Short Communication

A DEPENDENCE ON WATER CONTENT OF BACTERICIDAL EFFICIENCY OF GAMMA-RADIATION

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THE bactericidal efficiency of ionising radiations on cells irradiated at a controlled water content is governed by the nature of the environment during and after irradiation. Furthermore, recent experiments with soft X-rays show that for given conditions of irradiation and post-treatment, lethal efficiency can depend on water content (Tallentire and Powers, 1963). Quantitative data describing these relationships for radiations of greater energies are important on two accounts: (1) to allow recognition of physical and/or chemical processes occurring soon after energy absorption in irradiated cells, and (2) to provide a more complete understanding of the microbial aspects of "radiation sterilisation".

Spores of *Bacillus megaterium* (ATCC 8245) distributed on kaolin (Tallentire and Davies, 1961) were used for the experiments. After secondary drying (Tallentire and Dickinson, 1962) weighed samples were equilibrated in vacuum to known H_2O vapour pressures. Gamma-irradiation (cobalt-60) of samples of spores of different water content was carried out at 22° in the absence of oxygen. All samples were given an anoxic post-irradiation soaking with liquid H_2O before exposure to the atmosphere; this procedure avoids lethal damage from the post-irradiation oxygen effect. Surviving fractions, based on colony counts, give exponential dose/survival curves and the slopes of these are used as a measure of lethal efficiency of the radiation, higher values for the slopes indicating greater efficiency.

The range of equilibrium H_2O vapour pressures tested was from 5×10^{-4} to 21 torr. Fig. 1 shows that over this range the limiting values of the slopes are 7·7 and 10·4 $Krad^{-1} \times 10^3$. Thus, in changing from a condition in which the spores are driest to one in which they are in equilibrium with H_2O vapour at a partial pressure equivalent to 100 per cent relative humidity at room temperature (23°), the lethal efficiency of the gamma-radiation increases by about 35 per cent. The transition from low values of slopes to high values occurs over that section of the vapour pressure range between 4·6 and 8·0 torr. Below 4·6 torr, radiation efficiency is unaffected by a ten thousandfold decrease in H_2O vapour pressure and above 8·0 torr, when efficiency is highest, it remains unchanged over a threefold increase in equilibrium pressure. It is of particular interest that the same high efficiency is also seen when spores and kaolin are soaked in liquid H_2O during irradiation, a condition in which the spores can be expected to be fully hydrated. Using 50 Kvap X-rays, Tallentire and Powers (1963) have irradiated spores of the same strain of *B. megaterium* mounted on cellulose acetate discs and found a similar relationship. Here a 25 per cent increase in efficiency was observed on increasing H_2O pressure from 5×10^{-2} to 22 torr. The present experiments using gamma-rays and an insoluble inorganic substrate show that the increase (at 4·6 to 8·0 torr) occurs between the two wider pressures tested with X-rays and in addition, that the critical section of the vapour pressure range is narrow in comparison with those sections over which efficiency is invariant.

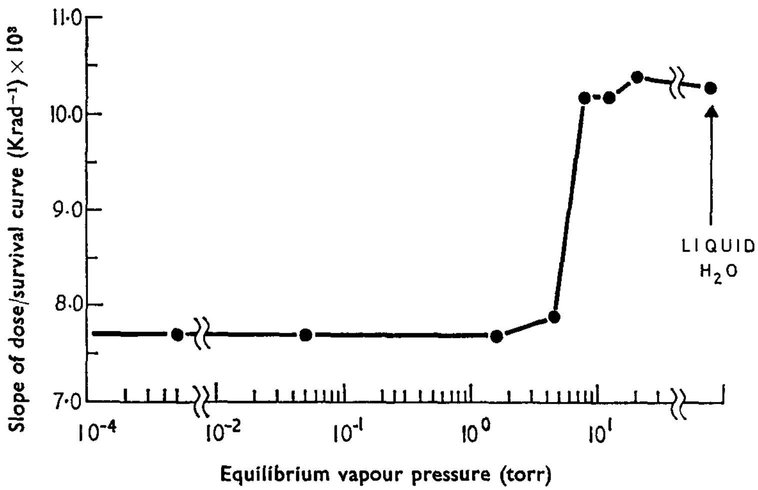

FIG. 1. Slopes of exponential dose/survival curves from anoxic gamma-irradiation of *B. megaterium* spores equilibrated to different H_2O vapour pressures.

We are not yet in a position to identify mechanisms by which changes in water content in our system alter radiation efficiency, but we have clearly established that a part of the lethal damage induced in spores by gamma-radiation can be mediated by water. Moreover, our findings are important from the viewpoint of "radiation sterilisation". We note that H_2O vapour partial pressures commonly encountered in working atmospheres may lie on either side of the critical section mentioned above and in this context our results further stress the need for consideration of known factors, which affect bactericidal efficiency, when selecting a working radiation dose.

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