International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

A Review on Removal of Heavy Metal (Cr and Cd) Using Plant Seeds for Purification of Water

Swati Gumfawar[1], Buddharatna J. Godboley[2]

[1]PG Student, Department of Civil Engineering, G.H. Raisoni College of Engineering Nagpur, India

[2]Assistant Professor, Department of Civil Engineering, G.H. Raisoni College of Engineering Nagpur, India

Abstract-*The water contamination consist of mainly heavy metals, fertilizers, microorganisms, toxic and organic compound as now due to rapid industrialization the water pollution is also increases. So this is a fact that water contamination is major problem world is facing today. Heavy metals are the most problematic contaminant because of their toxicity which are non-biodegradable. Some of the heavy metals Chromium, Cadmium, Arsenic, Nickel, Lead, Mercury, Zinc, Cobalt, and Selenium etc. are present in water. In present study use of seeds for heavy metal removal investigated. From this review study it can be concluded that seed has good capacity for heavy metal removal.*

Keywords-Seeds, Heavy metal, Purification of water, Natural coagulant, Coagulation

1. Introduction

Water is the most important factor of life. On earth 96.5% of water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers so it is very important to conserve the water. As now due to rapid industrialization the contamination of water is also increases. So this is a fact that water contamination is major problem world is facing today. The natural sources of water like surface water, ground water are very much affected by water pollution because of discharges containing heavy metal from industries and mines Heavy metals can be said that they have high atomic number, atomic weight and specific density more than 5g/cub.cm. Mainly industries are responsible for water contamination and also natural sources. From agricultural waste and household waste also the source of heavy metals pollution. Water pollution in India is a major problem as 70% of surface water and ground water are contaminated by chemicals, organic and inorganic, biological and toxic contaminants. Heavy metals are the most problematic contaminant because of their toxicity which are non-biodegradable. Heavy metals are also responsible for bioaccumulation. Some of the heavy metals Chromium, Cadmium, Arsenic, Nickel, Lead, Mercury, Zinc, Cobalt, and Selenium etc. are present in water, and their consumption affects the human health wildlife in small concentration even in ppb. Out of 59 elements which are classified as heavy metal elements Chromium (Cr), Cadmium (Cd), Copper (Cu), Lead (Pb), Zinc(Zn) are highly toxic and hazardous[6]. Chemicals are used to remove the heavy metals but they have drawback as they affect the human health. For example use of alum in purification of water causes Alzheimer's disease in human [7]. There are various methods for heavy metal removal like reverse osmosis, adsorption ,ion exchange, solvent extraction, chemical precipitation, flue gas purification, electrochemical treatment, filtration, fluidized bed reactor, chemical oxidation and coagulation. Numbers of chemicals have been found in drinking water supply around the world which are considered hazardous to human at high concentration as they are carcinogenic.

2. International and Indian Scenario of Chromium and Cadmium

16 million people are at risk for exposure to chromium globally with estimation of 3millions diseases. Upto 2015about 300 toxic sites are identified around the world. In India Sukinda valley in Jaipur, Kanpur, Yamuna River, Bay of Bengal, Harike wetland (Ramsar site) are facing problem of heavy metal pollution.14 districts found contaminated with chromium. Andhra Pradesh, Assam, Rajsthan, Punjab, Orissa, Tamilnadu Uttar Pradesh, Karnataka ,Himachal Pradesh, Haryana, Madhya Pradesh and five blocks of Delhi. 11 major Indian Rivers, Ganga, Hasdeo, Tel, Ramganga, Ong, Ib, Hamp, Jonk, Kwano, Mahanadi and Mayurakashi found to have chromium concentration exceeding the tolerance limit of 50µg/L which is found about 0.34 mg/L. In Harike wetland as shown in figure 1 chromium is found 0.12mg/lit [4].

Figure 1: Map of Harike wetland

In case of Cadmium about 5 million people are at risk for exposure to cadmium globally with estimation of 250000 diseases. As of 2015 toxic site identification over 150 sites have found threat of Cadmium in world. Cadmium is found more than acceptable limits in Yamuna, Hindon, Pennar and Cauvery rivers. The highest concentration of cadmium about 0.004mg/lit found in Delhi rly bridge and Mathura, Agra,

Mohana in Yamuna river. The Basin of Yamuna River is shown in figure 2 which contaminated with heavy metals. In harike wetland the average cadmium content found as 0.01mg/lit [4].

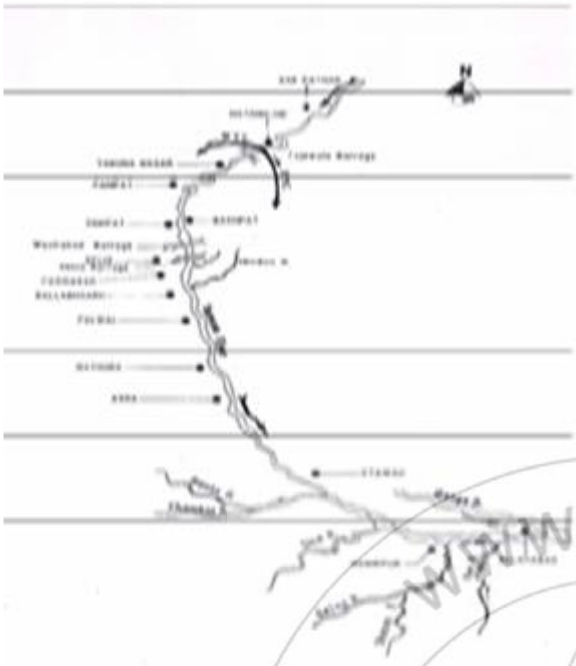

Figure 2: Basin of Yamuna River

3. Sources of Chromium and Cadmium

Cadmium is found in earth's crust and ocean in very small amount. It is more toxic than chromium. Cadmium is found in nature in the form of inorganic compounds. It is produced as by-product of zinc refining. Mainly the source of cadmium are industry and mining discharges. The use of cadmium in batteries now increases in recent years. Mostly the drinking water may contaminate with cadmium because of galvanised iron pipe and use of plated plumbing for fitting in water distribution system [4].

Chromium found by anthropogenic activities. The major sources of chromium are tanning industries, metal processing, textile industry, dyeing industry stainless steel welding, and chromate production [4].

4. Health Effects of Chromium and Cadmium

Exposure to chromium causes damage to the gastrointestinal, respiratory and immunological system, reproductive and development and causes cancer. It causes skin rashes, upset stomach and ulcers It also effects on aquatic life. It is mutagenic, carcinogenic. Consumption of Cr(VI) causes alteration of genetic material, weakened the immune system and may cause death. Its inhalation may cause nose irritation and nosebleed [4].

Cadmium causes nephrotoxicity. It causes Itai-Itai disease in which bones get weakened and it's very painful in which people suffers from joint pain. Its consumption also affects lung, kidneys, liver and skeletal system. Damage to the gastrointestinal, respiratory and immunological system, reproductive and development system. It causes lung cancer. Osteoporosis (skeletal damage) and fractures. It causes pulmonary cancer also prostate and kidney cancer, liver cancer .It affects urinary bladder, breast and stomach also causes cardiovascular risk. Only small amount of cadmium absorbed by body retain in kidney, bones and liver. Its ingestion and inhalation may cause renal tubular dysfunction and high blood pressure [4].

5. Standards of drinking water for Chromium and Cadmium

As per USEPA, the permissible limit of hexavalent chromium and cadmium in drinking water is 0.05 mg/lit and 0.005 mg/lit respectively. As per BIS (IS 10500), the permissible limit are 0.05mg/lit and 0.003mg/lit for Cr (VI) and Cd respectively. As per WHO they are 0.05 mg/lit and 0.003 mg/lit for Cr (VI) and Cd respectively.

6. Various Treatment Processes for Cr (VI) and Cd Removal

There are different technologies used to remove Cr (VI) and cadmium which include reverse osmosis, adsorption, ion exchange, solvent extraction, chemical precipitation, flue gas purification, electrochemical treatment, filtration, fluidized bed reactor, chemical oxidation and coagulation [7]. The drawback of these methods are that these methods are expensive, high reagents are required, not eco-friendly and incomplete removal. From these methods coagulation is easy method. By using natural coagulants which may available easily it becomes eco-friendly, inexpensive and effective. There are four mechanism of coagulation by which heavy metals are removed from water are double layer compression, charge neutralization, sweep flocculation, adsorption and, interparticle joining [14]. These mechanisms are depend upon the cationic or anionic polyelectrolytes present innaturalcoagulant. The natural coagulants which are used in this study are seeds in which proteins act as a polyelectrolyte. Polymeric coagulants are generally related to adsorption and charge neutralization or adsorption and interparticle bridging. Mostly these proteins present in coagulant destroy the metal ion.

In current research removal of Hexavalent chromium i.e. (VI) and Cadmium (Cd) are investigated by using coagulation process where seed use as coagulant. This research will give eco-friendly and low cost option for purification of water.In coagulation process protein present in seeds react with metal ion destroy them in water (Gregor et. al., 1997) [1].In present work coagulation process is used for heavy metal removal using natural coagulant where coagulant is prepare from seeds. So the complexes are form with metal ion and proteins[1].The protein present in seed act as polyelectrolyte which helps to remove the heavy metals [6]. Heavy metal ion are attached to molecules of protein by adsorption which can be describe by specific mechanism. The mechanism that brings about the adsorption of heavy metals is through the positive metal ion that forms a bridge among the anionic polyelectrolyte and negatively charged protein functional groups on the colloidal particle surface [8].In the present research an attempt has been made to study the feasibility of seed for removal of heavy metal.

7. Literature Review

Janet g. Hering et al. (1997) have studied the coagulation process for removal of arsenic using ferric chloride and alum. Efficiency of removal affected by the composition of water and organic matter present in it .so they found less efficient removal.

S. M. Sajidu et al.(2005) have investigate the removal of lead cadmium and iron using coagulation technology with moringaoliefera seed kernel and ram press cake with initial metal conc. At 5 and 7 ppm. Removal of Iron up to 92%, and lead up to 89% and Cadmium up to 48%.

IlhemGhodbane et al. (2007) used eucalyptus bark for bisorption of cadmium from aqueous solution. Initial concentration was kept of 100mg/L. Contact time and initial metal concentration studied for 2-60 min. and found maximum adsorption when increases. At 100and 200mg/L found maximum adsorption. Sorbent dose varying from 0.5-8g and found that with dose removal increases. In case of pH maximum adsorption found at 5 while at 2and 3 very less adsorption found.

Oboh O. I. et al. (2008)in this research paper researchers has studied the ability of sour soup seed for copper, zinc, nickel and lead by the process of bisorption. Experiment was done with 1gm of seed powder added to 50 ml sample at 300 rpm. parameters were studied. It was found that percent removal with time was increases. Removal is varies with the pH also found that with increase in dose removal efficiency also increases.

Venkata Subbaiah Munagapati et al. (2009) has done research on bisorption of copper, cadmium, lead by Acacia leucocephala bark powder. Maximum removal found at pH of 6.0, 5.0, 4.0for copper, cadmium and lead respectively. Studies were done at 30, 40,50°C.removal increases up to contact time of 180min.and as dose increases removal increases.

Vikashni Nand et al. (2012) has investigate the different seeds for removal of heavy metal from water. In this paper Moringaoleifera, Arachishypogaea (peanuts), Vignaunguiculata (cowpeas), Vignamungo (urad) and Zea mays (corn) are used and the percentage removal found by Moringa seeds were 90% for copper, 80 % for lead, 60 % for cadmium and 50 % for zinc and chromium. Coagulation process was used.

Ravi Kumar K et al. (2013) have investigate the moringaoleifera seed for removal of heavy metals Cu, Cr, Pb, Cd and the removal percentage found were 95 % for copper, 93 % for lead, 76 % for cadmium and 70 % for chromium. Coagulation used for removal which is here explained as adsorption and charge neutralization and inter particle bridging. Seed powder and their aqueous extract are used as coagulant.

Ravikumar K et al. (2013) has done experiments to remove fluoride from water using moringaoliefera seed by coagulation process following double filtration. As a coagulant aqueous extract and seed powder were studied.2.5g/L of dose of coagulant was fixed with varying initial metal concentration of 2, 4, 6, 8,10mg/L.As result 92% efficiency was found at 10mg/L concentration.

ArjumVirupakshi et al. (2013) investigate the moringaoliefera, Cicerarietinum and cactus used for treatment of tannery wastewater as a natural coagulant. Parameters like pH, chemical oxygen demand and turbidity studied and it was found satisfactory results.

Shaleesha A Stanley, et. al.(2013) have investigate the seeds efficiency for iron and chromium removal and they used Moringaoliefera (drumstick), Azadirachtaindica (neem), Tamarindusindica (tamarind) and Strychnospotatorum (nirmali).Bisorption studies were done with parameters pH, contact time, bisorbent dose, temperature. A maximum removal of 94.6 % of Cr (VI) is observed in Tamarindusindica seeds and Fe (III), maximum of 72.6 % is removed by MO seeds. It was found effective bisorbent.

Liang Xu et al. (2014) have investigate low cost material that is peanut shell which is chemically treated before use for adsorption Cd (II) ions. Batch study was done at room temp.25°C .At pH 8 removal efficiency found maximum at contact time of 40 min. Effect of initial metal concentration studied in the range of 100-600mg/L and found that above 400mg/L conc. Adsorption was more or less.

Amruta D. Parkhi et al. (2014) have used the mango seed powder for removal of copper by adsorption. Here it was found that increase in contact time percent removal also increases. Different parameters contact time, adsorption dose, temperature are studied. They give mango seed powder as a replacement to expensive adsorbent.

LukmanAliyu et al. (2015) has used natural coagulant in purification of water of Yamuna River. Seed extracts of moringaoliefera and okra seeds were used to check coagulation capacity. Jar test was performed with coagulant doses of 100, 150 and 200mg/l using Moringaoliefera and 150, 200, and 250mg/l using okra. Various parameters i.e. alkalinity, turbidity, TDS, TSS, total solid were studied. In case of turbidity MO coagulant gives 77% efficiency and 75% of okra seeds, and optimum coagulant dosage of 150mg/l and 200mg/l respectively.

J. Aravind et al. (2015) investigates the gooseberry seed for chromium removal from water by bisorption. Here batch study done with various parameters pH, contact time, temperature, and adsorbent dose. At the dose of 0.5gm removal found maximum @92%.in case of contact time removal increases at 30 min.and up to 60min.equilibrium was attained. Initial metal conc. from 20-100mg/L removal percentage decreases.

S. V. Maruti et al. (2016) have studied the coagulation process with natural coagulants Moringa Oliefera, Tamarindus Indica powder. It was found that Tamarindus Indica removes 62% Cr and 73% Cd & Moringa Oleifera removes 58% Cr and 70% Cd.

KiranPakhale et al. (2016) explore the waste material fenugreek which is treated chemically for removal of

chromium, copper and iron. Effects of various parameters were studied. Temperatures from 283 to 313°K were varied and found that increase in temperature decrease the adsorption. Contact time at initial metal conc.25mg/L at pH of 5 for Fe, Cu and6 for Cr (III).removal or adsorption found maximum within 20 min. When dose increases the removal increases while it decreases with increase in initial metal concentration.

Md.Yousuf Ali et al. (2016)explore the locally available low cost material Nypafruticans for heavy metal removal especially Cr (VI) from aqueous solution. Effects of pH, initial metal ion concentration, and temperature and contact time were studied. The process found pH dependent .it was found that adsorption capacity @76.92%.

8. Conclusion

From the above study it is revealed that the use of seed for removal of heavy metals Chromium and Cadmium and other also found efficient. It gives better option than those expensive material for treatment. Seeds are easily available at low cost so they are proved as economical also. It will give a eco-friendly method of removal of heavy metals rather than using expensive chemicals and giving a simple technology for treatment of water. In present research work pumpkin seed (cucurbitapepo) and Soybean (glycine max) powder is used for removal of Cr (VI) and Cd from aqueous solution. Previously pumpkin seed was used to treat dairy wastewater for turbidity removal and in current study it is used for heavy metal removal.

References

[1] AmrutaD.Parkhi et al., Adsorption of Copper from Aqueous Solution Using Mango Seed Powder, Int. Journal of Engineering Research and Applications, Vol. 4, Issue 4, (2014) pp.75-77
[2] ArjumVirupakshi et al., Treatment of Tannery Wastewater Using Natural Coagulants, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 8, (2013), pp. 4061-4068
[3] G. Vijayaraghavan, Application of Plant based Coagulants for Waste Water Treatment,IJAERS, Vol. I, Issue I, (2011), pp. 88-92
[4] Government of India Ministry of Water Resources Central Water Commission, Status of Trace and Toxic Metals in Indian Rivers, (2014)
[5] Janet g. Hering et al.,Arsenic removal from drinking water during coagulation, Journal of Environmental Engineering, Vol. 123, No. 8, (1997), pp. 800-807
[6] KhairiaM.Al-Qahtani, Assessment and Treatment some of the Local Seeds then used in Removal of Heavy Metals, Journal of American Science, (2015), pp. 198-03
[7] KiranPakhle et al., Adsorption Studies on Waste of VegetableMethi (Fenugreek) For Removal of Heavy Metal Ions fromAqueous Solution, J. Chem. Bio. Phy. Sci. Sec. D, February 2016 – April 2016, Vol. 6, No.2, pp. 312-320.
[8] Ravikumar K et al., Heavy Metal Removal from Water using Moringaoleifera Seed Coagulant and Double Filtration, International Journal of Scientific & Engineering Research, Vol. 4, No. 5,(2013), pp. 10-13
[9] Ravikumar K et al., Fluoride Removal from Water using MoringaoleiferaSeed Coagulation and Double Filtration, International Journal of Scientific & Engineering Research, Volume 4, Issue 8, August 2013,pp.
[10] Shaleesha A Stanley et al., Comparative Analysis of Cost Effective Bio sorbents in the Removal of Chromium and Iron from Aqueous Solution,Advanced Bio Tech., Vol.12, Issue 12 1 (2013), pp. 1-5
[11] S. M. Sajidu et al.,Removal of lead, iron and cadmium ions by means of polyelectrolytes of the MoringaOleifera whole seed kernel, WIT Transactions on Ecology and the Environment, Vol 80, (2005), pp. 251-258
[12] S.V.Maruti et al., Influence of Plant-Based Coagulants in Waste Water Treatment, IJLTEMAS, Vol. 5, Issue III, (2016), pp. 45-48
[13] VikashniNand et al., Water Purification using MoringaOleifera and Other Locally Available Seeds in Fiji for Heavy Metal Removal,International Journal of Applied Science and Technology, Vol. 2, No. 5, (2012),pp. 125-129
[14] U. Hashim et al., Plant seeds-potential alternative as natural coagulant to treat water for turbidity, Journal of Applied Sciences Research, 9(2),(2013) pp. 1067-1073