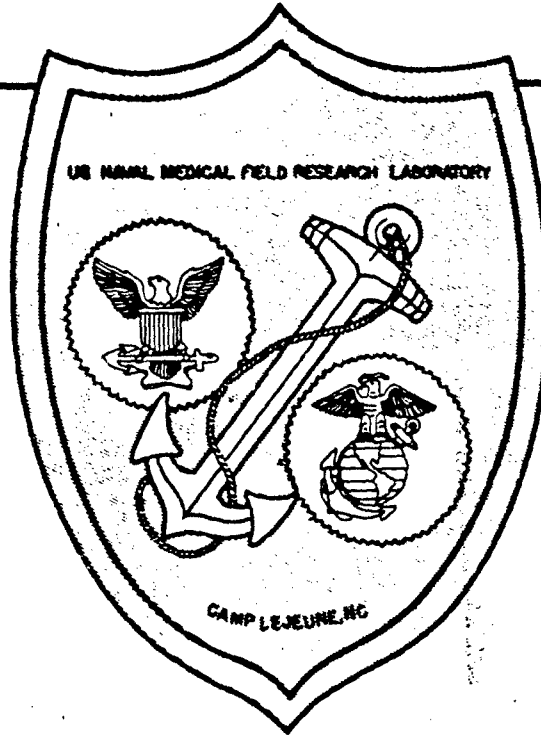


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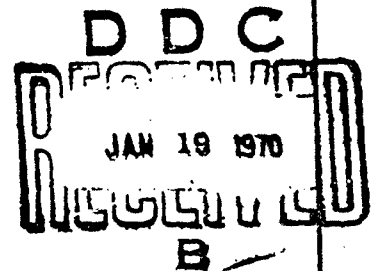
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THE EFFECTS OF ELECTROLYTE POWDER
 ON IODINE-TREATED WATER

Ned S. Hurst, B.S.

Bureau of Medicine and Surgery, Navy Department
 MF12.524.007-8007B.4

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**THE EFFECTS OF ELECTROLYTE POWDER
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Physiology Division
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SUMMARY PAGE

THE PROBLEM

To determine the effect of electrolyte powder on iodine-treated water.

FINDINGS

Free iodine found in iodine-treated water is neutralized by a component of the electrolyte powder.

RECOMMENDATIONS

1. Lemon oil should be removed from the lime-flavored electrolyte powder if it is to be used with iodine-treated water.
2. The use of the electrolyte powder could be continued with iodine-treated water without the oil of lemon found in the lime flavoring.
3. Research should be instituted to correct the deficiency in the packaging.

ADMINISTRATIVE INFORMATION

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The author acknowledges the professional assistance of LT P. L. Schwartz, MC, USNR, Physiology Division, Naval Medical Field Research Laboratory, Camp Lejeune, North Carolina. Mr. Mack Moore and HM3 M. J. O'Barr, USN, Physiology Division, Naval Medical Field Research Laboratory, Camp Lejeune, North Carolina also assisted.

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This restriction will be removed and the report may be released on 15 January 1970.

ABSTRACT

The influence of the electrolyte powder prepared by the Pharmacy Service, Naval Hospital, Bethesda, Maryland on iodine-treated water was investigated. When 77 gm of the electrolyte powder were placed in iodine-treated water, 12.69 mg/liter, essentially all of the free iodine was removed in 60 minutes.

The effect of electrolyte powder on the germicidal action of iodine was also investigated. The results were ambiguous and further research is indicated.

BACKGROUND

Marine troops in a combat situation use iodine tablets to disinfect small quantities of water. When proper procedures are followed, this system provides purified water. A study of the effect of an electrolyte powder prepared by the Pharmacy Service, Naval Hospital, Bethesda, Maryland, on the germicidal and chemical properties of free iodine was reported in an earlier paper,¹ and further investigation of the problem is presented in this paper.

The composition of the electrolyte powder is stated to be as follows: sucrose, 70.00 gm; citric acid, 3.00 gm; lime flavoring, 2.40 gm; sodium chloride, 1.00 gm; calcium chloride, 0.40 gm; potassium monophosphate, 0.04 gm. This is dissolved in one quart of water and stirred well.

METHODS

Only qualitative chemical tests for free iodine were performed, due to the problem of coloration from the lime flavoring. Free iodine was determined by the starch method and by the solvent extraction method.²

Germicidal properties were studied in the following manner:

One thousand milliliters of distilled water artificially contaminated* with bacteria were placed in a flask. Two iodine tablets and 77 gm of electrolyte powder were added simultaneously. Naturally contaminated water from Piney Green (near Camp Lejeune, N.C.) was treated similarly. Bacterial studies** were made 30 minutes after the addition of electrolyte powder and iodine tablets. Results are shown in Table 1.

Exactly 1000 ml of water artificially contaminated with bacteria were placed in a flask. Two iodine tablets were added and permitted to remain at room temperature for 20 minutes. Then 77 gm of lime-flavored electrolyte powder were added. Bacterial studies were made 30 minutes after the addition of the electrolyte powder. See Table 2 for results.

Free iodine was tested by the starch and solvent extraction methods and studied in the following manner:

Precisely 1000 ml of distilled water were placed in a flask. One

Table 1

Thirty Minutes Contact Time with
Electrolyte Powder and Iodine
Tablets Added Simultaneously

Sample/Source H ₂ O	Bacteria Study (col/ml)
Contaminated Distilled Control	40 col/1 ml
Contaminated Distilled Sample 1A	0 col/2 ml
Piney Green Control	Numerous col/1 ml
Piney Green Sample 1B	4 col/2 ml
Piney Green Sample 1C	3 col/2 ml

* Contaminated distilled water is distilled water artificially contaminated with *E. coli* and *Proteus*.

** Bacteria studies were made on pour plates composed of heart infusion agar and dextrose.

milliliter of 12.69 mg/ml iodine standard was added and 77 gm of electrolyte powder were added immediately. Tests were made for free iodine at the times indicated in Table 3. Naturally contaminated Piney Green water was treated similarly (Table 3).

Exactly 1000 ml of distilled water were placed in a flask. Free iodine determinations were made two minutes after addition of iodine, and 30 minutes after standing at room temperature.

Piney Green water was treated in a similar manner. Chemical studies were made at the time indicated (Tables 4 and 5).

Chemical and bacteriological studies of naturally contaminated Piney Green water indicated that after addition of 12.69 mg/liter of iodine, most of the free iodine is removed and germicidal properties are lost after 20 minutes contact with 77 gm of electrolyte powder.

Apparently, one or more characteristics of the naturally contaminated water and of the electrolyte powder neutralize the free iodine. Piney Green water is able to remove approximately 5.3 mg/liter of the free iodine added in 30 minutes. However, when the electrolyte powder and 1 ml of 12.69 mg/ml are added simultaneously, the free iodine is bound in approximately 20 minutes.

Table 2

Twenty Minutes Contact with Iodine from Iodine Tablets and Thirty Minutes Contact with Electrolyte and Iodine Water

Sample/Source H ₂ O	Bacteria Study (col/ml)
Contaminated Distilled Control	30 col/1 ml
Contaminated Distilled Sample 1A	0 col/2 ml
Piney Green Control	Numerous col/1 ml
Piney Green Sample 1B	2 col/2 ml
Piney Green Sample 1C	0 col/2 ml
Piney Green Sample 1D	1 col/2 ml

Table 3

Time Required for Electrolyte Powder to Bind 12.69 mg/liter of Iodine in Piney Green Water and Distilled Water

Sample/Source H ₂ O (20.9°C)	Method for Determining I ₂		Contact Time (min)
	Starch	Solvent Extraction	
Piney Green	P	P	10
Piney Green	T	A	20
Piney Green	A	A	30
Piney Green	A	A	40
Distilled	P	P	10
Distilled	P	P	20
Distilled	P	P	30
Distilled	P	T	40
Distilled	T	A	50
Distilled	A	A	60

P = Iodine Present
T = Iodine Trace
A = Iodine Absent or less than 0.6 mg/liter

On the basis of these results, we initiated a further study to determine the component(s) of the electrolyte powder which neutralized the free iodine.

Six liters of distilled water were placed in a flask and 6 ml of iodine stock standard 12.69 mg/ml were added. One liter of the iodine-treated water was placed in each of six flasks. The flasks were labeled 1A, 1B, 1C, 1D, 1E, and 1F. The components listed below were added to the appropriate flasks: 1A - 1.00 gm sodium chloride; 1B - 0.04 gm potassium monophosphate; 1C - 3.00 gm citric acid; 1D - 70.00 gm sucrose; 1E - 2.40 gm lime flavoring; 1F - 0.40 gm calcium chloride. Iodine studies were made by the solvent extraction and starch methods at the times indicated in the results (Table 6).

The study of the effect of lemon oil on free iodine was made in this manner:

Four liters of distilled water were placed in a flask and 4 ml of iodine stock standard 12.69 mg/ml were added. One liter of the iodine-treated water was placed in each of four flasks. The flasks were labeled 1A, 1B, 1C and 1D, and were treated as listed below: Flask 1A - 1.000 ml of lemon oil was added and suspended; Flask 1B - 0.500 ml of lemon oil was added and suspended; Flask 1C - 0.250 ml of lemon oil was added and suspended; Flask 1D - Control, 1 ml of distilled water was added. Iodine studies were made by the solvent extraction and starch methods at the time indicated in the results (Table 7).

Table 4

Determination of the Amount of Free Iodine
(12.69 mg/liter) After Two Minutes
Contact Time

Sample/Source H ₂ O (22°C)	Absorbance	Iodine Concentration (mg I ₂ /liter)
Standard	0.220	19.04
Standard	0.147	12.69
Standard	0.074	6.35
Standard	0.034	3.17
Distilled Control	0.150	12.69
Piney Green	0.123	10.35
Piney Green	0.123	10.35
Piney Green	0.124	10.50

Table 5

Determination of the Amount of Free Iodine
(12.69 mg/liter) After Thirty Minutes
Contact Time

Sample/Source H ₂ O (22°C)	Absorbance	Iodine Concentration (mg I ₂ /liter)
Standard	0.215	19.04
Standard	0.149	12.69
Standard	0.076	6.39
Standard (Sample Spilled)		3.17
Distilled Control	0.147	12.70
Piney Green	0.084	7.30
Piney Green	0.087	7.50
Piney Green	0.087	7.50

Table 6

Qualitative Results for the Presence of Free Iodine
(12.69 mg/liter of Distilled Water Initial Concentration)
When Components Found in Electrolyte Powder are Added

Time (min)	Sodium Chloride	Potassium Monophosphate	Citric Acid	Sucrose	Lime Flavoring	Calcium Chloride	Control
10	P	P	P	P	P	P	P
20	P	P	P	P	P	P	P
30	P	P	P	P	P	P	P
40	P	P	P	P	P	P	P
50	P	P	P	P	P	P	P
60	P	P	P	P	T	P	P
70	P	P	P	P	A	P	P
80	P	P	P	P	A	P	P
90	P	P	P	P	A	P	P
100	P	P	P	P	A	P	P
110	P	P	P	P	A	P	P
120	P	P	P	P	A	P	P
130	P	P	P	P	A	P	P
140	P	P	P	P	A	P	P
150	P	P	P	P	A	P	P
180	P	P	P	P	A	P	P

P = Iodine Present

T = Iodine Trace

A = Iodine Absent or less than 0.6 mg/liter

Table 7

Effect of Lemon Oil on Free Iodine
Standing at 26°C for Ten Minutes

Sample	Amount of Lemon Oil Added	Iodine Determination
1A	1.000 ml	A
1B	0.500 ml	A
1C	0.250 ml	A
1D	0.000 ml	P

A = Iodine Absent or less than 0.6 mg/liter

P = Iodine Present

RESULTS AND DISCUSSION

The results indicate that the germicidal properties of contaminated distilled water treated with iodine at 12.69

mg/liter would be lost in approximately 60 minutes after the addition of electrolyte powder (Table 6).

The following components of the electrolyte powder show no appreciable effect on the free iodine: potassium monophosphate, citric acid, sucrose and calcium chloride. However, the lime flavoring neutralizes the greater portion of the free iodine standing at room temperature in less than 70 minutes.

Investigation indicates that lemon oil is the component or one of the components responsible for the binding of the free iodine. Lemon oil, USP, manufactured in March 1969 by the Gentry Corporation, New York, N. Y., would neutralize 12.69 mg of iodine/liter

of distilled water in less than 10 minutes. The presence of free iodine after treatment with oil of lemon was determined by the solvent extraction and starch methods. The o-tolidine method could not be used as it gave uncertain results in the presence of lemon oil and iodine treated water.

Research indicates a difference in the rate of binding of free iodine between distilled water and Piney Green water. When 12.69 mg of iodine are added to one liter of naturally contaminated Piney Green water, approximately 5.3 mg of the free iodine are removed in 30 minutes. The difference in the Piney Green water and distilled water is attributed to the inorganic and organic matter found in the Piney Green water; thus, in the Piney Green water, only 7.39 of the original 12.69 mg/liter of free iodine is left to react with the electrolyte powder 30 minutes after the addition of the iodine. Further research would be necessary to determine the extent of competition between the electrolyte powder and natural contaminants for free iodine.

The electrolyte powder is packed in a plastic container with a heat seal. This system failed to make a complete seal in many of the samples tested. Several improperly sealed samples, standing at room temperature, collected moisture causing the powder to clump together.

CONCLUSIONS

1. One of the components in the electrolyte powder used to improve the palatability of iodine-treated contaminated water contains an agent which reduces or otherwise neutralizes the free iodine.
2. When free iodine is added to distilled water most of the free iodine is bound by the electrolyte powder in approximately one hour of contact time. However, in naturally contaminated Piney Green water, the free iodine is bound by the electrolyte powder in a shorter period of time, depending on the extent of contamination and on the content of organic and inorganic materials in the water.
3. In the presence of dissolved electrolyte powder, insufficient iodine would be present to inactivate additional bacteria after 30 minutes. Any additional germicidal activity would be due to the acidity of the solution and/or other factors.
4. Lemon oil is the component, or one of the components, responsible for the binding of the free iodine.
5. The oil of lemon should be removed from the lime flavoring used in the electrolyte powder.

RECOMMENDATIONS

1. Lemon oil should be removed from the lime-flavored electrolyte powder if it is to be used with iodine-treated water.
2. The use of the electrolyte powder could be continued with iodine-treated water without the oil of lemon found in the lime flavoring.
3. Research should be instituted to correct the deficiency in the packaging.

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2. Snell, F. D. and Snell, C. T. *Colorimetric Methods of Analysis*, Volume II, New York: D. Van Nostrand Company, Inc., 1951, pp. 737-742.

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