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Aloe vera (L.) Burm. F. A Potential Botanical Tool for Bioremediation of Arsenic

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Abstract: Arsenic contamination in groundwater and its consequences to human health have been one of the world's biggest natural calamities to the mankind. In India seven states namely West Bengal, Jharkhand, Bihar, Uttar Pradesh, Assam, Manipur and Chhattisgarh have been reported so far having Arsenic contaminated groundwater above the permissible limit. Most of the people of these states are exposed to high arsenic concentration and are facing arsenic related diseases; such cases are also increasing day by day. This study has been designed to test the efficiency of *Aloe vera* (L.) Burm. F. for mitigation of Arsenic contamination. Arsenic solution of known concentration was subjected to the treatment by varying amount of the botanical, i.e. the leaves of *Aloe vera.* Treatment by 30 gm of the botanical tool for 4 hours was found to be sufficient for 1 liter of water containing arsenic up to 43 ppb.
Keywords: Arsenic, Groundwater, Botanical Tools, Phytoremediation, *Aloe vera*

INTRODUCTION

With the exponential increase in population and deterioration in the water quality, the dependence on groundwater is increased to meet the water demand in rural as well as urban areas. However, the high exploration rate of groundwater and lowering of groundwater table the dependence on groundwater in deep aquifers is increasing [1]. Generally it is believed that hand pump and bore well water are safe for drinking but the report of occurrence of arsenic in such water lead to deep concern and major threat but still now people are not aware of arsenic contamination in groundwater and it is serious health hazard in coming future. Now a day's arsenic contamination is widely studied in India and neighboring countries because ground water is the primary source of drinking water and it is highly contaminated with element like arsenic, which is introduced in the groundwater during weathering of rocks and minerals followed by subsequent leaching and run off and also by anthropogenic sources.

Arsenic is an element with the symbol "As" atomic no. 33 and atomic weight 74. 92 referred to as metal but is classified chemically as non-metal or metalloid belonging to group 15. It is found in rocks in the earth crust. In groundwater inorganic arsenic exists as Arsenate As (v) and Arsenite As (iii) which is highly toxic [2]. Using this groundwater as drinking, in crops irrigation and in domestic use are the source of exposure, although it is also transferred through fish, meat, poultry and cereals but exposure from these foods is generally much lower compared to groundwater as drinking purpose.

High accumulation and long term exposure of Arsenic leads to the disease "arsenicosis" as well as cancer of bladder, lungs, and skin. Skin manifestations and other toxicity of Arsenic include hyperkeratosis, dorsal keratosis and non-pitting edema to "gangrene" and cancer [3].

Arsenic removal filters, identification of shortfalls in operating and maintenance of arsenic removal techniques, delineation of risk free deeper aquifers as an alternate source of groundwater, developing surface water based water supply schemes in many arsenic affected areas, success stories of community participating in running arsenic removal plants etc. are some of the important achievements which is done till now [4, 5]. The problem resolving issues seems to be partial and inadequate which needs to be strengthened by strategic scientific backing.

Many botanical tools have been suggested to be potential accumulator of Arsenic by Srivastava and Dwivedi [6]. *Bamboosa vulgaris* and *Vetiveria zizanioides* have also been suggested by Srivastava and Dwivedi (2016-2) and Singh *et al.;* [7] respectively; but the plants still appear to be under trial. In light of the above, this study has been designed to test the efficiency of *Aloe vera* (L.) Burm. F. for mitigation of Arsenic contamination.

MATERIAL AND METHODS

In search of the most convenient and suitable botanical tool for eradication of arsenic contamination in water, an experiment was designed with the focus on

phytoremediation potential of *Aloe vera* (L.) Burm. F. *Aloe vera* is well known for its medicinal as well as traditional importance; therefore this plant was selected for the experiment.

Arsenic solution of known concentration (43 ppb) was prepared using inorganic sodium arsenate (Na3AsO4) and the solution was subjected to four different treatments. One Liter of the solution each, were subjected to treatment by four different weights of *Aloe vera* leaves (10, 20, 30 and 40 gram). Change in the concentration of Arsenic was recorded after 1, 2 and 4 hours. For comparative study a control was also placed without any tool. The experiment was designed in the multiple of three; to avoid any confusion, the values presented here are arithmetic mean of the three.

Estimation of Arsenic in the water was done using the digital arsenator developed by "Wagtech International" (Figure: 1). Detection range of the instrument is between 1 ppb (Parts per Billion) to 500 ppb.

Fig 1: Wagtech International digital arsenator

RESULT AND DISCUSSION

Findings of the experiment have been summarized in the table 1. Graphical representation of the data has been presented in figure 2. The experiment was started with the concentration of 43 ppb of arsenic in the water. Experiment was conducted for four hours, as convincing result was obtained with in this period of time. The experiment in which no botanical tool was used, i.e. the control samples show no considerable change in the concentration of arsenic. The graph as well as the table clearly indicates that by increasing the amount of the botanical tool, there is exponential decrease in the concentration of arsenic in the solution. It appears that the colloidal substance present in the leaf must be separating the arsenic from the solution, may be due to the process of chelation.

Aloe vera used as a botanical tool appears to be a better plant for phytoremediation of Arsenic, as compared to *Bamboosa vulgaris* (Srivastava and Dwivedi (2016-2) because compete eradication of arsenic was found by the plant *Aloe vera* (L.) Burm. F.

Table 1: Variation in Arsenic concentration with respect to time

Weight of *Aloe vera* leaf (g)	**Arsenic Conc. (µg)**			
	Initial (0 Hour)	**After treatment for:**		
		1 Hour	**2 Hours**	**4 Hours**
Control	43	43	43	42
10	43	40	25	10
20	43	35	22	5
30	43	23	14	0
40	43	21	13	0

30 gm as well as the 40 gm of the botanical tool completely eradicates arsenic from the solution after 4 hours of treatment. As conclusion, the treatment of 30 gm leaves of *Aloe vera* for 4 hours was required for treatment of 1 liter of water containing arsenic concentration up to 43 ppb. The shortcomings recorded in the use of leaves of *Aloe vera* as a botanical tool for biosorption of arsenic is that, the leaf releases jelly like substance which may affect the other physicochemical

properties of water. In addition, the treated water may not be appealing for the purpose of drinking.

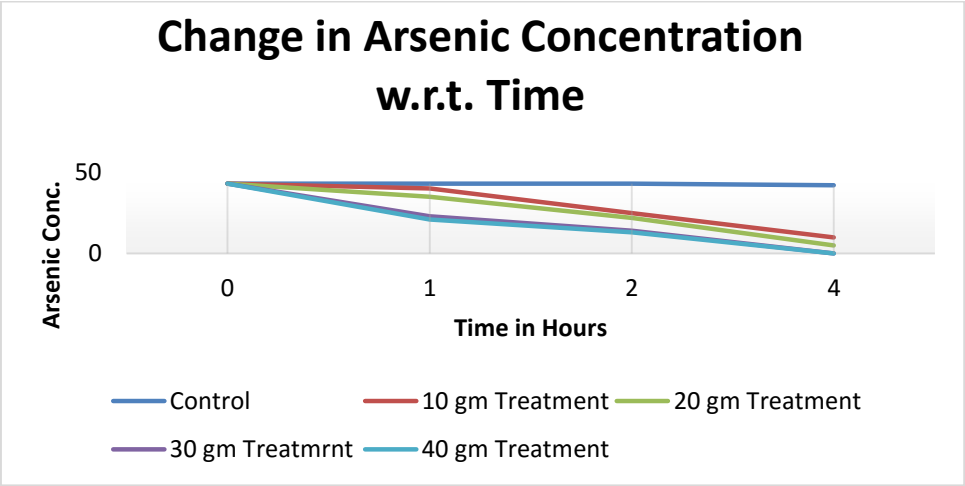

Fig 2: Graphical representation of change in Arsenic concentration w.r.t. time

However, this botanical tool can be safely used for treatment of arsenic contaminated water on large scale. Additional advantage of this tool is that the taste and odour of the water is not affected. Also, this plant is easily available in tropical countries.

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