β-*d*-xylosidodihydroxyacetone tetraacetate
A = +33,700 (oxygen ring right)
β-*l*-xylosidodihydroxyacetone tetraacetate
A = −33,700 (oxygen ring left)

(The value of A for β-*d*-glucosidodihydroxyacetone pentaacetate may be derived from its rotation of $[\alpha]^{18}D$ −25.2° reported by Kreider and Evans.[4])

The above numerical values of A agree among themselves very closely when it is remembered that the Van't Hoff rule of optical superposition on which these calculations are based is known to be only approximate in its quantitative predictions. These values tend to substantiate the structure ascribed to the new compounds reported in the experimental part of this paper.

Acknowledgment.—The authors wish to express their thanks to Dr. Ralph T. Major, of Merck and Company, for his kind gift of the *l*-xylose used in carrying out a portion of the work described in this paper.

Summary

1. The preparation of the following new compounds in crystalline condition has been accomplished: β-*d*-arabinosidodihydroxyacetone tetraacetate, β-*l*-arabinosidodihydroxyacetone tetraacetate, β-*d*-xylosidodihydroxyacetone tetraacetate, β-*l*-xylosidodihydroxyacetone tetraacetate, and β-acetobromo-*l*-xylose.

2. The first disaccharide to contain a pentose and a triose as its constituent parts has been prepared.

3. The first examples of pairs of disaccharide derivatives that are exact optical antipodes have been synthesized in β-*d*- and β-*l*-arabinosidodihydroxyacetone tetraacetate and in β-*d*- and β-*l*-xylosidodihydroxyacetone tetraacetate.

4. The first disaccharide racemate has been demonstrated in the case of β-*dl*-arabinosidodihydroxyacetone tetraacetate.

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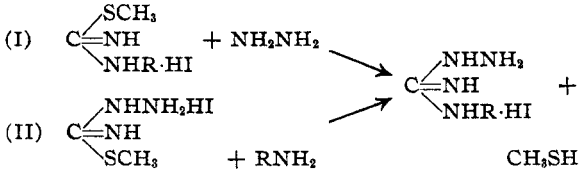
Reduction of Nitroguanidine. V. The Synthesis of (a) α-Methyl-, (b) α-Ethyl-, (c) α-*n*-Butyl-γ-aminoguanidine[1]

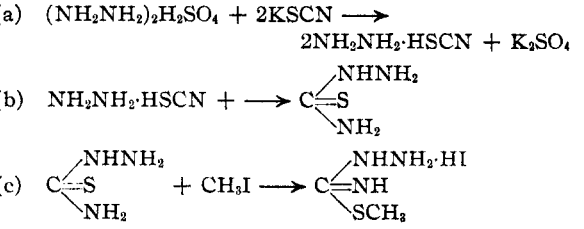
BY G. W. KIRSTEN AND G. B. L. SMITH

Introduction

In this study of the reduction of nitroguanidine, α-alkyl-γ-aminoguanidines are of interest as the final reduction products of α-alkyl-γ-nitroguanidines. The two general schemes of synthesis used were as follows: (I) S-methyl-N-alkyl isothioureas were allowed to react with hydrazine hydrate; (II) S-methyl-N-aminoisothiourea was treated with primary alkylamines. These reactions can be formulated as



The S-methyl-N-aminoisothiourea was prepared through the following series of reactions



α-Methyl-γ-aminoguanidinium iodide was made by both methods, while method (I) alone was used in case of the two other preparations. The synthesis of α-phenyl-γ-aminoguanidine was unsuccessful.

Experimental

α-Methyl-γ-aminoguanidinium Iodide.—S-N-Dimethylisothiourea iodide[2] (58 g.) was dissolved in 100 ml. of water and 13 g. of hydrazine hydrate in a total volume of 50 ml. (aqueous solution) was added.[3] After the evolution of methyl mercaptan had ceased the solution was concentrated to crystallization and the solid product was dissolved in 100 ml. of hot ethanol and cooled. One hundred

(1) This paper was abstracted from part of the thesis submitted by Mr. Kirsten to the faculty of the Polytechnic Institute of Brooklyn in partial fulfilment of the requirements for the degree of Master of Science in Chemistry in June, 1935. On the basis of this thesis Mr. Kirsten was awarded a "certificate of commendation of research" by the Society of the Sigma Xi in 1935.

(2) (a) Delepines, *Compt. rend.*, **144**, 1126 (1907); (b) Andreasch, *Monatsh.*, **2**, 277 (1881). (c) Schenck, *Z. physiol. Chem.*, **77**, 328 (1912).

(3) Smith and Anzelmi, THIS JOURNAL, **57**, 2730 (1935).

and fifty ml. of anhydrous ether was added and α-methyl-γ-aminoguanidinium iodide separated as a white crystalline solid. The product was separated by filtration, washed with anhydrous ether and dried in a desiccator; yield, 48.5 g., 90.6%; m. p. 121–122°. *Anal.* Calcd. for $C_3H_9N_4I$: I, 58.77. Found: I, 58.73, 58.64. (Method 2.) 2.33 g. of S-methylisothiosemicarbazide iodide[4] was dissolved in 6 ml. of water and 1.05 g. of a 30% solution of monomethylamine was added.[5] The mixture was heated under reflux for about thirty minutes and then evaporated to dryness. The solid residue was dissolved in 6 ml. of hot 95% ethanol, filtered and allowed to cool. α-Methyl-γ-aminoguanidinium iodide precipitated on the addition of 12 ml. of anhydrous ether. The solid product was separated by filtration, washed with anhydrous ether and dried in a desiccator; yield 1.5 g., 69%; m. p. 121–122°. The product was identified by a mixed melting point determination which the product obtained when method 1 was used.

α-Methyl-γ-aminoguanidinium Sulfate.—α-Methyl-γ-aminoguanidinium iodide (10 g.) was dissolved in 100 ml. of water, acidified with 4 drops of glacial acetic acid and 7.21 g. of silver sulfate was added and the mixture was agitated for several minutes. After standing at room temperature for two hours the precipitated silver iodide was separated by filtration and the filtrate was evaporated to dryness. The solid product was dissolved in 75 ml. of hot 95% ethanol to which was added sufficient water to effect complete solution. The solution was filtered and α-methyl-γ-aminoguanidinium sulfate was allowed to crystallize from the chilled solution. The crystalline precipitate was separated by filtration, washed with cold 95% ethanol and dried; yield 4.75 g., 75%; m. p. 229–230° with decomposition. *Anal.* Calcd. for $(C_2H_9N_4)_2H_2SO_4$: S, 11.69; N_2H_4, 23.37. Found: S, 11.71; N_2H_4, 23.4, 23.6.

α-Methyl-γ-aminoguanidinium Picrate.—This compound was prepared by precipitation from aqueous solution which picric acid; m. p. 162–163°.

α-Ethyl-γ-aminoguanidinium Iodide.—The S-methyl-N-ethylisothiourea iodide[6] obtained from 10.4 g. of ethylthiourea was used directly in its original solution in ethanol. To this solution was added 13.3 ml. of a 39% solution of hydrazine hydrate and allowed to stand overnight at room temperature. The solution was then evaporated to dryness and the solid residue was dissolved in 50 ml. of hot 95% ethanol, filtered and evaporated to about half volume. To this solution was added 100 ml. of anhydrous ether, and two liquid layers separated but the lower layer solidified on vigorous agitation. The solid product was separated by filtration, washed with anhydrous ether and dried. This product was crystallized from ethanol and ether a second time; yield 21 g., 91%; m. p. 84.5–86°. *Anal.* Calcd. for $C_3H_{11}N_4I$: I, 55.18. Found: I, 55.42, 55.18.

α-Ethyl-γ-aminoguanidinium Sulfate.—α-Ethyl-γ-aminoguanidinium iodide (5 g.) was dissolved in 50 ml. of water, acidified with 2 drops of glacial acetic acid and 3.38 g. of solid silver sulfate was added and the mixture violently agitated for several minutes. After standing for two hours with occasional agitation the silver iodide was separated by filtration and the filtrate was evaporated to dryness. About 10 ml. of chloroform was added to the slightly gummy residue and evaporated to dryness a second time. The residue was now definitely crystalline and was recrystallized from absolute ethanol in which it is rather more soluble than is the analogous methyl compound; yield 2.10 g., 64%; m. p. 161–163°. *Anal.* Calcd. for $(C_3H_{10}N_4)_2H_2SO_4$: S, 10.60, N_2H_4, 21.20. Found: S, 10.55; N_2H_4, 21.1, 21.2.

α-Ethyl-γ-aminoguanidinium picrate was prepared from the iodide and picric acid; m. p. 113–114.5°.

S-Methyl-N-*n*-butyl Isothiourea Iodide.—This substance has not been prepared previously so details of preparation are given herewith. Ten grams of *n*-butylthiourea,[7] 50 ml. of absolute ethanol, and 11 g. of methyl iodide were allowed to stand together in a stoppered 250-ml. flask for one week. At the end of this period one-third of the ethanol was evaporated, the solution was allowed to cool to room temperature and 150 ml. of anhydrous ether was added. The product separated as a white crystalline precipitate. After standing for one day at about 10° the solid was separated by filtration, washed with anhydrous ether and dried in a desiccator; yield 18 g., 87%; m. p. 88–89°. *Anal.* Calcd. for $C_6H_{15}N_2IS$: I, 46.30. Found: I, 46.35.

α-*n*-Butyl-γ-aminoguanidinium Iodide.—Five grams of S-methyl-N-*n*-butyl isothiourea iodide was dissolved in a mixture of 10 ml. of ethanol and 2 ml. of a 50% solution of hydrazine hydrate. The mixture was allowed to stand for about sixteen hours, evaporated almost to dryness on a steam-bath, and the residue solidified on standing in a desiccator. The solid was dissolved in the smallest possible volume of warm amyl alcohol, filtered and ligroin was added until a precipitate formed. The precipitate was redissolved by adding amyl alcohol. The solution was allowed to stand in a refrigerator for twenty-four hours and the α-*n*-butyl-γ-aminoguanidinium iodide separated as needle crystals. The crystals were separated by filtration, washed with ligroin and anhydrous ether and dried; m. p. 51–52°. *Anal.* Calcd. for $(C_6H_{14}N_4)HI$: I, 49.18; N_2H_4, 12.4. Found: I, 49.18; N_2H_4, 12.2. (The hydrazine was determined as in previous cases by titration with a standard solution of potassium iodate but allowance was made for the iodate reduced by iodide ion.)

Summary

This paper describes the preparation of salts of (a) α-methyl-γ-aminoguanidine, (b) α-ethyl-γ-aminoguanidine and (c) α-*n*-butyl-γ-aminoguanidine. Two general methods for the preparation of these compounds are suggested.

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(4) Freund, *Ber.*, **34**, 3114 (1901).

(5) (a) Phillips and Clarke, THIS JOURNAL, **45**, 1755 (1923); (b) Smith, *ibid.*, **51**, 476 (1929).

(6) (a) Hofmann, *Ber.*, **18**, 2788 (1885); (b) Schenk and Kirchof, *Z. physiol. Chem.*, **154**, 297 (1926).

(7) Prepared by the method employed by Hecht, *Ber.*, **23**, 283 (1890).