

It is interesting to note, in this connection, that morphinized dogs dying within 24 hours of the administration of the poison still hold a large amount of digitalis in their stomach, while dogs dying within 2 days had an almost empty stomach. Inasmuch as the death, in either case, was due to the digitalis, one is led to suspect that the gastric juice is capable of extracting the active principles even from tolu-coated digitalis. It seems fair to infer that tolu-coated digitalis will exert its action in the human being.

CONCLUSIONS.

1. Tolu and sugar coating of granulated medicaments of slight degree of solubility in alcohol and water is distinctly advantageous from the standpoint of disguising.
2. This coating does not interfere with the activity of digitalis, senna and of calcium salicylate. It may lessen somewhat the effect of ipecac upon the stomach.
3. Tolu and sugar coating can easily be carried out by any pharmacist, provided with a set of sieves.
4. The medication, thus disguised, might be administered in the form of powder or preferably in form of compressed tablets.

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SOME COLOR CHANGES IN SOLUTIONS CONTAINING FERRIC CITRO-CHLORIDE.*

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In making a stock solution of ferric citro-chloride, the same strength as the Tincture Ferric Citro-Chloride, N. F., for use in making elixirs, I have frequently noticed a difference in the shade of the green color produced. Seeking to obtain the same shade each time, I proceeded along the lines suggested by Prof. Otto Raubenheimer in his article published in the JOURNAL OF THE A. PH. A., Vol. IV, p. 351. By adding sodium bicarbonate I succeeded in getting the desired apple-green color. The process was tedious and the effervescence annoying, and induced me to make other experiments.

I soon found that not only would alkali carbonates and bicarbonates change the color of the solution from an olive-green to an apple-green but also that the alkali hydroxides would produce the same results; an excess, however, destroys the green color, which changes to a reddish brown.

I next tried the effect of the mineral acids, hydrochloric, sulphuric and nitric, and found that when they were added in excess to a green solution, the green color was entirely destroyed and like with the excessive addition of alkali a reddish brown color produced. Also if the acid is added gradually to a reddish brown solution, produced by the addition of excess alkali, the solution again assumes a green color; continued addition of acid causes the green color to disappear and the solution again becomes reddish brown. By adding alkali to a reddish brown solution, due to excess of acid, the green color is again developed and gives place to the reddish brown color when the alkali is in excess.

These experiments proved that the green color does not persist in a ferric citro-chloride solution unless the acidity or alkalinity is within certain degrees

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of limitation. In order to determine the limits of the green zone, 5 mls of the N. F. tincture of ferric citro-chloride were titrated with half-normal V. S. hydrochloric acid and it was found that 8.5 mls of the latter would destroy the green color, and to 5 mls of the same tincture 61.8 mls $\frac{N}{10}$ NaOH V. S. were added to obtain the same yellowish tint with both solutions being made up to the same volume with distilled water. One hundred mls of tincture of citro-chloride of iron then would require 85 mls $\frac{N}{1}$ HCl V. S., and 123.6 mls $\frac{N}{1}$ NaOH V. S.; the end-point, however, was not very sharp and these figures may be considered as approximate.

Having learned from these investigations how to get the desired shade, I then began a series of experiments to find out why the green color of solutions, containing iron citro-chloride, would turn darker when exposed to light. On May 21, 1917, I made up a solution containing 10 percent of a solution of ferric citro-chloride, of same strength as the N. F. tincture and 90 percent of distilled water. To one and one-half ounces I added 10 grains of boric acid; to a like quantity 10 grains of reduced iron; to four ounces 5 grains of potassium chlorate; to three and one-half ounces $\frac{1}{2}$ ounce of syrup. The bottles containing these solutions were placed in a window and exposed to sunlight. To these a bottle with one and one-half ounces of the original 10 percent solution was added, and another like quantity was placed in a box, protecting the solution from the light.

After three days each of the solutions exposed to light liberated carbon dioxide, indicated by tests with solution of lead subacetate and solution of calcium hydroxide; the one with reduced iron had become decolorized, but turned yellow when exposed to the air, which indicated a case of reduction and oxidation.

After three months all of the solutions exposed to light had assumed a reddish brown color except the one with reduced iron and this varied from colorless to brown, always turning darker when the stopper was removed and the solution exposed to the air. The sample not exposed to the light retained its green color with no apparent change.

The discovery of the development of carbon dioxide is in accordance with the work done by W. L. Scoville (JOURNAL A. PH. A., Vol. IV, p. 590), who showed its presence in wine of beef and iron, made with ferric citro-chloride, and he claimed that it was produced by the ferric salt oxidizing the citric acid. J. J. Willaman, in an article entitled "A Modification of the Pratt Method for Determination of Citric Acid" (*J. Am. Chem. Soc.*, Vol. 38, p. 2193), demonstrated that citric acid can be determined quantitatively by the fact that it forms acetone when oxidized by potassium permanganate. Believing that the citric acid is oxidized by the ferric iron and thinking that perhaps acetone might be formed in the solutions under consideration, a test was made which proved its presence.

An effort was then made to discover what would restore the green color to solutions of ferric citro-chloride which had turned brown by the action of sunlight. It was found that the addition of the mineral acids named would lighten the solutions materially, and in those which had only turned a reddish brown, the green color would be partially restored.

Citric acid was added and produced the same results in restoring the green

color and it was found that an excess of it would not cause the reddish brown color produced by excess of the mineral acids, therefore citric acid seems best suited for restoring the green color. However, when citric acid was added to an elixir of calisaya and iron, made about a year previous that had turned black, the citric acid alone failed to restore the color, but with the further addition of reduced iron the solution was restored to a light yellow color.

It was found that the green solutions responded to the test for ferric iron, while those of a reddish brown color to a ferrous condition.

SUMMARY.

The following conclusions have been reached:

1. That acids and alkalis beyond certain limits will destroy the green color of solutions of ferric citro-chloride, and these limits have been approximately determined.
2. That in solutions of ferric citro-chloride, exposed to sunlight, the citric acid is decomposed with the formation of carbon dioxide and acetone, and it is probable that the sodium liberated combines with the chlorine, lessening the acidity; the restoration of the color by the addition of acids indicates this.
3. That the iron exists in the green compounds in the ferric state and is reduced to the ferrous in the reddish brown and colorless solutions.
4. That citric acid can be used to lighten solutions and elixirs when of a reddish brown color, but that citric acid and reduced iron should be used together when these preparations have turned black.
5. That the green color is more than likely the result of a new compound of sodium citro-chloride and that the excess of acids destroys this. An excess of alkali in all probability causes the formation of ferric hydroxide, producing a reddish brown color.

The work done so far on this paper is presented in the hope that it will stimulate further investigation of this important subject.

Samples of the various products were shown.

ABSTRACT OF DISCUSSION.

W. L. SCOVILLE: This work of Mr. White is very interesting and practical; we need more of that kind on the iron preparations. This whole question of the physical chemical qualities of iron has got to be worked out from the bottom up. Prof. Stevens started an investigation some years ago, but he did not have time to finish it. We must consider that iron has an acidic as well as a basic character. We have a class of compounds known as the ferrates. Now there seems to be a condition in which the iron takes on the acidic character, and in which it is very sensitive to chemical change, not so much in itself, but in the agents with which it is combined. This action on the citric acid is simply an evidence that the iron is probably active in its acidic character.

I hope some day the universities will take up the whole question of the physical properties of iron, and give us the fundamental principles under which these color changes, as well as other changes, in the iron actually take place.

C. P. WIMMER: I might add that the problem, to my mind, is more of a color chemical problem all the way through, because I believe, for example, that this solution of iron citro-chloride is a colored solution and when the iron chloride is dialyzed out citric acid will be left. I want to substantiate what Prof. Scoville has said, that this aspect of the iron salts presents untold possibilities for research. I have done some work on it, and I hope by another year I will be far enough advanced to make a report on it.