Chapter 12
An Eco-Friendly Approach for the Eradication of Heavy Metal Contaminants by Nano-Bioremediation

Chandana Mohanty
https://orcid.org/0000-0002-2107-141X
Kalinga Institute of Industrial Technology (Deemed), India

Sneha Shriparna Satpathy
Kalinga Institute of Industrial Technology (Deemed), India

Sweta Mohanty
Kalinga Institute of Industrial Technology (Deemed), India

ABSTRACT

Nanomaterials manifest distinct physical and chemical properties and have received much attention from researchers in different areas of environmental sciences, specifically in bioremediation. However, bioremediation may not always impart contrivable approaches when subjected to high concentrations of contaminants that are harmful to most microorganisms, which include heavy metals and salts. Nanotechnology on the other hand exhibits a number of potential environmental benefits such as treatment and remediation, pollution prevention, and sensing and detection of pollutants. Nanomaterials used towards bioremediation provide less-toxic effects on indigenous microorganisms and improve microbial biodegradation activity. Credibility of nanotechnology to cut down pollution is in its developing stage and could potentially revolutionize the field of environmental sustainability. Nano-bioremediation is a new emerging technique for remediation of pollutants using biosynthetic nanoparticles.

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INTRODUCTION

Widespread industrialization, urbanization and modern agricultural practices have unleashed extraordinarily alarming figures of pollutants & contaminants into the environment. An environment can be polluted or contaminated. Elevated concentration of pollutants or contaminants leads to unenviable and abhorrent change in the physical, chemical and biological attributes of the environment. Now the challenging task of the 21st century is to eradicate the contaminants by environmentally sound, viable, non-polluting, and economically compliant technologies (Yadav, Singh, Gupta, & Kumar, 2017). Currently pollution due to heavy metals has caused serious long-term health impact in human beings. The accretion of heavy metals certainly cause various lethal effects in the body by inducing oxidative stress. The main threat to human health is associated with subjection to heavy metals such as Pb, As, Hg, and Cd etc. These metals have been extensively studied and their effect on human health has been regularly reviewed by international bodies such as WHO (Järup, 2003). Heavy metals have a specific density of 5gm/c.m.^{3}. These heavy metals have been used in different areas for thousands of years. Though the adverse effects of heavy metals have been known for quite a long time, exposure to heavy metal still continues and even increasing in some areas. Generation and remissive handling of these toxic materials leads to serious complications, summoning environmental, social and economy of the world. In order to attenuate, such threats efficient strategies need to be implemented to accomplish the environmental sustainability. The field of study focuses on investigating the irradiation of contaminant from the environment is known as environment remediation(Tripathi, Sanjeevi, Anuradha, Chauhan, & Rathoure, 2018).

"Remediate" means to solve the problem and "bioremediation" means the use of different biological agent (like microbes, plants, fungi etc.) to degrade the contaminant, on-site or off-site and convert it into less toxic forms (Rizwan, Singh, Mitra, & Morve, 2014). Although, these bio-based remedial approaches are highly efficient, cost effective and causes less disruption to the environment but its indomitable practices give rise to severe toxic by-product which trigger environmental damage as well as deterioration of biological organism used in this process (Cecchin et al., 2017). To overcome this obstacle, one of an environment-friendly and cost-effective method is the bioremediation of pollutants using bio-nanoparticles. Nano-bioremediation is a highly studied and explode area of remediation of contaminants using nano technologies. Many studies suggested that nano-bioremediation is more effective and significant strategies for the management of heavy metal hazards. In contrast, several conventional strategies like precipitation, ion exchange etc. are also in use for the eradication of these heavy metal but they have certain limitation such as non-specificity, expensive, less efficient and generate toxic by-product (Gaur, Flora, Yadav, Tiwari, & Impacts, 2014). Therefore, nano-bioremediation has the potential not only to reduce the overall costs of cleaning up from large-scale contaminated sites, but it can also reduce clean up time. Further researches in the field of nano-bioremediation should focus on the integrated exploitation of nanoparticles, genetically modified microbes and plants to design eco-friendly, inexpensive, robust and sustainable remediation strategies. In this chapter, we will try to recollect the different aspects of nano-bioremediation with reference to heavy metal contamination and its application to mitigate efficient strategies to achieve environmental sustainability.

Need for New Technique

Traditionally, remediation of heavy-metal-contaminated soils employs either onsite management or excavation and ultimately dumping to a landfill site. This method of subsequent scrapping merely switches