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**Research Article**

# Removal of Arsenic Using Mango, Java Plum and Neem Tree Barks

## S. Mumtazuddin* and AK. Azad

University Department of Chemistry, B. R. A. Bihar University, Muzaffarpur- 8, Bihar, India.

**ABSTRACT**
We report here the use of dried and powdered tree barks of Mango (*Mangifera indica*), Java Plum (*Eugenia jambolana*) and Neem (*Azadirachta indica*) for the removal of arsenic from aqueous solutions by adsorption. The adsorption process was studied as a function of pH (3-8), contact time (20-180 min), initial concentration (10 ppb to 100 ppb) and doses of bark (3-7 g). It was observed that maximum removal of arsenic takes place at pH 6 in all the three cases. It was also observed that maximum removal of arsenic occurs after a contact time of 150 minutes. % removal of arsenic decreases with increase in the initial concentration of solution whereas it increases with the increase in the dosages of tree barks. It was observed that among the three tree barks studied java plum bark has the maximum % removal capability, followed by mango and neem tree barks in that order.

**Keywords:** Arsenic removal; Mango tree bark; Java Plum tree bark; Neem tree bark.

## INTRODUCTION
In typical ground water environments, arsenic may be present in both As (III) and As (V) states. As (III) is generally more mobile in water than As (V), and has higher toxicity[1]. Due to the withdrawal of excessive amounts of groundwater, problems of increased iron, fluoride and arsenic contamination have been reported in different parts of India[2,3]. A recent study on cancer risks from arsenic in drinking water indicates that it could cause liver, lung, kidney and bladder cancers besides skin cancer[4].

In some of our studies, we have observed that quite a few of the ground water samples in the Budhi Gandak river belt in Muzaffarpur town have arsenic contamination and exceeded the maximum permissible limit of 10 ppb set by WHO[5,6]. Various techniques[7-21] have been reported for the removal of arsenic from drinking water and waste water. We have, in our present study, investigated the utility of some tree (viz., mango, java plum and neem) barks and found these as good bioadsorbent for the removal of arsenic from aqueous solution. Of the three tree barks studied, we found maximum % removal of As from 50 ppb of aqueous solution of arsenic in the case of java plum (75 %), followed by that in the case of mango (60 %) and neem (55 %) tree barks.

## MATERIALS AND METHODS
### Preparation of Adsorbent
The experimental techniques required for the removal of arsenic involve use of mango, java plum and neem barks. First of all the barks were dried and finely powdered in an electrical grinder. The grinded powder was sieved to obtain fine particles. The powdered bark was washed several times with 0.1 N $HNO_3$ and then with distilled water so that all the traces of acid was removed. Finally, it was sun dried and used for study.

### Reagents
All the chemicals used were of analytical grade. Stock solution of 1000 mg/L of Arsenic trioxide was prepared by dissolving required amount in distilled water. Solutions of required concentrations were prepared by diluting the stock solutions. The pH of the solution was adjusted using 0.1 N HCl and 0.1N NaOH solutions.

### Instrumentations
A UV-Visible Spectrophotometer (Systronics, model no. 2201) was used for analysis. A high precision digital balance was used for weighing and a digital pH meter (Systronics, model no. 361) was used for pH measurement.

## EXPERIMENTAL METHODS

Estimation of arsenic was carried out experimentally by silver diethyldithiocarbamate (SDDC) method[22]. In batch study, effect of different parameters (i.e., pH, contact time, initial concentration and doses of adsorbents) on adsorption of arsenic was studied. For the effect of pH, the contact time was uniformly taken as 150 minutes taking 50 ppb initial concentration and 6 g of adsorbent dosage. For the effect of contact time, 50 ml metal ion solution of 50 ppb concentration was placed with a fixed mass of bark powder (i.e., 6 g) at pH 6 at varying contact times of 20 min, 40 min, 60 min, 80 min, 100 min, 120 min, 150 min and 180 min. For the study of the effect of initial concentration, 50 ml metal ion solution of different concentrations (10 ppb, 20 ppb, 30 ppb, 40 ppb, 50 ppb, 60 ppb, 70 ppb, 80 ppb, 90 ppb and 100 ppb) were placed together with a fixed mass of bark powder (i.e., 6 g) at pH 6. For the study of the effect of adsorbent dosage, 50 ml metal ion solution of 50 ppb concentration was placed with varying masses of bark powder (3 g, 3.5 g, 4 g, 4.5 g, 5 g, 5.5 g, 6 g, 6.5 g and 7 g) at pH 6. The experiments were carried out at room temperature (about $35^0$C).

## RESULTS AND DISCUSSION

The adsorption of metal ions is influenced by various factors including pH, contact time, initial concentration and amount of adsorbent.

### Effect of Ph

pH is the key factor for the control of the adsorption of metal ions on the adsorbent. The effect of pH on removal of arsenic is shown in Fig. 1. The study was done in the pH range of 3 to 8. It was found that the adsorption of arsenic ion gradually increases as the initial pH of the solution is raised from 3 to 6. The maximum removal of arsenic in the case of the three tree barks, viz., java plum, mango and neem was found to be 75 %, 60 % and 55 %, respectively, all at pH 6. Hence, pH of the arsenic solution was maintained at 6 for further study.

### Effect of contact time

% removal was recorded at contact time of 20 min to 180 min. The results are shown in Fig. 2. Evidently, more than 15 % arsenic removal in the case of all the three barks occurred within 20 min showing that initially the rate of uptake of arsenic is very fast and gradually increases attaining a steady value after reaching the equilibrium at about 150 min. Hence, 150 min contact time was fixed for further study.

### Effect of initial metal ion concentration

Experiments were performed by taking different initial concentrations of arsenic solution (10 ppb to 100 ppb) at pH 6 for a contact time of 150 min, taking 6 g of tree bark powder as bio adsorbent. The results (Fig. 3) show that % removal of arsenic ions decreased with increasing initial concentration in the case of all the three tree barks. This is because the adsorbtion sites become more saturated as the metal ion concentration increases.

### Effect of adsorbent dosage

The adsorbent doses were varied from 3 g to 7 g. It was observed that the removal of metal ion increased with the increase in dosage of all the three tree barks studied attaining a maximum at 6 g of bark dosage (Fig. 4). Obviously, higher dose of adsorbent results in higher surface area providing greater number of binding sites for the metal ions.

## CONCLUSION

The present work was carried out using different tree bark powder, viz., mango,  java plum and neem bark powder as biosorbents which were found to be quite effective for the adsorption of arsenic from aqueous solutions.

The effects of process parameters like pH, contact time, initial metal ion concentration and adsorbent concentration on equilibrium were studied. Of the three tree barks studied, maximum removal of arsenic took place in the case of java plum tree bark followed by mango and neem tree barks in that order.
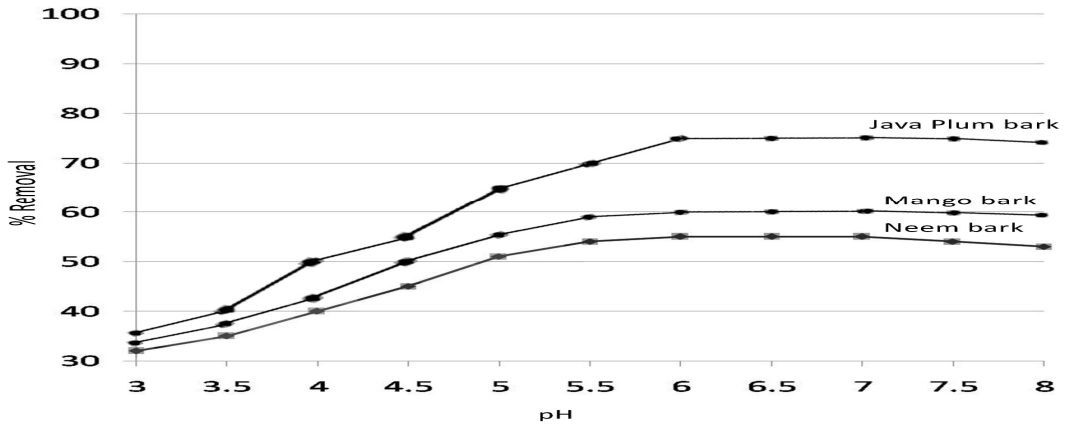
Fig.1. Effect of pH on adsorption of arsenic on different tree barks
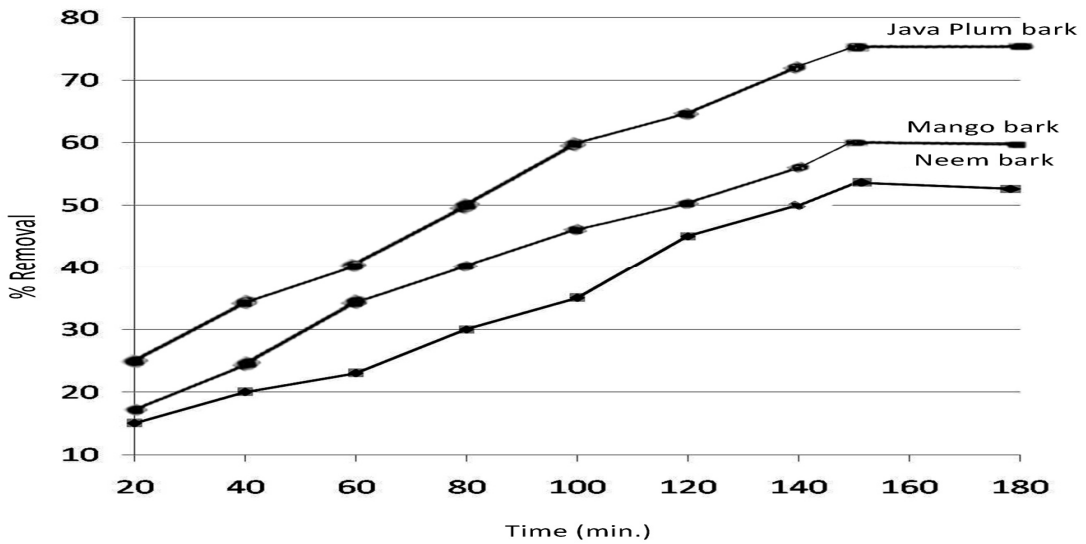(contact time: 150 min., arsenic ion concentration: 50 ppb, biomass dosage: 6 g)



Fig.2. Effect of contact time on adsorption of arsenic on different tree barks
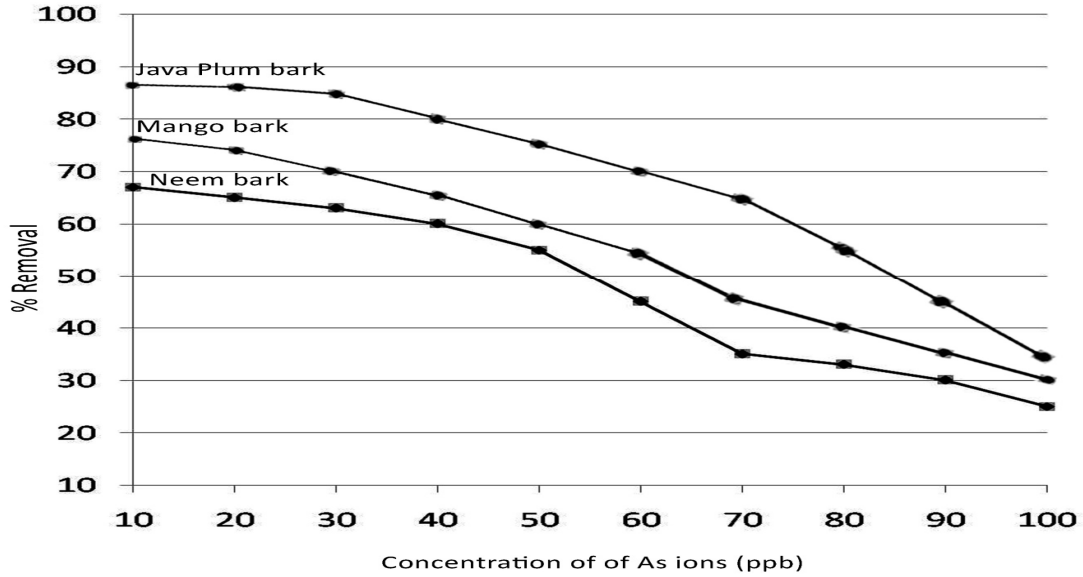at 308K (pH: 6, arsenic ion concentration: 50 ppb, biomass dosage: 6 g)

Fig.3. Effect of arsenic ion concentration on adsorption on different tree barks
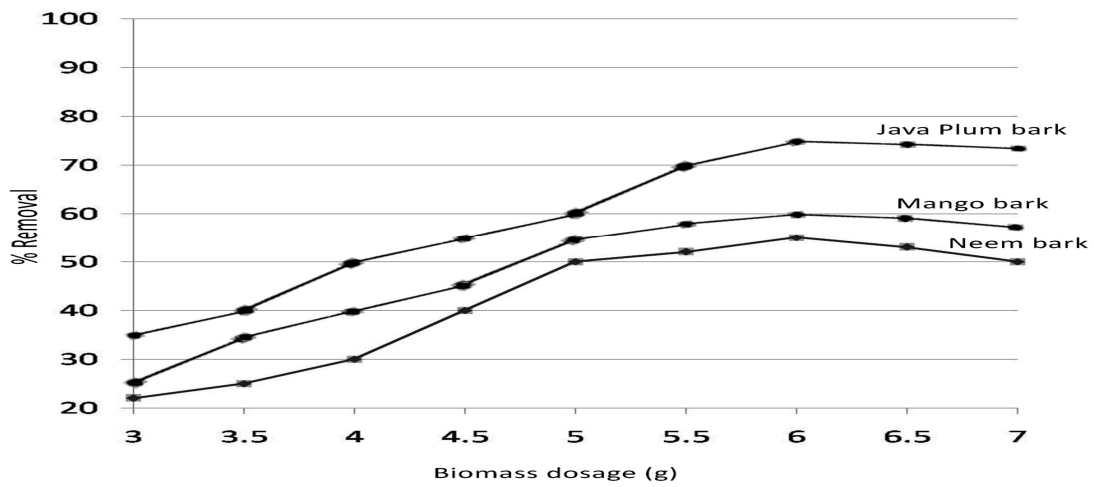at 308K (pH: 6, time: 150 min., biomass dosage: 6 g)



Fig.4. Effect of biomass dosage on adsorption on different tree barks
at 308K (pH: 6, time: 150 min., arsenic ion concentration: 50 ppb)

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