the preparation of carbethoxy derivatives of other ketones, and of their substitution products, for Claisen condensations of alkyl esters with ketones, and for cyclizations of the Dieckman type. It probably could be used with advantage for many reactions where powdered sodium or sodium ethylate is usually employed. We are therefore presenting some observations which we have made in the use of this catalyst in these reactions.

The reaction of ketones with ethyl carbonate starts promptly when the finely ground catalyst is employed, but with the coarser material there is a considerable lag, or occasionally the reaction may not start at all. Since at present sodium hydride is supplied only in the coarser size, which is easier and less hazardous to handle but less reactive, it is generally necessary to reduce the particle size by some means of grinding.

A laboratory apparatus for this purpose has been designed by V. L. Hansley[4] in which reactions are carried out in a revolving closed cylinder containing steel balls. Since this rather expensive equipment will not be generally available, we have employed the same principle in connection with the usual glass apparatus. When several ceramic spheres about 13 mm. in diameter are placed in the reaction flask with the solvent and the ethyl carbonate, and rolled slowly over the catalyst with a glass paddle stirrer for about thirty minutes, the particle size of the sodium hydride is reduced sufficiently so that the reaction starts soon on addition of a small quantity of the ketone. Care should be taken not to add very much of the ketone until the reaction, which is observed by the evolution of hydrogen, has definitely started. When the experiment is performed in this manner, the yield in the case of ethyl β-oxocaprylate is usually 80 to 85% of the theoretical.

In the preparation of sodium derivatives of β-keto esters the reaction starts at once regardless of the physical state of the sodium hydride, and the addition of the ester is regulated according to the rate of evolution of hydrogen. The solvent is generally anhydrous ether. Dioxane, in which most sodium enolates are soluble, is sometimes used.

Alcohol-free sodium alcoholates are conveniently prepared by dropping a slight excess of the alcohol on sodium hydride covered with benzene and, after refluxing, distilling off the solvent until it is alcohol-free, as shown by measurement of the refractive index. Sodium hydride dissolves more readily than sodium lumps or wire.

The following examples illustrate the employment of sodium hydride in reactions referred to above.[5]

Ethyl-3-oxo-6-octenoate[6] was prepared from 58 g. (2.4 moles) of sodium hydride covered with 300 ml. of dry ether and 283 g. (2.4 moles) of ethyl carbonate in a nitrogen atmosphere by dropping 136 g. (1.2 moles) of 5-heptene-2-one into the stirred suspension over a period of five hours. More ether was added as the contents of the flask thickened. Acetic acid was added in quantity equivalent to the sodium hydride diluted with ice and water, and the reaction product was isolated from the ethereal solution by removing first the ether and then the excess ethyl carbonate in vacuum: b. p. 110–120° (10 mm.), $n^{25}\text{D}$ 1.4460, yield 188 g. (85%).

Anal. Calcd. for $C_{10}H_{16}O_3$: C, 65.19; H, 8.76. Found: C, 64.67; H, 8.80.

2,4-Nonanedione.—A mixture of 28.8 g. (0.2 mole) of ethyl caproate and 12.7 g. (0.22 mole) of dry acetone was added to 4.8 g. (0.2 mole) of sodium hydride covered with 10 ml. of dry ether. The evolution of hydrogen started after refluxing for several minutes, and more ether was added as solid material separated. Refluxing was continued for one hour. Ice and water containing a suitable quantity of sulfuric acid were added, and the reaction product was isolated from the ethereal solution and distilled from a modified Claisen flask: b. p. 94–98° (11 mm.), $n^{25}\text{D}$ 1.4222, yield 16.8 g. (54%).

2,5-Dioxo-1,4-cyclohexandicarboxylic Acid Diethyl Ester.—The Dieckman cyclization between two molecules of ethyl succinate occurs smoothly on addition of the ester to two equivalents of sodium hydride covered with a small quantity of ether and refluxing until the evolution of hydrogen has ceased. Upon addition of dilute acid the reaction product separates in crystalline form on removal of the ether and it can be recrystallized from ethanol (m. p. 130–131°).

Ethyl β-Carbethoxy-γ-oxo-pelargonate.—To 4.8 g. (0.2 mole) of sodium hydride covered with 100 ml. of ether, 37.2 g. (0.2 mole) of ethyl β-oxocaprylate was slowly added with stirring, more ether being added as the contents of the flask thickened. It was refluxed for thirty minutes, after which 37 g. (0.22 mole) ofe thyl bromoacetate was added dropwise at a rate to cause gentle refluxing of the ether. The reaction was completed by further refluxing for thirty minutes, after which the separated sodium bromide was dissolved by addition of water containing 5% of sulfuric acid. The ethereal layer was washed and dried and the solvent removed. The residue was distilled on a modified Claisen flask: b. p. 133–136° (0.4 mm.), $n^{25}\text{D}$ 1.4388. The yield was 46 g. (84.5%).

Anal. Calcd. for $C_{14}H_{24}O_5$: C_2H_5O, 32.4. Found: C_2H_5O, 33.0.

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AGRICULTURAL RESEARCH ADMINISTRATION
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BELTSVILLE, MARYLAND
RECEIVED MARCH 10, 1948

The Action of Copper Sulfate on the Phenylosazones of the Sugars. VI.[1] Gentiobiose Phenylosotriazole[2]

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

In continuation of the investigation of the conversion of the sugar phenylosazones to the corresponding phenylosotriazoles through the action of copper sulfate, we have prepared the phenylosotriazole of gentiobiose. This phenylosotriazole differs from those described in the previous articles in that its crystals contain one molecular equivalent of ethanol which is tenaciously retained at ordinary temperatures even in moderately high

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[4] Private communication from V. L. Hansley of E. I. du Pont de Nemours and Co., Niagara Falls, N. Y.

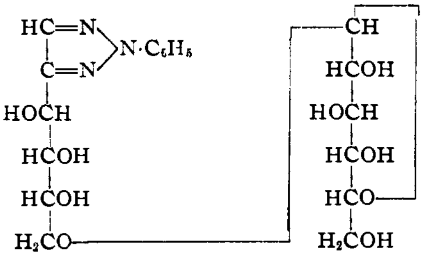
[5] We wish to express our appreciation to the E. I. du Pont de Nemours and Co. for donating the sodium hydride we employed in this and previous work.

[6] Prepared in collaboration with S. B. Soloway.

[1] Number V was published in THIS JOURNAL, 69, 1461 (1947).

[2] Presented in part before the Division of Sugar Chemistry and Technology at the Chicago meeting of the American Chemical Society, April 19–23, 1948.

vacuum but is eliminated *in vacuo* at elevated temperatures. It is also unique in that its heptaacetate and heptabenzoate crystallize readily whereas, among the other disaccharide phenylosotriazoles investigated, only one crystalline acyl derivative has been obtained (cellobiose phenylosotriazole heptaacetate). Acid hydrolysis of gentiobiose phenylosotriazole produces a high yield (93%) of D-glucose phenylosotriazole and D-glucose (65%) as expected from the accompanying formula.



Gentiobiose Phenylosotriazole

We are indebted to Mr. Charles A. Kinser and Mrs. Betty Mount for the microchemical analyses.

Experimental

Gentiobiose Phenylosotriazole.—To a suspension of 10 g. of gentiobiose phenylosazone[3] in 900 ml. of boiling water was added a hot solution of 5.3 g. (1.1 molecular equivalents) of copper sulfate pentahydrate in 100 ml. of water. Solution of the phenylosazone took place rapidly and after refluxing for thirty minutes the solution was cooled, filtered, and the excess copper removed from the filtrate as the sulfide; the copper-free solution was neutralized with 10 g. of barium carbonate and following filtration, concentrated *in vacuo* to a thick reddish sirup. The sirup was dried by successive evaporations with three 25-ml. portions of absolute alcohol, and dissolved in 25 ml. of warm absolute alcohol, filtered to remove a small amount of inorganic contaminant and diluted with 35 ml. of ether; upon scratching, the product separated as somewhat gelatinous flocs which were recovered by filtration and washed with cold absolute alcohol and ether; yield 5.3 g. An additional 1.2 g. of product was obtained by concentration of the mother liquor; total yield 6.5 g. (71%). The material was recrystallized from 5 parts of absolute alcohol forming minute needles which melted at 91–93°[4] with foaming and rotated −34.3° in aqueous solution (*c*, 0.83). Analyses showed that the material contained one molecular equivalent of ethanol of crystallization which was retained tenaciously *in vacuo* at temperatures below the sintering point; at 97° *in vacuo* the alcohol was removed leaving an amorphous glassy material of no definite melting point; its analysis corresponded closely to that of an unsolvated disaccharide phenylosotriazole. The crystalline alcoholate was readily soluble in water, pyridine and hot alcohol and sparingly soluble in ether, acetone, ethyl acetate and cold alcohol. Upon separating from solution in impure form it shows a marked tendency to form gelatinous precipitates rather than discrete crystals.

Anal. Calcd. for $C_{18}H_{25}N_3O_9 \cdot C_2H_5OH$: C, 50.73; H, 6.60; loss on drying, 9.7. Found: C, 50.94; H, 6.39; loss on drying, 9.5.

Anal. (of the alcohol-free amorphous material). Calcd. for $C_{18}H_{25}N_3O_9$: C, 50.58; H, 5.90. Found: C, 50.56; H, 5.99.

On refluxing 1.2 g. of the crystalline alcoholate with 50 ml. of 0.5 *N* hydrochloric acid for six hours and chilling the solution, a 93% yield of D-glucose phenylosotriazole (m. p. 195–196°) was obtained and the concentrated aqueous mother liquor, after neutralization with silver carbonate, yielded 65% of D-glucose ($[\alpha]^{20}_D$ +52.5°).

Gentiobiose Phenylosotriazole Heptaacetate.—A solution of 1.0 g. of gentiobiose phenylosotriazole monoalcoholate in a mixture of 8 ml. of acetic anhydride and 0.25 g. of fused sodium acetate was heated on the steam bath for two hours, cooled, and poured into ice water; the crystalline heptaacetate (1.6 g., quantitative) was recrystallized from 10 parts of alcohol and formed clumps of very fine needles melting at 144–146° and rotating −28.1° in chloroform solution (*c*, 0.84). It was readily soluble in chloroform, acetone–ether and warm alcohol and nearly insoluble in water and hexane.

Anal. Calcd. for $C_{32}H_{39}N_3O_{16}$: C, 53.26; H, 5.45; CH_3CO, 41.8. Found: C, 53.53; H, 5.62; CH_3CO, 41.6.

Gentiobiose Phenylosotriazole Heptabenzoate.—To a solution of 0.5 g. of gentiobiose phenylosotriazole monoalcoholate in 5 ml. of pyridine was added 2 ml. of benzoyl chloride; after standing at 25° for twenty-four hours the mixture was poured into ice water and the gummy precipitate washed by decantation with dilute sodium bicarbonate solution and water. The damp precipitate was digested on the steam-bath with 25 ml. of alcohol when spontaneous crystallization occurred; the cooled mixture was filtered and washed with alcohol yielding 1.2 g. (quantitative) of the heptabenzoate. The compound was recrystallized by dissolving it in 10 parts of chloroform and adding 20 parts of hexane or 50 parts of absolute alcohol; it crystallized as fine, short needles melting at 122–123° and rotating +1.5° in chloroform solution (*c*, 0.88). It is soluble in chloroform, ether, acetone and pyridine and sparingly soluble in water, hexane and hot alcohol.

Anal. Calcd. for $C_{67}H_{53}N_3O_{16}$: C, 69.60; H, 4.62; C_6H_5CO, 63.6. Found: C, 69.40; H, 4.57; C_6H_5CO, 63.3.

CONTRIBUTION FROM THE
FEDERAL SECURITY AGENCY
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTE OF HEALTH
EXPERIMENTAL BIOLOGY AND
MEDICINE INSTITUTE
CHEMISTRY LABORATORY
BETHESDA, MARYLAND

RECEIVED MAY 3, 1948

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[3] Berlin, THIS JOURNAL, **48**, 1107 (1926).

[4] The melting points were made with the stem of the thermometer fully immersed in the heated bath. The rotations are specific rotations $[\alpha]^{20}_D$; the tube length was 4 dm. and *c* is the concentration in grams in 100 ml. of solution. All the crystalline compounds were recrystallized to constant m.p. and rotation.

The Separation of Iodine-131 from Tellurium

BY MILTON LEVY, ALBERT S. KESTON AND SIDNEY UDENFRIEND

The irradiated unit[1] supplied by the U. S. Atomic Energy Commission as a source of I^{131} contains 50 g. of tellurium. The chromic or nitric acid oxidations such as have been used in working up cyclotron targets proved cumbersome in the case of the pile units because of the large amount of tellurium. The following method based on fusion with sodium hydroxide has proven rapid and reliable.

The tellurium powder is transferred to a 100-ml. Pyrex kjeldahl flask (through a powder funnel) containing 5 g. of sodium hydroxide pellets. The

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[1] Catalog item No. 37, "Radioisotopes," Catalog No. 2, revised September, 1947, U. S. Atomic Energy Commission, Oak Ridge, Tenn.