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An approach towards safe and sustainable use of the green alga *Chlorella* for removal of radionuclides and heavy metal ions

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Abstract

Release of radionuclide and heavy metals in environment during healthcare, agriculture and military practices, and mining and energy production, poses a serious threat to humans and whole ecosystems. Acute or chronic exposure to human causes serious health effects such as acute radiation syndrome, burns, neurological disorders, renal damage and cancers. Hence, there is a need to find safe, wide-spectrum and cost-effective agents for removing internalized radionuclides and preventing internalization of these ions. In this direction, nutritional supplements offer an excellent option. The present review examines the potential of *Chlorella* for removal of radionuclide and heavy metal ions. *Chlorella* is a green alga consumed as dietary food supplement in powdered form. In addition to its high nutritional value, it is reported as an excellent detoxifying agent. The powdered *Chlorella* has been reported for removal of mercury, cadmium and radioactive strontium from the body. *Chlorella* contains a variety of metal-binding functional groups such as carboxyl, amino, phosphoryl, hydroxyl and carbonyl groups, which have high affinity towards various metal ions. Different species of *Chlorella* in live, dead or powdered forms has shown removal efficiency for different toxic metal ions from living as well as non-living things.

Keywords *Chlorella* · Chlorophyta · Radionuclides · Heavy metals · Decorporation · Adsorption

Introduction

Radioactive contamination of the environment has occurred not only through use of radiological dispersal devices (dirty bombs) but also through other means like destruction of nuclear reactors or by virtue of an industrial or military nuclear accident. The radioactive contaminants released during such instances include cesium-137, strontium-90, iodine-131, cobalt-60, americium-241 etc. (FDA 2006). Barium-141, cesium-137 and strontium-90 are produced from the nuclear fission of uranium and plutonium. Cesium-137 decays to barium-137. Although some metal ions, such as cobalt and iron are essential for maintaining normal physiological functions, at higher concentration or their radioactive isotopes lead to poisoning. Heavy metals like cadmium and mercury are highly toxic and exposure even small amount has serious health effects. Ingestion or inhalation of these radionuclides and/or metal ions leads to internalization. After entering the systemic circulation, most of the ions are excreted through the kidneys and some of them accumulate in their target organs or tissues. Once inside the body they affect liver, kidney, hematopoietic and nervous systems. Further, they cause various disorders like cardiac irregularities, anxiety, tremor and paralysis. Their presence in bones can cause bone cancer, cancer of nearby tissues, and leukemia. The biological behavior of cesium and thallium is similar to that of potassium and they are excreted by the bile in enterohepatic recirculation (Avery 1995) whereas strontium behaves like calcium (EPA 2017). After entering the body most of the cesium-137 (biological half-life, 70 days) and thallium (biological half-life, 8-10 days) is deposited into soft tissues, and strontium-90 (biological half-life, 18 years) into the bone and bone marrow (ATSDR 2004) .

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