 2.18 (s, 3H, OAc) and 5.64 (d, 1H, $J_{1,2}$ 3.4 Hz, H-1).

Found: C, 47.43; H, 5.49; N, 6.35%. Calcd for $C_{26}H_{35}N_3O_{17}$: C, 47.20; H, 5.33; N, 6.35%.

*6′-Amino-6′-deoxysucrose (**3**).* Compound **2** (401 mg) was hydrogenated in ethanol (60 ml) in the presence of platinum catalyst (85 mg) at 3.4 kg/cm² of hydrogen atmosphere at 40 °C for 20 hr. After the catalyst was removed, the solution was concentrated. The residue was de-*O*-acetylated in 0.1 M sodium methoxide in methanol (13 ml) for 2 hr and the solution was neutralized with Amberlite IR-120 (H^+). The solution was evaporated and the residue was crystallized from ethanol–methanol–water (3 : 3 : 4, v/v) in a refrigerator for two weeks to give **3** (110 mg, 53%), mp 132—135 °C (dec). $[\alpha]_D^{24}$ +57.5° (*c* 1.8, water). PMR data (D_2O): δ 5.46 (d, 1H, $J_{1,2}$ 2.9 Hz, H-1).

Found: C, 42.47; H, 6.54; N, 3.93%. Calcd for $C_{12}H_{23}NO_{10}$: C, 42.22; H, 6.79; N, 4.10%.

*2,3,4,6,1′,3′,4′-Hepta-*O*-acetyl-6′-acetamido-6′-deoxysucrose (**4**).* Compound **3** (92 mg) was acetylated in the usual manner to give **4** (138 mg, 76%) as an amorphous solid. $[\alpha]_D^{25}$ +56.0° (*c* 0.54, chloroform). PMR data ($CDCl_3$): δ 2.00 (s, 6H, OAc and NAc), 2.04 (s, 3H, OAc), 2.09 (s, 6H, 2 OAc), 2.10 (s, 6H, 2 OAc), 2.17 (s, 3H, OAc) and 5.60 (d, 1H, $J_{1,2}$ 3.5 Hz, H-1).

Found: C, 49.33; H, 5.90; N, 2.27%. Calcd for $C_{28}H_{39}NO_{18}$: C, 49.63; H, 5.80; N, 2.07%.

*2,3,4,6,1′,3′,4′-Hepta-*O*-trideuterioacetyl-6′-acetamido-6′-deoxysucrose (**5**).* Compound **4** (96 mg) was dissolved in methanol (20 ml) previously saturated with ammonia. After settled overnight, the solution was evaporated and the residue was acylated with acetic anhydride-d_6 in pyridine. The product was purified on a silica gel column in acetone–chloroform (1 : 4, v/v) to give **5** (92 mg, 93%). $[\alpha]_D^{14}$ +55.1° (*c* 1.4, chloroform). PMR data ($CDCl_3$): δ 2.00 (s, 3H, NAc) and 5.62 (d, 1H, $J_{1,2}$ 3.5 Hz, H-1).

*2,3,4,6,3′,4′-Hexa-*O*-acetylsucrose (**6**).* This compound

was prepared from 2,3,4,6,3′,4′-hexa-*O*-acetyl-1′,6′-di-*O*-tritylsucrose[8,9] by detritylation with hydrogen bromide in glacial acetic acid[10] in a yield of 75%. Mp 131—132 °C. $[\alpha]_D^{18}$ +40.4° (*c* 2.24, chloroform). Found: C, 48.88; H, 5.94%. Lit,[9] mp 132 °C, $[\alpha]_D$+40.1° (*c* 2.07, chloroform). PMR data ($CDCl_3$): δ 2.00 (s, 3H, OAc), 2.04 (s, 3H, OAc), 2.07 (s, 3H, OAc), 2.08 (s, 6H, 2 OAc), 2.19 (s, 3H, OAc), 2.56 (s, 2H, 2 OH) and 5.66 (d, 1H, $J_{1,2}$ 3.5 Hz, H-1).

*2,3,4,6,3′,4′-Hexa-*O*-acetyl-1′,6′-di-*O*-tosylsucrose (**7**).* Compound **6** (830 mg, 1.4 mmol) was treated with tosyl chloride (1.33 g, 7.0 mmol) in pyridine (10 ml) for 44 hr. The reaction mixture was poured into ice cold water (100 ml) to give the crude product (1.22 g, 97%), mp 62—67 °C. $[\alpha]_D^{21}$ +57° (*c* 1.0, chloroform). PMR data ($CDCl_3$): δ 2.02 (s, 3H, OAc), 2.03 (s, 6H, 2 OAc), 2.08 (s, 6H, 2 OAc), 2.13 (s, 3H, OAc) and 2.50 (s, 6H, 2 CH_3).

Found: C, 50.64; H, 5.07; S, 6.80%. Calcd for $C_{38}H_{46}O_{21}S_2$: C, 50.55; H, 5.14; S, 7.10%.

*2,3,4,6,3′,4′-Hexa-*O*-acetyl-1′,6′-diazido-1′,6′-dideoxysucrose (**8**).* A mixture of **7** (1.22 g, 1.4 mmol) and sodium azide (0.7 g, 10.8 mmol) in DMF (30 ml) was heated and subsequently treated as described in the preparation of **2** to give **8** (0.51 g, 59%) as a glassy solid. $[\alpha]_D^{24}$ +53.7° (*c* 1.42, chloroform). PMR data ($CDCl_3$): δ 2.01 (s, 3H, OAc), 2.02 (s, 3H, OAc), 2.08 (s, 9H, 3 OAc), 2.15 (s, 3H, OAc) and 5.60 (d, 1H, $J_{1,2}$ 3.5 Hz, H-1).

Found: C, 44.61; H, 5.03; N, 12.62%. Calcd for $C_{24}H_{32}N_6O_{15}$: C, 44.72; H, 5.01; N, 13.04%.

*1′,6′-Diamino-1′,6′-dideoxysucrose (**9**).* Compound **8** (356 mg) was dissolved in 0.1 M sodium methoxide in methanol (10 ml). After settled for 2 hr, the solution was neutralized with Amberlite IR-120 (H^+), and the solution was hydrogenated as described in the preparation of **3**. The crude product was dissolved in aqueous methanol and precipitated by adding acetone to give **9** (113 mg, 60%), mp 119—124 °C (dec). $[\alpha]_D^{20}$ +77.3° (*c* 0.97, water).

*2,3,4,6,3′,4′-Hexa-*O*-acetyl-1′,6′-diacetamido-1′,6′-dideoxysucrose (**10**).* Compound **9** (157 mg) was acetylated in the usual manner and the crude product was purified by column chromatography to give an amorphous solid (119 mg, 38%). $[\alpha]_D^{21}$ +51.8° (*c* 0.74, chloroform). PMR data ($CDCl_3$): δ 2.00 (s, 3H, NAc), 2.02 (s, 6H, OAc and NAc), 2.04 (s, 3H, OAc), 2.08 (s, 6H, 2 OAc), 2.12 (s, 3H, OAc), 2.17 (s, 3H, OAc) and 5.64 (d, 1H, $J_{1,2}$ 3.5 Hz, H-1).

Found: C, 49.78; H, 6.01; N, 3.92%. Calcd for $C_{28}H_{40}N_2O_{17}$: C, 49.70; H, 5.96; N, 4.14%.

*2,3,4,6,3′,4′-Hexa-*O*-trideuterioacetyl-1′,6′-diacetamido-1′,6′-dideoxysucrose (**11**).* Compound **10** (70 mg) was de-*O*-acetylated and subsequently acylated as described in the preparation of **5** to give **11** (70 mg, 97%). $[\alpha]_D^{20}$ +51.2° (*c* 3.7, chloroform). PMR data ($CDCl_3$): δ 1.99 (s, 3H, NAc), 2.01 (s, 3H, NAc) and 5.62 (d, 1H, $J_{1,2}$ 3.5 Hz, H-1).

References

1) a) T. Suami, T. Otake, S. Ogawa, T. Shoji, and N. Kato, This Bulletin, **43**, 1219 (1970); b) T. Suami, N. Kato, M. Kawamura, and T. Nishimura, *Carbohyd. Res.*, **19**, 407 (1971); c) T. Suami, T. Otake, N. Kato, T. Nishimura, and T. Ikeda, *ibid.*, **21**, 451 (1972); d) T. Suami, T. Otake, T. Nishimura, and T. Ikeda, *ibid.*, **26**, 234 (1973); e) *Idem.*, This Bulletin, **46**, 1014 (1973).

2) S. Umezawa, T. Tsuchiya, S. Nakada, and K. Tatsuta, *ibid.*, **40**, 395 (1967).

3) R. Khan, K. S. Mufti, and M. R. Jenner, *Carbohyd. Res.*, **30**, 183 (1973).

4) I. Jezo, *Chem. Zvesti*, **25**, 364 (1971).

5) T. Otake, This Bulletin, **43**, 3199 (1970).

6) J. G. Buchanan, D. A. Cummerson, and D. M. Turner, *Carbohyd. Res.*, **21**, 283 (1972).

7) J. M. Ballard, L. Hough, and A. C. Richardson, *ibid.*, **24**, 152 (1972).

8) T. Otake, This Bulletin, **45**, 2895 (1972).

9) J. G. Buchanan and D. A. Cummerson, *Carbohyd. Res.*, **21**, 293 (1972).

10) H. Bredereck, H. Zinner, L. Wagner, G. Faber, W. Greider, and W. Huber, *Chem. Ber.*, **91**, 2824 (1958).

11) D. Horton, J. B. Hughes, J. S. Jewell, K. D. Philips, and W. N. Turner, *J. Org. Chem.*, **32**, 1073 (1967).

12) D. Horton, W. E. Mast, and K. D. Philips, *ibid.*, **32**, 1471 (1967).

13) T. Suami, S. Ogawa, Y. Naito, and H. Sano, *ibid.*, **33**, 2831 (1968).