

## Role of cyanobacteria in cadmium bioremediation in rice fields

Amrita Bhattacharjee, Natasha A Nongrum, Mayashree B Syiem\*, Samrat Adhikari and  
Amar Nath Rai<sup>1</sup>

Department of Biochemistry, North Eastern Hill University, Shillong-793022, Meghalaya, India

<sup>1</sup>Vice Chancellor, Mizoram University, Aizawl, Mizoram.

\*Corresponding author: mayashreesyiem@yahoo.co.in

### Introduction:

Cyanobacteria are extremely diverse group of gram negative prokaryotes showing diversity in physiology, morphology, developmental characteristics and habitats<sup>1-4</sup>. In nature they are free-living as well as symbiotic<sup>3,5</sup>. Cyanobacteria as diazotrophs, have a long history of usage in agriculture as biofertilizer<sup>6-8</sup>, and are known to enrich the nitrogen content of the rice fields<sup>9</sup>. Species of *Nostoc*, *Anabaena*, *Aulosira*, *Tolypothrix*, *Cylindrospermum*, *Gloeotchia*, *Gloeocapsa*, *Anabaenopsis*, *Camptylonema*, *Scytonema*, *Westiellopsis* widespread in Indian soils and rice fields contribute immensely to soil fertility. Cyanobacterial presence in rice field ecologies is of interest to scientists especially from rice growing countries as positive effects of cyanobacteria in rice fields are well established.

Mineral nutrients can be defined as all the inorganic elements required for life. In case of human inorganic nutrients include water, sodium, potassium, chloride, calcium, phosphate, sulphate, magnesium, iron, copper, zinc, manganese, iodine, selenium and molybdenum. Mineral toxicity is a condition where concentration of any one of the minerals in the body becomes abnormally high leading to adverse health effects. Apart from these, some common heavy metals that humans are exposed to are Al, As, Cd, Pb and Hg that can pose serious health hazards. Among these, Cd (atomic wt. 48) is a common bivalent metal naturally

present in environment in different chemical forms such as cadmium sulfide, cadmium oxide, cadmium sulfate, and cadmium carbonate and cadmium chloride. It is used in production of colored inks and dyes, in metal plating, engraving, soldering, in plastics and in production of Ni-Cd batteries used in cell phones, portable computers and in many toys. Trace amount of Cd is found in most foods (higher in shell fish). Humans get exposed to Cd from sources that include drinking water, fertilizer, fungicides, pesticides, soil and pollution, refined grains, rice, coffee, tea, soft drinks and cigarettes. Cd accumulates in the body and replaces body's essential mineral zinc in the liver and kidney leading to serious kidney disease and liver damage.

Elevated levels of Cd result in hypertension, dulled sense of smell, anemia, joint soreness, hair loss, dry and scaly skin, loss of appetite, weakened immune system by reduced T cell production.

Agricultural soils are mainly contaminated with Cd from excessive use of fertilizers, dispersal of sewage sludge and atmospheric deposition. Cd is readily taken up by many crops including cereals, potatoes, vegetables (leafy and root) and fruits. Cd causes phytotoxicity in plants and its uptake and accumulation drives it further up the food chain. Negative effects of cadmium on RNA level, ribonuclease activity, phosphorolytic and

proteolytic enzymes in germinating rice seed are well documented<sup>10-12</sup>.

Removal of metal ions from polluted waters using microbes is a well studied subject<sup>13</sup>. Microbes accumulate metal ions by two well defined processes: (1) energy independent binding on the cell wall called 'Biosorption' and (2) energy dependent uptake of metal ions called 'Bioaccumulation'<sup>14</sup>. Both living and non-living microbial biomass have been used for removing toxic metal ions<sup>15-18</sup>. Mucilage containing polysaccharides producing cyanobacteria are highly efficient in passively absorbing high levels of dissolved metals using a charge mediated attraction<sup>19</sup>. Many cyanobacteria have been studied for their role in bioremediation of polluted environments<sup>20-23</sup>. Proline accumulation in response to stress has been studied in many organisms including algae, protozoa, bacteria, marine invertebrates and plants<sup>24</sup>. In recent years, role of intracellular proline content in ameliorating environmental stress has been studied in cyanobacteria<sup>22-23</sup>.

Rice field environment provides ideal conditions for cyanobacterial growth. Cyanobacteria are also efficient in metal uptake. Combining these two facts, the present study was undertaken to determine intracellular proline content of a heterocystous

cyanobacterium belonging to *Nostoc* sp. in response to cadmium exposure and its role in decreasing the magnitude of the adverse effects of cadmium exposure to germinating rice seedlings.

### Materials and Methods:

#### Sample collection:

**Cyanobacteria:** Soil and water samples were collected from different rice fields during the month of August when the rice planted into the fields were about one and half months old (Table 1). These rice fields were water logged as there was continuous rain throughout the month of June, July and August.

**Rice seeds:** Rice seeds of RCPL-1-87-8, DR-92 & Megha-I varieties were collected from ICAR, Umiam Complex, Meghalaya.