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Bioremediation of Arsenic by utilizing leaves and stem biomass of *Catharanthus roseus*

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Abstract
The purpose of the current study is to determine whether using *Catharanthus roseus* leaves to remove arsenic from contaminated water is feasible. Water contaminated with 90 ppb arsenic. Different amounts of dried *Catharanthus roseus* leaf and stem biomass were used to remediate arsenic. After treating 12g of *Catharanthus* leaf, the concentration of arsenic dropped by 55%, while after treating 12g of *Catharantus* stem biomass, the concentration dropped by 44%. It was discovered that the *Catharanthus* leaf had a higher adsorption than the *Catharanthus roseus* stem. The study shows that biomass from *Catharanthus roseus* leaves and stems can be an effective method for phytoremediation of water contaminated with arsenic.

Keywords: *Catharanthus roseus*, leaf, stem, biosorption, bioremediation,water pollution, arsenic

Introduction

Arsenic (As-33) ranks 12th in the human body, 14th in seawater and 20th in the earth's crust [1]. Arsenic ranks close to the top of the toxic list among different elemental species. Arsenic can infiltrate water bodies as a result of both natural erosion processes and human activity. In many nations, including Mexico, Bangladesh, Vietnam, and Argentina, elevated levels of arsenic in drinking water are a major issue [2]. Since the past ten years, research has been conducted on the removal of arsenic utilising inexpensive adsorbents including lignocellulosic materials and agricultural byproducts. Because agricultural by-products are readily available worldwide and produced in enormous quantities, they are of special interest. The sugarcane businesses in Vietnam create a significant amount of sugarcane bagasse, which can be used to remove arsenic from water streams. Cellulose (46.0%), hemicellulose (24.5%), lignin (19.95%), fat and waxes (3.5%), ash (2.4%), silica (2.0%), and others (1.7%) are the primary constituents of sugarcane bagasse, according to reports [3]. Inorganic arsenic species are potent carcinogens to humans, although arsenic is poisonous to plants and animals [4]. The most common routes that arsenic enters and builds up in the human body are through contaminated food, drinking water, and air. Arsenic poisoning in humans can cause anything from skin blemishes to brain, liver, kidney, and stomach cancer. Consuming arsenic can cause neurological system dysfunction and death [5]. Arsenic has been extracted from aqueous solution using a variety of technologies, such as reverse osmosis, ion-exchange resin, adsorption onto coagulated floc, membrane techniques, and coprecipitation with iron or alum [6, 17]. Tree leaves, peanut and walnut husks [8], coconut shell, waste tea, rice straw, eucalyptus bark [18], and maize bran [7]. Rapid industrialisation has resulted in environmental contamination, which is harmful to human health [9, 19]. Cadmium, mercury, copper, arsenic, zinc, and lead are among the potentially dangerous heavy metals that pose a major risk to both humans and animals due to their high toxicity and propensity to bioaccumulate in the food chain, even at relatively low environmental concentrations. Industrial operations such metal plating, electroplating, metal polishing, mining, batteries, pigment, dyestuff, and paint are typically the sources of these heavy metal emissions [10]. Using plants to restore deteriorated habitats [11] Utilising plants, such as grasses and trees, to eliminate or sequester dangerous pollutants from media including soil, water, and air [12] using vascular plants to remove or neutralise pollutants in the environment. Green plants are engineered to eliminate, contain, or render innocuous environmental toxins such organic chemicals, radioactive compounds, heavy metals, and trace components from soil or water [14]. A collection of technologies referred to as "Phytoremediation" use different plants for containment, destruction, or extraction. An developing technique called phytoremediation employs a variety of plants to break down, remove, contain, or immobilise pollutants from soil and water [13]. Both rural and urban areas are increasingly reliant on groundwater to meet their water needs as a result of the fast population expansion and deteriorating water quality. However, the reliance on groundwater in deep aquifers is growing due to the high rate of groundwater exploration and the declining groundwater table [20].

Materials and methods

The leaves and stems of the plant *Catharanthus roseus* have been removed for experimentation. They were gathered in April and chosen for As adsorption; this is members of the Apocynaceae family. Due to the fact that these are inexpensive and readily accessible in India's arsenic-prone regions. After being cleaned, the stem and leaves of *Catharanthus roseus* were dried for two hours at 60 degrees Celsius in an oven. The stem and leaf were combined and ground into tiny particles.

Eight beakers that had been cleaned and labeled A, B, C, D and I, II, III, IV contained a solution of 250 ml of dibasic sodium arsenate (Na2HAsO4.7H20), or 90 ppb of arsenic. Ninety parts per billion is the typical concentration of As. Five replicates of varying weights (3 g, 6 g, 9 g, and 12 g) of finely powdered biomass of *Catharanthus roseus* leaves were placed in beakers A, B, C, and D that contained a 250 ml Na2HAsO4.7H20 solution. Beakers I, II, III, and IV, which contained a solution of 250 ml Na2HAsO4.7H2O, were treated to the same varying weight of powdered biomass of *Catharantus roseus* stem in five replicates. At DDU Gorakhpur University Pollution and Environmental Assay Research Laboratory (PEARL), Gorakhpur, India, the experiment was carried out. Following a particular procedure, the Waghtech Digital Arsenator was used to measure the amount of arsenic in a solution of 250 ml of $Na2HAsO4.7H2O$ (Dibasic Sodium Arsenate) at intervals of one, three, four, and five hours, respectively [15]. Room temperature (25°C) was used for the studies.

Results and discussion

Tables 1 and 2 provide a summary of the results. The fluctuation in As concentration by treatment of *Catharanthus roseus* stem and leaf biomass is shown graphically in Figures 1 and 2, respectively. As the weight of the powdered stem and leaf biomass increased over time, the concentration of arsenic in the water dramatically dropped. After being exposed to 250 ml of sodium arsenate solution for five hours, 12 g of *Catharanthus roseus* leaf biomass showed the greatest reduction in As content, which was measured at 35 parts per billion. The arsenic concentration was found to have decreased by 55% overall. After being exposed to 250 ml of sodium arsenate solution for five hours, 12 g of *Catharanthus roseus* stem biomass showed the greatest reduction in As content, at 46 parts per billion. The As concentration was found to have decreased by 44% overall. Additionally, Srivastava and Dwivedi carried out similar research [16]. Whereas reducing the amount of arsenic to 55% of its initial concentration after 4 hours of treatment with 8 g of *Bamboosa* leaves produced the best results. Therefore, the *Luffa cylindrica* fruit biomass treatment was discovered to be even more effective than the *Bamboosa* treatment. Future research potential will examine the impact of various physico-chemical parameters of the solution as well as the real mechanism of arsenic absorption.

Table 1: Change in arsenic concentration in the solution, after treatment with *Catharanthus roseus* leaf biomass

***Catharanthus roseus* leaf biomass**	**Time interval**				
	Control ppb	**1hr.**	**3hr.**	**4hr.**	**5hr.**
3g	90ppb	90ppb	85ppb	83ppb	80ppb
6g	90ppb	88ppb	83ppb	65ppb	52ppb
9g	90ppb	85ppb	75ppb	60ppb	40ppb
12g	90ppb	83ppb	70ppb	58ppb	35ppb

Table 2: Change in Arsenic concentration in the solution, after treatment with *Catharanthus roseus* stem biomass

***Catharanthus roseus* stem biomass**	**Time interval**				
	Control ppb	**1hr.**	**3hr.**	**4hr.**	**5hr.**
3g	90ppb	90ppb	87ppb	85ppb	83ppb
6g	90ppb	85ppb	75ppb	68ppb	58ppb
9g	90ppb	80ppb	72ppb	65ppb	55ppb
12g	90ppb	78ppb	70ppb	60ppb	46ppb

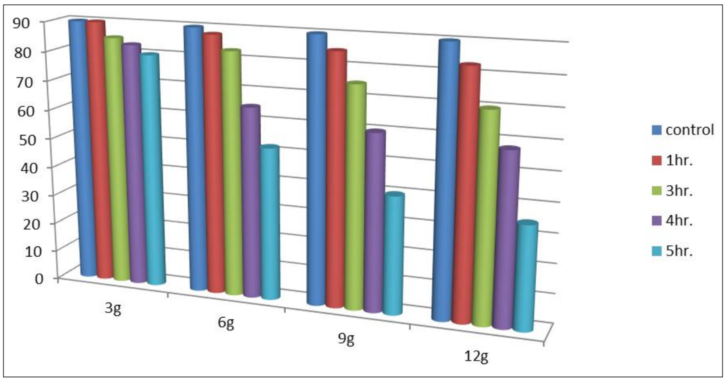

Fig 1: Change in arsenic concentration in the solution, after treatment with *Catharanthus roseus* leaf biomass

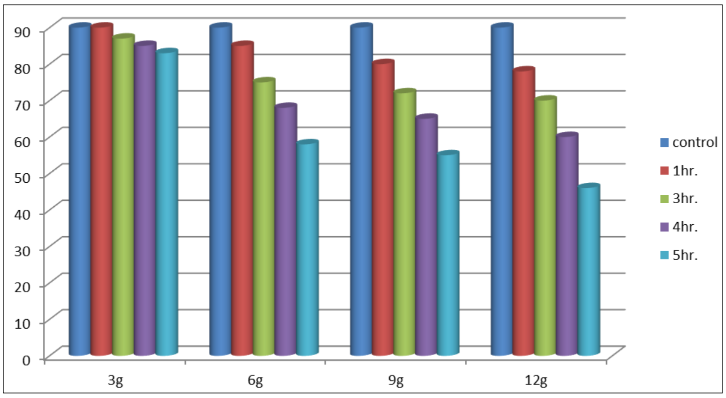

Fig 2: Change in arsenic concentration in the solution, after treatment with *Catharanthus roseus* stem biomass

Conclusion

According to the experiment, *Catharanthus roseus* leaves have a higher ability for arsenic adsorption than *Catharanthus roseus* stems. Therefore, it can be said that *Catharanthus* leaves have the ability to reduce the amount of arsenic in contaminated water. The study's findings indicate that *Catharanthus* leaf and stem powdered biomass is good at adsorbing however more research with this powdered biomass is required to recommend this product for phytoremediation. For better results, other comparable botanicals can also be investigated because they may be more affordable, practical, and environmentally friendly.

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