

than the first order within the precision limits of the experimental technique used.

The heats of activation of these methylated

sugars show a marked agreement with the heats of activation of analogous non-methylated sugars.

LINCOLN, NEBRASKA

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

Sulfofenylarsonic Acids and Certain of their Derivatives. II. *p*-Sulfonamidophenylarsonic Acid

By J. F. ONETO AND E. L. WAY

In this paper, which is a continuation of our studies of sulfofenylarsonic acids and their derivatives, a number of compounds have been described, two of which (*p*-sulfonamidophenylarsonic acid and *p*-sulfonamidophenylarsine oxide) should be of pharmacological interest.

The preparation of *p*-sulfonamidophenylarsonic acid was effected by application of the Bart reaction to sulfanilamide.

p-Sulfonamidophenylarsine oxide was prepared by two methods: (A) hydrolysis of *p*-sulfonamidophenyldibromoarsine with ammonium hydroxide; (B) interaction between *p*-chlorosulfonylphenyldichloroarsine and ammonium hydroxide. The oxide was converted to *p*-sulfonamidophenylarsonic acid by oxidation with hydrogen peroxide in alkaline solution.

p-Chlorosulfonylphenylarsonic acid, obtained by partial hydrolysis of *p*-chlorosulfonylphenyltetrachloroarsine, reacts with aniline to form *p*-sulfonanilidophenylarsonic acid. This reaction is now being studied in the preparation of substituted anilide and amide derivatives of *p*-sulfofenylarsonic acid.

Experimental Part

***p*-Sulfonamidophenylarsonic Acid.**—This acid was prepared by application of the Bart reaction to sulfanilamide (*p*-aminobenzenesulfonamide). It crystallizes from water in colorless, glistening needles, yield 25%. The acid is somewhat soluble in alcohol and in acetic acid; insoluble in acetone.

Anal. Calcd. for $C_6H_5O_3NAsS$: As, 26.66. Found: As, 26.51.

When heated for two hours under reduced pressure at 185–190°, the acid loses one molecule of water to form the anhydride.

Anal. Calcd. for $C_6H_4O_4NAsS$: As, 28.47. Found: As, 28.36.

The crystalline silver salt of *p*-sulfonamidophenylarsonic acid was obtained when 0.7 g. of the acid dissolved in 10 cc. of boiling water was treated with an excess of 0.25 *N* silver nitrate solution; yield 0.7 g.

Anal. Calcd. for $C_6H_7O_3NAsSAg$: As, 19.31; Ag, 27.81. Found: As, 19.39; Ag, 27.50.

In a second procedure the acid was obtained when 2 g. of *p*-sulfonamidophenylarsine oxide (obtained by treating *p*-chlorosulfonylphenyldichloroarsine with ammonium hydroxide) dissolved in 10 cc. of 10% sodium hydroxide was oxidized with 3 cc. of 30% hydrogen peroxide by heating on the steam-bath for one-half hour. The hot solution was acidified, whereupon the acid crystallized on cooling; yield 0.7 g.

The acid thus obtained was converted to the corresponding dibromoarsine; mixed m. p. 190–191°.

***p*-Sulfonamidophenyldiiodoarsine.**—A hot solution consisting of 1.7 g. of *p*-sulfonamidophenylarsonic acid in 25 cc. of water was treated with 15 cc. of 50% hydriodic acid. The diiodoarsine crystallized on cooling; yield, after recrystallizing from glacial acetic acid, 1.8 g.; m. p. 192–193°.

Anal. Calcd. for $C_6H_5O_2NAsSI_2$: As, 15.45; I, 52.35. Found: As, 15.36; I, 52.70.

***p*-Sulfonamidophenyldibromoarsine.**—A solution prepared from 2 g. of *p*-sulfonamidophenylarsonic acid, 20 cc. of 30% hydrobromic acid and a trace of hydriodic acid was saturated with sulfur dioxide. The resulting crystalline precipitate was recrystallized from glacial acetic acid; yield 2 g.; m. p. 191–192°.

Anal. Calcd. for $C_6H_5O_2NAsSBr_2$: As, 19.16. Found: As, 19.26.

***p*-Sulfonamidophenyldichloroarsine.** (A).—A solution consisting of 2 g. of *p*-sulfonamidophenylarsonic acid, 10 cc. of 37% hydrochloric acid and a trace of hydriodic acid was saturated with sulfur dioxide. The resulting dichloroarsine was recrystallized from glacial acetic acid; yield 1.5 g.; m. p. 176–177°.

Anal. Calcd. for $C_6H_5O_2NAsSCl_2$: As, 24.81. Found: As, 24.85.

(B).—Two grams of *p*-sulfonamidophenylarsonic acid was ground in a mortar with 12 cc. of phosphorus trichloride. After standing for one-half hour, the mixture was treated with ice water and the resulting crude dichloroarsine removed by filtration. The crude dichloroarsine was purified by dissolving in hot 10% hydrochloric acid and precipitating the crystalline substance by the addition of concentrated hydrochloric acid; yield 1.4 g.; mixed m. p. 176–177°.

(C).—One gram of *p*-sulfonamidophenylarsine oxide was dissolved in 10 cc. of hot 10% hydrochloric acid. The crystalline dichloroarsine was precipitated by the

addition of an excess of concentrated hydrochloric acid; yield 0.8 g.; mixed m. p. 176–177°.

***p*-Sulfonamidophenylarsine Oxide.** (A).—Three and one-half grams of *p*-sulfonamidophenyldibromoarsine was boiled with 20 cc. of 27% ammonium hydroxide. The mixture was then chilled in ice and the crude oxide removed by filtration; yield, 1.8 g. after recrystallizing from 2% phosphoric acid.

Anal. Calcd. for $C_6H_6O_2NaAsS$: As, 30.32; N, 5.67. Found: As, 30.21; N, 5.67.

(B).—Seven grams of crude *p*-chlorosulfonylphenyldichloroarsine was treated with 20 cc. of concentrated ammonium hydroxide. After standing for one hour the mixture was acidified with dilute sulfuric acid and the resulting oxide purified as above; yield 2.2 g.

One-half gram of the oxide was converted to the corresponding dichloroarsine by method (C) outlined under *p*-sulfonamidophenyldichloroarsine; mixed m. p. 176–177°.

***p*-Chlorosulfonylphenyldichloroarsine.**—This substance was prepared by the method of Barber¹ using phosphorus trichloride and phosphorus pentachloride. The yield from 5 g. of sodium *p*-sulfophenylarsonic acid² after several recrystallizations from glacial acetic acid was 1 g.; m. p. 84–85°. This substance is soluble in most organic solvents.

Anal. Calcd. for $C_6H_4O_2AsSCl_2$: As, 23.30; Cl, 33.09. Found: As, 23.42; Cl, 32.87.

(1) Barber, *J. Chem. Soc.*, 2047 (1930).

(2) Oneto, *THIS JOURNAL*, **60**, 2058 (1938).

***p*-Chlorosulfonylphenylarsonic Acid.**—Five grams of *p*-chlorosulfonylphenyldichloroarsine was dissolved in 10 cc. of warm chloroform and saturated with chlorine. The mixture was chilled in ice and the unstable, crystalline *p*-chlorosulfonylphenylarsonic acid tetrachloride removed by filtration. The tetrachloroarsine was hydrolyzed to the corresponding *p*-chlorosulfonylphenylarsonic acid by treating with ice water. The crude acid was dried in vacuum over calcium chloride and recrystallized from ethyl acetate; yield 1.5 g.

Anal. Calcd. for $C_6H_5O_5AsCl$: As, 24.93. Found: As, 24.89.

***p*-Sulfonanilidophenylarsonic Acid.**—A mixture consisting of 5.3 g. of *p*-chlorosulfonylphenylarsonic acid and 12 cc. of aniline was heated on a water-bath for one-half hour. The resulting mass was treated with 40 cc. of 5% sodium hydroxide. The alkaline layer, which separated on standing, was treated with concentrated hydrochloric acid until acid to congo red paper, whereupon the *p*-sulfonanilidophenylarsonic acid precipitated in a crystalline form; yield, after recrystallization from water, 5 g.

Anal. Calcd. for $C_{12}H_{12}O_5NaS$: As, 20.97. Found: As, 20.66.

Summary

The preparation and properties of *p*-sulfonamidophenylarsonic acid and a number of its derivatives have been described.

SAN FRANCISCO, CALIF.

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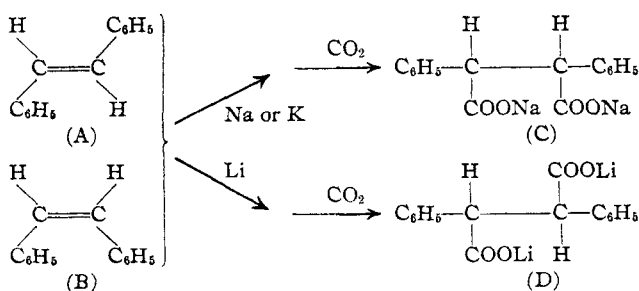
[CONTRIBUTION FROM THE CHEMICAL LABORATORY, UNIVERSITY OF TORONTO]

Addition of Alkali Metals to the Stilbenes

BY GEORGE F. WRIGHT

Introduction

In 1928 Schlenk and Bergmann¹ presented evidence to show that when alkali metals were added to ethylenes, the configuration of the adduct depended on the metal added and not upon the geometric isomer which was used. Thus, the addi-



tion of sodium or potassium to either stilbene (A) or isostilbene (B) gave, after carboxylation, the salt of *meso*-diphenylsuccinic acid (C), whereas

addition of lithium to either geoisomer under similar conditions gave the salt of *dl*-diphenylsuccinic acid (D). They further demonstrated that, under conditions not conducive to the addition reaction, isostilbene was isomerized by sodium to stilbene.

While such a directed addition is not impossible from stereochemical considerations, it would seem improbable that two metals as similar as are sodium and lithium should orient themselves so specifically that mixtures of diastereomers would not be formed. The observations of Schlenk and Bergmann have not been questioned; indeed Bachmann and Pence² assumed, on the basis of color, that addition of lithium or sodium to 1,2,3,4-dibenzanthracene yielded each a characteristic diastereomer. However Jeanes and Adams³

(1) Schlenk and Bergmann, *Ann.*, **463**, 98 (1928).

(2) Bachmann and Pence, *THIS JOURNAL*, **59**, 2339 (1937).

(3) Jeanes and Adams, *ibid.*, **59**, 2608 (1937).