Phytoremediation as an Alternative Method to Remove Lead and Cadmium from Wastewater Using Some Aquatic Plants

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Abstract
Water pollution by heavy metals is among the most worldwide occurrence as a result of human activates, agricultural and industrial activities. Lead and cadmium are easily absorbed and accumulated in different plant parts, however they are counting as non-essential elements. Both disrupt the food chain and are toxic even at low concentrations to plants. Despite of having several traditional methods using for removal pollutants from wastewaters, they cause many negative impact on environment, and very costly, as well. Phytoremediation is energy efficient, ecofriendly and ascetically pleasing technologies, which are both ecologically, sound and economically proved as a proper alternative option to purify polluted water. It is based on the use of plants to remove contaminants from the environment and aquatic plants are efficient and suitable plants to remove, detoxify or immobilizing methods. This review article deals with the assessing state of phytoremediation as an environmentally friendly technology, and also to discuss the potentiality of different aquatic plants in the remediation of lead and cadmium in wastewater.

Keywords: Aquatic plants, lead, cadmium, phytoremediation, wastewater.

Introduction

Due to rapid industrialization, mining activity, irrigation with wastewater, and the application of sewage sludge to agricultural farms have dramatically increased the release of metals into water, soil and air ecosystems, causing serious damage at different steps to living systems (Chen, Zheng, Tu, and Shen, 2000).At least, 23 metals have been classified as heavy metals; the most common are lead (Pb), cadmium (Cd), cobalt (Co), chromium (Cr) and mercury (Hg), which have the toxicity effects at high concentration as well as low concentration for plants. Lead and cadmium are considered the most toxic heavy metal and have been recognized for its harmful influence on environment where it's accumulate via food chain having a serious threat to human health, animals and plants (Nagajyoti et al., 2010).Therefore, it is very crucial to treat lead and cadmium from wastewaters properly. Ion exchange, chemical precipitation, and reverse osmosis are the most conventional methods that have being using to remove lead and cadmium form wastewaters. They are quite expensive and also they produce a large amount of sludge requiring special disposal. Recently, there has being a great interest in developing an effective and environmentally friendly technology involving the removal of heavy metals from wastewaters. Several aquatic plants from

submerged, emerged and free floating have been used to remove lead and cadmium from natural as well as wastewaters. This review article illustrating the phyto-accumulation potential of various aquatic vascular plants for remediation of lead and cadmium inpolluted water.

Source of lead and cadmium

Lead and cadmium are majors' environmental pollutants and quite widespread. They usually reach water system via discharges like sewage treatment plants and industrial plants or urban runoff. Above the natural processes, the main sources are coming from factories using lead and cadmium, batteries,mining operation, alloys and smelting of lead ores, lead piping used in water distribution system, metal plating and finishing operations, fertilizers, pesticides and additives in pigments and gasoline (Eick et al., 1999 & Demiezen et al., 2007)

Effects of lead and cadmium on plants

Lead and cadmium are accounted significant pollutants, due to solubility in water, which results in wide distribution in aquatic ecosystems and both are strongly toxic to organisms.

The excessive amount of lead and cadmium in water causesmany physiological and biochemical stress symptoms in plants, such as growth reduction, disturbed mineral nutrition, water imbalance, and growth productivity and root elongation. When they enter inside the cell wall, like any other heavy metals,they produce an oxidative stress in plant and lead to cell damages (Sharma and Dubey, 2005).

Traditional methods for treatment of metal

Among heavy metals lead and cadmium have attracted considerable notice from scientist, as they are very toxic to human and aquatic life. In water, they have to be reduced to levels in correspondence to the rules of regulatory agencies. Several of traditional methods exist for the remediate of lead and cadmium from wastewater that methods were as follows;

Table (1): Traditional methods for removal of lead and cadmium.

Phytoremediation

The term of phytoremediation comes from a Greek prefix "Phyto" and attached to latin word remediation "to correct". Simply, it refers to utilize green plants to remove contaminants from soil and water. It is cost effective, as ethically accepted, and it is less disturbed to the environment. The plants used in this ecofriendly technology must have a considerable capacity of metal uptake. There are many ways by which plants remediate contaminated sites.

Phytoextraction

Phytoextraction is the uptake of contaminants by roots and trans-located into aerial parts, which enrich with metals. To reach the acceptable level of metals, plants should use continuously. However, phytoextraction is among the best approach to remove contaminants from soil, sludge and sediment, it takes a long time (Malik and Biswas, 2012).

Advantageous:

- The contaminants are removed permanently from soil
- It is an expensive method

Disadvantageous:

- The plants are growing very slowly with small biomass and shallow root systems
- The plants must be harvested and followed by metal reclamation

Rhizofiltration

Rhizofiltration is the uptake and concentrate (absorb and adsorb) contaminants by roots from polluted arouses sources. The tolerance and translocation of the metals to aerial parts are irrelevant (Jadia and Fulekar, 2009).

Advantageous:

- Aquatic plants and terrestrial plants can be used in situ or situ applications
- The contaminants do not have to translocate to the aerial parts.

Disadvantageous:

- pH adjustment needs
- Metal accumulators might need to grow on a greenhouse

Phytovolatilization

In phyotvolatilization, plants use to uptake contaminants from, soil, sediments and sledges transforming them into volatilized compounds after that, transpiring them into the atmosphere.

Advantageous:

- It is possible to transform contaminants to less toxic compounds
- As a result of releasing contaminants to the atmosphere, they may be degraded quickly.

Disadvantageous:

- There is a probability to accumulate.

Phytostabilization

It is defined as the use of transcription and root growth to reduce the mobility bioavailability of pollutants in the environment through creating an aerobic condition in the root zone and could be achieved via the addition of organic matter and soil amendment.

Advantageous:

- Due to the presence of plants, soil erosion reduces also the availability of water decreases
- The biomass is not requiring disposing.

Disadvantageous:

- The majority of contaminants remain in soil
- In this case, the soil needs a lot of amendments and monitoring

Potential of different aquatics in proving water quality

Phytoremediation includes the use of plants to mitigate, transfer, stabilize or degrade pollutants in soil, sediment and water. From the stand point of accumulation, aquatic plants known as to accumulate and concentrate of heavy metals. Research has revealed that aquatic plants are very effective to remove heavy metals from contaminated water.

Low cost, quite easy to culture in the laboratory, high growth rate and very sensitive to various pollutants make the aquatic plant system more attractive to utilize for Eco toxicological and environmental investigations (Kanabkaew and Puetpaiboon, 2004).

Aquatic plants take up metals from wastewater from the water, producing an internal concentration several fold greater than their surroundings. Therefore, aquatic macrophytes are increasingly used as a useful treatment for wastewater. The accumulation of metals in various parts of macrophytes is usually followed an induction of a variety of cellular changes, part of which directly participate to metal tolerance capacity of the plants (Prasad et al., 2001). Aquatic plants are capable of removing the heavy metals from the water as a

result of the solubility of the metals in water. In fact, in an aqueous solution, metals are in soluble shapes, which are accumulated by plants much easier.

In the recent past, research has been focused on using roots and rhizomes of semi-aquatic and aquatic plants to mitigate of heavy metal from contaminated water (Maine et al., 2001 and Pei-ying Xue et al., 2010).*Hydrila verticillata*, is a common submerged aquatic angiosperm and has a worldwide distribution. It grows quickly and reproduces rapidly. It has been established as a potential and convenient to utilize in bioassay to monitoring the manifestation of heavy metal toxicity (Sinha and Pandey, 2003 andXue, et al., 2010). In an investigation, *Hydrila verticillata* exposed to different concentrations of lead and cadmium. The uptake was concentration dependent, at lower concentrations (2.5, 5, 10 mg/l Pb and 0.5 and 1 mg/l Cd), the accumulation was higher than 20 mg/l Pb and 10 and 20 mg/l Cd, respectively. In addition, cadmium found to be more toxic which affected the growth of the plant than lead(Singh et al., 2011). Research reported that submerged plants, have significant potential to bio concentrate metals due to their greater surface area compare to non-submerged plants (Guilizzoni 1991 and Sinha et al., 1997).

Lemna spp. is a widespread, free, fragile floating aquatic plant. It is fast growingand reproduces more quickly than other vascular plants and adapt easily to different aquatic conditions. They can grow at a range of pH (3.5-10.5) with a wide temperature ranging from 7-35 C) with optimum growth between 20-31C (Naumman et al., 2007).So far, 40 species belonging to four genera (Lemna, Spirodela, Wollia, and Wolffiella) have ben identified, which are worldwide distribution in wetlands from fresh water to brackish estuaries (Skillicorn et al., 1993). It is small size, rapid vegetative reproduction and easy handling in laboratory condition. Also, it is high sensitivity to different chemicals and tolerance to high nutrient levels and excellent nutrition uptake. It is a source of food for different organisms and shelters for small aquatic invertebrate (Wang, 1990). Due to its special, is often chosen as a potential test organism to represent aquatic vascular plants toxicity studies and in wastewater treatment (Wang, 1986 and Axtell et al., 2003). Recently, lead and cadmium accumulations in various parts of different species of free-floating aquatic plants have been reported (Mohan and Hosetti, 1998 and Singh et al., 2011). Some studies observed a higher lead and cadmium accumulations in roots than shoots (John, R., et al. 2008 and Matagi and Mugabe, 1998) as well, however, other authors reported a higher accumulation in shoots than in roots (Roosens et al. 2003). Due to differences in root morphology, plants capabilities of metals accumulation are different. Plants with plenty of thin roots would accumulate more metal than one few thick roots (Schierup and Larsen, 1981).

Conclusion

Phytoremediation is the utilization of plant to remove and accumulate contaminants from environment. It seems that foliage plants and tree is quite interesting and it might be better than other methods to improve the quality of water. This review revealed the capacity of a submerged (*Hydrila verticillata*) and free-floating aquatic plant (*Lemna spp.)* to mitigate lead and cadmium from wastewater. Therefore, the uptake of heavy metals by aquatic plants depends on type of species and sort of metals.

Lemna spp. Seem it to be an effective alternative that have been recommended for wastewater treatment as they have a rapid growth on a vast range of pH and can survive in different water systems. They produce biomass more quickly than any other aquatic plants. Furthermore, it explored a better mitigate of lead and cadmium by Lemna spp. than other aquatic plants from contaminated water and might be helpful in further investigations.

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