THE EFFECT OF CHELATING AGENTS ON THE ABSORPTION OF RADIUM BY PLANTS

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SUMMARY

The absorption of radium from solution, by plants, has been compared with that of calcium, active strontium being used as a label for the calcium. It was found that radium was preferentially retained by the roots and discriminated against in passage to the shoots. However, the uptake and distribution of radium was influenced by ethylenediaminetetra acetic acid (EDTA) and citrate at the concentrations employed in water culture media to keep iron in solution. There was little discrimination against radium after plants had grown for a week in active nutrient solution when EDTA was present, but in the presence of citrate radium moved less rapidly by a factor of about 0.3. In the early stages of treatment, less than a day, the results with citrate were comparable with those of EDTA, whence it is inferred that the decrease in transfer to the shoots is dependent upon the relative rates at which the two complexes decompose.

INTRODUCTION

Numerous studies of the comparative behaviour of calcium and strontium in soils and plants have shown that the two elements are absorbed by plants in a closely similar manner. Thus, although some quantitative differences between the distribution of the two ions in plants are well established, the ratio of strontium to calcium in plant tissues, and hence the concentration of the former element, can be largely inferred from the ratio of the two ions in the nutrient source on which the plants depend *. Little comparable information is, however, available for the heavier alkaline earths barium and radium.

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In the past decade interest in the behaviour of radium has been encouraged by the fact that, next to potassium-40, radium-226 is the main naturally occurring radioactive nuclide which enters vegetable foods thereby becoming a source of internal radiation to man and animals. It therefore seemed relevant to consider the extent to which the transfer of radium into plants can be inferred from that of calcium. A preliminary study of this question, by Mistry 7, indicated considerable discrimination against the heavier ion in the transfer to plant shoots but the relationships between the ratio of radium to calcium in the tissue to that in the external solution (i.e. the OR) was much less consistent than the corresponding relationships between strontium and calcium. In the present paper, relationships between radium and both strontium and calcium are considered in greater detail; the course of the work was much influenced by the unexpected observation that low concentrations of ferric ethylenediaminetetra-acetic acid (Ferric EDTA), profoundly affect the uptake of radium, when present in the external medium.

EXPERIMENTAL METHODS

Barley, var. Maris Badger, peas, var. Meteor, and maize, var. Canada Cross, grown in water culture were used in different experiments. At the commencement of experiments plants were transferred to fresh nutrient solutions containing radium-226 in activities ranging from $4 - 33 \, \text{nC/l}$ (i.e. $3.5 \rightarrow 29.2 \times 10^{-8} \, \text{me/l}$). In the majority of experiments strontium-85 or strontium-89 were also used, the accompanying carrier strontium being in the range of concentration normally found in AR grade reagents (molar ratio Ca/Sr approximately 1000). On occasions the pH of the solutions was adjusted with N/10 sulphuric acid. When treatment periods exceeded 24 hours, transpiration losses from the solution were made up daily with distilled water. Except for Experiment 4, the work was carried out in a greenhouse without supplementary lighting and only limited control of temperature, thus appreciable variations in growth occurred between experiments.

After treatment, entrained solution was removed from the roots by blotting. The leaves and roots were separated, dried at 90°C and wet ashed using nitric and perchloric acids. To avoid the risk of silica precipitation during the subsequent chemistry silica was removed by treatment with hydrofluoric and perchloric acids in platinum dishes. The residues of this treatment were then dissolved in a small quantity of 3M hydrochloric acid and made to known volumes, from which aliquots were taken for analysis.

Calcium was precipitated as oxalate dissolved in dilute perchloric acid and measured by flame emission spectrophotometry.

Radium was estimated by a modification of the method of Goldin 3. To