IODINE AS AN AERIAL DISINFECTANT

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(With 1 Figure in the Text)

Several writers (Lombardo, 1926; Plesch, 1941) have advocated the use of iodine as an aerial disinfectant, but the evidence they give is inconclusive. Others (Lipkin, 1934; Lebduska & Pidra, 1940) have tested the effect of the vapour against bacteria growing on agar plates. White, Baker & Twort (1944) mention that iodine is a disinfectant that is effective at concentrations much below its saturation vapour pressure in the air. In the course of his tests on iodine diffusers carried out in Chesterfield, Dr J. A. Goodfellow has called our attention to the possible use of iodine as an aerial disinfectant. The following tests were conducted to investigate the bactericidal power of iodine vapour against air-borne bacterial particles, both moist salivary organisms and dry dust-borne organisms.

METHOD OF TEST

The killing action of iodine was studied against two types of bacteria:

(*a*) Salivary bacteria, mainly streptococci and micrococci. These were put up into the air by spitting violently between closed lips, giving an exceedingly fine spray of small bacterial droplets. This method has been found to give a very reproducible spray, particularly with regard to the number of droplets put up (between 400,000 and 800,000 for each spit).

(*b*) Dry organisms from a blanket, mainly sarcina and chromobacteria. These were put up into the air by blowing a high-velocity air stream through a tube across the end of which the blanket was held. The bacterial particles put up have been found to be more resistant to the action of aerial disinfectants than salivary organisms, which are moist.

The bacteria, put up by one of the above methods, were mixed by a fan in the air of a room of 800 cu.ft. capacity, and the air then sampled at 1 cu.ft./min. on to serum agar plates, using a slit sampler (Bourdillon, Lidwell & Thomas, 1941). After 1 min. iodine was vaporized and rapidly mixed by the fan, and the dieaway of bacteria in the air was measured by sampling for a further 4–10 min. The plates were incubated at 37° C. for 18 hr. and then counted. The rate of kill of the bacteria, expressed in equivalent air turn-overs per hour, was found from the equation

$$T = (\log_{10} n_1 - \log_{10} n_2)\frac{138}{t},$$

where T = turn-over rate per hour, $n_1 n_2$ = bacterial counts per cu.ft. of air, and t = time in minutes between counts n_1 and n_2.

In assessing the killing action of the iodine, allowance was made for the rate of disappearance of bacteria from the air due to sedimentation and natural death. This was found from many control experiments to be $3\frac{1}{2}$–4 turn-overs for salivary organisms, and 2 for dry blanket organisms. A great advantage of the use of turn-overs per hour in expressing the rate of disappearance of bacteria is that the total turn-over rate is the sum of the turn-over rates of the various contributing processes, in this instance killing by iodine plus natural dieaway. Thus from the turn-over rate found by the above equation was subtracted 4 for salivary organisms and 2 for blanket organisms to give the net killing rate due to the iodine.

During each test the wet- and dry-bulb temperatures in the room were recorded.

The iodine was vaporized directly into the fan draught from a heated asbestos gauze. It was put up from either (*a*) solid iodine, (*b*) iodine in alcohol solution, (*c*) iodine in chloroform, or (*d*) iodine in aqueous potassium iodide. No difference in efficiency was detected between these methods.

RESULTS

(*a*) *Salivary organisms.* In fifty-five of the tests here summarized, 0·1 g. of iodine was vaporized by one of the above methods in killing tests on salivary organisms. The results of these tests are shown in Fig. 1 *A*. Above 50 % R.H. 0·1 g. of iodine in the room (i.e. about 0·1 mg./cu.ft. of air) gives rapid killing of salivary organisms, but at lower humidities the rate of kill drops very rapidly. This effect of humidity is very much greater than on most other air disinfectants.

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Several tests were conducted with iodine at lower concentrations. While no quantitative relation was obtained, these indicated that the killing rate by

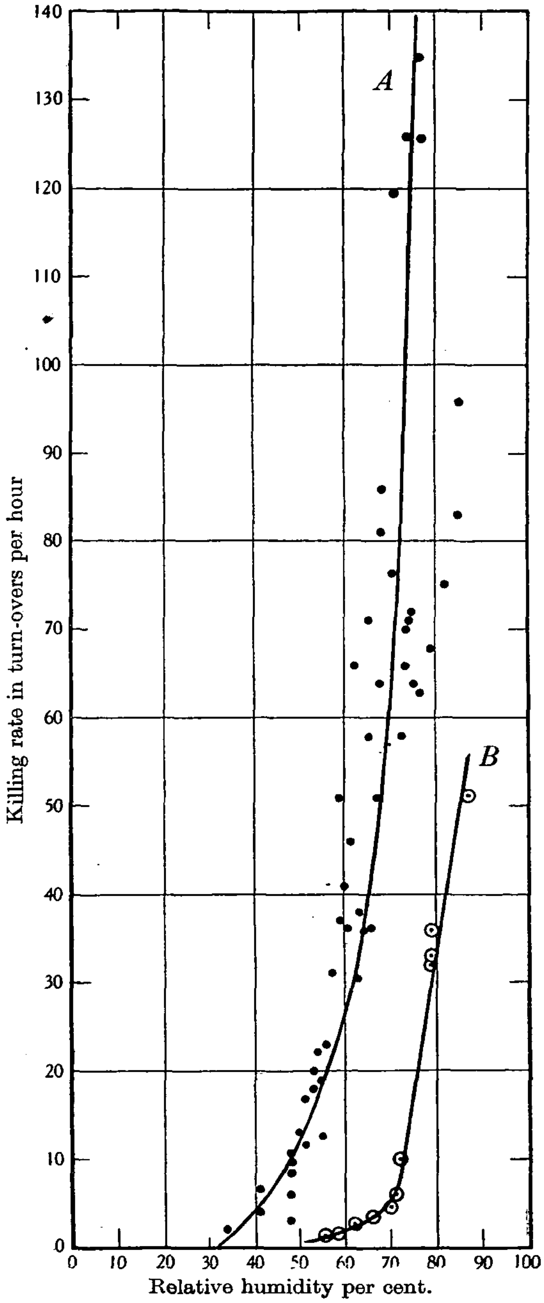

Fig. 1. Killing of airborne bacteria by iodine at 0·1 mg./cu.ft. *A*. Salivary bacteria. *B*. Bacteria from a dry blanket.

iodine is roughly proportional to its concentration down to 0·05 mg./cu.ft., but falls off rapidly at some concentration below this.

(*b*) *Dry bacteria*. Fig. 1 *B* shows the killing action of iodine on dry bacteria. Above 70 % R.H. the rate of kill is rapid, but slow at lower humidities. The shape of the curve is similar to that found for salivary organisms, but the humidity needed for effective killing is about 20 % greater.

No appreciable effect of temperature on the rate of killing of bacteria by iodine was found over the range 55–70° F.

Persistence. This was tested by leaving the experimental room undisturbed for 10 min. after 0·1 g. of iodine had been put up in a killing test on salivary bacteria, and then finding the kill produced on a further spraying spit by the residual iodine. At 82 % R.H. the residual killing rate was found to be 20 turn-overs (initial killing rate 90) and at 59 % 16 turn-overs (initially 20). Thus, while the actual residual killing rate is higher at high humidities, the percentage of the initial killing rate is less.

Tolerance. In the majority of these tests an iodine concentration of about 0·1 mg./cu.ft. was used. This produces only a slight smell of iodine, and the air is readily tolerable by normal people. A concentration twice as great, while readily respirable, causes some irritation in the eyes and at the back of the throat. At this concentration about 3 mg. of iodine per hour will pass into the lungs; although, as with all aerial disinfectants, the possibility of sensitization must be considered, it is improbable that this quantity, even if completely absorbed by the lungs, will produce any sensitization or other ill effects.

DISCUSSION

Iodine at a concentration of 0·1 mg./cu.ft. is found to be an effective aerial disinfectant at suitable humidities, thus confirming the observations of White *et al.* (1944) that it operates at pressures well below its saturation point. In this respect it behaves similarly to hypochlorous acid, chlorine (Baker, Finn & Twort, 1940), and bromine. The latter, at a concentration of 0·1 mg./cu.ft., has been found to give rapid killing of salivary organisms at humidities above 55 %. This compares with lactic acid (Lovelock, Lidwell & Raymond, 1944), propylene glycol, and various phenols which appear to become effective only at or near their saturation vapour pressures.

SUMMARY

1. Iodine vapour at a readily tolerable concentration of 0·1 mg./cu.ft. of air gives a rapid kill of freshly sprayed salivary organisms at humidities above 50 %.

2. At the same concentration dry bacteria are not as readily killed, the killing rate only becoming appreciable above 70 % R.H.

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