[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF RICHMOND]

Creatinine Derivatives. I

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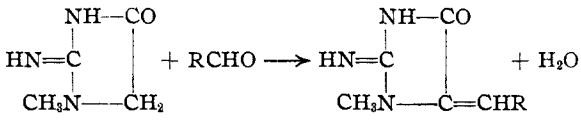
It has been shown that creatinine will condense with aldehydes according to the equation



however, very few condensations have been reported. Nicolet and Campbell[1] have prepared 5-benzalcreatinine and derivatives using the method of E. Erlenmeyer, Jr.[2] Richardson, Welch and Calvert[3] prepared 5-*m*-nitrobenzalcreatinine and 5-(*m*-methoxy-*p*-hydroxybenzal)-creatinine by fusing the aldehydes with creatinine.

In the present work the condensations were carried out by fusing creatinine with an excess of the aldehyde. In most cases the main reaction involved one molecule of creatinine and one of the aldehyde.

Di- Derivatives.—From condensations of furfural, cinnamyl aldehyde and furfuralacrolein with creatinine, products were obtained whose analysis indicated that two aldehyde molecules had condensed with one of creatinine. In the case of the furfural derivative one aldehyde molecule was split off with hydrochloric acid, yielding the mono derivative and furfural, indicating that the second aldehyde molecule was more loosely bound. Work is in progress toward the solution of a molecular structure for these di- derivatives.

The creatinine used in these preparations was made by the method of Edgar and Hinegardner[4] from commercial creatine which was kindly furnished by the Valentine Meat Juice Company.

Experimental Part

5-Furfuralcreatinine.—Five grams of creatinine and an excess of furfural were thoroughly mixed and heated in an oil-bath at 140° for thirty minutes or until the creatinine had all dissolved and the mixture became solid. The product was washed with alcohol and ether to remove excess furfural and then extracted with three one-liter portions of boiling water. The material crystallizing from the first liter of water consisted of difurfuralcreatinine which will be described later. The remainder after boiling with charcoal crystallized as silvery needle-shaped crystals, m. p. 273° with decomposition; yield 63%.

Anal. Calcd. for $C_9H_9O_2N_3$: N, 21.91. Found: N, 22.03.

5-Furfuralcreatinine Picrate.—A flocculent yellow precipitate was formed on adding an aqueous solution of picric acid to a solution of 5-furfuralcreatinine, m. p. 244° with decomposition.

5-Furfuralcreatinine Hydrochloride.—One gram of 5-furfuralcreatinine was dissolved in hot concentrated hydrochloric acid. On cooling, purplish-green crystals were formed of m. p. 257° with decomposition; yield 65%.

Anal. Calcd. for $C_9H_9O_2N_3 \cdot HCl$: N, 18.46; Cl, 15.58. Found: N, 18.50; Cl, 15.54.

Furfuralcreatine.—5-Furfuralcreatinine was dissolved in warm 10% sodium hydroxide solution and allowed to cool. After a short time a flocculent precipitate appeared which was filtered, washed free from sodium hydroxide, and proved not to be a sodium salt, m. p. 254° with decomposition.

Anal. Calcd. for $C_9H_{11}O_3N_3$: N, 20.07. Found: N, 20.11.

The hydrochloride and picrate made from this substance gave the same melting points as those made from 5-furfuralcreatinine.

Difurfuralcreatinine.—The product obtained from the first extraction of the creatinine-furfural condensation was redissolved in water and boiled with charcoal. On cooling 1.8 g. of grayish needles was obtained of m. p. 243°.

Anal. Calcd. for $C_{14}H_{11}O_3N_3$: N, 15.61. Found: N, 15.48.

Picrate, m. p. 205°, with decomposition.

Treatment of this compound with concentrated hydrochloric acid gave 5-furfuralcreatinine, the filtrate showing a positive test for furfural with aniline acetate paper.

Di-(furfural-acrolein)-creatinine.—Five grams of creatinine and slight excess of furfuralacrolein were heated in an oil-bath at 140° for one hour. A resinous mass was obtained which on crystallization from alcohol gave 6 g. (41%) of brick red crystals, insoluble in water and ether, of m. p. 268°.

Anal. Calcd. for $C_{18}H_{18}O_3N_3$: N, 13.08. Found: N, 13.45.

The picrate decomposes at about 200° without melting.

5-Furfural-methylcreatinine.—Three grams of methylcreatinine sulfate, 1 g. of sodium carbonate, and 8 g. of furfural were heated together at 120° for forty-five minutes and the product extracted with ether and then alcohol. The residue was crystallized from water, giving light gray crystals of m. p. 134°; yield 30%.

Anal. Calcd. for $C_{10}H_{11}O_2N_3$: N, 20.49. Found: N, 20.20.

Picrate, m. p. 235° with decomposition.

(1) Nicolet and Campbell, THIS JOURNAL, **50**, 1155 (1928).
(2) Erlenmeyer, Jr., *Ann.*, **284**, 49 (1895).
(3) Richardson, Welch and Calvert, THIS JOURNAL, **51**, 3075 (1929).
(4) Edgar and Hinegardner, *J. Biol. Chem.*, **56**, 881 (1923).

Difurfuralmethylcreatinine.—The alcoholic extract of the preceding experiment gave 0.7 g. of light gray crystals of m. p. 137°.

Anal. Calcd. for $C_{15}H_{13}O_3N_3$: N, 14.84. Found: N 15.01.

Picrate, m. p. 205° with decomposition.

5-Salicylcreatinine.—Five grams of creatinine and an excess of salicylaldehyde were heated at 130° for forty-five minutes. A red transparent mass was obtained which was crystallized from alcohol giving orange-yellow needles of m. p. 232° with decomposition; yield 83%.

Anal. Calcd. for $C_{11}H_{11}O_2N_3$: N, 19.33. Found: N, 19.41.

Picrate, yellow needles of m. p. 269° with decomposition.

5-Cinnamylcreatinine.—Eleven grams of creatinine and 13 g. of cinnamic aldehyde were heated in an oil-bath at 135° for eight hours. The gummy solid was extracted twice with boiling acetone, then boiled with water and the residue crystallized from alcohol, giving orange-red crystals of m. p. 280° with decomposition; yield 17%.

Anal. Calcd. for $C_{13}H_{13}ON_3$: N, 18.48. Found: N, 18.46.

Picrate, m. p. 261° with decomposition.

Dicinnamylcreatinine.—The acetone extract from 5-cinnamylcreatinine was diluted with ether and a flocculent mass of fine yellow crystals separated. These were boiled with water and recrystallized from acetone, giving a product of m. p. 220° with decomposition; yield, 19%.

Anal. Calcd. for $C_{22}H_{19}ON_3$: N, 12.32. Found: N, 12.17.

Picrate, m. p. 193° with decomposition.

Summary

1. Furfuraldehyde, cinnamyl aldehyde, salicyl aldehyde and furfuralacrolein have been condensed with creatinine and furfuraldehyde has been condensed with methylcreatinine.

2. The picrates of the above condensation products and the hydrochloride of furfuralcreatinine have been prepared and described.

3. Products formed by the reaction of two molecules of the aldehyde and one of creatinine have been isolated and described.

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[CONTRIBUTION FROM THE RESEARCH LABORATORY OF THE FIRESTONE TIRE AND RUBBER COMPANY]

A Method for the Preparation of 2-Mercaptobenzothiazole[1]

BY R. F. DUNBROOK AND M. H. ZIMMERMANN

Introduction

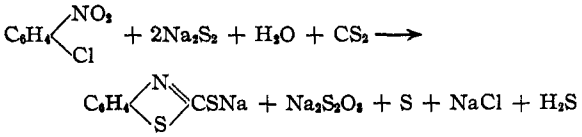
The discovery that 2-mercaptobenzothiazole and its derivatives are useful accelerators for the vulcanization of rubber has in recent years led to extensive searches for new methods of preparing this compound.

A method for preparing 2-mercaptobenzothiazole distinctly different from processes previously recorded was described by Teppema and Sebrell.[2] The reaction was carried out by heating *o*-nitrochlorobenzene with an aqueous solution of sodium hydrosulfide while passing into the mixture a stream of hydrogen sulfide previously saturated with carbon disulfide. The time of reaction was approximately twenty hours and yields from 87.5–90% were reported.

A modification of this process was mentioned by Sebrell and Teppema by which *o,o'*-dinitrodiphenyl disulfide was first prepared from *o*-nitrochlorobenzene and sodium disulfide and was subsequently converted into 2-mercaptobenzothiazole by the action of acid sodium sulfide, hydrogen sulfide and carbon disulfide.

This paper presents a new method[3] for the preparation of 2-mercaptobenzothiazole by the action of sodium polysulfide on *o*-nitrochlorobenzene in the presence of carbon disulfide. This method differs from that of Teppema and Sebrell in dispensing entirely with the use of hydrogen sulfide. The reaction is completed in a shorter time and the optimum yields of 2-mercaptobenzothiazole are somewhat higher than those reported by Teppema and Sebrell.

The ultimate reaction may be represented by the equation



$$C_6H_4\begin{cases}NO_2\\Cl\end{cases} + 2Na_2S_2 + H_2O + CS_2 \longrightarrow C_6H_4\begin{cases}N\\S\end{cases}CSNa + Na_2S_2O_3 + S + NaCl + H_2S$$

In just what steps it proceeds is not definitely

(1) Presented at the Cleveland Meeting of the American Chemical Society, September, 1934.

(2) Teppema and Sebrell, THIS JOURNAL, **49**, 1748 (1927); Sebrell and Teppema, U. S. Patent 1,662,015, March 6, 1928; U. S. Patent 1,785,656, December 16, 1930; U. S. Patent 1,669,630, May 15, 1928.

(3) Dunbrook, U. S. Patent 1,960,205, March 22, 1934.