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A Study on the Potential of Moringa Leaf and Bark Extract in Bioremediation of Heavy Metals from Water Collected from Various Lakes in Bangalore

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Abstract

Many industrial water bodies are polluted with organic and inorganic contaminants discharged into them as effluents. Bioremediation is a waste water management technique that facilitates removal or neutralization of pollutants from a contaminated site. Many plants and their extracts have been used for bioremediation of heavy metals in the process of phytoremediation. *Moringa olifera*, also known as drumstick is a fast growing, drought resistant plant that belongs to the family of *Moringaceae.* Its fruit and leaf are consumed as diet and the bark has healing properties as recorded in ancient medicine. *Moringa olifera* seeds have been reported to have bioremedial property which can be enhanced on chemical modification. Data optimization studies have been performed for various heavy metals and their adsorption on to the chemically modified biosorbent.Our study aims at identifying major polluted lakes in and around Urban Bangalore and their phytoremediation using dried and chemically modified leaf and bark powders. Contaminated water samples were collected from Bellandur, Varthur and Hebbal lakes and were subjected to biosorption by the modified leaf and bark powders according to the parameters optimized for seed powders. The reduction in heavy metal content was observed by Thin Layer Chromatography (TLC) and Atomic Absorption Spectroscopy (AAS) methods. Other physico chemical parameters like turbidity, BOD, COD, DO, Nitrate and Phosphate content were examined to emphasize the bioremedial property of chemically modified *Moringa olifera* leaf and bark extracts. Biosorption of heavy metals was found for the bark and leaf treated water samples and also reduction in the BOD, COD, nitrate and phosphate content and turbidity were observed for both the biosorbents. These results showed the enhancement of potability of these treated water samples and their applications in a larger scale. Further recovery and reusability of the biosorbents for enhanced recovery of the pollutants has to be studied for their commercialization.

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1.0 Introduction

There are many inorganic pollutants that contaminate various ecosystems such as air, water and soil and cause serious problems. Toxic metal compounds that are disseminated into the environment by anthropogenic activities contaminate not only surface water bodies such as ponds, lakes and reservoirs but even ground water after seepage into the water table. There are many heavy metals that are resultants of industrial and domestic activities. Some of them are Copper (Cu), Arsenic (As), Chromium (Cr), Lead (Pb), Nickel (Ni), Cadmium (Cd), mercury (Hg), zinc (Zn), manganese (Mn), etc. Most of the heavy metals are released from anthropogenic sources such as mineral ores, metallurgical industries, paints and ceramics, wood preservatives, dyes and pesticide manufacturing industries.(Ghani and Chaghaby 2014)

Chromium is emitted into air, water and ground water in the form of a particulate. Cr (VI) is highly reactive compared to Cr (III) and causes oxidative damage to the lungs, liver and gastrointestinal tract. The permissible limit of Cr (VI) in drinking water is 50µg /L whereas the major rivers of our country are polluted with much more higher concentrations exceeding the tolerable limits. (CWC report 2014). Nickel (Ni) is released from smelting operations, battery industry, thermal power plants and others.The source of Cadmium (Cd) in water bodies is from Zinc smelting, e-waste, paint sludge, incinerations, waste batteries& fuel combustion.Lead (Pb)is a by-product of lead acid batterie, E-waste, Smelting operations, paints, coal- based thermal power plants, ceramics and bangle industry (Indian National Science Academy2011).

Metal ions are being reported as priority pollutants, due to their dispersibility in natural water ecosystems and also due to their toxicity (Demirbas A 2008). The problem associated with the existence of metal ions as pollutants is their non-biodegradability and high persistence in the environment. They accumulate in living tissues, leading to various diseases and disorders (Ngah andHanafiah, 2008). Heavy metals toxicity can effect in damaged or reduced function of mental and central nervous systems, lower levels of energy and damaged blood composition, liver, lungs, kidneys and other vital organs. (Ahmaruzzaman M, 2011)

Many strict legislations have been introduced in various countries to control water pollution. Various regulatory bodies have prescribed the maximum permissible limits for toxic heavy metals discharge into aquatic systems. The permissible limits for heavy metals in industrial effluents discharge set by the World Health Organization (WHO) are 0.05-1.5(Cu), 0.1(Cd), 5-15(Zn), 0.1(Pb), 0.1-1 (Fe), and 0.05-0.5 (Mn), 0.02 (Ni), in ppm. (EPA, 2013).The conventional methods used for the removal of metal ions from water are restricted due to technical and financial barriers, mainly due to low concentration of heavy metals in water(<100 ppm).According to the Central Water Commission report of 2014, heavy metals were found beyond the permissible limits in water samples from the water quality (WQ) monitoring stations spread across 16 river basins of our country.The process of bioremediation is the most suited process for the effective removal of heavy metals from the environment (Vidali 2001). In this effort, biosorption has emerged as an alternative sustainable strategy for heavy metal removal (Garnica et al, 2013).

Biosorption is a physico-chemical process, defined as the removal of compounds from solution by surface adsorption to biological material.Various waste biomaterials, micro-organisms, bacteria, fungi, yeast and algae have been reported for the removal of metal ions from aqueous solutions. Agricultural wastes are a potential source for biosorbents as they have lignocellulosic compounds as major constituents and also other polar functional groups such as alcohols, aldehydes, carboxylic, ketones, phenolic, thiol and ether groups(Ghani and Chaghaby, 2014). These groups have the ability to bind heavy metals by donating an electron pair to complex the metal ions in solution (Demirbas, 2008).

Many plants such as Neem, Garlic, Turmeric and drumstick are reported to have biosorbent properties that chelate the heavy metals from water sources. Chemically modified biosorbents have been developed to enhance the heavy metal chelation property. This property has been promising because of its simplicity, in line with conventional ion-exchange technology, due to its efficiency and availability of biomass and waste bio-products.(Bennet et al