

Effective size and pH of DHR for mitigating Arsenic from water

Srivastava Anamika

Department of Civil and Environmental Engineering, Birla Institute of Technology, Mesra, Ranchi, INDIA

Available online at: www.isca.in, www.isca.me

Received 29th April 2014, revised 10th May 2014, accepted 10th June 2014

Abstract

Dried hyacinth root (DHR) powder is very efficient and provides a cost effective method for removing arsenic from water. There are various biosorbent available which are efficient in removing heavy metals. The present study successfully assess the potential of dried powder of hyacinth root (*Eichhornia Crassipes* (Mart.) Solms), referred as dried hyacinth root (DHR), by determining the effective size and pH at which it is capable of removing arsenite (As III) efficiently. At different size and pH, the experiment was conducted. Results from ICP-OES suggest that at 0.063mm, and at pH 6.2 to 8.2, DHR was more effective in mitigation of arsenic whereas at bigger size, that is, 4.1 mm, and at pH 2.2 and 4.2, DHR was not very effective. It is concluded that at finer size (0.063 mm), and at pH 6.2 to 8.2, DHR have more potential to remove arsenic from water.

Keywords: DHR, effective size, water hyacinth, arsenic.

Introduction

Eichhornia Crassipes (Mart.) Solms is a common aquatic weed ubiquitously present in many tropical countries¹. It is a wild fern belonging to the family Pontederiaceae, is a submerged aquatic plant, found copiously throughout the year; it is common in India, particularly in regions like Bangladesh and Eastern India^{2,3}. The plants grow plentifully in wide region all over the world⁴.

Water hyacinth is the fastest growing plant; reproduce primarily by way of runner or stolons, which eventually form daughter plants; produce large quantities of seeds which are viable up to 30 years³. Water hyacinth has been shown to possess a great potential to remove pollutants when being used as a biological filtration system⁵. Water hyacinth is reported to remove arsenic as Na_2HAsO_4 and used as a bio-accumulator for arsenic provided the solution contains no or low level of phosphate⁶. There are also some disadvantages in using whole live plant of hyacinth for remediation purposes, for instance, needed to construct ponds if they are not available near the proposed point of use, and heavy metals have phyto-toxic effects on plants, which results in the inhibition of chlorophyll synthesis and necrosis⁷. To overcome these limitation, It was suggested by Schneider et al.⁷, that water hyacinth could provide best result if it is utilize in dried powder form as it have many advantages in term of transport and handling.

This study was conducted with an aim to identify the effective size and effective pH of dried hyacinth root (DHR), in which it is capable of removing arsenic from water.

Material and Methods

Preparation of DHR powder: For the present investigation, water hyacinth collected from pond situated at Chinhat,

Lucknow was utilized for conducting this experiment. The water hyacinth root was dried and converted into powder form and by sieve analysis, different sizes of dried hyacinth root was taken. The figure 1, 2,3,4,5 indicates the photographs of different sizes of DHR.

Preparation of Standards and Reagents: Distilled water was used for the preparation of 1N of 1000 ppm arsenic (Analytical grade chemical- Sodium arsenite 'Excel R' NaAsO_2 (Mol. Wt. 129.91)). Out of which working solution of 2 ppm was prepared.

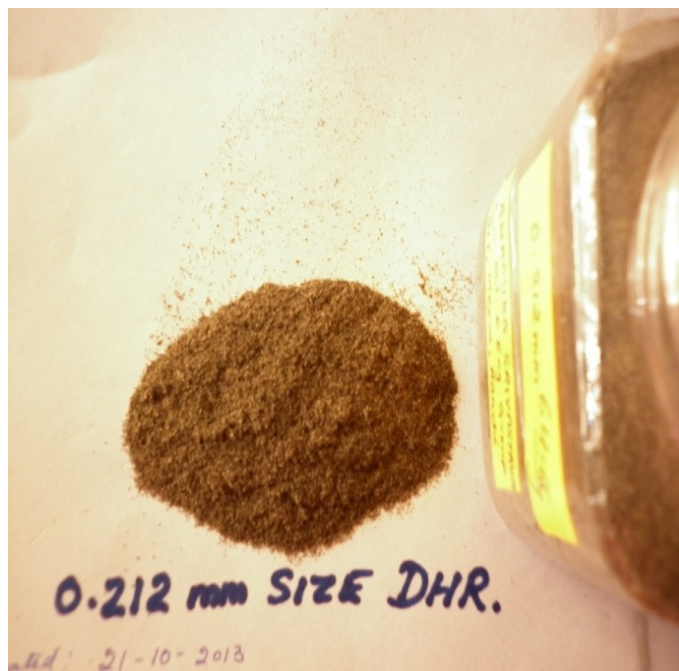


Figure-1
Size 0.212 mm

100 ml of 2 ppm solution was added to each of the beaker containing different size at different pH. The mixture was shaken for 120 minutes at magnetic stirrer. At different time intervals roots were removed by filtration to obtain a supernatant solution, which are further analysed in ICP-OES for arsenite presence. The filter was stored in conical with a screw cap at room temperature. The experimental beakers were covered with thermoplastic self-sealing laboratory film to prevent evaporative loss and volume change in the reaction mixture.

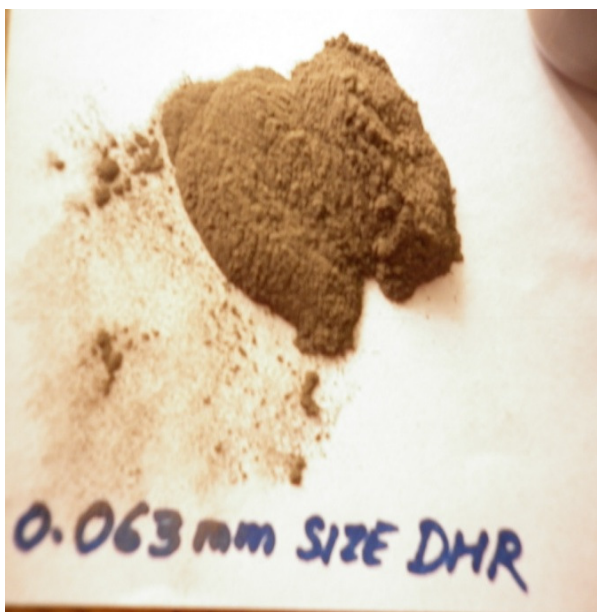


Figure-2
0.063 mm



Figure 3
Size 0.106 mm



Figure-4
Size 4.1 mm



Figure-5
Size 0.33 mm

Results and Discussion

In the present investigation, dried hyacinth root in a finer size (0.063 mm) is capable of removing arsenic up to 30 percent in 12 hrs whereas up to 99 percent in 72 hrs which is shown in figure 6. This result supports the research conducted by Ramalli et al.⁸ and Harris and Harrington⁹; they emphasis the use of DHR in fine powder form. Further, dried hyacinth root in bigger sizes, that is, 4.1 mm, 0.33 mm, 0.212 mm, and 0.106mm indicates decrease in potential to mitigate arsenic at same time. The comparison of the sizes of dried hyacinth root to determine the effective size is indicated in figure 6.

The pH at which dried hyacinth root is efficient in removing arsenic is conducted by taking the effective size 0.063mm of DHR at the different time intervals with different pH of 2.2,4.2,6.2,7.2, and 8.2 mentioned in figure 7. This indicates dried hyacinth root effectively removes arsenic from water from pH 6.2 onwards. Below pH 6.2, shows average removal percentage which is not very effective. This result goes well with the experiments demonstrated by Govindaswamy, Schupp and Rock¹⁰, and Ramalli et al.⁸

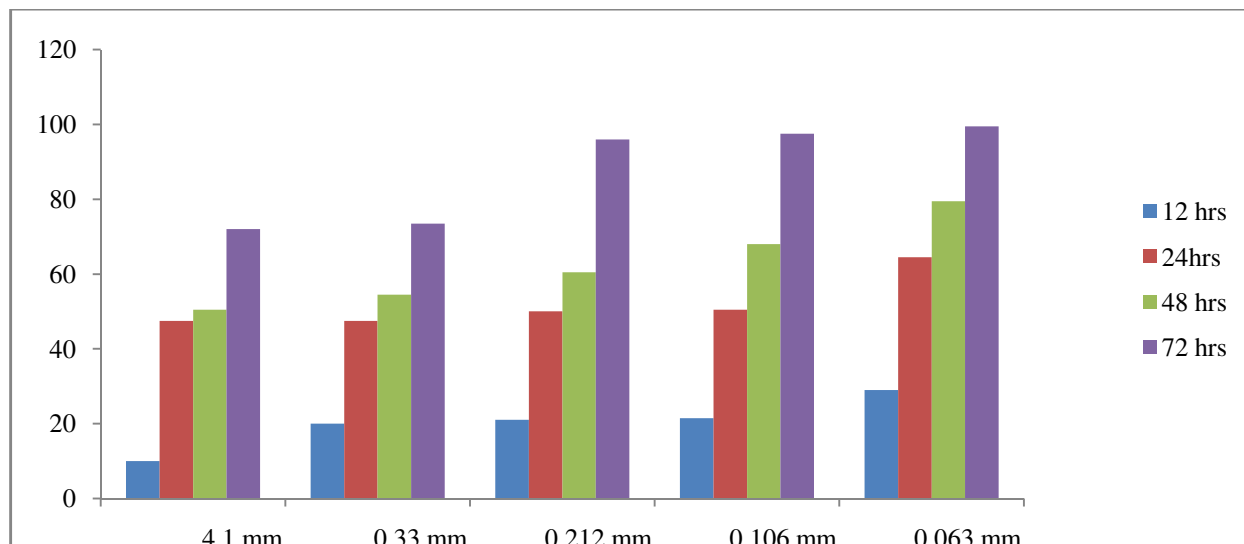


Figure-6
 Comparison of Effective Size of DHR in mitigation of arsenic

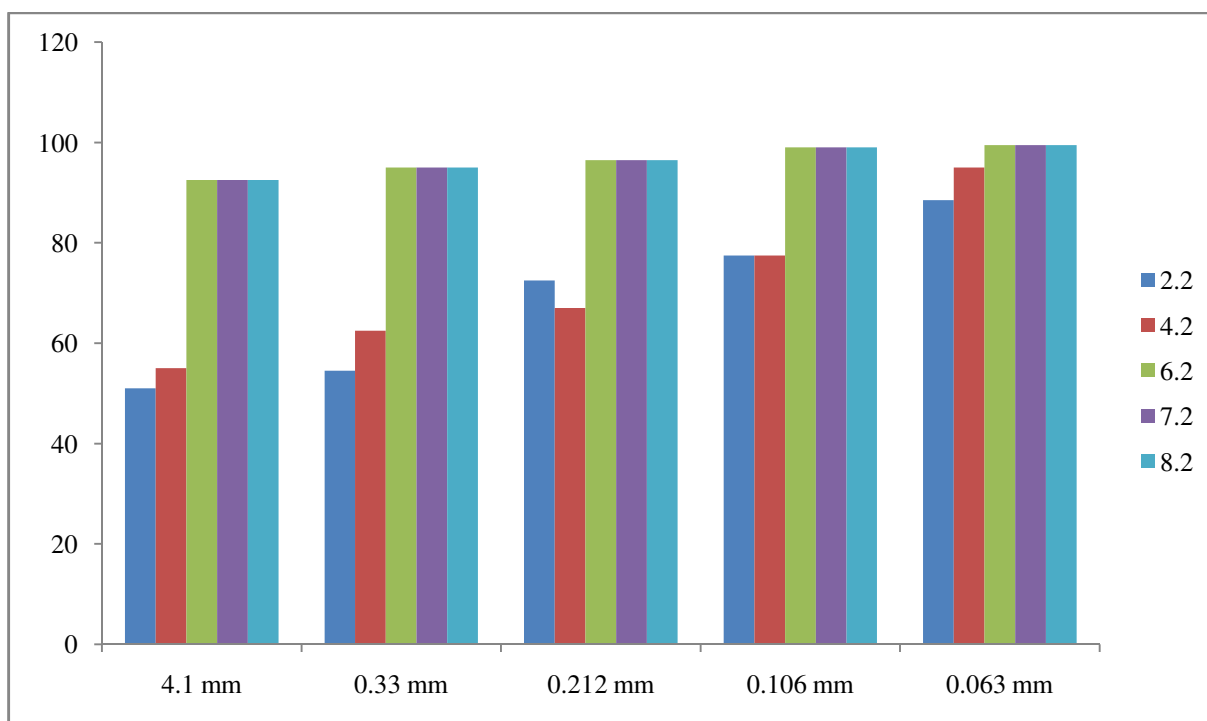


Figure-7
 Comparison Chart for DHR at different pH for removal of arsenic from water

It is already established from the experiments conducted by Ramalli et al.⁸ and Harris and Harrington⁹; and Govindaswamy, Schupp, and Rock¹⁰, that DHR is effective in removing arsenic from water and could be used to develop low-cost technique for mitigation of arsenic. This experiment was conducted to identify the effective size and pH so that it could be useful in optimizing this technique for developing low-cost filter for mitigation of arsenic using DHR.

Conclusion

This research was conducted to analyze the effective size and pH in which dried hyacinth root could work efficiently in removing arsenic from water. It was concluded that at pH 6.2 to 8.2, and size 0.063 mm, DHR was very effective in removing arsenic from water. Whereas at pH 2.2 and 4.2 at the same time, removal percentage was found to be below 60 percent for size

4.1mm and 0.33mm and below 80 percent for 0.212 mm and 0.106 mm. Although in size 0.063 mm and at same pH, DHR was found to be efficient up to 90 percent. Therefore, for developing suitable filter for mitigating arsenic from water, the effective size for DHR could be 0.063mm and suitable pH is 6.2 onwards.

References

1. Gonzalez H, Lodenius M, Otero M.. Water hyacinth as indicator of heavy metals pollution in the Tropics, *Bull. Environ. Contam. Toxicol.*, **43**, 910-914 (1989)
2. Mohanty K., Jha M., Meikap B.C. and Biswas M.N., Biosorption of Cr (VI) from aq. Sol. By water hyacinth, *Chemical Engn. J.*, **117**, 71-77 (2006)
3. El-Khaiary M.I., Kinetics & mechanism of adsorption of methylene blue from aq. Sol. By nitric acid treated water hyacinth, *J. of Haz. Mat.*, **147**, 28-36 (2007)
4. Centre TD. Biological control of weeds: water hyacinth & water lettuce, In: Rosen D, Benett FD, Capinera JL (eds.) Pest mgt. in the subtropics: Biological control, 481-521 (1994)
5. Muramoto S, Ayama I & Oki Y. Effect of salinity on the concentration of some elements in water hyacinth at critical levels, *J. of Envntl. Sci. & Health A*, **26** (2), 205-215 (1991)
6. Low K.S, Lee C.K., Removal of arsenic from soln. by water hyacinth, *Bio. Technol.*, **13**(1),129-131 (1990)
7. Schneider IAH, Rubio J, Misra M, Smith RW. Eichhornia crassipes as biosorbent for heavy metal ions. *Min. Eng.*, **8**, 979-988 (1995)
8. Al-Ramalli SW, Harrington CF, Ayub M, Haris PI. A biomaterial based approaches for arsenic removal from water, *J. Environ. Monit.*, **7**, 279-282 (2005)
9. Harrington CF, Haris PI. The use of dried hyacinth roots to remove arsenic from surface water, *Envntl. Chemistry Group Bulletin*, Jan. 14-16, (2006)
10. Govindaswamy Shekar, Schupp Donald, Rock Steven. Batch and Continuous Removal of Arsenic using Hyacinth Roots, *Int. J. of Phytoremediation*, **13** (6), 513-527 (2011)