A CHEMICAL METHOD OF STERILIZING WATER WITHOUT AFFECTING ITS POTABILITY.

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It is impossible to think of the late war in South Africa without deploring the appalling loss of life from water-borne diseases (especially enteric fever) that it entailed—a loss out of all proportion to the number of men dying from wounds received in action. And not only this, but the cost of the campaign was greatly increased and the action of the troops constantly hampered by the necessity of adequate provision for so large a number of sick men.

Attention is naturally turned to the methods in vogue for the rendering of water safe for drinking purposes.

Boiling is undoubtedly the best and simplest way of procuring water free from living typhoid, cholera, dysentery, and other non-sporing organisms pathogenic to man when taken into his stomach. But this method cannot always be managed on account of the fuel being often very difficult to procure; and then, again, the water takes time to cool, and if at all warm soldiers will not drink it, but will prefer to drink polluted water.

The Waterhouse-Forbes heating sterilizer is claimed to be able to sterilize and cool water; but it is a somewhat bulky machine, and there is still the difficulty about fuel.

Filters frequently get blocked or cracked, and need constant attention and cleaning, and, moreover, cannot always be relied on.

It comes to this, then: that there is still wanted for soldiers on the march, and for persons travelling in localities where typhoid and cholera are rife, some quick process by which water may be rendered sterile, and therefore safe for drinking purposes; and for the process to be of any service in preventing disease it must be also certain.

One naturally thinks whether there is not a chemical method by means of which this may be accomplished.

Now, for a chemical process to be of any value it must conform with four conditions:

1. It must be certain of effect.
2. It must leave the water tasteless.
3. It must leave the water free from any noxious chemical substance.
4. It must be in such a form as to be suitable for foreign travel—*i.e.*, it must be easily portable, and must not deteriorate by keeping.

Many substances will answer one or other of these requirements, but hitherto no satisfactory solution of the whole problem has been brought forward.

It occurred to me that chlorine gas might be found to be satisfactory on all four points if suitable means could be found for using it. In order to test the sufficiency of chlorine on these points I have made an extensive series of experiments.

First, with regard to the germicidal powers of chlorine. I used twenty-four, forty-eight, and sixty-four hour old cultures of *B. typhosus*, *B. coli*, and Shiga's dysentery bacillus broth, pouring 10 c.c. of this teeming fluid into a litre of tap-water. Each organism was experimented on separately. I constantly found that 0·125 gramme of chlorine per infected litre was quite sufficient to sterilize it in five minutes as regards these pathogenic bacteria and other non-sporing bacteria and cocci. In no case was there a failure. But the spores of the Hay bacillus are occasionally capable of withstanding this germicide, as they are also able to withstand boiling. But as one is striving to render the water free only of typhoid, coli, and other vicious organisms which do not spore, the Hay bacillus may be left to itself. The water is subsequently dechlorinated with sodium sulphite in accordance with the formula:

$$Cl_2 + H_2O + Na_2SO_3 = Na_2SO_4 + 2HCl.$$

The HCl is neutralized at once by the alkali present in sodium sulphite (commercial) and in the water, about 3-4 grains of sodium sulphite and sodium chloride remaining in the pint, 0·22 gramme of sodium sulphite being necessary for 0·125 gramme of chlorine; and so 100 grammes of chlorine will sterilize 176 gallons of water, and will require 6¼ ounces of sodium sulphite to neutralize it, or in grammes 177·46.

The next important question was how to render the gas portable. This may be effected in one of two ways:

1. By liquefying it, and storing it in lead-lined iron vessels, having a jet with a very fine capillary canal, and fitted with a tap or a screw cap. The tap is turned on, and the cylinder placed in the amount of water required. The chlorine slowly bubbles out, and in ten to fifteen minutes the water is absolutely safe, and has only to be rendered tasteless by the addition of sodium sulphite made into a cake or tablet. Chlorine at 0° C. liquefies under a pressure of six atmospheres; and 100 grammes of the liquid gas occupy 74·1 c.c. volume. The cylinders could, of course, be refilled. This method would be of use on a large scale, as for service water-carts.

2. When it is required to sterilize smaller quantities at a time—*e.g.*, that in a water-bottle—a tablet may be used which evolves nascent chlorine.

I have found that 1½ grains of bleaching-powder mixed thoroughly with ½ grain of sodium bicarbonate and made into a 2-grain tablet will sterilize a pint of water in five minutes, though it would be as well, for safety's sake, to allow ten. The water is rendered free of chlorine and tasteless after the sterilization has been completed by ¼ grain of sodium sulphite. The bicarbonate is added to keep the tablet dry, also because the CO_2 it contains makes the salt sufficiently acid to liberate the very feebly combined chlorine from bleaching-powder (chlorinated lime), whose solution it hastens, also, doubtless, forming the chloride and hypochlorite of sodium, and these latter salts are decomposed by the CO_2 dissolved in the water, and so also give off chlorine. The tablet remains, apparently unaltered in size, at the bottom of the vessel, the water keeping of the same clearness as before the operation.

The tablets will keep well in corked glass tubes, and are readily made by compressing the mixture in a mould.

I have recently been experimenting with a tablet of sodium sulphite formed by compressing the dry salt moistened with gum-acacia water, and covering it with a film of gelatine that takes just ten minutes to begin to dissolve.

This is affixed to the chlorinating tablet, which thus has ten minutes to exert its influence before its antagonist can take effect; so, in fifteen minutes or less, the water is sterile and tasteless.

There are still a few more experiments to perform to confirm the efficacy of this double tablet.

From my experiments I find that chlorine in solution has very great penetrating powers, and may be relied upon to reach organisms even when enveloped in particles of mud or algæ.

This method satisfies all the conditions which I have laid down above, and it is eminently applicable to the following purposes:

1. For soldiers or travellers in countries who must depend for their water-supply on any stream, well, or hole, they may pass. Even the Modder River might have thus been rendered harmless.

2. For rendering water aseptic for surgical purposes, and thus giving a better chance of success in grave operations undertaken in emergency.

3. For washing oysters, watercress, and similar food-stuff liable to sewage contamination.

4. For domestic use in times of epidemics of cholera, typhoid, etc.