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S12

Accumulation of Radionuclides in Aquatic Organisms

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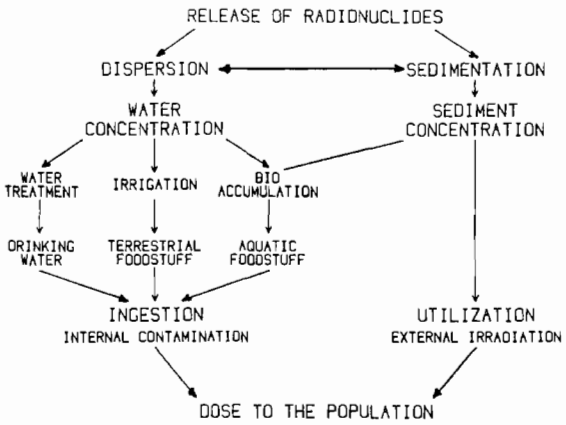
A good knowledge of the physico-chemical and biological processes involved in the transfer of radionuclides in the environment is essential for evaluating the radiological consequences of radioactive effluents released in the various phases of the nuclear fuel cycle [1]. As far as radionuclide releases to aquatic environments are concerned, the main transfer pathways may be represented schematically as follows:



Radioecological studies provided a considerable amount of information on the environmental behaviour of many radionuclides. Since critical pathways to man are generally food chains, particular emphasis was given to research on radionuclide transport and accumulation in living organisms. Bioaccumulation factors for a given radionuclide may differ by several orders of magnitude in freshwater and marine biota (plants, invertebrates, fish, waterfowl or shorebirds).

The acquired knowledge allowed the application of mathematical models for describing the transfer of the most important radionuclides through food chains and for evaluating the radiological impact of radionuclides released in normal operations [2]. Steady-state concentrations in the aquatic environment can be easily converted to equilibrium concentrations in biota and potential doses to man calculated considering the more important ingestion pathways [3].

The critical pathways are generally consumption of fish and ingestion of water when radionuclides are released to freshwater ecosystems, consumption of molluscs or crustaceans when radioactive effluents are released to marine ecosystems. Therefore, bioaccumulation factors are very important parameters in determining the dose to man.

In the case of light water nuclear power reactors discharges, most of the dose is caused by a relatively few radionuclides, such as:

– tritium (pressurized water reactors), phosphorus-32, cobalt-60, niobium-95, iodine-131, cesium-134 and cesium-137, for freshwater environments;

– manganese-54, cobalt-58, cobalt-60, zinc-65, iodine-131, and cesium-137 for marine environments.

The information collected from research on the environmental behaviour of radionuclides may be very useful for a better understanding of the processes responsible for accumulation of stable metal ions in aquatic organisms and biomagnification through food chains.

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S13

New Aspects of the Interaction between Polysaccharides and Metal Ions in Relation to the Mineral Nutrition of Plant Roots

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Recent discoveries emphasize the newly emerging concept that an extracellular apparatus, rich in

polyuronates, allows plant roots to remove nutrient cations from clay particles [1, 2].

The study of metal binding to polygalacturonic acid (Fig. 1) has drawn attention to the possible role

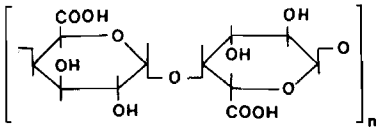
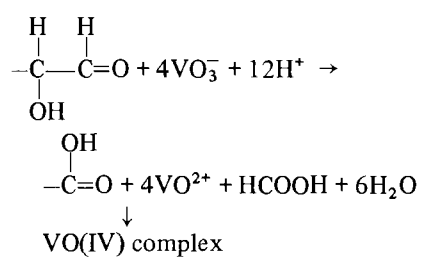


Fig. 1. Polygalacturonic acid.

of root polysaccharides in the mineral nutrition of plants. Evidence was found to show that specific interactions, which could have relevant functional and physiological implications, are established by the polysaccharide with metal ions [3–5]. Metal–polyion interactions of electrostatic nature are possible mechanisms accounting for the uptake and buffering of faster-moving nutrient ions. In this case, metals bound to the polysaccharide moiety retain enough mobility to reach the root cells and translocate into the plant. On the other hand, inner-sphere binding to carboxylate groups could be necessary for the uptake of certain micronutrients which, being in low concentration, are less competitive in the exchange process. With regard to the iron uptake, it has been shown that Fe(III) gives rise to polynuclear structures on the surfaces of the polysaccharide, whereas Fe(II) is more weakly retained as hydrated ion [4].

Recent developments have been concerned with redox processes occurring upon interaction of polygalacturonic acid with soil mineral species. Reduction of Fe(III) to Fe(II), V(V) to V(IV) and Mo(VI) to Mo(V), followed by complexation of reduced ions, has been observed. The reaction is due to the reducing properties of the polysaccharide end-units. For example, the following mechanism has been assessed for the reduction of VO_3^- to VO(IV):



Such processes appear to be highly significant, particularly in relation to iron uptake by plant roots. In fact, ferric species are not available for plants unless reduction to the divalent state occurs [6]. Based on our results, it is suggested that polysaccharides are active also in redox interactions and provide suitable pathways for the adsorption and transport of iron, which is essential for the survival of plants.

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S14

90% of Erythrocyte Copper is Coordinated in Cu_2-Zn_2 Superoxide Dismutase

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37% of the total copper concentration in red blood cells is found in superoxide dismutase as determined by immunochemical assays [1]. Most of the present purification techniques of superoxide dismutase include solvent precipitation of the haemolysate. Using this method 60% of erythrocyte copper cannot be further characterized due to coprecipitation and/or denaturation of possible other copper proteins.

A strictly aqueous preparation technique was employed which allowed the recovery of 90% of intracellular copper in the first step and 50% after the fifth and final step.

Bovine erythrocyte lysate was passed through DEAE-Sephacel. The bonded copper proteins were eluted with a linear NaCl-Gradient. By way of contrast discontinous absorption of the haemolysate resulted in the recovery of limited amounts of superoxide dismutase [1]. Concentration of the DEAE eluate and gel filtration of Sephadex G-75 yielded crude copper proteins of both high and low relative molecular mass. The first Cu-protein was the previously described $M_r = 400\,000$ Cu_2–$(haem_b)_2$–protein. It was purified to homogeneity and characterized as published elsewhere [2, 3]. The latter species turned out to be Cu_2Zn_2 superoxide dismutase which was further purified according to Stansell and Deutsch [1].

Determination of superoxide dismutase activity in the haemolysate employing the nitrotetrazolium blue assay in the presence and absence of EDTA