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Comparison of Biomasses of Different Plants for Phytoremediation of Arsenic

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The removal of heavy metals from drinking water, lake and waste water is crucial issue concern to health. The brake fern, *Pteris vittata*, is claimed to be the first found to function as an arsenic hyper accumulator. Phytoremediation by water hyacinth presents a potential solution to the arsenic problem. In the present study three plants (*Calotropis procera, Eichhoenia crassipes* and *Pteris vittata*) biomasses are selected and there arial parts and roots (dry biomasses) are compared for the first time. Also these plants are checked for the presence of other metals. After the removal of metal the treated water is then checked for the drinking water parameters. It was found that roots of *Calotropis procera* are best of biomasses selected for the phytoremediation of arsenic. The capacity of removal of *Calotropis* roots was also determined. After treatment water samples meet all EPA standards for drinking water.

Key Words: EPA, Phytoremediation, Biomass.

INTRODUCTION

The presence of toxic heavy metals in surface and ground water has become a serious concern due to the possible health threat. In recent past, arsenic contamination in groundwater has emerged as an epidemic in different Asian countries such as Bangladesh, India and China[1]. The ability of biological materials to adsorb metals has received considerable attention because of an efficient, clean and cheap technology for water treatment at low metal concentration[2] *e.g.*, 1 mg/L. Elevated concentrations of arsenic in drinking water are a considerable hazard to human health[3-6].

The removal of heavy metals from river water, lake and waste water is crucial issue concern to health. Several methods have been proposed for the removal of heavy metals *e.g.*, ion exchange, filtration, coagulation and adsorption. Materials include ion exchange resins, membrane filters, hydroxides, activated carbon, chelating resin and porous polymer beads; however materials are expensive[7]. Conventional methods for the removal of heavy metals from water, however, are cost prohibitive and have inadequate efficiency at low metal concentration levels, particularly in the range of 1-100 mg/L. Phytoremediation is a bioremediation *e.g.*, various types of plants to remove, transfer, stabilize and/or destroy contaminants in groundwater.

The American brake fern, *Pteris vittata*, is claimed to be the first found to function as an arsenic hyper accumulator. Phytoremediation by water hyacinth presents a potential solution to the arsenic problem[8].

EXPERIMENTAL

Plant material workup and preparation of biomass: Plants used in the study were collected from the university (Lahore College for Women University, Lahore) and Herbarium, voucher specimen is deposited at Lahore College for Women University, Lahore). Aerial parts and roots of these plants were washed with distilled 0.1 M HCl and then with distilled water. This material was then dried in oven at 60 ºC and then grinded. This material then stored for experiments.

Determination of metals: All plant samples were digested and metals were determined using atomic absorption spectroscopy (Hitachi-5000 polarized zeeman). Arsenic in the samples (before analysis and after analysis) was determined using arsenic field kit (Highly sensitive: range 0-500 ppb of $As^{3+/5+}$) Merck. According to the report published by Pakistan Council of Research, there is very less percentage difference between the result of kit and atomic absorption[9].

Analysis of water samples after treatment with biomasses: BOD and electrical conductance was determined using BOD meter and conductometer. pH was checked using pH meter.

RESULTS AND DISCUSSION

For accurately measure the rate of removal of the selected plants, solutions of 200 and 100 ppb were prepared from arsenic standard (Merck) and the selected amounts of plants were suspended in 250 mL of contaminated water. 15 g of *Calotropis procera* were suspended in 100 ppb. Its concentration decreased to 60, 40 and 10 ppb in 10, 20 and 40 min, respectively. With 200 ppb and 30 g concentration decreased to 100, 20 and 5 ppb in 10, 20 and 40 min. 20 g Aerial parts of *Pteris vittata* reduced 200 and 100 ppb to 150, 80, 10 ppb and 80, 50 and 20 ppb in 10, 20 and 40 min, respectively. *Eichhornia crassipess* aerial parts 40 and 20 g reduced the concentration of 200 and 100 ppb to 150, 50, 80 ppb and 50, 40 and 20 ppb after 10, 20 and 40 min, respectively (Fig. 1).

Under similar conditions roots of *Caloltropis procera* reduced from 200 ppb to 50, 40 and 5 ppb in with 12 g of biomass and from 100 to 50, 30 and 5 ppb with 6 g of biomass. Similarly 30 and 16 g of roots of *Pteris vittata* were more efficient than aerial parts as the levels of 200 and 100 ppb reduced to 150 ppb, 50, 5 and 70, 50 and 5 ppb, respectively. While the concentration of 200 and 100 ppb solutions after 10, 20 and 40 min on treatment with 30 and 16 g of *Eichhornia*, respectively changed to 100, 80, 50 and 60, 25 and 25, respectively (Fig. 2).

These observations have not only compared the biomasses of three plants but have also revalidated that doubling the amount and concentration reproduced the same results. It has been observed that roots of *Calotroppis procera* were more efficient than roots and aerial parts of other plants.

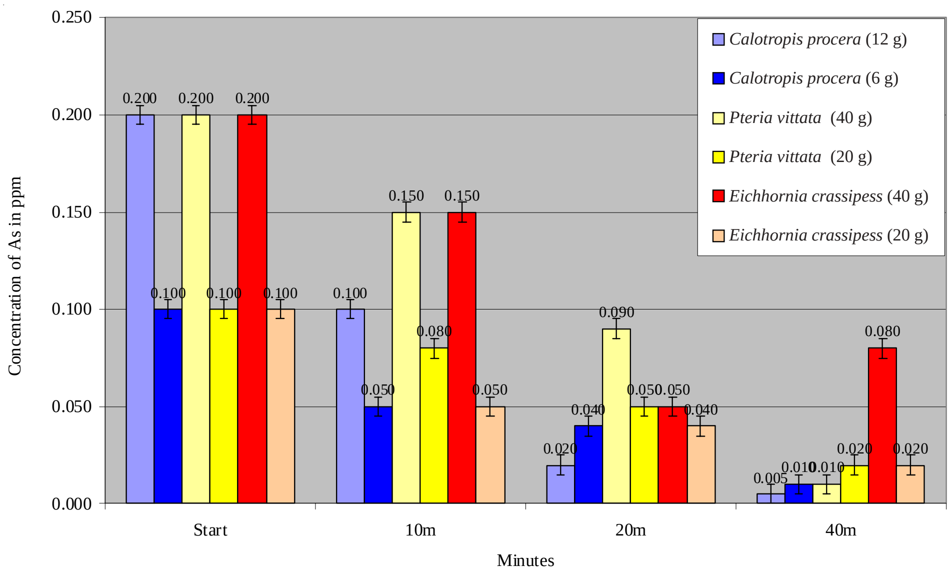

Fig. 1. Comparison of aerial parts of *Calotropis procera*, *Pteria vittata* and *Eichhornia crassipess*

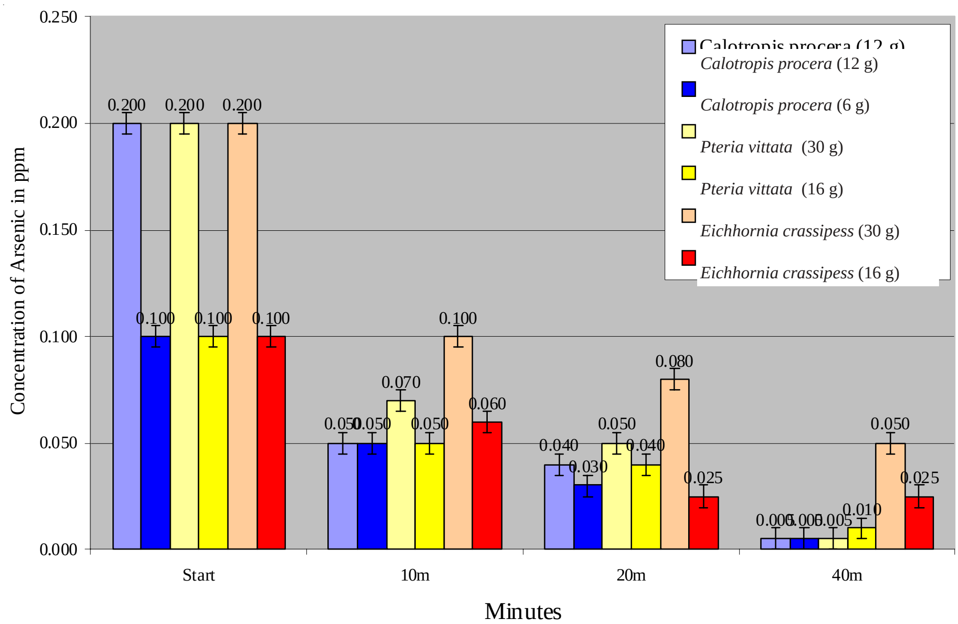

Fig. 2. Comparison of roots of *Calotropis rocera*, *Pteris vittata* and *Eichhornia crassipess*

Drinking water parameters: Water after treatment was checked for drinking water parameters (Table-1). Results have shown that it is safe to drink.

Other heavy metals in plants under study: These plants were also checked for other metals already present in them, which shows high amounts of iron and lead were present (Table-2).

TABLE-1
DRINKING WATER PARAMETERS OF BIOMASS TREATED WATER SAMPLES

Name of plant	pH	Conductivity (ms/cm)	BOD (mg/L)	Dissolved solids (g)	Conc. of arsenic by AA (ppb)
Calotropis procera (aerial parts)	6.1	7420	0.50	0.5	Nil
Calotropis procera (roots)	6.6	410	1.10	0.5	Nil
Pteris vittata (aerial parts)	5.8	5130	0.50	1.0	Nil
Pteris vittata (roots)	7.1	512	1.70	0.5	Nil
Eichornia crassipes (aerial parts)	6.2	10800	2.10	0.5	Nil
Eichornia crassipes (roots)	7.9	1020	1.80	0.5	Nil
Arsenic contaminated water (200 ppb)	7.6	11800	1.80	0.2	200
EPA standard	6.5-8.5	–	0.79	–	10

TABLE-2
OTHER METALS PRESENT IN *Calotropis procera, Pteris vittata* AND *Eichornia crassipes*

Sample	Cd	As	Pb	Co	Fe	Mg	Cr	Ni
	ppb				ppm			
Eichornia crassipes (aerial parts)	1.29	3.56	269.11	8.21	11.09	-0.18	0.36	0.10
Pteris vittata (aerial parts)	3.74	3.56	152.50	8.03	14.22	-0.19	0.32	0.88
Calotropis procera (aerial parts)	1.13	8.04	103.31	3.44	4.26	1.68	0.36	0.10
Calotropis procera (roots)	1.20	1.20	175.93	17.58	14.18	1.58	0.00	-0.11

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