Chapter 17
Heavy Metal(loid) Remediation Using Bio-Waste:
A Potential Low-Cost Green Technology for Cleaning Environment

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ABSTRACT

Heavy metal(loid)s are hazardous, biologically non-essential, non-biodegradable and persistent in nature, which can accumulate in plants and animals as well as in environment especially agri- and aqua- culture ecosystems. It is severely responsible for causing several health hazards problems in human, such as, cardiovascular, pulmonary, hepatic, nephrological, dermatological, neurological disorders as well as carcinogenic effects. Removal of these heavy metals from living systems is extensively expensive and also unsuccessful in sent percent removal. Therefore, in order to protect the environment, the removal of heavy metal(loid)s from polluted effluents is essential before discharging into environment. Besides various treatment technologies, sorption of metal(loid)s using bio-wastes are highly potent alternatives in recent years. The present chapter deals with the removal efficiencies of various bio-wastes, orange peels, waste tea leaves, rice husk, wheat stalk, sugar cane bagasse, coconut husk, sun flower stalk, corn cob, nut shell, water hyacinth, crab shell particle, activated carbons etc. The present discussion has also revealed that bio-waste could be a low-cost eco-friendly and green emerging alternative technology in treating the metal(loid)s contaminated environment without posing any further adverse environmental impacts.

INTRODUCTION

Industrialization, urbanization and population explosion are the prime reason for tremendous environmental pollution in last few decades (Bhakta, Son, & Munekage, 2009; Bhakta & Munekage, 2010). Massive amount of pollutants generating from anthropogenic activities are indiscriminately discharging

into the environment which contaminating the life system through the food chain (Jillian, Robert, & Rajakaruna, 2015). Effluents from industries like chlor-alkali, electrical, electronic, electroplating, glass manufacture, photography, oil refinery, pesticide, paint-pigment, plastic, paper and pulp, pharmaceutical, gun, steel etc. contain heavy metals such as, Hg, Cd, Pb, Cr, Cu, As, Ni etc (Tack, Vanhaesebroeck, Verloo, Rompaey, & Ranst, 2005). in extensively high concentration and are disposed into sea, river, canal or pond directly and contaminate them. These metals percolate into ground water and contaminate. Irrigated water is also not safe from heavy metals. Aquatic plants and animals and ultimately human beings are being affected greatly. Domestic wastes (such as, batteries, paints, electrical and electronics goods etc.) have also similar contribution.

Heavy metal(loid)s are hazardous, biologically non-essential, non-biodegradable and persistent in nature and have severe several toxic impacts on lives (Bhakta, Ohnishi, Munekage, Iwasaki, & Wei, 2012). They enter into the body of plants and animals through absorption of water in plants and drinking of water and ingestion of food in animal and get accumulated within tissue. These metals bind to functional groups such as amino ($-NH_2$), imino ($=NH$), sulfhydryl ($-SH$), carboxyl ($-COOH$), phenolic (C_6H_5-), phosphoryl ($-P_2O_5$), imidazole ($C_3H_4N_2$) and phosphate ($-PO_4$) of bio-molecules and form stable coordination complexes within the tissues (Perez Marín, Aguilar Meseguer, Ortũno, & Śaez, 2008; Gönen & Serin, 2012). They tend to form more stable complexes with sulphur and nitrogen ligands than oxygen ligand. Thus, heavy metals are accumulated in liver, kidney, brain, bones, teeth, lungs and blood and damage and impair various systems in human. This accumulation when crosses the critical level causes death of the living machine.

Therefore, decontamination of environment from the severe pollution of heavy metal(loid)s is an urgent issue to scientists. To overcome this problem, many technologies have been developed by researches, sorption, precipitation, coagulation, membrane filtration, etc. so far. Sorption is one of the important technologies in treating the polluted water using various inorganic (chemical) and organic based sorbent media in this respect. However, most of them are expensive and having adverse impact to environment. There is always significant demand in developing the low-cost green eco-friendly technology in this respect. In recent years, biomass based sorbents have drawn much attention to the scientist for applying as a potential sorbent in treating various pollutants of polluted water especially heavy metal(loid)s. Most common domestic biomass wastes (such as - banana peel, orange peel, cotton fiber, cellulose paper, *Eichhornia* plant, coconut coir, waste tea leaf etc.) and different industrial and agricultural bio-wastes (such as, sugarcane baggasse, rice husk, wheat and rice straw, pineapple crown top, sun flower stalk, olive stone, sea weeds, crab shell etc.) have the capability in binding of heavy metal by the process of adsorption and /or absorption, and thus, they can remove heavy metals from polluted water significantly.

The objective of this chapter is to evaluate the bio-sorbent potentiality of biomass waste as a potent low-cost agent of eco-technology in the heavy metal(loid)s remediation of environment. The chapter also concisely discussed applicability of various bio-wastes for remediation of heavy metal(loid)s from contaminated aquatic ecosystem or aqueous solution without harming environment.

CHEMICAL PROPERTIES OF BIO-WASTE

Bio-wastes possess many functional groups such as -COOH, -OH which play important role to bind metal ions coordinately and form a stable complexes resulting sorption. According to Perez Marín,

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