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Siderophore mediated uranium sequestration by marine cyanobacterium *Synechococcus elongatus BDU 130911*

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HIGHLIGHTS

- Uranium induced siderophore production observed in marine cyanobacteria.
- Siderophore – uranium complexation was evidenced by CAS modified assay.
- Siderophore produced by *Synechococcus elongatus* BDU130911 was identified as hydroxamate type.
- *In silico* analysis divulges the complexation of siderophore with iron and uranium.

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ABSTRACT

Four different marine cyanobacterial morphotypes were tested for their efficacy to produce siderophores in Fe minus [Fe(−)], Fe minus Uranium dosed [Fe(−)U(+)], and Fe dosed Uranium dosed [Fe(−)U(+)] media. Of the four organisms tested, *Synechococcus elongatus* BDU 130911 produced the highest amount of siderophore of 58 $\mu g\ mg^{-1}$ dryweight. The results clearly indicate that uranium induces siderophore production in marine cyanobacteria even in the presence of iron [Fe(−)U(+)] condition. The type of siderophore revealed by $FeCl_3$, Tetrazolium and Atkin's tests is a hydroxamate; and thin layer chromatogram also authenticates our finding. Uranium siderophore complexation was confirmed through modified Chrome Azurol S (CAS) assay as well as based on residual uranium presence. *In silico* docking studies further validate siderophore complexation with uranium.

1. Introduction

An increase in environmental metal contamination due to mining and industrial effluent disposal has led to a progressive deterioration of ecological eminence. Uranium, the radionuclide gets released into the environment which is threatening because of its high toxicity and long half life (Cecal et al., 2012). Biosequestration or bioreduction serves a promising, alternative and economically viable strategy for metals like uranium that is in very low concentrations. Microorganisms exhibit ability to sequester radionuclides through various mechanisms, *viz*., direct enzymatic reactions and/or indirect chemical reductions, which involves physical adsorption, complexation, ion exchange, and precipitation (Acharya et al., 2012).

Siderophores, constitute a major class of naturally occurring chelators that includes hydroxamate, catecholate, and carboxylic acid functional groups secreted by microorganisms in various habitats, which bind to iron and mediate its transport to the cell. These metal chaperone or public goods though are majorly specific for iron, also bind effectively with a variety of environmentally and biologically important metals such as arsenic, magnesium, manganese, chromium, gallium and radionuclides, such as plutonium (John et al., 2001).

Though a number of organisms are believed to be involved in bioremediation process through siderophores (Frazier et al., 2005), cyanobacteria, the unique oxygen evolving photosynthetic prokaryotes have an edge over all of them in view of their tropic independence for nitrogen and carbon (Prabaharan et al., 2010). In the recent past, marine cyanobacteria have been known to bioremediate effluents containing dyes (Priya et al., 2011), metals and complex phenols (Swaminathan et al., 2010).

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