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Isolation and Characterization of Salt-Tolerant Selenium-Oxyanion-Reducing Microorganisms for Microbial Formation of Selenium Containing Heavy Metal Salts and the Application to Bioremediation Fields

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Summary

Selenium is one of metalloid element widely distributing in terrestrial ores and aquatic zones on the earth. It is found in a variety of chemical forms in soil, sediment, ground water, and biological components. Its soluble oxyanions as selenate and selenite are lethal toxicants to animals, and cause the serious toxication and carcinoma. Although metalloid elements such as selenium can be essential to industrial material production as rare earth element, the effective recovery method of these released or contaminated elements have not been required. Further research should explore the biological function which can apply to develop the recovery and recycling technology. In this study, we have isolated and characterized newly isolated selenium-oxyanion-reducing bacteria from various marine organisms and environments. Furthermore, microbial formation of CdSe and CdTe has been carried out and we have attempted and performed the simultaneous removal of potassium tellurite and cadmium chloride due to conversion to CdTe crystal with anaerobic reactions of microbial consortia and its isolates.

Many short rod-shaped, selenate or selenite-reducing bacteria were isolated from marine sediments which were not contaminated with selenium or from marine organisms such as whiting fish and scallop. The one of isolate, strain NZ3-1 was able to reduce selenate (SeO_4^{2-}) to elemental selenium (Se^0) under anaerobic conditions. TEM observation of the red cells grown under anaerobic conditions showed that nano-sized crystalline elemental selenium was deposited in their cells. Many soil and sediment samples were collected from terrestrial, freshwater and marine environments. These samples were inoculated to the anaerobic isolation medium contained at 1 mM of SeO_4^{2-} (or TeO_3^{2-}) and CdCl_2 respectively. EDX analysis and HRTEM observation showed the microbial depositions in the enrichments were nano-sized particles that were composed of Cd and Se (or Te) with 5 to 25 nm in diameter. Furthermore, we have obtained pure isolates from enrichments, which can sustain in the presence of 1 mM of TeO_3^{2-} and CdCl_2 respectively. HRTEM, EDX and electron diffraction analyses on the produced particles indicated that microbial formation of CdTe with sphalerite (zincblende) structure has been achieved.