Sorboses. III. The Acetonization of L-Sorbose by Ketal Interchange[1]

By Kanji TOKUYAMA and Etsuko HONDA

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In a previous paper,[1] the reaction mechanism of the acid-catalyzed acetonization of L-sorbose (I) with acetone was reported. The acetonized derivatives proved to be useful materials for the production of L-ascorbic acid. However, when the most important derivative, 2, 3 : 4, 6-di-*O*-isopropylidene-α-L-sorbofuranose (II),[2] is formed from I with acetone, it is desirable to remove the water formed during the reaction in order to move the equilibrium toward the favorable side. As azeotropic procedures and the use of various dehydrating agents brought no improvement, we turned to a ketal interchange reaction,[3] that is, to a reaction with a ketal of acetone in the presence of an acid, because no water was formed.

The reaction of I with 2, 2-diethoxypropane[4] (acetone diethyl ketal) in the presence of *p*-toluenesulfonic acid gave a crystalline sirup, whose gas chromatogram exhibited three major components (A, B, and C). L-Sorbose (I), 1, 2-*O*-isopropylidene-α-L-sorbopyranose (III)[1] and 2, 3-*O*-isopropylidene-α-L-sorbofuranose (IV)[1] were detected only as minor spots on thin layer chromatography. The major products, A, B, and C, were separated in pure states by fractional gas chromatography. The infrared absorption spectra showed that all the products had a furanose ring[5] and that the product B was identical wih the desired II.

The product A had a hydroxyl group, which was not considered to be primary because it did not react with trityl chloride. On the basis of these facts and the optical rotation, the structure of the product A was determined to be 1, 2 : 4, 6-di-*O*-isopropylidene-α-L-sorbofuranose (V). The product C had one ethoxy and no hydroxyl group, and it was converted into II by partial hydrolysis. Therefore, the structure of the product C was determined to be 1-*O*-1′-ethoxyisopropyl-2, 3 : 4, 6-di-*O*-isopropylidene-α-L-sorbofuranose (VI).

No change in ultraviolet absorption spectra was observed throughout the course of the reaction.[1] The interchange was also achieved from IV,[6] but not from III, which is a key intermediate in the acetonization with acetone in which only II was obtained as a major product. Consequently, we would like to suggest that the acetonization of I with ketal proceeds on the path, $\mathrm{I} \rightarrow \mathrm{IV} - \mathrm{II} \rightarrow \mathrm{VI}$, which is quite different from the process of the acetonization with acetone, $\mathrm{I} \rightarrow \mathrm{III} \rightarrow \mathrm{II} \rightleftarrows \mathrm{IV}$.

Experimental[7]

The Ketal Interchange of L-Sorbose (I) with 2, 2-Diethoxy-propane. — Dry, powdered L-sorbose (I) (19.5 g.) was added to a solution of *p*-toluenesulfonic acid (0.5 g.) in 2, 2-diethoxypropane (100 ml.). The dissolution of I was completed after stirring it for 4 hr. at room temperature.[8] The solution was neutralized with ethanolic sodium ethylate, the solvent was removed in vacuo, and the residue was distilled to give a pale yellow sirup (12.7 g.) (b. p. 120~160°C/2 mmHg), which crystallized on cooling. The sirup was fractionated by gas chromatography under the following conditions :[9] Column — silicone 550 (HCl-treated). Flow rate—hydrogen, 200 ml./min. Temperature — 200°C. Sample used : 30~33 mg. (5 times). Yields : V, 18 mg., II, 69 mg., and VI, 43 mg. Retention times : V, 14 min., II, 18 min. and VI, 22.5 min. Ratio of area : V, 19 : II, 67 : VI, 44.

V :[10] colorless rods, m. p. 72~73°C (recrystallized from *n*-hexane), $[\alpha]^{23}_{D}$ −23.9 (*c* 1.059, acetone). Found : C, 55.32 ; H, 7.63. Calcd. for $C_{12}H_{20}O_6$ (260) : C, 55.39 ; H, 7.79%.

VI :[11] colorless needles, m. p. 99~100°C (recrystallized from *n*-hexane), $[\alpha]^{25}_{D}$ +1.3 (*c* 1.109, acetone). Found : C, 58.25 ; H, 8.73 ; OC_2H_5, 12.97. Calcd. for $C_{17}H_{30}O_7$ (346) : C, 58.94 ; H, 8.73 ; OC_2H_5, 13.00%.

Partial Hydrolysis of VI. — The mixture of VI (170 mg.) and 60% acetic acid (2 ml.) was warmed at 80°C for 40 min. After cooling, the solution was made alkaline with sodium carbonate, the

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[2] T. Reichstein, *Helv. Chim. Acta*, **17**, 311 (1934).

[3] J. Angyal and R. M. Hoskinson, *J. Chem. Soc.*, **1962**, 2985.

[4] C. D. Hurd and M. A. Pollack, *J. Am. Chem. Soc.*, **60**, 1905 (1938).

[5] K. Tokuyama, M. Kiyokawa and N. Hōki, This Bulletin, **36**, 1392 (1963).

[6] In this case, scarcely any V was detected.

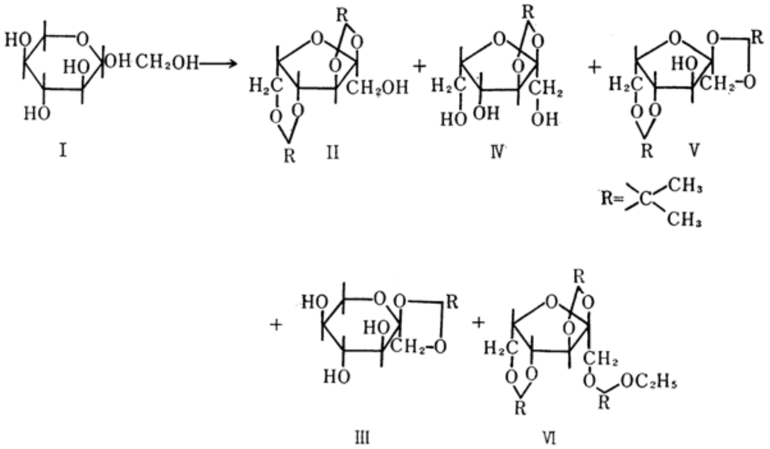
[7] All melting points are uncorrected.

[8] The higher the reaction temperature, the shorter the reaction time.

[9] The fractionation was carried out by Dr. S. Sumimoto and his co-workers.

[10] As temperature rose, the yields of V became lower.

[11] Since VI was insoluble in water, it was easily isolated by washing the sirup with water. From the aqueous solution, II was extracted with chloroform with no accompanying V, because V was immediately decomposed to I by water.



solvent was removed in vacuo, the residue was extracted with acetone and the acetone was distilled off to obtain a sirup. Recrystallization of the sirup from *n*-hexane gave 100 mg. of II (m. p. 87°C).

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Shionogi Research Laboratory
Shionogi & Co., Ltd.
Fukushima-ku, Osaka