[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF NORTHWESTERN UNIVERSITY]

A STUDY OF SOME PARA-ALKYLPHENOLSULFONIC ACIDS

BY C. M. SUTER AND EUGENE W. MOFFETT

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The purpose of this investigation was to prepare some sodium *p*-alkylphenolsulfonates and to determine their activity as antiseptics. It was thought that the presence of a sulfo group would confer the properties of increased solubility and decreased toxicity upon a phenol without seriously diminishing its bactericidal power. Since phenol-*o*-sulfonic acid has been shown[1] to be more active than its isomers and *p*-cresol-*o*-sulfonic acid more effective than phenol-*o*-sulfonic acid, it seemed reasonable to assume that the higher *p*-alkylphenol-*o*-sulfonic acids would be the most useful compounds of this type.

The four *p*-alkylphenols, *n*-propyl- to *n*-hexyl-, were sulfonated and the solubilities in water of the sodium salts of the resulting *o*-sulfonic acids were determined. The values obtained are listed in column four of Table I. It is interesting to note the alternation in the solubilities with the increase in the length of the alkyl group.

Determination of the phenol coefficients[2] indicated that only the *n*-propyl and *n*-butyl compounds have a detectable disinfectant action, the values for these being 1.8 and 2.4, respectively. A saturated solution of each of the other sulfonates gave no indication of bactericidal activity.

Experimental

***p*-Alkylphenols.**—These were made by a recently[3] used procedure involving the Fries reaction for the preparation of the *p*-hydroxyphenyl alkyl ketones and their reduction by the Clemmensen method to the alkylphenols. Part of the necessary phenyl esters were made from acyl chlorides and phenol and part of them by a method similar to one recently[4] reported.

Sodium *p*-Alkylphenol Sulfonates.—The sulfonation of *p*-butylphenol is described here. The other preparations were carried out in a similar manner.

A mixture of 40 g. of *p*-butylphenol and 30 cc. of concentrated sulfuric acid was heated on the steam-bath for an hour and poured into a saturated solution of sodium

TABLE I

Sodium *p*-phenol-*o*-sulfonate	Yield, %	S, % calcd.	S, % found	Sol. in H_2O at 26°, g./100 cc.	M. p. of *p*-toluidine salt, °C.
n-Propyl	56	13.44	13.47	1.52–1.61	141–143
n-Butyl	66	12.70	12.80	0.99–1.01	149–150
n-Amyl	72	12.04	11.90	1.30	147–149
n-Hexyl	83	11.43	11.45	0.54–0.48	139–140

[1] Frankel, "Arzneimittelsynthese," 6th ed., Julius Springer, Berlin, 1927, p. 542.

[2] We are indebted to Professors A. A. Day and A. W. Walker of the Department of Bacteriology of the Northwestern University Medical School for these determinations.

[3] Coulthard, Marshall and Pyman, *J. Chem. Soc.*, 280 (1930).

[4] Hartung, Munch, Miller and Crossley, THIS JOURNAL, **53**, 4153 (1931).

chloride. The precipitate of the sodium salt was twice recrystallized from hot water. The yield of pure product was 44 g. or 66% of the theoretical. The analytical data and yields of the four sulfonates are included in Table I.

The sulfur analyses were made by the Parr bomb method. The solubility determinations consisted of weighing the residues obtained by evaporation of the water from 25-cc. portions of saturated solutions of the various salts.

Summary

Four new *p*-alkylphenol-*o*-sulfonic acids have been made and the solubilities of their sodium salts in water determined. Of the compounds studied only the *n*-propyl- and *n*-butylphenolsulfonates have a measurable antiseptic action.

EVANSTON, ILLINOIS

[CONTRIBUTION FROM THE MCCARTHY NEUROLOGICAL FOUNDATION AND THE DEPARTMENT OF PHYSIOLOGICAL CHEMISTRY, MEDICAL SCHOOL, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, AND THE LABORATORY OF BIOLOGICAL CHEMISTRY, WASHINGTON UNIVERSITY SCHOOL OF MEDICINE, ST. LOUIS]

THE MECHANISM OF THE PRODUCTION OF THIOL ACIDS (R SH) AND SULFONIC ACIDS (R SO_3H) FROM DITHIO ACIDS (R S S R). III. THE ACTION OF COPPER SALTS[1,2]

BY PAUL W. PREISLER AND DORIS B. PREISLER

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Dithio acids (R S S R) have been shown to be simultaneously converted into thiol acids (R SH) and sulfonic acids (R SO_3H) by the action of Ag^+,[3,4] $BrHg^+$,[5] and Hg^{++},[6,7] the final result may be expressed by the equation

$$3R\,S\,S\,R + 3H_2O = 5R\,SH + R\,SO_3H$$

in which the formation of R SH and R SO_3H appears to be accelerated by reactants which remove the R SH by precipitation (Ag^+, Hg^{++}) or by formation of un-ionized complexes ($BrHg^+$).

The reaction between cupric salts and dithio acids has been studied by a quantitative method in which the corresponding sulfonic acid barium salt and the di-cuprous derivative of the thiol acid were isolated and identified. Of several possible reactions, the most probable is expressed by the equation

[1] Presented at the Meeting of the American Chemical Society in Buffalo, N. Y., September, 1931.

[2] The authors are indebted to the Smith, Kline and French Co., of Philadelphia, and to the Science Research Fund of Washington University, who have shared the expenses of this investigation with the respective institutions.

[3] Vickery and Leavenworth, *J. Biol. Chem.*, **86**, 129 (1930).

[4] Preisler and Preisler, *ibid.*, **89**, 631 (1930).

[5] Preisler and Preisler, *ibid.*, **95**, 181 (1932).

[6] Andrews and Wyman, *ibid.*, **87**, 427 (1930).

[7] Simonsen, *ibid.*, **94**, 323 (1931).