CONCLUSIONS

The enantioselective hydrogenation of the methyl ester of N-acetyl-α-aminocinnamic acid on a catalytic chiral system based on cobalt was effected in an optical yield of 60%, which increases with increase in the phosphine/Co ratio in the catalyst and decreases with increase in the degree of conversion.

LITERATURE CITED

1. L. O. Nindakova, F. K. Shmidt, E. I. Klabunovskii, V. N. Sheveleva, and V. A. Pavlov, Izv. Akad. Nauk SSSR, Ser. Khim., 2621 (1981).
2. L. O. Nindakova, V. A. Pavlov, F. K. Shmidt, and E. I. Klabunovskii, Izv. Akad. Nauk SSSR, Ser. Khim., 2094 (1982).
3. R. F. Heck, U. S. Patent 3,270,087; Chem. Abstr., 65, 16857 (1966).
4. F. K. Shmidt, V. V. Saraev, and V. S. Levkovskii, React. Kinet. Catal. Lett., 10, 195 (1979).
5. V. V. Saraev, F. K. Shmidt, V. A. Gruznykh, L. O. Nindakova, Yu. S. Levkovskii, G. M. Larin, and V. I. Dmitriev, Koordinats. Khim., 5, 1198 (1979).
6. B. D. Vineyard, W. S. Knowles, M. J. Sabacky, G. L. Bachman, and D. J. Weinkauff, J. Am. Chem. Soc., 99, 5946 (1977).
7. A. S. C. Chan and J. Halpern, J. Am. Chem. Soc., 102, 838 (1980).
8. A. M. Aguiar, C. J. Morrow, and J. D. Morrison, J. Org. Chem., 41, 1545 (1976).

NEW METHOD FOR THE SYNTHESIS OF 2,4-DIDESOXY-2,4-DI-C-METHYL-D-GLUCOPYRANOSE DERIVATIVES

A. F. Sviridov, D. V. Yashunskii, M. S. Ermolenko, and N. K. Kochetkov

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2,4-Didesoxy-2,4-di-C-methyl-D-glucopyranose derivatives are intermediates in the synthesis of many natural compounds, including macrolide antibiotics, pheromones, etc. [1, 2]. The known methods for their preparation, which consist of either the desoxy generation of the tertiary alcohol (I) or the catalytic reduction of the methylene derivative (IV) [3] or similar derivative [4], are not optimum due to the multistep synthesis of the starting compounds.

α-Oxides are the most convenient compounds for obtaining branched sugars, and consequently the purpose of our studies was to find a convenient method for converting the readily available α-oxide (V) [5] to the desired 2,4-didesoxy-2,4-di-C-methyl-D-glucopyranose.

It is known [6] that various alkyl cuprates open the oxirane ring with a high degree of stereoselectivity. However, attempts to obtain compound (IX) by treating oxide (V) with cuprates of type Me_2CuLi, MeCuSPhLi, $MeCuC{\equiv}CC_4H_9Li$, and $Me_2CuCNLi$ proved unsuccessful due to the competing opening of α-oxide (V) by the nucleophiles (Cl^-, Br^-, CN^-, SPh^-) accompanying the cuprates.

Previously we had shown [7] that when treated with dimethylmagnesium the 4-O-benzyl analog of oxide (V) (compound (II)) is quantitatively converted to the gluco isomer (III). However, under analogous conditions the stereochemical result proved to be the reverse for α-oxide (V). The altrose isomer (VIa) was formed predominantly, since apparently attack by the nucleophile at the C^2 atom, needed for the formation of the gluco isomer (IX), is hindered by the axially oriented methyl group at C^4, and alcohol (IX) was formed only in small amount (12%).

N. D. Zelinskii Institute of Organic Chemistry, Academy of Sciences of the USSR, Moscow.

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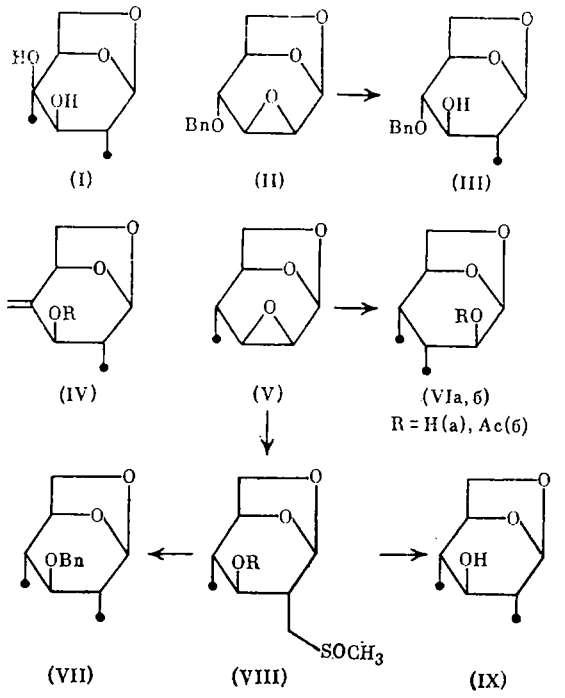

The structure of the altrose isomer (VIa) follows from a comparison of the spectral data for (VIa), (VIb), and (IX). Thus, in the PMR spectrum of (VIb) the SSCC of the protons at C^2 and C^3 is equal to 10.5 Hz, which indicates their axial orientation, whereas for the equatorially oriented protons of alcohol (IX) at C^2, C^3, and C^4 the SSCC values are small (< 0.5 Hz) (cf. [3]).

In addition, in the ^{13}C NMR spectrum of (VIb) the signal of the C^1 atom is shifted upfield when compared with its position in the ^{13}C NMR spectrum of alcohol (VIa) (β-effect), which confirms the position of the OH group at C^2. As a result, attempts to insert the methyl group in one step in the 2 position proved unsuccessful.

It is known [8] that the dimethyl sulfoxide anion stereoselectively opens the α-oxides of sugars to give sulfoxides of type (VIII), whose methyl derivatives are obtained by desulfurization, for example, by Raney nickel. Actually, it proved that the treatment of (V) with a DMSO solution of dimsylsodium and subsequent desulfurization over skeletal nickel gives the gluco isomer (IX) in 80% yield (the formation of the altrose isomer (IVa) is not observed). Decomposition of the reaction mixture (after oxide (V) was opened by the dimsylsodium) using benzyl chloride and subsequent desulfurization gave the 3-O-benzyl ether (VII) in 50% yield.

EXPERIMENTAL

The ^1H and ^{13}C NMR spectra were taken on a Bruker WM-250 instrument, using $CDCl_3$ as the solvent and TMS as the internal standard. The specific rotation was measured on a Perkin-Elmer-141 polarimeter in $CHCl_3$ solution. The reactions and purity of the obtained compounds were checked employing TLC on silica gel L (5-40 μm) and GLC on a Biochrom-21 instrument (50-m-long glass capillary column packed with XE-60). The mixtures were separated by column chromatography on silica gel (25-40 μm) using continuous linear gradients of the solvents at an excess pressure of 0.5-1.2 atm.

1,6-Anhydro-3,4-didesoxy-3,4-di-C-methyl-β-D-altropyranose (IVa) and 1,6-Anhydro-2,4-didesoxy-2,4-di-C-methyl-β-D-glucopyranose (IX). To a solution of 0.284 g of (2 mmoles) of (V) [5] in 2 ml of abs. Et_2O was added 4.5 ml of an 0.68 M solution (3 mmoles) of Me_2Mg [9] in Et_2O. The mixture was refluxed for ∿ 10 h until all of the (V) had disappeared and then it was decomposed with NH_4Cl solution, the ether layer was separated, and the aqueous layer was extracted with 20 ml of ether. The combined organic extract was washed in succession with water and satd. NaCl solution, dried over Na_2SO_4, evaporated to dryness, and the residue was chromatographed. Yield of (VIa) 0.21 g (68%), mp 68-70°C (EA:hexane), $[\alpha]_D^{23}$ −214.0° (C 1.0); yield of (IX) 0.037 g (12%), syrup, $[\alpha]_D^{22}$ 54.3° (C 1.0) (cf. [3]). ^{13}C NMR spectrum (δ, ppm) for (VIa): 12.8 and 14.3 (CH_3 at C^3 and C^4) 34.5 (C^3), 38.1 (C^4), 68.2 (C^6), 73.0 (C^2), 79.2 (C^5), 102.7 (C^1). Found: C 60.8%; H 9.1%, $C_8H_{14}O_3$. Calculated: C 60.7%; H 8.9%.

^{13}C NMR spectrum (δ, ppm) for (VIb): 12.6 and 14.2 (CH_3 at C^3 and C^4), 20.9 (CH_3COO at C^2), 30.3 (C^3), 38.4 (C^4), 68.6 (C^6), 74.7 (C^2), 78.9 (C^5), 99.8 (C^1), 170.5 (CO). ^1H NMR spectrum (δ, ppm) for (VIb): 0.92 d (3H, $J_{CH_3,3}$ = 7.5 Hz, CH_3 at C^3), 1.08 d (3H, $J_{CH_3,4}$ = 7.5 Hz, CH_3 at C^4), 1.78 m (1H, H^4), 2.08 s (2H, CH_3COO at C^2), 2.17 m (1H, H^3), 3.82 d.d. (1H, $J_{6exo,5}$ = 5 Hz, $J_{6exo,6endo}$ = 7.5 Hz, H^6_{exo}), 3.91 d.d. (1H, $J_{6endo,5}$ = 1 Hz, H^6_{exo}), 4.32 d. t. (1H, $J_{5,4}$ = 1 , H^5) 4.57 d.d. (1H, $J_{2,3}$ = 10.5 Hz, $J_{2,1}$ = 1,5 Hz, H^2), 5.32 d (1H, H^1).

1,6-Anhydro-2,4-didesoxy-di-C-methyl-β-D-glucopyranose (IX). To a solution of dimsylsodium in DMSO (1.7 N, 340 ml, 0.57 mole) was added a soltuion of 27 g (0.19 mole) of (V) in 50 ml of DMSO and the mixture was allowed to stand at ∿ 20°C for 12 h until the (V) had had disappeared. The mixture was decomposed by the successive addition of 10 ml of water and excess solid CO_2, the DMSO was vacuum-distilled, the residue was dissolved in 200 ml of EtOH, 250 ml of Raney nickel was added, and the mixture was refluxed for 2 h. Then another 250 ml of Raney nickel was added and the mixture was heated for another 2 h. The nickel was filtered, washed with MeOH, the filtrate was evaporated, and the residue was purified by chromatography. Yield 24.5 g (81.5%), syrup, $[\alpha]_D^{23}$ −56.2 (C 1.0) (cf. [3]).

1,6-Anhydro-2,4-didesoxy-2,4-di-C-methyl-3-O-benzyl-β-D-glucopyranose (VII). To a solution of dimsylsodium in DMSO (0.89 N, 450 ml, 0.4 mole) was added a solution of 23.6 g (0.17 mole) of (V) in 50 ml of DMSO and the mixture was allowed to stand at ∿ 20°C for 12 h, after which 9.5 ml (0.23 mole) of MeOH and 46 ml (0.4 mole) of BnCl were added. The mixture was stirred for 0.5 h and then decomposed with 200 ml of water, and the aqueous layer was separated and extracted with 3 × 150 ml of $CHCl_3$. The combined extract was washed with water, dried over Na_2SO_4, evaporated to dryness, the residue was dissolved in 200 ml of acetone, 100 ml of deactivated Raney nickel (by refluxing in acetone for 1 h) was added, and the stirred mixture was refluxed for 2 h, after which another 150 ml of the above deactivated Raney nickel was added, and the mixture was heated for another 2 h. The nickel was filtered, washed with MeOH, the solution was evaporated, and the residue was vacuum-distilled. Yield 20.5 g (50%), syrup , bp 134-140° (0.2 mm), $[\alpha]_D^{23}$ −58.5° (C 0.8). ^1H NMR spectrum (δ, ppm): 1.07 and 1.22 d (3H and 3H, $J_{CH_3,2}$ = $J_{CH_3,4}$ = 7.5 Hz, CH_3 at C^2 and C^4), 1.95 and 2.03 q (1H, and 1H, H^2 and H^4), 3.07 s (1H, H^3), 3.76 t (1H, $J_{6exo,6endo}$ = $J_{6exo,5}$ = 5.5 Hz, H^6_{exo}), 4.22 d (1H, H^6_{endo}), 4.26 d (1H, H^5), 4.50 AB (2H, OCH_2Ph at C^3), 5.30 s (1H, H^1), 7.32 s (5H, Ph). ^{13}C NMR spectrum (δ, ppm): 16.8 and 18.9 (CH_3 at C^2 and C^4), 38.0 and 38.7 (C^2 and C^4), 67.6 (C^6), 70.8 (OCH_2Ph at C^3), 76.5 and 81.6 (C^3 and C^5), 104.1 (C^1).

CONCLUSIONS

An efficient method was proposed for the synthesis of 2,4-didesoxy-2,4-di-C-methyl-D-glucopyranose.

LITERATURE CITED

1. N. K. Kochetkov, A. F. Sviridov, and M. S. Ermolenko, Tetrahedron Lett., 22, 4315 (1981).
2. D. E. Plaumann, B. J. Fitzsimmons, B. M. Ritchie, and B. Fraser-Reid, J. Org. Chem., 47, 941 (1982).
3. A. F. Sviridov, A. Ya. Shmyrina, O. S. Chizov, A. S. Shashkov, and N. K. Kochetkov, Bioorg. Khim., 6, 1647 (1980).
4. S. C. Soares, A. Lagrange, A. Olesker, G. Lukacs, and T. T. Ton, J. Chem. Soc. Chem. Communs., 721 (1980).
5. A. F. Sviridov, G. E. Berdimbetova, and N. K. Kochetkov, Izv. Akad. Nauk SSSR, Ser. Khim., 2572 (1982).
6. D. R. Hicks and B. Fraser-Reid, Can. J. Chem., 53, 2017 (1975).
7. A. Ya. Shmyrina, A. S. Shashkov, A. F. Sviridov, O. S. Chizhov, and N. K. Kochetkov, Bioorgan. Khim., 3, 1349 (1977).
8. M. Sharma and R. K. Brown, Can. J. Chem., 46, 757 (1968).
9. B. G. Christensen, R. G. Strahan, R. N. Trenner, B. H. Arison, R. Hirschmann, and J. M. Chemerda, J. Am. Chem. Soc., 82, 3995 (1960).