



Scholars Research Library  
Der Pharmacia Lettre, 2016, 8 (20):37-40  
(<http://scholarsresearchlibrary.com/archive.html>)



## Adsorption efficiency of few bark extracts for removal of mercury from synthetic solutions

A. Kalandar\* and R. Hiranmai Yadav\*\*

\*School of Medicine, College of Health And Medical Sciences, Post Box No.235, Haramaya University, Dire dawa, Ethiopia

\*\*Department of Botany, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India

### ABSTRACT

Adsorption using natural materials is now becoming one of the common methods used to remove heavy metals from effluents. The process is simple and it depends on the nature of adsorbate used for the removal of metal. Activated carbons prepared from plants are gaining momentum due to their economic and ecofriendly nature. They are found to be efficient in removing metals from different effluents. The industries discharge their effluent into the environment that causes pollution of soil, air and water. The preparation and utilization of activated carbon from plant resources are reported by many workers. Heavy metal are non degradable and regarded as cytotoxic, mutagenic and carcinogenic. Uptake of them by plants and animals are reported to produce toxic effects in them by interfering with their metabolism. The present study was carried out to prepare activated carbon from *Pongamia glabra*, *Tamarindus indicus*, *Tesphesia populnea* and *Mangifera indica* barks and assess its efficiency in removing the mercury content in solutions. The plant barks were found to be efficient in removing the heavy metals in different concentrations.

**Key words:** biosorption, plant barks, mercury, adsorption, activated carbon

### INTRODUCTION

Mercury constitutes 0.00003% by weight of earth's crust. It is used in chlor-alkali industries. It finds application in electrical switches, thermometers, in chemical fungicide and medical appliances. From the electrodes of these industries an estimation of one million pounds of mercury go to the environment. Combustion of fossil fuels releases 3000 tones of mercury in to the atmosphere. Natural weathering processes and submarine volcanism release about 5000 tones of mercury in to the ocean. Electrical industries which manufacture fluorescent lamps, batteries, electric switches are also step in as sources of mercury pollution. Plastic, paper and pulp industries, pharmaceutical industries, and organomercurial industries produce effluents rich in mercury posing threat to the environment. Mercury compounds enter the water bodies from the effluent and are metabolized in to methyl mercury compounds by anaerobic microbes. Though the industries contribute a major portion, natural agencies are the predominant suppliers of mercury in to the environment[1].

Several past disasters are due to contamination of heavy metals in aquatic environment. One among them is Minamata Tragedy[2] worth mentioning, caused by methyl mercury generated in the Minamata Bay. Metallic mercury from laboratory and chlorine manufacturing industries is capable of being converted to concentrated methyl mercury by aquatic life [3]. Methyl mercury is highly toxic as it is able to cross cell membrane resulting in higher absorption as well as higher retention in the body system. It is also highly persistent and gets accumulated in body fat tissues. Sea food is a major source of mercury to which humans are exposed. In the United States, some 60,000 babies per year are born with neurological damage caused by mercury poison of their mothers from consuming of

large amounts of fish from polluted locations during pregnancy [4]. Mercury chloride is found to be, highly toxic to brain, liver, kidney, spleen and heart. It alters the biochemical reactions in all the above organs [5].

In fish, mercury chloride causes changes in the hormone levels resulting in the dysfunction of pituitary and testicular axis affecting spermatogenesis and steroidogenesis. Thus it has adverse effects in the reproductive process [6]. Mercury contamination causes pink disease, insomnia and nephrotic syndrome and nerve tissue necrosis [7]. Mercuric chloride exposure to *Notopterus* causes inhibition of succinate dehydrogenase in liver and gills [8].

Exploration of good low cost and nonconventional adsorbent may contribute to the sustainability of the environment and offer promising benefits for the commercial purpose in future. The costs of the activated carbon prepared from biomaterials are negligible when compared to the cost of commercial activated carbon. The biological products are renewable sources of raw materials for the production of activated carbon.

Therefore in the present investigation it is proposed to make use of the readily available inexpensive plant barks such as *Pongamia glabra* (PGBM), *Tamarindus indicus*(TIBM), *Tesphesia populnea*(TPBM), and *Mangifera indica* (MIBM) as test cases to remove the heavy metal ions Hg (II) in synthetic solutions.

## MATERIALS AND METHODS

Due to the spurt in the industrialization of tannery in various places in our country, the environment is highly polluted primarily by tannery effluents. The most polluted area by tanneries in Tamil Nadu, India being Ambur, in Vellore District, India, to have an eye to nullify the pollution in this area gains importance. The pollution level in the effluent is determined by the various physico-chemical parameters as described in literature. Hence it has become necessary to collect tannery effluent at various stages in Ambur and to study the various parameters to find out the level of pollution, which will give imputes for their treatment, to save the wastewater from the clutches of pollutants including the toxic heavy metals present. Hence it is planned to take up the estimation of various physico-chemical parameters to find out the effectiveness of the treatment given by their treatment system and to ascertain the current status of the tannery wastewater.

### Experimental design for the removal of heavy metals

Batch studies were conducted at 31°C with constant amount of bark adsorbents (1-3g/L) at the constant pH 2 and 4.5 to evaluate the bark materials for the removal of different metal ions separately. Prior to the introduction of the metal ions, the flasks were vigorously stirred for 1.5 hours to hydrate the material, pH was adjusted with HNO<sub>3</sub> at 4.5. After the introduction of the required initial concentrations of metal ions, samples were collected at suitable time intervals for 1 and 2 hours and filtered through 0.45 µm membrane filter and then analyzed for metal ions using AAS.

### Removal of Mercury

First 0.4, 0.7 and 1.0 g the bark materials were introduced in 95 ml of deionized water, prior to the introduction of the metal ions, the flasks were vigorously stirred for 1 – 5 hours to hydrate the materials and then the initial pH was adjusted to 4.5 with HNO<sub>3</sub>. After the introduction of the initial concentrations of metal ion in the range of 4.024, 6.080 and 8.024 mg/L, then the flask was agitated and samples were collected at suitable time intervals and filtered through a 0.45 µm membrane filter. The filtrates were used for the estimation of Mercury (II) using atomic absorption spectrophotometer at 253.6 nm.

## RESULTS AND DISCUSSION

### 1. Effect of initial metal concentrations on the removal of Mercury (II) using PGBM, TIBM, TPBM and MIBM

Table 1 shows the variation of initial Hg (II) concentration from 4.024 to 8.240 mg/L at bark dose of 4 g/L MIBM (Fig. 24D) for contact time 24 hours. Percentage removal of Hg (II) decreased from 38.6 to 32 as the initial concentration is increased. Under the same condition 7 g/L increase of Hg (II) decreases the percentage removal of Hg (II) from 57.5 to 49. At 10 g/L increase in initial Hg (II) concentration decreases the percentage removal of Hg (II) from 94.8 to 58.7. For 48 hours, at 4 g/L, percentage of Hg (II) removal is found to be decreased from 43.3 to 40.4 as the initial Hg (II) increased from 4.024 to 8.240 mg/L. Under similar conditions for 72 hours the above increase of initial Hg (II) concentration has decreased the percentage removal from 52.8 to 46.6. For 96 hours also the above increase of metal concentration decreases the removal from 59.6 to 51.4 (Fig. 4).

For 48 hours at 7, 10 g/L percentage removal of Hg (II) was decreased from 64.6 to 53.2 and 100 to 72 respectively. For 72 hours at 7, 10 g/L an increase in initial concentration of Hg (II) decreases the percentage removal from 76.4 to 63.5 and 100 to 74.5. At 96 hours with the same concentration, decrease in the Hg (II) removal was from 85.4 to 68.4 and 100 to 76.9. When the same experiment was conducted with the plants PGBM, TIBM and TPBM the same increase in concentrations was found to decrease the percentage of removal (Fig. 1,2 and 3). For this type of observations, references were available with the adsorbents raw saw dust, treated saw dust and charred coconut carbon[9] coconut husk based carbon for the removal of Hg (II) and activated carbon[10] from *Parthenium* as adsorbent [11]

### **Effect of Contact time on the removal of Mercury (II) using PGBM, TIBM, TPBM and MIBM**

For 4 g/L PGBM at 4.024 mg/L Hg (II), when the contact time was varied from 24 to 96 hours, percentage removal of Hg (II) increases from 50.2 to 69.1, at 7 g/L removal was from 71.4 to 94.3 and at 10 g/L removal was 100%. For 4 g/L PGBM at 6.084 mg/L Hg (II), when the contact time was varied from 24 to 96 hours, percentage removal of Hg (II) increases from 45.7 to 60.5, at 7 g/L removal was from 60.3 to 83.5 and at 10 g/L removal was 72.5 to 89.4. Under the same condition at 8.240 mg/L Hg (II) concentration, when the contact time was varied from 24 to 96 hours, percentage removal of Hg (II) increases from 38 to 56.1, at 7 g/L removal was from 50.2 to 74.7 and at 10 g/L removal was 61.2 to 84.8.

When the same experiment is carried out with other plants TIBM (2), TPBM (Fig. 3) and MIBM (Fig. 3) similar increase in the percentage removal of metal with increase in contact time is observed.

### **2. Effect of bark dose on the removal of Mercury (II) using PGBM, TIBM, TPBM and MIBM**

When Hg (II) removal is studied for 24 hours, at an initial concentration of 4.024 mg/L of TIBM (Fig. 2) the bark dose is increased from 4 to 10 g/L, the percentage of Hg (II) removal is found to increase from 52.8 to 100. At 6.080 mg/L and variation of bark dose from 4 to 10 g/L increase in the removal was from 47.2 to 75.3. Under the similar conditions at 8.240 mg/L the above increase of bark dose has increased the percentage of metal removal from 40.5 to 72.

For 48 hours of contact time and 4.024 mg/L of Hg (II), increase of bark dose has increased the Hg (II) removal from 60.1 to 100. When initial concentration was 6.080 mg/L, increase of bark dose is found to increase Hg (II) removal from 50.3 to 80.2. At 8.240 mg/L increase of bark increased the percentage removal from 48.9 to 75.7.

When the contact time is kept as 72 hours and 4.024 mg/L of bark dose has increased the percentage removal from 66.7 to 100. At higher initial concentration of 6.080, 8.240 mg/L the removal was 55.4 to 83.5 and 57.5 to 80.2 respectively.

When the experiment was carried out with an initial concentration of 4.024 mg/L of Hg (II) for a contact time of 96 hours and increase of bark dose from 4 to 10 g/L, the percentage removal was increased from 78.3 to 100. At 6.080, 8.240 mg/L concentration, the percentage removal was found to increase from 67.1 to 91.2 and 61.1 to 86.7 respectively. When the above experiment was conducted with other plants PGBM (Fig. 1), TPBM (Fig. 3) and MIBM (Fig.4) the increase in bark dose is found to increase the percentage of Hg (II) removal as is done by TIBM.

[12] have found such an increase of adsorption of Hg (II) with increased dose of activated carbon from *Parthenium* plant. [13] also found the same type of results with the sorbent-treated saw dust, treated granulated activated carbon from coconut for the removal of Hg (II).The increase in the dose of *Acetobacterxylinium* cellulose increases the amount of removal of Hg (II).

### **3. Efficacy of the PGBM, TIBM, TPBM and MIBM plant barks for the removal of Hg (II).**

Keeping the initial Hg(II) concentration as 8.024 mg/L for a contact time of 24 hours and a bark dose of 4g/l (Fig. 5) of PGBM, TIBM, TPBM, and MIBM, the plant TPBM has the maximum capacity of removal of Hg (II) 42.3% compared to other plants. Similar maximum amount of removal of mercury is achieved by TPBM in 48, 72, and 96 hours of contact time compared to the other plant barks. When the experiment is conducted with 7 g/L (Fig. 6) of bark dose of PGBM, TIBM, TPBM and MIBM for all the contact times of 24, 48, 72 and 96 hours, TPBM alone removes maximum amount of Hg (II). Similar results are obtained with the bark dose of 10g/l (Fig. 7). Likewise 4, 7 and 10 g/L of bark doses of PGBM, TIBM, TPBM and MIBM are employed for adsorption with an initial mercury concentration of 4.024 and 6.080 mg/L for all the contact time employed viz. 24, 48, 72 and 96 hours. TPBM alone is found to remove mercury to maximum extent. It is found that TPBM is effective in the removal of Hg (II) from its solutions. This can pave the way for the use of the plant TPBM to selectively absorb Hg (II).

### 4.3 Maximum sorption capacity

In the maximum metal sorbent capacity studies using four plant bark materials, for Pb (II) the results reveals that the plant bark material prepared from PGBM was 28.8 while TIBM-26.3, TPBM – 23.3 and MIBM – 21.2 mg/g of bark material respectively. In the case of Hg (II) TPBM–25.2, PGBM - 24.3, TIBM - 22.6, MIBM – 20.9 mg/g of bark material respectively and in case of Cd (II) PGBM – 15.5, TPBM - 13.2, MIBM – 12.5, TIBM – 10.3 mg/g of bark material respectively were the order.

Similar to the present study, [14] have reported the efficiency of *Azadirachta indica* bark in removal of heavy metal by adsorption. [15] has reported *Mangifera indica* leaves as effective bioadsorbents for removal of Cu(II). [16] has reported the use of oak saw dust as an effective measure to adsorb the metals like copper, nickel and chromium.

### CONCLUSION

Lignocellulosic plant bark materials can be made into good sorbents for the removal of many metals. It would add value to this agricultural commodity, and provide a potentially cheap alternative to existing commercial carbons. This study showed that barks studied might be an interesting material in the treatment of metal contamination in water. All these data's will be useful for the development and the optimization of a new process involving low cost sorbents from plant barks.

### REFERENCES

- [1] SS Dara, A text book of Environmental Chemistry and pollution control, 4<sup>th</sup> Edition, S.Chand and Company Ltd, **2001** pp 208.
- [2] A Kudo; S Miyahara, *Wat, Sci. Tech*, **1991**,23, 283 – 290
- [3] LJ Gold Water, *Amer*, **1971**,224:15– 21
- [4] M Schrope, *Nature*, **2001**, 409 : 124.
- [5] M Anuradha; Rajeswari; P Varalakshmi, *Biomedicine*, **1998**, 18(3) ,145 – 150
- [6] V Ramalinga, *J. of Environment Biology*, **2003**, 24 (4), 491 – 404,
- [7] AJ Thatheyus, Heavy metals in Bio co-ordination and Bio-imbances, Management of Natural Resources for sustainable Development. Edited by Dr. S. John William, Loyola College, Chennai, **2002**.
- [8] SR Verma; Ramesh Chand, *Indian J. Environ HLTH*, **1986**,28 (1), 1 – 7
- [9,13] Ajay Kumar Meena; GK Mishra Satish Kumar ; Chitra Rajagopal, *Defence Science Journal* , **2004**,54 (4) ,537 -548
- [10] TS Anirudhan; MK Sreedhar, *Indian J. Environ. Protection*, **1999**,19 (1): 6 – 10
- [11,12] C Kadirvelu; Sivasankari ,*Indian journal of Chemical Technology*, **2002**, 449 – 503,
- [14] SP Rajjak; BA BabuRao, *Journal of Applied phytotechnology in Environmental sanitation*, **2013**,2(1),31-36
- [15] VS Sethu; KS Goey; FRCM IffahKhoo; JM Andresen,*Journal of Environmental Research and development*, **2010**,5(2),262-278
- [16] ME Argun; CS DursunOzdemir; M Karatas, *Journal of Hazardous materials*, **2007**,141,77-85