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# Studies on removal of heavy metals by cymbopogon *flexuosus*

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**Abstract**

Heavy metals are causing serious health hazard due to its toxicity and persistence in soil and aqueous medium too. Heavy metals contamination in drinking water has become a major cause of concern for the environmentalists. Arsenic(III) and Chromium(VI) is widely distributed in aqueous medium in the Gangetic plain causing skin pigmentation and liver disorders. Fluoride is also a major pollutant of drinking water in southern part of the Ganges. Several methods of removal of heavy metals from aqueous medium e.g. precipitation, adsorption, ion exchange are in practice. But the naturally grown aquatic weeds, biomass and medicinal plants can be utilized for the removal of arsenic and chromium(VI) from aqueous medium. Medicinal plants e.g. Cymbopogon *flexuosus* (Lemon grass) is grown by farmers in this area due to its aroma. In the present study, medicinal plants have been put to study by taking different masses up to fixed interval of time in the synthetic solutions of As(III) and Cr(VI) . The kinetic study of adsorption of As(III) and Cr(VI) by Lemon grass has been done with a view to know the order and characteristics of the reaction.

**Highlights**

- Medicinal plants growing in this area.
- Removal of Cr(VI) and As(III) from aqueous medium.
- Cymbopogon *flexuosus* (Lemon grass) as accumulator of Cr(VI) and As(III)

**Keywords:** Medicinal plants, Lemon grass, Chromium(VI), Arsenic(III).

Heavy metals enter the water and food cycles through a variety of chemicals and geochemical processes(Aswani et.al. 2011). It is almost impossible to see soil without heavy metals, but their excess amount more then permissible limits are harmful to the living beings. Chromate is toxic, mutagenic and carcinogenic in nature (Park Et.al. 2006). Chromium, a heavy metal is released into the environment and water bodies through anthropogenic activities and industrial effluents, dyes and pigments, electroplating, metal finishing, petroleum refining, leather tanning and corrosion inhibitors in conventional power plants (Elangovan 2008, Gajalakshmi 2012, Park 2005). This metal is the most common heavy metal contaminant of groundwater at hazardous waste sites. Hexavalent Chromium present in aqueous medium in the form of $CrO^-_4$ and $Cr_2O_7^-$ possess higher levels of toxicity than trivalent Chromium (Quintelas 2008, Horsfall Jr. 2006).

Arsenic, a metalloid, is harmful for living beings when ingested in amounts more than permissible limits causing skin lesions, hyper pigment action and lead to even death by continued uptake of arsenic contaminated water (Rao 2004, Mondal 2002). Millions of people around the world are facing the risk of arsenic contamination in groundwater which can enter in food chain through drinking water and agricultural products. Arsenic is taken up by plants and accumulated in several plant parts. Arsenic is released into the environment in organic and inorganic forms. Several varieties of rice have been found to be contaminated with arsenic (Zhao 2008, Zhao 2010).

The conventional method for heavy metal removal are precipitation, coagulation, ion exchange, cementation and electro-dialysis. These processes are expensive and not eco-friendly (Horsfall 2006). Several recent works have been reported regarding removal of Cr(VI) and As(III) from aqueous medium e.g. use of adsorbents e.g. flyash, minerals,peat and agricultural by-products. The sorption capacity of these substances have been determined and utilized for suitable heavy metals.

The effectiveness of agro-based material e.g. crushed coconut shell, almond cell, groundnuts have also been evaluated.

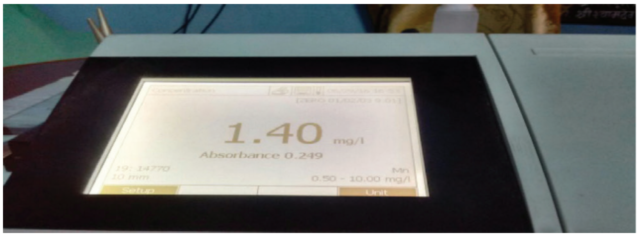
Attempts have been made to use them for heavy metals removal . Recently various studies have been carried out to develop transgenic plants which can combat As stress. A number of fern species e.g. *pitrogram macalomelanos, Petris vitata, Petris criteca, petris longifolia and Petris umbrosa* are known to be As hyperaccumulators (Kumar et.al., WHO 2007) Some aquatic macrophytes like *hydrilla verticillata, potamogeton pectinatus, Eichhornia crassipes, Egeriadensa, Ceratophyllum demersum* and water *cress lepidium sativum* also accumulate As.

A number of medicinal plants which grow naturally in this area are *Acacia nilotica, Bacopa monnieri, Commiphora wightii, Ficus religiosa, Glyeyrrhiza glabra, Hemidesmus indicus, Salvadora oleoides, Terminalia bellirica, Terminalia chebula and Withania somnifera* (Kulhari 2013, Agely 2005). Cymbopogon *flexuosus* (Lemon grass) is cultivated by farmers in this area for aromatic oils and the leaves of this grass are used as a substitute of lemon in tea. Besides this, several other plants are being grown in this area to boost up the economy of this specific area (Jha et.al. 2011, 2015). Very little information and researches are available on the influence of these medicinal plants on diseases and chemical compositions of these medicinal plants and its physiological action on human beings. But several medicinal plants have the potential to adsorb heavy metals when grown in polluted sites. Higher level of heavy metals can cause cancer and disorders in central nervous system (Jha 2014, Mohan 2007,Jha 2014).

In the present study, the experiment has been designed from Lemon grass to study the kinetics of removal of Cr(VI), Arsenic and Manganese.

### *Experimental*

Cymbopogon *flexuosus* (Lemon grass) have been collected from B.A.U. Sabour. The root of these plants have been washed with water and then doubled distilled water. The plants have been put in MS liquid media (Plant nutrient media) to avoid stress. 100 ml of 2 ppm Cr(VI), 4 ppm Cr(VI) and 6 ppm Cr(VI) solution are taken in which 8.26 g, 8.43 g and 8.20 g of lemon grass are put up to 24 hr. and 72 hr. The concentration of 2 ppm Cr(VI) decrease to 1.31 ppm and 6 ppm Cr(VI) decreased to 2.34 ppm in 24 hrs. Same experiment is repeated for 72 hr in which concentration of 2 ppm decreased to 0.42 ppm and 6 ppm decreased to 0.39 ppm. But without MS media(nutrient support) lesser amount of Cr(VI) decreases in 72 hrs.




2 ppm, 4 ppm and 6ppm As(III) solutions are prepared from stock solution of 100 ppm sodium arsenite. 9.07 g, 9.20 g and 9.74 g of Cymbopogon *flexuosus* (lemon grass) are put in 2 ppm, 4 ppm and 6 ppm As(III) solution up to24 hr and 72 hr. The concentration of As(III) solution decreased to amount not traceable. In this experiment too, Lemon grass is taken in nutrient media and without nutrient media. the pH of the solution ranges from 6.3 to 7.3.

Similarly 2 ppm, 4ppm and 6 ppm $KMnO_4$ solutions have been prepared and 3.40 g, 11.40 g and 6.84g Cymbopogon *flexuosus* (Lemon grass) are put in the solution. the concentration of Mn have been measured after filtration. Mn and Cr(VI) concentration have been measured by UV double beam spectrophotometer Pharo 300. Residual arsenic concentration is measured by Merckoquant kit and AAS perkin Elmer.

## Result and discussion

Lemon grass commonly grown in this area has been tested for adsorption capacity of As(III), Cr(VI) and Mn. Lemon grass has been put in water with and without nutrient media. 100 ml 2 ppm Cr(VI) concentration decreased to 1.31 ppm with 8.26 g Lemon grass in nutrient media in 24 hr and 6 ppm Cr(VI) concentration decreased to 2.34 ppm (Table 1). 100 ml 2 ppm Mn concentration decreased to 1.75 ppm and 6 ppm to 2.38 ppm with 3.40 g and 6.84 g respectively (Table 2).

The results are more satisfactory when 2 ppm, 4ppm and 6 ppm As(III) solution treated with almost 9 g of lemon grass in nutrient media. The residual Arsenic is almost not detectable. It has been removed from the aqueous medium completely (Table 3). Similar results have been obtained when repeated up to 72 hrs (Table 4). But whole set of experiments have been carried out with the living plants in nutrient media so it was difficult to take fixed mass of Lemon grass. Lemon grass was found to be a good accumulator of Arsenic. The mechanism of biosorption may be through intracellular uptake are important for detoxification of Cr(VI) and As(III)by the application of medicinal planta. The surfaces of the roots of these plants are reactive towards dissolved metals. Thus the investigation presents the applicability of Cymbopogon *flexuosus* in order to remove hexavalent chromium and arsenic from aqueous media. Further the leaves have been dried and powdered after which the experiments will be done with leaf powder.

**Table 1 :** Cr(VI) concentration up to 24 hr with lemon grass in nutrient media

| Initial concentration in ppm | Weight (g) | Residual concentration in ppm |
|---|---|---|
| 100 ml 2ppm | 8.26 g | 1.31 |
| 100 ml 4 ppm | 8.49 g | 3.13 |
| 100 ml 6 ppm | 8.20 g | 2.34 |

**Table 2 :** Mn concentration up to 24 hr with Lemon grass in nutrient media

| Initial concentration in ppm | Weight (g) | Residual concentration in ppm |
|---|---|---|
| 100 ml 2ppm | 3.40 g | 1.75 |
| 100 ml 4 ppm | 11.40 g | 0.05 |
| 100 ml 6 ppm | 6.84 g | 2.38 |

Table 3: As (III) concentration up to 24 hr with Lemon grass in nutrient media

| pH | Initial concentration in ppm | Weight (g) | Residual concentration in ppm |
|---|---|---|---|
| 6.3 | 100 ml 2ppm | 9.07 g | 0.00 |
| 7.0 | 100 ml 4 ppm | 9.20 g | 0.00 |
| 7.0 | 100 ml 6 ppm | 9.74 g | 0.00 |

Table 4 : As(III) concentration up to 72 hr with Lemon grass in nutrient media

| pH | Initial concentration in ppm | Weight (g) | Residual concentration in ppm |
|---|---|---|---|
| 6.3 | 100 ml 2ppm | 9.07 g | 0.00 |
| 7.0 | 100 ml 4 ppm | 9.20 g | 0.00 |
| 7.0 | 100 ml 6 ppm | 9.74 g | 0.00 |

Table 5 : Cr(VI) concentration up to 72 hr with Lemon grass in nutrient media

| Initial concentration in ppm | Weight (g) | Residual concentration in ppm |
|---|---|---|
| 100 ml 2ppm | 8.26 g | 1.65 |
| 100 ml 4 ppm | 8.43 g | 3.50 |
| 100 ml 6 ppm | 8.20 g | 6.60 |

It is clear from Table 5 that removal of chromium (VI) is not taking place satisfactory in 72 hr. Some release by the roots might have taken place.

## References

Aswani B, Khemnani S, Arora A, Sindal RS, 2011 Analysis of Heavy metals contents and their effects on human health. International Journal of Basic *and* Applied Chemical Sciences (online), Vol 1(1) October – December, pp 21 – 28, www.cibtech.org/jcs.htm

Park D, Yun YS, Park JM 2006 Mechanism of removal of hexavalent chromium by biomaterials or biomaterial-based activated carbons. J. Hazard. Mater. B 137 1254-1257.

Elangovan R., Philio Ligy, Chandraraj K, 2008. Biosorption of Chromium species by aquatic weed: Kinetics and mechanism studies. Journal of Hazardous materials 152, pp 100-102.

Gajalakshmi S, Iswarya V, Ashwini R, Divya G, Mythili S. Sathiavelu A 2012 Evolution of heavy metals in medicinal plants growing in Vellore District. Eur. J Exp Biol 5:1457-1461

Park D, Yun YS, Park JM 2005 Use of dead fungal biomass for the detoxification of hexavalent chromium: screening and kinetics. Process Biochem. 40 2005 2559-2565.

Quintelas C, Fernandes B, Castro J, Figueiredo H.,Tavares T. (2008) Biosorption of Cr(VI) by three different bacterial species supported on granular activated carbon – A comparative study. Journal of Hazardous Materials 153, 799 – 809.

Horsfall Jr. M., Ogban F, Akporhonor EE 2006. Sorption of Chromium(VI) from aqueous solution by cassava (Manihot sculenta CRANZ) waste biomass. Chem. Biodivers. 3, 161 – 173.

Rao MR, Palada MC, Becker BN 2004 Medicinal and aromatic plants in agro-forestry system. Agroforestry syst 61: 107-122

Mondal BK, Suzuki KT 2002. Arsenic round the world: a review. Talanta 58, 201-235.

Zhao FJ, Ma JF, Meharg AA, McGrath SP 2008 Arsenic uptake and metabolism in plants. New phytol. 181, 777-794.

Zhao FJ, McGrath SP and meharg AA 2010 Arsenic as a food chain contaminant: mechanism of plant uptake and metabolism and mitigation strategics. Annu. Rev. Plant. Biol. 61, 532-559.

Horsfall M, Ogbon F, Akporhonor EE 2006 Sorption of chromium(VI) from aqueous solution by cassava (Manihot sculenta CRANZ) waste biomass. Chem. Biodivers. 3, 161-173.

Kumar S, Dubey RS, Tripathi RD, Chakrabarty D, Trivedi PK 2015 Omics and biotechnology of arsenic stress and detoxification in plants: Current updates and prospective. Environment International 74, 221 – 230.

WHO 2007 Guideline for assessing quality of herbal medicines with reference to contaminants and residues. World Health Organization, Geneva

Kulhari A, Sheorayan A, Bajar S, Sarkar S, Chaudhary A, Kalia RK, 2013 Investigation of heavy metals in frequently utilized medicinal plants collected from environmentally diverse locations of north western India Springer plus . 2:676.

Agely AA, Sylvia DM, Ma LQ 2005 Mycorrhizae increase arsenic uptake by the hyperaccumulator Chinese brake fern fern (P. vittata L.). J. Environ. Qual,34, 2181-2186.

Jha AK, Pranita, Mishra B. 2011 Studies on medicinal plants of Bhagalpur district, Bihar. Int. J. chem. App. Vol 2; issue 3, 41-51.

Jha AK, kumar U, Gupta YC, 2015 Biosorption of heavy metals by aquatic weeds. Chemical science review and letters, 4(15), 827 – 834.

Jha AK kumar U, 2014 A case study of arsenic and fluoride contamination in groundwater of Bhagalpur District. Journal of chemical and pharmaceutical research, 6(11) 735 – 738.

Mohan D, Pittmen CU, 2007 Arsenic removal from water/ waste water using adsorbents – a critical review. J. hazard. Mater. 142, 1-53.

Jha A.K 2014 Adsorption of Cr(VI) and Arsenic onto Bentonite. Chemical science review and letters 3(12),1182 – 1189.

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