[CONTRIBUTION FROM THE COLLEGE OF PHARMACY, UNIVERSITY OF CALIFORNIA]

Sulfophenylarsonic Acids and Certain of their Derivatives. I. *p*-Sulfophenylarsonic Acid

BY J. F. ONETO

In a recent paper Barber[1] suggests that the Bart reaction appears not to be applicable to aminophenylsulfonic acids due to the strongly negative group present.

This investigation was undertaken with the object of preparing derivatives of a number of sulfo- and sulfonamidophenylarsonic acids and of studying the application of the Bart reaction in the preparation of the parent compounds.

p-Sulfophenylarsonic acid was first prepared by Hewitt, King and Murch[2] through application of the Leuckardt xanthate method[3] to arsanilic acid. The product thus obtained was purified by recrystallization from water. This is a very unsatisfactory method because of the extreme solubility of the acid. Voegtlin[4] refers to *p*-sulfophenylarsonic acid as being so freely soluble in water at any *p*H that it is very difficult to obtain the acid in pure form.

Sodium *p*-sulfophenylarsonic acid was prepared in this Laboratory in 28% yields by application of the Bart reaction to sulfanilic acid. The free acid, obtained from the sodium salt through the barium salt stage, was purified readily by dissolving in the least amount of boiling 80% acetic acid and precipitating the acid in glistening, colorless needles by the addition of boiling glacial acetic acid. The work of Hewitt and coworkers was repeated and the acid thus obtained purified in the same manner with satisfactory results.

With the piperidine salt of N-pentamethylenedithiocarbamic acid,[5] sodium *p*-sulfophenyldiiodoarsine forms a well-defined, crystalline, piperidine salt of *p*-sulfophenylarsylene N-pentamethylenedithiocarbamate.

Sodium *p*-sulfophenylarsine oxide, containing three molecules of water, was obtained by hydrolysis of the corresponding bromo-arsine with sodium hydroxide. This product forms a crystalline silver salt when its hot aqueous solution is treated with a solution of silver nitrate.

(1) Barber, *J. Chem. Soc.*, 2048 (1930).
(2) Hewitt, King and Murch, *ibid.*, 1369 (1926).
(3) Leuckardt, *J. prakt. Chem.*, **41**, 179 (1890).
(4) Voegtlin, *Physiol. Rev.*, **5**, 91 (1925).
(5) Blicke and Oakdale, THIS JOURNAL, **54**, 2993 (1932).

Experimental Part

Sodium *p*-Sulfophenylarsonic Acid.—A mixture consisting of 76 g. of sulfanilic acid, 28 g. of anhydrous sodium carbonate and 400 cc. of water was diazotized at 0° with 100 cc. of 37% hydrochloric acid and a solution of 32 g. of sodium nitrite in 160 cc. of water in the usual manner. The diazo solution was coupled at 10–15° with an alkaline arsenite solution prepared by dissolving 80 g. of sodium hydroxide, 98 g. of arsenic trioxide and 1.2 g. of copper sulfate in 1000 cc. of water. After standing for two days, the reaction mixture was concentrated to 350 cc., thoroughly cooled and the precipitate of inorganic salts removed by filtration. The filtrate was heated to boiling, made acid to congo red paper with 37% hydrochloric acid and then allowed to stand at room temperature for twenty-four hours. The heavy, granular precipitate which consisted chiefly of sodium *p*-sulfophenylarsonic acid was partially purified by repeatedly boiling with decolorizing carbon in aqueous solution, concentrating the solution to a small volume and precipitating the sodium salt by the addition of 95% alcohol; yield 60 g. Thirty grams of the material thus obtained was dissolved in 125 cc. of boiling water and 30 g. of sodium chloride was added to the boiling solution. Colorless, crystalline sodium *p*-sulfophenylarsonic acid started to precipitate almost immediately. The mixture was cooled in ice, filtered and the product washed with cold, saturated sodium chloride solution, then with small portions of cold 80% alcohol and finally with acetone. Eighteen grams of product was obtained sufficiently pure for analysis.[6] It is insoluble in alcohol and acetic acid, exceedingly soluble in water.

Anal. Calcd. for $C_6H_6O_6AsSNa$: As, 24.64. Found: As, 24.36.

Barium *p*-Sulfophenylarsonic Acid.—Ten grams of sodium *p*-sulfophenylarsonic acid was dissolved in 30 cc. of boiling 0.7% hydrochloric acid. To the hot solution was added 20 cc. of a saturated solution of barium chloride. The barium salt started precipitating at once from the hot solution in the form of colorless needles. After cooling, the product was filtered, washed first with cold 0.7% hydrochloric acid, then with water and finally with acetone. The material thus obtained, which was sufficiently pure for analysis, is relatively soluble in water; yield 9.5 g.

Anal. Calcd. for $C_{12}H_{12}O_{12}As_2S_2Ba$: As, 21.42; Ba, 19.64. Found: As, 21.09; Ba, 19.64.

***p*-Sulfophenylarsonic Acid.**—Five grams of barium *p*-sulfophenylarsonic acid was dissolved in 100 cc. of boiling water and the barium was precipitated from the hot solution by adding the calculated amount of 0.1 *N* sulfuric acid. After removal of the barium sulfate, the filtrate was allowed to evaporate at room temperature. The residue was purified by dissolving in the least amount of boiling

(6) A halogen analysis indicated the presence of 0.7% sodium chloride.

80% acetic acid and then treating the hot solution with boiling glacial acetic acid. The *p*-sulfophenylarsonic acid crystallized in the form of colorless, glistening needles; yield 2.5 g. When heated, the product gradually darkens but remains solid up to 300°. It is insoluble in ether, acetone and benzene; soluble in alcohol.

Anal. Calcd. for $C_6H_7O_6AsS$: As, 26.56. Found: As, 26.51.

Sodium *p*-Sulfophenyldiiodoarsine.—Ten cc. of 50% hydriodic acid was added to a hot solution of 2 g. of sodium *p*-sulfophenylarsonic acid in 5 cc. of water. The crystalline iodoarsine began precipitating immediately. The mixture was filtered after cooling thoroughly and the product washed first with glacial acetic acid and then with acetone. The yield was 2 g. after recrystallizing from 80% acetic acid. It is insoluble in cold glacial acetic acid and alcohol but readily soluble in water. When heated the compound liberates vapors of iodine.

Anal. Calcd. for $C_6H_4O_3AsI_2SNa$: As, 14.75; I, 49.98. Found: As, 14.65; I, 49.76.

Sodium *p*-Sulfophenyldibromoarsine.—A solution prepared from 10 g. of sodium *p*-sulfophenylarsonic acid, 30 cc. of water, 20 cc. of 48% hydrobromic acid and a trace of hydriodic acid was saturated with sulfur dioxide at room temperature. The mixture was then concentrated on the steam-bath to about 20 cc., chilled in ice and the product removed by filtration; 8.5 g. of sodium *p*-sulfophenyldibromoarsine was obtained after recrystallizing from glacial acetic acid–ethyl acetate mixture. The product is readily soluble in alcohol and water.

Anal. Calcd. for $C_6H_4O_3AsBr_2SNa$: As, 18.10; Br, 38.62. Found: As, 18.07; Br, 38.36.

The Piperidine Salt of *p*-Sulfophenylarsylene N-Pentamethylenedithiocarbamate.—To a hot soluiton of 0.5 g. of sodium *p*-sulfophenyldiiodoarsine in 13 cc. of 50% alcohol there was added a hot solution of 0.5 g. of the piperidine salt of N-pentamethylenedithiocarbamic acid in 25 cc. of alcohol. The colorless needles which formed were removed by filtration and washed repeatedly with cold 95% alcohol. The product weighed 0.3 g. and when heated decomposed at 230–232°. The compound is insoluble in ether, acetone and benzene.

Anal. Calcd. for $C_{23}H_{36}O_3N_2AsS_5$: As, 11.75. Found: As, 12.01.

Sodium *p*-Sulfophenylarsine Oxide.—Five grams of sodium hydroxide was added to as olution of 15 g. of sodium *p*-sulfophenyldibromoarsine in 100 cc. of water and the solution boiled under a reflux condenser for fifteen minutes. The solution was then cooled, made acid to congo red paper with 37% hydrochloric acid and allowed to evaporate at room temperature. After several days a heavy mass of large colorless crystals was obtained which weighed 8 g. The product, containing three molecules of water, was purified by dissolving in water, concentrating the solution in a desiccator over sulfuric acid to a small volume and recovering the crystalline residue.

Anal. Calcd. for $C_6H_4O_4AsSNa\cdot 3H_2O$: As, 23.11. Found: As, 23.00.

The product effloresced at room temperature and was completely dehydrated by heating to 200° for four hours in an oil-bath under reduced pressure.

Anal. Calcd. for $C_6H_4O_4AsSNa$: As, 27.74. Found: As, 27.81.

On adding 10 cc. of 0.25 *N* silver nitrate solution to a hot solution of 0.52 g. of sodium *p*-sulfophenylarsine oxide in 10 cc. of water, a silver salt of *p*-sulfophenylarsine oxide crystallized on slight cooling; yield 0.5 g.

Summary

The preparation of sodium *p*-sulfophenylarsonic acid by the Bart reaction and a method for the purification of the free acid have been described. The following derivatives and salts have been prepared: barium *p*-sulfophenylarsonic acid, the piperidine salt of *p*-sulfophenylarsylene N-pentamethylenedithiocarbamate, sodium *p*-sulfophenyldiiodo and -dibromoarsine and sodium *p*-sulfophenylarsine oxide.

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The Cleavage of the Carbon Chain of α-Methyl-*d*-lyxopyranoside by Oxidation with Periodic Acid[1]

BY W. DAYTON MACLAY AND C. S. HUDSON

The known α-methyl-*d*-lyxoside (m. p. 108–109°, $[\alpha]^{20}D$ + 59.4° in water)[2] has been shown by Hirst and Smith[3] through methylation methods to be a pyranoside and it is regarded as the alpha form because it is more dextrorotatory than *d*-lyxose ($[\alpha]^{20}D$ −14°, final); under this classification its structure is (I). It is to be expected that the oxidation of this substance by periodic acid will proceed in the manner that has been demonstrated in the case of the alpha forms of the methyl pyranosides of *d*-xylose and *d*-arabinose[4] to produce the dialdehyde (II); the latter substance, on oxidation by bromine water in the presence of strontium carbonate, should be oxi-

(1) Publication authorized by the Surgeon General, U. S. Public Health Service.

(2) Phelps and Hudson, THIS JOURNAL, **48**, 505 (1926).

(3) Hirst and Smith, *J. Chem. Soc.*, 3147 (1928).

(4) Jackson and Hudson, THIS JOURNAL, **59**, 994 (1937).