[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE OHIO STATE UNIVERSITY]

Dibenzylidene-xylitol and its Reaction with Tetraacetyl-D-glucosyl Bromide; Dibenzylidene-L-fucitol

BY M. L. WOLFROM, W. J. BURKE AND E. A. METCALF

In attempts to synthesize a glycoside of a sugar alcohol, dibenzylidenexylitol[1] was condensed with tetraacetyl-D-glucosyl bromide and the resultant product was isolated in two isomeric forms. It is probable that the dibenzylidene-xylitol was unsymmetrically substituted and was thus racemic. An additional complication is introduced by the aldehydic carbon of each of the benzylidene groups being asymmetrically substituted. Four racemic forms are thus possible. The resolution by the optically active sugar reagent then led to the isolation of two of the theoretically possible eight diastereoisomers. Attempts to remove the substituent groups from the condensation products led to no definitive crystalline products.

The structure of dibenzylidene-xylitol is presently unknown. Hann, Ness and Hudson[2] have prepared 2,4-benzylidene-xylitol by the periodate cleavage of 2,4-benzylidene-D-glucitol. These same workers have reported[3] a sound proof of structure for 2,4-methylene-xylitol and D,L-(2,4:3,5-dimethylene-xylitol) and have shown[4] that in D,L-(di-*i*-propylidene-xylitol) position one is free. It is therefore probable that in dibenzylidene-xylitol a primary hydroxyl group is open and this view is further supported[5] by the reaction of its *p*-toluenesulfonate ester, herein reported, with sodium iodide and also by the ready formation of a triphenylmethyl ether.

With the objective of extending these reactions to another sugar alcohol having only one position free, dibenzylidene-L-fucitol was prepared but lack of time has prevented its further study.

Experimental

Preparation of Dibenzylidene-xylitol.—A dibenzylidene-xylitol of melting point 175° was recorded by Lobry de Bruyn and Alberda van Ekenstein[1] without the citation of any preparative details. To 8 ml. (2.2 moles) of benzaldehyde was added 5 g. of xylitol[6,7] and 10 ml. of cold 50% sulfuric acid. A crystalline product began to form almost immediately. The reaction mixture was cooled and in five minutes it was a solid mass. The crude product was poured into a mixture of ice and water. Aqueous sodium hydroxide was added until the solution was slightly basic. The product was removed by filtration, washed successively with water and ether, and recrystallized from pyridine–water and from ethanol; yield 5 g., m. p.[6] 187.5–188° (cor.).

Dibenzylidene-xylitol *p*-Toluenesulfonate.—*p*-Toluenesulfonyl chloride (2.0 g.) and dibenzylidene-xylitol (1.5 g.) were dissolved in 15 ml. of dry pyridine and maintained at room temperature. Crystallization ensued in a few days and was enhanced by the addition of ethanol and standing at ice-box temperature. The crystals were then removed by filtration and washed with ethanol; m. p. 143–144°. Pure material in the form of colorless needles was obtained on recrystallization from pyridine–ethanol; m. p. 155–156°.

Anal. Calcd. for $C_{26}H_{26}O_7S$: C, 64.71; H, 5.43; S, 6.64. Found: C, 64.79; H, 5.48; S, 6.86.

This substance was recovered unchanged on heating in an acetone solution of sodium iodide at 60° for four days. It reacted on heating an amount of 2.4 g. with a 2-molar quantity (1.5 g.) of sodium iodide in 50 ml. of acetonylacetone for forty hours at 100 ± 5°; yield of separated sodium *p*-toluenesulfonate 66%.

Dibenzylidene-xylitol Triphenylmethyl Ether.—One gram (1 mole) of dibenzylidene-xylitol and 1.1 g. (1.2 moles) of triphenylmethyl chloride were dissolved in 10 ml. of dry pyridine and the solution was maintained at room temperature for four days. Crystallization was effected by the addition of ethanol and standing at ice-box temperature; yield 1.6 g., m. p. 209–210°. Pure material in the form of elongated prisms was obtained on further crystallization from pyridine–ethanol; m. p. 210°.

Anal. Calcd. for $C_{19}H_{19}O_5[C(C_6H_5)_3]$: C, 79.98; H, 6.00; $C(C_6H_5)_3$, 42.63. Found: C, 79.70; H, 6.07; $C(C_6H_5)_3$,[8] 42.57.

Dibenzylidene-L-fucitol [Dibenzylidene-L-(6-desoxy-dulcitol)].—L-Fucitol[9] (1.0 g.) was dissolved in a mixture of 1.5 ml. of benzaldehyde and 1.5 ml. of 50% sulfuric acid. In about four hours a crystalline substance separated. The mixture was allowed to stand overnight whereupon the product was removed by filtration and washed successively with water, dilute sodium hydroxide, water and ether. Pure material was obtained on further crystallization from ethanol; yield 0.3 g., m. p. 115–116°, $[\alpha]^{24}D$ +9.1° (*c* 1.5, acetone).

Anal. Calcd. for $C_{20}H_{22}O_5$: C, 70.15; H, 6.47. Found: C, 70.07; H, 6.46.

Two Diastereoisomeric Forms of Tetraacetyl-D-glucopyranosido-dibenzylidene-xylitol.—Dibenzylidene-xylitol (16 g.), silver oxide (22 g., or an equivalent amount of silver carbonate) and 35 g. of freshly regenerated soluble anhydrite (Drierite) were added to 300 ml. of dry, ethanol-free chloroform that had been freshly distilled from phosphorus pentoxide. After stirring mechanically for ninety minutes at a temperature just short of reflux, 8.3 g. of tetraacetyl-D-glucosyl bromide dissolved in 10 ml. of dry, ethanol-free chloroform containing 5 g. of Drierite, was added. The reaction mixture was maintained under mechanical stirring at a temperature just short of reflux for five hours whereupon 16.6 g. of tetraacetyl-D-glucosyl bromide dissolved in 20 ml. of dry, ethanol-free chloroform containing 5 g. of Drierite was added and the vigorously stirred mixture was refluxed for fourteen hours. At the end of this period the cooled mixture was filtered and to the filtrate was added 20 ml. of water. After the addition of a little silver carbonate and some decolorizing charcoal, the mixture was heated to 50° under mechanical stirring for thirty minutes. The cooled mixture was filtered and the filtrate was dried with anhydrous calcium chloride. The chloroform was removed under reduced pressure and the resultant sirup was crystallized by the addition of absolute ethanol with subsequent removal by distillation under reduced pressure; yield 34 g., m. p. 120–150°.

(1) C. A. Lobry de Bruyn and W. Alberda van Ekenstein, *Rec. trav. chim.*, **18**, 150 (1899).

(2) R. M. Hann, A. T. Ness and C. S. Hudson, THIS JOURNAL, **68**, 1769 (1946).

(3) R. M. Hann, A. T. Ness and C. S. Hudson, *ibid.*, **66**, 670 (1944).

(4) R. M. Hann, A. T. Ness and C. S. Hudson, *ibid.*, **66**, 73 (1944).

(5) *Cf.* also R. M. Hann and C. S. Hudson, *ibid.*, **66**, 1909 (1944).

(6) M. L. Wolfrom and E. J. Kohn, *ibid.*, **64**, 1739 (1942).

(7) J. F. Carson, S. W. Waisbrot and F. T. Jones, *ibid.*, **65**, 1777 (1943).

(8) F. Valentin, *Coll. Czechoslov. Chem. Commun.*, **3**, 499 (1931).

(9) E. Votoček and R. Potměšil, *Ber.*, **46**, 3653 (1913).

The above crystalline material was dissolved in 300 ml. of chloroform, 1300 ml. of 95% ethanol added, the solution cooled to the temperature of a solid carbon dioxide–acetone-bath and then warmed slowly to room temperature by placing it in an ice-bath and allowing this to melt at room temperature. This procedure induced crystallization; yield 11.2 g. The crystalline material was fractionally crystallized from chloroform–ethanol (95%) (1:3 by volume) into two compounds (A and B) whose constants remained unchanged on further crystallizations from the same solvent or from pyridine–ethanol; yield, 1.1 g. of compound A crystallizing in long, silky, white needles of m. p. 187–187.5° and $[\alpha]^{20}D$ −34° (*c* 1.2, pyridine); 0.9 g. of compound B of m. p. 154–156° and $[\alpha]^{20}D$ −10° (*c* 2.6, pyridine).

Anal. Calcd. for $C_{33}H_{38}O_{14}$: C, 60.17; H, 5.82. Found for compound A: C, 60.16; H, 5.87. Found for compound B: C, 60.14; H, 6.01.

Both of the above substances were non-reducing toward Fehling solution and liberated benzaldehyde (detected by odor) on heating with acids. Attempts to remove the substituent benzylidene or acetate groups resulted only in sirupy products.

Acknowledgment.—Preliminary experiments in this work were carried out by Messrs. S. W. Waisbrot, T. S. Gardner and R. L. Brown.

Summary

1. Dibenzylidene-L-fucitol is described.

2. The *p*-toluenesulfonate and triphenylmethyl ether of dibenzylidene-xylitol are reported. The former substance reacts with sodium iodide.

3. Two diastereoisomeric forms of tetraacetyl-D-glucopyranosido-dibenzylidene-xylitol are described.

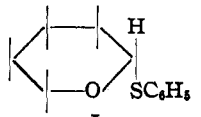
COLUMBUS, OHIO RECEIVED MARCH 17, 1947

[CONTRIBUTION FROM THE CHEMISTRY LABORATORY, NATIONAL INSTITUTE OF HEALTH, U. S. PUBLIC HEALTH SERVICE]

Relations between Rotatory Power and Structure in the Sugar Group. XXXV.[1] Some 2′-Naphthyl 1-Thioglycopyranosides and their Acetates

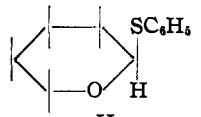
BY W. T. HASKINS, RAYMOND M. HANN AND C. S. HUDSON

Purves'[2] application of isorotation calculations to the rotations of the phenyl 1-thioglycopyranoside[3] acetates of various aldoses showed that the value of A_{SPh}, the portion of the molecular rotation in chloroform that is related to the presence of the phenylthio group on carbon atom 1, is nearly constant in the series and is thus approximately independent of the other portion B_x, the values of which are characteristic of the various sugars and are obtainable from the rotations of the α- and β-anomers of the fully acetylated sugars themselves. Purves' conclusions are illustrated by the values of B_x and A_{SPh} that are shown in columns six, eight and nine of Table I; A_{SPh} is approximately constant and thus independent of the corresponding B_x. His conclusions have led to the classification of these five phenyl 1-thioglycopyranoside acetates and the phenyl 1-thioglycopyranosides that result from their deacetylation, as β-D-anomers having in common the configurational element I.[4] It is to be noted for reference later that no arabinoside occurs in the list of Purves' derivatives. The corresponding α-D-anomers are not known but it is reasonable to assume that their molecular rotations will be found to approximate the values $B_x + A_{SPh}$ that can be calculated from the data of Table I. Consider an example from the D-glucose series. The



I

β-D-Anomers



II

α-D-Anomers

molecular rotation of the known phenyl 1-thio-β-D-glucopyranoside tetraacetate ($[\alpha]D$ −18°, mol. wt. 428) is formulated as $B_{gl} - A_{SPh} = (-18)(428) = -7{,}700$. The value of B_{gl} is obtained as half the sum of the molecular rotations of the α- and β-D-glucopyranose pentaacetates (mol. wt. 390), which is $[(B_{gl} + A_{ac}) + (B_{gl} - A_{ac})] \div 2 = B_x = [(101.6 + 3.8)(390)] \div 2 = +20{,}600$[5]; the value of A_{SPh} from the D-glucose series thus becomes $(7{,}700 + 20{,}600) = +28{,}300$. The molecular rotation of the unknown phenyl 1-thio-α-D-glucopyranoside tetraacetate is assumed therefore to be approximately $B_{gl} + A_{SPh} = 20{,}600 + 28{,}300 = +48{,}900$, which corresponds to an $[\alpha]D$ value of +114°. The difference that is to be expected between the values for the α- and β-anomers, which is 114 + 18 = 132°, is so large in comparison with reasonable limits of approximation in the isorotation calculations that it becomes possible to classify the anomers confidently.

The present research extends the scope of these correlations to seven members of a related series of aromatic 1-thioglycopyranoside acetates which carry the 2-thionaphthyl ("β-thionaphthyl") radical in their aglycon. These substances, which in general crystallize very satisfactorily, were prepared according to Purves' directions, with the substitution of 2-thionaphthol for thiophenol. When a chloroform solution of the appropriate

(1) Number XXXIV was published in THIS JOURNAL, **61**, 2972 (1939).

(2) Purves, *ibid.*, **51**, 3619, 3627, 3631 (1929). Through a typographical error the negative sign was given to the rotation of 49.0° on p. 3632; the substance is dextrorotatory, as was stated later in that article.

(3) In naming such thio-carbohydrate derivatives we follow the suggestions of A. L. Raymond in "Advances in Carbohydrate Chemistry," Vol. 1, Academic Press, New York, N. Y., 1945, p. 135.

(4) Hudson, THIS JOURNAL, **60**, 1537 (1938).

(5) Hudson and Dale, *ibid.*, **37**, 1264 (1915).