LIQUOR SODAE CHLORINATAE U. S. P. 1840–1920.*

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ABSTRACT.

Although a formula for Chlorinated Soda Solution did not appear before 1822, similar solutions had been prepared before this. Thus in 1788 Berthollet had prepared a liquid with "bleaching and disinfecting" properties, by the action of chlorine upon aqueous alkaline solutions. In 1792 the physician Percy prepared the chlorinated potash solution, a product placed on the market under the title *Eau de Javel*, which was at first used by the pharmacist Labarraque, but later replaced by the chlorinated soda solution.

Labarraque prepared his solution by passing chlorine into an aqueous solution of soda. Payen offered a modification of the process using chlorinated lime and sodium carbonate, the method now generally used.

The French Pharmacopoeia of 1837 was the first to introduce this solution, applying to it the title *Hypochlorite de Soude Liquide*. The London Pharmacopoeia of 1838 introduced it under the title *Liquor Sodæ Chlorinatæ*, as did the U. S. Pharmacopoeia of 1840.

Little was done with the development of this form of disinfectants and antiseptics until the advent of the European war. The investigation of the uses of this preparation led to the formulation of the well-known "Carrel-Dakin" solution, the literature on which alone constitutes an exhaustive study. Likewise an investigation of organic combinations of chlorine for antiseptic purposes was begun as manifested in the preparations under the trade names "Chloramines."

The development of the U. S. P. formula for Chlorinated Soda Solution for the past eight revisions offers an interesting study from the nomenclature to the method of assay. A brief oversight over this part may be had by a glance at the list of text subjects commented upon:

1. Titles and Synonyms.
2. Definition.
3. Preservation.
4. Sodium Carbonate as an Ingredient.
5. Chlorinated Lime as an Ingredient.
6. Ratio of Ingredients.
7. Water.
8. Amount of Water to Effect Solution.
9. Heat Used to Effect Solution.
10. Method of Preparation.
11. Solution of Sodium Carbonate.
12. Solution of Chlorinated Lime.
13. Appearance of Finished Product.
14. Odor of Finished Product.
15. Volume of Finished Product.
16. Taste of Finished Product.
17. Qualitative Tests.
18. Assay.

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THE GERMICIDAL VALUE OF MERCURIC IODIDE ALONE AND ASSOCIATED WITH SOAP.*

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Mercury salts are well recognized as germicidal agents, but the different salts differ widely in germicidal power depending on several factors. The acid radical with which they are combined, the substances with which they are asso-

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ciated, and the conditions of the test are all highly important factors in estimating this value.

In one case, that of mercuric iodide, it is essential that the soluble double salt of mercuric potassium iodide be prepared. The solvent probably does not in any way enhance its value except in making a soluble compound. This is apparently proved by the fact that when molecularly combined, one molecule of the mercury salt with two of potassium iodide, the resulting compound is not affected by further additions of the latter.

By the Hygienic Laboratory Method[1] the values of three of them are as follows:

Mercuric Iodide	5000
Mercuric Chloride	1000
Mercuric Cyanide	125

These values, however, are not absolute even by one method, since variable results are often found when no apparently different technique is applied.

These values, further, are usually very greatly lowered when any medium containing a greater proportion of nutrient material is used. Using plain bouillon containing very much more beef extract and peptone, the coefficients are usually reduced to about one-third the above values.

The term phenol coefficient, therefore, is meaningless, without the qualification which specifies the nature of the medium and the organism, the two essential factors which differentiate the different methods commonly applied.

A recent publication by Widman[2] summarized some experiments in which the phenol coefficients of two germicidal soaps and the U. S. P. Liniment of Green Soap were shown to be so nearly alike that there appeared to be no advantage in using a germicidal soap.

This is also in accord with a statement of Rosenau.[3] "Medicated soaps are for the most part a delusion and a snare so far as any increased germicidal action is concerned; in fact, the addition of phenol and other substances which have the property of combining with soap seems actually to diminish the disinfecting power of that substance." In a later publication,[4] however, he added the statement, "An exception seems to be the soap devised by McClintic in which a mercury salt exists unchanged and active."

Rosenau's statement is corroborated by Stassano and Gompel,[5] who compared three of the salts of mercury and found the iodide to be about 10 times as effective as the chloride, using the same organism—Staphylococcus. While this was mercuric iodide without the soap, the results should not be greatly different when the germicide is incorporated with a good soap base.

The soap referred to by Rosenau was one of the soaps used by Widman and his very low results led to some further investigations.

While there is apparent reason to doubt his statement that a soap with a Hygienic Laboratory Phenol Coefficient of not less than 30 could under any circumstances be found with a coefficient less than 1, the character of the medium and the selection of the organism can greatly influence the results of an assay.

I have since then tested this Mercuric Iodide soap on three occasions, using each time a different strain of the organism he selected, *Staphylococcus aureus*, and

obtained three different results, coefficients of 8, 26 and 33. In each case the work was carefully carried out and checked.

Under normal conditions of testing, namely, the Hygienic Laboratory Method, the coefficients of Mercuric Iodide and the 1 percent Mercuric Iodide Soap are in proportion to their content of the active agent. For various reasons, mostly undetermined, this is by no means invariable, but it is approximately true in most cases and may be regarded as a general statement.

This indicates that under the conditions imposed, the soap is merely a vehicle and adds nothing to the actual germicidal value of the agent. As a vehicle, however, it has obvious advantages, such as its cleansing action, and its alkaline solution. Using *Staphylococcus aureus* as the test organism, however, quite different results were obtained, as follows:

Mercuric Iodide	1100
Germicidal Soap containing 1% Mercuric Iodide	33

In this case, the mercuric iodide, associated with the soap, is 3 times as effective as mercuric iodide alone.

In another test, with a different strain of organism and a different culture medium, careful tests carried out showed results as follows:

Mercuric Iodide	86
Germicidal Soap containing 1% Mercuric Iodide.	26

This result was very surprising and must be regarded with suspicion, although carried out three times.

In both these cases, therefore, the action of the soap is to enhance the value of the agent very materially.

This combination has a number of advantages not possessed completely by either alone.

Soap, although for actual disinfection practically devoid of value,[6] is capable of bringing about a surprisingly high reduction in a bacterial count because of its detergent action. An efficient disinfecting agent associated with it, therefore, possesses a combination of valuable properties. This agent, however, must be high in intrinsic value, on account of the low solubility of the soap. A soap solution, as ordinarily obtained in lather, is not stronger than 1 in 100; the agent must therefore be of sufficiently high value that this further dilution will still be effective. For example, suppose 5 percent phenol were present in the soap, the dilution of phenol in the lather would be 1 in 2000, a dilution devoid of any germicidal value.

Another advantage possessed by the association of an active agent with soap is the fact that the solution is slightly alkaline and as such it promotes penetration both through the fatty film on the skin and into denuded tissue.

Macfarlan[7] summarizes a number of advantages corroborating my own experiments, showing that mercuric iodide has a truly remarkable value in diseases of the skin and mucous membrane.

Incorporating a definite proportion of sodium bicarborate, readily overcomes any corrosive action on metals. This again brings out the fact that the

value of a germicidal agent may often be greatly increased by association with other substances.

The object of this paper is to emphasize three points:

1st. The incorporation of an active germicidal agent with soap, if there is no combination which interferes with either substance, often enhances the values of both.

2d. Germicidal experiments should not be summarized in terms of phenol coefficients without specifically stating in what respects the assay methods differ from the accepted methods of obtaining the phenol coefficient.

PROTOCOLS OF GERMICIDAL TESTS

Sample—Germicidal Soap.
Method—A. P. H. A.
Organism—*B. typhosus.*

Sample.	5.	20 min.	Phenol.	5.	20 min.
1–2000	—	—	1–80	—	—
2500	—	—	90	—	—
3000	+	—	100	—	—
3500	+	—	110	+	—
4000	+	+	120	+	—
1–2700	—	—	1–100	—	—
3000	+	—	110	+	—
3300	+	—	120	+	—
3600	+	—	130	+	—
4000	+	+	140	+	—

Coefficient 26.4.

Sample—Germicidal Soap.
Organism—*Staph. aureus.*
Medium—Hygienic Laboratory.[1]

Soap.	2½.	15 min.	Phenol.	2½.	15 min.
1–400	+		1–50	—	
600	+		60	—	
800	+		70	—	—
1000	+		80	+	—
1200	+	+	90		—
1400	+	+	100		+
1600		+			
1800		+			
1–100	—		1–50	—	
200	—		60	—	
300	—		70	—	—
400	+		80	+	—
500	+	—	90		—
600	+	—	100		+
800		—			
1000		+			
1200		+			
1400		+			

$$\text{Coefficient} = \frac{300}{70} + \frac{900}{90} = 7.$$

[1] Adjusted to + 1.5 acidity.

Sample—Green Soap.
Organism—*Staph. aureus.*
Medium—Plain Bouillon.

	2½.	12 min.	Phenol.	2½.	15 min.
1–20	+		1–70	—	
30	+		80	+	—
40	+		90	+	—
50	+	+	100	+	+
60		+	110		+
70		+			
80		+			

Coefficient less than 0.3.

Organisms—*Staphylococcus aureus.*
Medium—Plain Bouillon.
Substance—Mercuric Iodide as Mercuric Potassium Iodide.

	5.	20 min.	Phenol.	5.	20 min.
1–80000	—	—	1–80	—	—
100000	+	—	90	+	—
150000	+	+	100	+	+
200000	+	+			
250000	+	+			

Coefficient 1100.

Organism—*Staphylococcus aureus.*
Medium—Plain Bouillon.
Substance—-Mercuric Chloride Phenol.

	5.	20 min.	Phenol.	5.	20 min.
1–10000	—	—	1–80	—	—
50000	—	—	90	+	—
20000	—	—	100	+	+
30000	+	—	110	+	+
40000	+	+			

Coefficient 333.

Organism—*Staphylococcus aureus.*
Medium—Plain Bouillon.
Substance—Germicidal Soap.

	5.	20 min.	Phenol.	5.	20 min.
1–2000	—	—	1–80	—	—
2500	—	—	90	+	—
3000	+	—	100	+	+
3500	+	+	110	+	+
4000	+	+			

Coefficient 33.

3d. Staphylococcus is a logical organism to use for such tests, but on account of the variation in resistance of different strains of the organism, no result can be taken as final and invariable.

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THE EFFECT OF VARIOUS IONOGENS ON THE TIME PERIOD REQUIRED FOR THE GELATION OF COLLOIDAL SILICIC ACID.*

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The retarding and accelerating effect of ionogens upon the setting of (sol) colloidal silicic acid has been the subject of study of quite a number of investigators in the past, but the results achieved have not always been harmonious or comparable. This was due, apparently, to the fact that the various investigators were experimenting with colloidal silicic acid of various concentrations and varying degrees of hydration.

It was endeavored therefore, in the work undertaken, to work with a pure silicic acid of uniform concentration, and of like hydration.

METHOD OF PREPARATION USED IN MAKING THE COLLOID.

The colloidal silicic acid was made by diluting 50 mils of commercial sodium silicate solution (density 40° Beaumé) with 150 mils of distilled water, and then adding this solution, with constant stirring, to 50 mils of pure concentrated hydrochloric acid. The mixture was dialyzed, using a "Parlodion" bag, made by coating the inside of a 350-mil Erlenmeyer flask with an ether alcohol solution of that substance, and separating from the flask after the solvent had vaporized.

The dialysis was carried out in a tall cylindrical glass vessel holding about 3 liters of water, and wide enough to prevent the dialyzing capsule from touching the sides. The water (distilled) was changed after 3, $3^1/_2$, 15, and 6 hours. The total time of dialysis was therefore 29.5 hours, and this method was rigidly followed in each batch of colloidal silicic acid prepared. The product secured in this way was but slightly translucent, and gave but a slight opalescence with silver nitrate solution. Further dialysis to remove this slight trace of chloride always resulted in gelation.

EXPERIMENTAL METHOD.

The method of procedure was to pipette out the required amount of ionogen solution, dilute with the required amount of distilled water to make 4 mils of the mixture, and then 4 mils of colloid solution added, thoroughly mixing after each addition. The tubes were then allowed to stand until no evidence of flow was noted upon inverting the tube. This point was taken as the end-point.

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