Repetition of the procedure on **17α-methyl-5α-androstane-3β,17-diol 3-acetate 17-trifluoroacetate** [mp 107–108.5 °C (from methanol); $[\alpha]_D$ −7.5°; ir CF_3COO 1770 cm^{-1}] resulted in the formation of 17α-methoxy-17β-methyl-5α-androstan-3β-yl acetate (23%): mp 94–94.5 °C (from methanol); $[\alpha]_D$ −24°; identical with an authentic sample.[10]

In the same manner were carried out the solvolyses of **1a** in MeOH in the presence of sodium acetate and of **1** in MeOH alone and in 0.92 M anhydrous methanolic lithium azide.[20]

Solvolysis of 17β-Trifluoroacetate 1 in Ethanol in the Presence of Sodium Acetate. Treatment of **1** (1.74 g, 3.9 mmol) with AcONa (1.62 g, 19.5 mmol) in EtOH (50 ml) in the above manner gave, after chromatography of the residue (1.36 g) on alumina, **17α-ethoxy-17β-methylandrost-5-en-3β-yl acetate (1e)** (147 mg, 11%): mp 96–97 °C (from MeOH); $[\alpha]_D$ −90°; ^1H NMR δ 0.68 (3 H, s, 13-Me), 1.04 (3 H, s, 10-Me), 1.10 (3 H, s, 17β-Me), 1.11 (3 H, t, J = 7 Hz, CH_3CH_2O–), 2.03 (3 H, s, 3β-OAc), 3.34 (2 H, q, J = 7 Hz, CH_3CH_2O–), 4.6 (1 H, m, 3α-H), 5.4 ppm (1 H, m, C-6 H).

Anal. Calcd for $C_{24}H_{38}O_3$ (374.5): C, 76.93; H, 10.26. Found: C, 76.93; H, 10.23.

Solvolysis of 17β-Trifluoroacetate 1 in Me_2SO in the Presence of NaN_3. **1** (4.4 g, 10 mmol) in Me_2SO (120 ml) containing NaN_3 (6.6 g, 100 mmol) was heated at 80 °C with stirring for 24 h.[21] The mixture was cooled and water was added. The product was isolated with ether, washed with water, and dried over Na_2SO_4. Evaporation of the ether gave 3.2 g of an oily residue which was chromatographed on alumina (192 g). Elution with n-hexane–benzene (7:3) gave **2** (0.23 g, 7%) followed by **3** + **4** (1.6 g), by a mixture of **3**, **4**, and **1f** (0.81 g), and by pure **17α-azido-17β-methylandrost-5-en-3β-yl acetate (1f)** (0.20 g): mp 138–139 °C (from n-hexane); $[\alpha]_D$ −109°; ir N_3 2100 cm^{-1}; ^1H NMR δ 0.75 (3 H, s, 13-Me), 1.05 (3 H, s, 10-Me), 1.29 (3 H, s, 17β-Me), 2.02 (3 H, s, 3β-OAc), 4.6 (1 H, m, 3α-H), 5.4 ppm (1 H, m, C-6 H).

Anal. Calcd for $C_{22}H_{33}N_3O_2$ (371.5): C, 71.22; H, 8.95; N, 11.33. Found: C, 71.03; H, 8.92; N, 11.29.

Elution with benzene–ether (9:1) gave 0.33 g of predominantly **1c**, mp 156–158 °C (from acetone), identical with an authentic sample[8] (trace amounts of **1b** were present). Repeated chromatographies of the mixture of **3**, **4**, and **1f** (0.81 g) on alumina as above gave more pure **1f** (0.21 g, total yield 13%) in addition to 0.6 g of **3** + **4** (total yield 69%).

In the same manner were carried out solvolyses of **1** and **1a** in Me_2SO + AcONa.

17α-Acetamido-17β-methylandrost-5-en-3β-yl Acetate (1g). To 0.2 g of $LiAlH_4$ in 10 ml of dry ether was added 0.2 g (0.54 mmol) of **1f** in 10 ml of dry ether. The mixture was stirred at room temperature for 5 h, and excess $LiAlH_4$ decomposed with AcOEt and water. The mixture was filtered and the filtrate washed with water. The ether was evaporated after drying and the crude amino derivative obtained [0.17 g, ir 3670 and 3600 (NH_2) and 3440 cm^{-1} (OH)] was directly acetylated (Ac_2O–pyridine) to give 0.21 g of 17α-acetamido-17β-methylandrost-5-en-3β-yl acetate (**1g**): mp 155–156 °C (from isopropyl ether); $[\alpha]_D$ −96°; ir 3450 (NH), 1720 (3β-OAc), and 1665 cm^{-1} (acetamido); ^1H NMR δ 0.76 (3 H, s, 13-Me), 1.04 (3 H, s, 10-Me), 1.40 (3 H, s, 17β-Me), 1.92 (3 H, s, $NHCOCH_3$), 2.01 (3 H, s, 3β-OAc), 4.6 (1 H, m, 3α-H), 5.4 (2 H, m, C-6 H and NH).

Anal. Calcd for $C_{24}H_{37}NO_3$ (387.5): C, 74.38; H, 9.62; N, 3.61. Found: C, 74.18; H, 9.49; N, 3.46.

Registry No.—**1**, 474-34-0; **1a**, 60282-52-2; **1b**, 33854-98-7; **1c**, 3090-73-1; **1d**, 60282-53-3; **1e**, 60282-54-4; **1f**, 60282-55-5; **1g**, 60282-56-6; trifluoroacetic anhydride, 407-25-0; 17α-methyl-5α-androstane-3β,17-diol 3-acetate 17-trifluoroacetate, 60282-57-7; 17α-methoxy-17β-methyl-5α-androstan-3β-yl acetate, 60282-58-8.

References and Notes

(1) D. N. Kirk and M. P. Hartshorn, "Steroid Reaction Mechanisms", Elsevier, Amsterdam, 1968, Chapters 2 and 5; "Terpenoids and Steroids", K. H. Overton, Ed., *Spec. Period. Rep.*, **1–5**, Part II, Chapter 1, Section 2.
(2) G. Just and V. Di Tullio, *Can. J. Chem.*, **42**, 2695 (1964).
(3) D. J. Barnes, M. Cole, S. Lobo, J. G. Winter, and J. M. W. Scott, *Can. J. Chem.*, **50**, 2175 (1972), and references cited therein.
(4) C. W. Marshall, R. E. Ray, I. Laos, and B. Riegel, *J. Am. Chem. Soc.*, **79**, 6308 (1957); J. A. Campbell and J. C. Babcock, U.S. Patent 3 029 263 (April 10, 1962).
(5) V. Tortorella, G. Lucente, and A. Romeo, *Ann. Chim. (Rome)*, **50**, 1198 (1960).
(6) G. Drefahl, K. Ponsold, and H. Schick, *Chem. Ber.*, **98**, 604 (1965).
(7) S. A. Julia and H. Heusser, *Helv. Chim. Acta*, **35**, 2080 (1952).
(8) K. Miescher and W. Klarer, *Helv. Chim. Acta*, **22**, 962 (1939).
(9) Obtained by repetition of the methanolysis procedure on the 17α-methyl-5α-androstane-3β,17-diol 3-acetate 17-trifluoroacetate.
(10) G. Ortar and I. Torrini, *Tetrahedron*, submitted for publication.
(11) D. N. Jones and M. A. Saeed, *J. Chem. Soc.*, 4657 (1963).
(12) M. Leboeuf, A. Cave, and R. Goutarel, *Bull. Soc. Chim. Fr.*, **6**, 2100 (1967), and references cited therein.
(13) The ethoxy group was assigned the 17α configuration by analogy with that of **1d**.
(14) G. Just and V. Di Tullio, *Can. J. Chem.*, **42**, 2154 (1964).
(15) F. X. Jarreau, B. Tchoubar, and R. Goutarel, *Bull. Soc. Chim. Fr.*, 887 (1962).
(16) The reduction could alternatively be carried on the crude solvolytic residue and the amine isolated by extracting with 2 N HCl.
(17) G. E. Arth, A. A. Patchett, T. Jefopoulus, R. L. Bugianesi, L. H. Peterson, E. A. Ham, F. A. Kuehl, Jr., and N. G. Brink, *J. Med. Chem.*, **14**, 675 (1971).
(18) D. V. Banthorpe, "Elimination Reactions", Elsevier, Amsterdam, 1963, p 155.
(19) The disappearance of the starting material was monitored by TLC.
(20) R. Huisgen and I. Ugi, *Chem. Ber.*, **90**, 2914 (1957).
(21) The intensity of the asymmetric azide stretching band was used for monitoring the reaction.

Resolution of Anomeric Ethyl 2-Amino-2-deoxy-D-glucopyranoside by Cation-Exchange Chromatography, and Its N-Acylation with Carboxylic Anhydrides

Shigehiro Hirano,* Makoto Ishigami, and Yasuo Ohe

Department of Agricultural Biochemistry, Tottori University, Tottori 680, Japan

Received June 12, 1975

Ethyl 2-acetamido-2-deoxy-β-D-glucopyranoside is found in some microorganisms[1] and has a growth-promoting activity (the bifidus activity) for *Lactobacillus bifidus* var. *pennsylvanicus*.[2,3] The bifidus activity is found in the β anomer only, but the α anomer is inactive.[2,3] Little is known about the structural specificity of the *N*-acyl group for the bifidus activity.[4] Therefore, a modification of the *N*-acyl group is of significance from these points of view. The bifidus activity was originally observed with oligosaccharides[5] and glycopeptides[5,6] present in human milk.

The anomeric mixtures are generally produced in the course of the preparation of glycosides by the Fischer method,[7a] and the anomeric resolution is one of the important tasks. In the past, the resolution of anomeric hexosaminides in a preparative scale has been performed by differential solubilities in various solvents[7b] or, more recently, by anion-exchange chromatography utilizing the difference in acidities of the glycoside bonds.[8]

The present paper reports a novel and facile method for the anomeric resolution of ethyl 2-amino-2-deoxy-D-glucopyranoside by cation-exchange chromatography utilizing the difference in basicities of the amino groups, and the preparation of some novel *N*-acyl derivatives by N-acylation with carboxylic anhydrides.

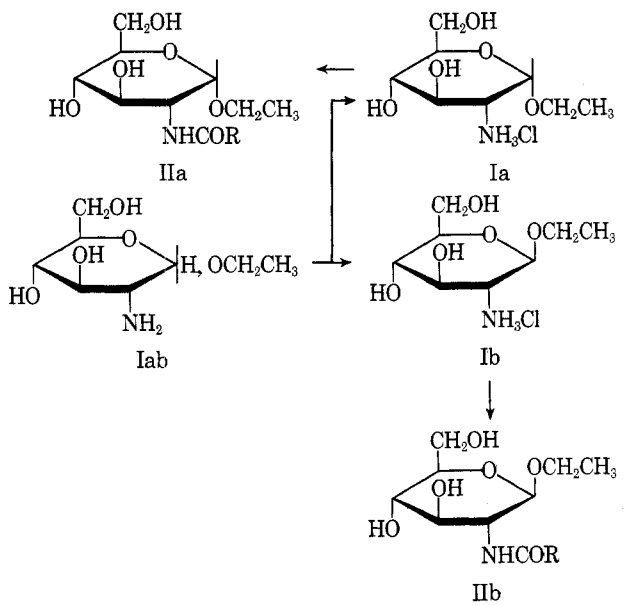
Results and Discussion

The anomeric ethyl 2-acetamido-2-deoxy-D-glucopyranoside was N-deacetylated with 1.0–6.0 N NaOH in a boiling water bath for 1–5 h. The extent of N-deacetylation was analyzed by the ninhydrin reaction and by an amino acid analyzer. The maximum yield (42.6% Ia and 39.8% Ib) was obtained by treating with 2.0 N NaOH in a boiling water bath for 3 h, and the reaction with 6.0 N $Ba(HO)_2$ under these conditions afforded 35.0% Ia and 24.1% Ib. Product degradation occurred with 3.0–6.0 N NaOH in the reaction for 4 h and longer, and N-deacetylation was incomplete in the reactions with 1.0 N NaoH for 1 h and shorter. The degradation was evident by the detection of a strong NH_3 peak by the amino acid analyzer.

Table I. Ethyl 2-Acylamino-2-deoxy-D-glucopyranosides Prepared by the Reaction of Fatty Acid Anhydrides[f]

Acylamino group[a]	Anomeric configuration	Mp, °C	$[\alpha]^{20}D$, deg	Yield, %	Registry no.
Propionyl	α	162–166	+134 (c 0.5, water)	54.0	32469-95-7
	β	172	−17.8 (c 0.45, methanol)	58.0	32469-96-8
Butyryl	α	169–171	+100 (c 0.46, water)	57.0	60538-24-1
	β	169–172	−42.6 (c 0.68, water)[b]	93.0	60538-25-2
Caproyl	α	172–174	+107 (c 0.44, water)	56.0	60538-26-3
	β	173–175	−10.2 (c 0.44, water)	n.d.[c]	60538-27-4
Capryloyl	α	160–163	+134 (c 0.73, methanol)	83.6	60538-28-5
	β	191–193	−17.7 (c 0.62, methanol)	54.0	60538-29-6
Caprinoyl	α	163–164	+116 (c 0.83, methanol)	64.0	60538-30-9
	β	203–205	−14.1 (c 1.1, methanol)	n.d.	60538-31-0
Lauroyl	α	159–163	+110 (c 0.53, methanol)	92.3	60538-32-1
	β	206–208	−13.9 (c 0.96, methanol)	88.0	60538-33-2
Myristoyl	α	167–169	+70.5 (c 0.53, methanol)	60.0	60538-34-3
	β	205–207	−16.6 (c 0.96, methanol)	73.0	60538-35-4
Palmitoyl	α	160–163	+78.8 (c 0.8, methanol)	68.6	60538-36-5
	β	200–203	−13.0 (c 1.0, methanol)[e]	87.7	60538-37-6
Stearoyl	α	130–133	+60.0 (c 0.5, methanol)[d]	87.7	60538-38-7
	β	202–205	−18.6 (c 1.0, methanol)[e]	84.0	60538-39-8

[a] The reaction of ethyl 2-amino-2-deoxy-β-D-glucopyranoside with acetic anhydride by the present procedure produced ethyl 2-acetamido-2-deoxy-β-D-glucopyranoside (76%): mp 177–180 °C; $[\alpha]^{20}D$ −41.0° (c 1.0, water) [lit.[13] mp 178–180 °C; $[\alpha]^{20}D$ −42.5° (water)]. [b] $[\alpha]^{23}D$ −17.4° (c 1.1, methanol). [c] Not determined. [d] Measured at 33 °C because of its slight solubility in methanol at 20 °C. [e] Measured at ~50 °C because of its slight solubility in methanol at 20 °C. [f] All C, H, and N analyses of the compounds listed in the table were within 0.5% of theoretical.



A portion of the anomeric ethyl 2-amino-2-deoxy-D-glucopyranoside (Iab) was analyzed on the amino acid analyzer, and it showed the presence of two components: R_{NH_3} 0.56 (the α anomer) and 0.47 (the β anomer).[9] The anomers (Iab) resolved clearly on a column of Amberlite CG 120 (H^+) eluted with 0.3 N HCl, and this elution pattern in a preparative scale was essentially similar to that in the amino acid analyzer.

Each amino group of the anomeric hexosaminides has a unique basicity.[9] This is due to an anomeric effect associated with the dipole–dipole interaction of aglycons.[10] The α anomer ($K_a = 1.95 \times 10^{-8}$) of 2-amino-2-deoxy-D-glucose is more basic than the β anomer ($K_a = 5.3 \times 10^{-8}$).[11] The difference in basicity is utilized in the present study for the anomeric resolution of Iab in a preparative scale by cation-exchange chromatography.

Each of Ia and Ib was converted to the free base by the addition of sodium methoxide (1.0 molar equiv to hexosaminide) in methanol, and its N-acylation was performed with carboxylic anhydride (1.2 molar equiv) by our procedure as reported previously.[12] The *N*-acyl derivatives (IIa and IIb) were isolated in 54–93% yields (Table I). IIa and IIb are soluble in methanol but insoluble in petroleum ether (bp 30–70 °C) and ethyl ether. *N*-Acyl derivatives of the lower member of fatty acids (C_2–C_6) are soluble in water but those of the higher member of fatty acids (C_8–C_{18}) are slightly soluble or almost insoluble in water. The α anomer of the *N*-palmitoyl derivative is very soluble in methanol at room temperature but the β anomer is slightly soluble in this solvent. Both the α and β anomers of the *N*-stearoyl derivative are slightly soluble in methanol. The β anomer of the *N*-benzoyl derivative is soluble in water but the α anomer is insoluble. IIa and IIb are expected to be active in the bifidus assay. All of these products are novel, but the *N*-acetyl derivative has been reported.[13]

All the *N*-acyl derivatives isolated show strong ir absorptions at ~1650 (C=O in *N*-acyl) and ~1540 (N–H in *N*-acyl) and at 2920–2850 cm^{-1} (C–H in fatty acid), but these products show the disappearance of ir absorptions at ~1750 (C=O in *O*-acyl) and ~1240 cm^{-1} (C–O in *O*-acyl).

A weak ir absorption at ~855 cm^{-1} appears in all the α-D anomers, and that at ~870 cm^{-1} appears in all the β-D anomers.[14] Furthermore, the anomeric configuration is confirmed by their specific rotations (Table I). The *N*-propionyl, butyryl, and caproyl derivatives of anomerically pure ethyl 2-amino-2-deoxy-D-glucopyranoside show H-1 of the α anomer at δ 4.85–4.86 ppm as a doublet with $J_{1,2}$ = 3.0 Hz, H-1 of the β anomer at δ 4.54–4.68 ppm as a doublet with $J_{1,2}$ = 10.0–11.0 Hz, and the corresponding *N*-acyl protons in the NMR spectra.

Table I summarizes the melting points, specific rotations, yields, and elemental analysis of both the pure anomers.

Experimental Section

Melting points were measured on a Yanagimoto SP-2 apparatus and are uncorrected. NMR spectra were recorded at 60 MHz on a Hitachi R-24 spectrometer in D_2O using sodium 2,2,3,3-tetradeuterio-3-(trimethylsilyl)propionate as an internal standard, and ir spectra on a Hitachi 215 grating spectrometer (KBr). Specific rotations were recorded in methanol using a cell of path length 1.0 cm on a Yanagimoto OR-50 automatic polarimeter.

The anomeric mixture of ethyl 2-amino-2-deoxy-D-glucopyranoside was analyzed with a Hitachi KLA-2 amino acid analyzer as reported previously.[9]

Elemental analysis was performed at the Elemental Analysis Center of Kyoto University, Kyoto.

Ethyl 2-Amino-2-deoxy-D-glucopyranoside (Iab). The anomeric mixture of ethyl 2-acetamido-2-deoxy-D-glucopyranoside was prepared by refluxing 2-acetamido-2-deoxy-D-glucose in the presence of dry IRA 120 (H^+) resin in anhydrous ethanol for 5 h. The anomeric mixture (500 mg), $[\alpha]^{23}D$ +35.7° (c 1.02, water), was dissolved in 10 ml of 2.0 N NaOH and the solution was kept in a boiling water bath for 3 h. After cooling to room temperature, the reaction mixture was neutralized with 2.0 N HCl and diluted with distilled water to ~150 ml.

Ethyl 2-Amino-2-deoxy-α-D-glucopyranoside (Ia) and Ethyl 2-Amino-2-deoxy-β-D-glucopyranoside (Ib). The diluted solution of **Iab** obtained above was applied to a column (2.7 × 52 cm) of Amberlite CG 120 (H^+). The column was eluted with 0.3 N HCl at a flow rate of 30 ml/h, and fractions of 7.0 g each were collected. A screening test was carried out by the ninhydrin reaction. Each of the peaks was combined and concentrated in vacuo to dryness. Crystallization was performed from a mixture of water, ethanol, and ethyl ether, and two recrystallizations from the same solvent. Ethyl 2-amino-2-deoxy-α-D-glucopyranoside hydrochloride (Ia) was isolated from fractions 139–157, yield 213 mg (42.6%): mp 199–203 °C; $[\alpha]^{23}D$ +135° (c 0.48, water) [lit.[15] mp 197–198 °C; $[\alpha]^{19}D$ +129.2° (c 0.4, water)]. The β anomer (Ib) was isolated from fractions 123–135, yield 199 mg (39.8%): mp 227–228.5 °C; $[\alpha]^{24}D$ −18.7° (c 0.48, water) [lit.[16] mp 213–214 °C; $[\alpha]D$ −27.8° (water)].

Ethyl 2-Acylamino-2-deoxy-α-D-glucopyranosides (IIa) and Ethyl 2-Acylamino-2-deoxy-β-D-glucopyranosides (IIb). Each of Ia and Ib (72.9 mg each) was placed in 0.5 ml of anhydrous methanol involving 7 mg of Na. Upon gentle swirling, NaCl separated and was removed by filtration and washed with 0.5 ml of anhydrous methanol. An amount of carboxylic anhydride (1.2 molar equiv to Ia or Ib) was added at room temperature with stirring. In the case of the anhydride of the fatty acids higher than C_{12}, an additional 2.0 ml of methanol was added to the mixture and the mixture was warmed at ~60 °C for a few seconds. The mixture was allowed to stand at room temperature overnight, and ethyl ether and petroleum ether (bp 30–70 °C) were added. The mixture was kept in a refrigerator to give crystals, and two recrystallizations were performed from ethanol, ethyl ether, and petroleum ether. It was essential for analysis to remove a trace of NaCl contaminated through the recrystallizations. The crystalls were filtered, washed with ethyl ether, and dried over P_2O_5 in vacuo at 100 °C for 2 h. Table I shows the anomerically pure *N*-acyl derivatives thus prepared in the reaction with the anhydrides of fatty acids.

Ethyl 2-Benzamido-2-deoxy-α-D-glucopyranoside. The above procedure was applied to the preparation of the title compound by using benzoic anhydride, yield 93.2%: mp 199–202 °C; $[\alpha]^{20}D$ +85.4° (c 0.48, methanol); ir (KBr) 3500–3300 (OH, NH), 1630 (C=O in *N*-benzoyl), 1540 (N–H in *N*-benzoyl), 1140–1030 (C–O–C), 850 cm^{-1} (the α-D configuration).

Anal. Calcd for $C_{15}H_{21}O_6N$: C, 57.86; H, 6.80; N, 4.50. Found: C, 57.63; H, 7.00; N, 4.40.

Ethyl 2-Benzamido-2-deoxy-β-D-glucopyranoside. The same procedure was applied to prepare the title compound, yield 55%: mp 192–195 °C; $[\alpha]^{21}D$ −40.3° (c 0.62, water); λ_{max} (water) 230 nm (ε 6400); ir (KBr) 3450–3250 (OH, NH), 1630 (C=O in *N*-benzoyl), 1550 (N–H in *N*-benzoyl), 1070–1020 (C–O–C), 870 cm^{-1} (the β-D configuration); NMR (D_2O) δ 1.05 (t, 3 protons, CH_3), 3.72 (q, 2 protons, CH_2), 4.65 (d, 1 proton, $J_{1,2}$ = 7.0 Hz, H-1), 7.55 ppm (m, 5 protons, phenyl).

Anal. Calcd for $C_{15}H_{21}O_6N$: C, 57.86; H, 6.80; N, 4.50. Found: C, 57.77; H, 7.08; N, 4.54.

Registry No.—Ia, 57120-95-3; Ib, 6835-60-5; ethyl 2-benzamido-2-deoxy-α-D-glucopyranoside, 60538-40-1; benzoic anhydirde, 93-97-0; ethyl 2-benzamido-2-deoxy-β-D-glucopyranoside, 60538-41-2; propionic anhydride, 123-62-6; butyric anhydride, 106-31-0; caproic anhydride, 2051-49-2; caprylic anhydride, 623-66-5; capric anhydride, 2082-76-0; lauric anhydride, 645-66-9; myristic anhydride, 626-29-9; palmitic anhydride, 623-65-4; stearic anhydride, 638-08-4.

References and Notes

(1) S. Pope, R. M. Tomarelli, and P. György, *Arch. Biochem. Biophys.*, **68**, 326 (1957).
(2) C. S. Rose, R. Kuhn, F. Zilliken, and P. György, *Arch. Biochem. Biophys.*, **49**, 123 (1954).
(3) F. Zilliken, C. S. Rose, G. A. Braun, and P. György, *Arch. Biochem. Biophys.*, **54**, 329 (1955).
(4) R. Lambert and F. Zilliken, *Arch. Biochem. Biophys.*, **110**, 544 (1965).
(5) A. Gaube, P. György, J. R. E. Hoover, R. Kuhn, C. S. Rose, H. W. Rullius, and F. Zilliken, *Arch. Biochem. Biophys.*, **48**, 214 (1954).
(6) S. Hirano, H. Hayashi, T. Terabayashi, K. Onodera, S. Iseki, N. Kochibe, Y. Nagai, N. Yagi, T. Nakagaki, and T. Imagawa, *J. Biochem. (Tokyo)*, **64**, 563 (1968).
(7) (a) R. H. Pater, R. A. Coelho, and D. F. Mowery, Jr., *J. Org. Chem.*, **38**, 3372 (1973); (b) G. N. Bollenback, *Methods Carbohydr. Chem.*, **2**, 326 (1963).
(8) (a) Y. Matsushima, T. Miyazaki, and J. T. Park, *J. Biochem. (Tokyo)*, **54**, 109 (1963); (b) Y. Matsushima and T. Miyazaki, *Bull. Chem. Soc. Jpn.*, **38**, 1325 (1965); (c) A. Neuberger and B. M. Wilson, *Carbohydr. Res.*, **17**, 85 (1971); (d) S. Beychok, G. Ashwell, and E. A. Kabat, *ibid.*, **17**, 19 (1971).
(9) S. Hirano, N. Akimoto, M. Ishigami, and Y. Koga, *Anal. Biochem.*, **66**, 627 (1975).
(10) J. E. Stoddart, "Stereochemistry of Carbohydrates", Wiley-Interscience, New York, N.Y., 1971, pp 72–87.
(11) (a) A. Neuberger and A. P. Fletcher, *Carbohydr. Res.*, **17**, 79 (1971); (b) A. Neuberger and A. P. Fletcher, *J. Chem. Soc. B*, 179 (1969); (c) S. Inouye, *Chem. Pharm. Bull.*, **16**, 1134 (1968).
(12) (a) Y. Inouye, K. Onodera, S. Kitaoka, and S. Hirano, *J. Am. Chem. Soc.*, **78**, 4722 (1956); (b) Y. Inouye, K. Onodera, S. Kitaoka, and S. Hirano, *J. Org. Chem.*, **25**, 1265 (1960).
(13) R. Kuhn and W. Kirschenlohr, *Chem. Ber.*, **86**, 1331 (1953).
(14) (a) S. A. Barker, E. J. Bourne, M. Stacey, and D. H. Whiffen, *J. Chem. Soc.*, 171, 3468, 4211 (1954); (b) H. Spedding, *Adv. Carbohydr. Chem.*, **19**, 23 (1964).
(15) P. F. Lloyd and G. P. Roberts, *J. Chem. Soc.*, 2962 (1963).
(16) J. C. Irvine and J. C. Hynd, *J. Chem. Soc.*, 103 (1913).

Selectivity in the Reduction of Enantiomers of Hexahelicene in an Optically Active Solvent

S. I. Weissman

Department of Chemistry, Washington University, St. Louis, Missouri 63130

Received August 10, 1976

The reduction of aromatic molecules to their anions by alkali metals is now a well-established chemical process. Soon after the identification of the reduction products as anions it was recognized that interactions involving the anions, the solvent, and the alkali metal counterions play an important part in the behavior of the systems. It has also been recognized for a long time that interactions between chiral solvents and solutes produce a variety of observable effects such as induced optical activity in nonchiral solutes and selective formation of enantiomers of chiral products in chemical reactions. Examples of the latter phenomena are provided by Wright's observations that reductions carried out in one of the enantiomers of dimethoxybutane are selective among the enantiomers of chiral products.[1-4]

In this note I describe experiments which were intended to isolate some features of solvent–anion interaction through a study of the selective reduction to their mononegative anions of the enantiomers of hexahelicene in the optically active solvent (+)-2,3-dimethoxybutane (DMB). Because of the stability of the anions of hexahelicene and the enormous rotation and circular dichroism of neutral hexahelicene the system is ideal for the observation of small effects. The reactions were followed by recording the circular dichroism spectra of a solution of hexahelicene in the optically active solvent subsequent to successive reductions by a potassium mirror. The standard high vacuum methods for handling solutions of radical anions were used. The apparatus was fitted with two quartz optical cells, one with a 0.10-mm light path, the other with a 1.00-mm path. Either cell could be inserted into the light beam of a Jasco J-20 spectropolarimeter. Readings were as reproducible on removal and reinsertion of the cells as they were on successive recordings during which the cells were not removed. For the experiments with the optically active solvent, the shorter light path was used in order to minimize contributions in the 300–350-nm region of the tail of the ultraviolet circular dichroism peak of DMB.