**IIPER1681305955**

**IIPER1681305955**

**Adsorption of heavy metal Fe by bird bone particles from the Industry effluent**

**S.M. Jearmeen\***

**\*Department of Advanced Zoology and Biotechnology, GuruNanakCollege,   
Chennai – 600 042, Tamil Nadu, India.**

**Abstract**

Bird bone particles have the ability to remove heavy metal Fe from the titanium industry effluent.   
The binding of Fe by bird bone was found to be mainly influenced by pH, bird bone absorbed the highest quantity of iron at pH 7 and when 5g of adsorbent was leaving only 278.27+0.93 ppm of Fe in the raw untreated effluent. The metal uptake by bird bone particles was maximum at room temperature and 254.71+0.84 ppm of Fe was left in the effluent after adsorption and increasing temperatures decreased the Fe uptake.

**Keywords:** Biosorption, Fe uptake, bird bone particles, titanium industry effluent.

**Introduction**

Heavy metals released into the environment by industrial activities tended to persist indefinitely, circulating and eventually accumulating through the food chain, and becoming a serious threat to the environment ( Kuppusamy *et al.,* 2004).

Bonechar as an adsorbent is effective and can be easily adapted at a low cost to remove heavy metals from large amounts of industrial wastewater. Poorly crystallized apatite, such as bone car-apatite, might represent a low-cost and readily available phosphate source that could be used as an adsorbent. Bone char, a mixed absorbent containing around 10 percent carbon and 90 percent calcium phosphate, is mainly produced by the carbonization of bone (Choy and Mckay, 2005; Smiciklas *et al.,* 2008).

Bone charcoal is used in the sugar refining industry to remove the color from sugar solutions and it is also used to adsorb radioisotopes of antimony from radioactive wastes (Gary *et al.,* 2007; Ofomaja and Ho, 2007).

The main objective of the study was to find out how efficient bird bone powder was in adsorbing heavy metal Fe in various parameters such as pH and temperature.

**Materials and Methods**

**Preparation of bone char**

Bird bones collected from common fowls were boiled for 30 minutes and the meat attached to the bones was completely removed the bone was crushed into small fragments in a mechanical crusher. After it was dried at 60oC in a hot air oven for 24h, bone char was further powdered in an electric blender and sifted in an 80 mesh sieve   
(<180 μm)

The experiment was designed to analyze the adsorptive potential of cheap bioresource, capable of entrapping Fe in the aquatic and semi-aquatic media.   
The powdered adsorbents were mixed with the two different types of effluents (raw and partially treated effluent) in 5 different concentrations of 1, 2, 3, 4, and 5 mg/*l*. The medium was separately maintained at six different pH levels (0.5, 2, 4, 7, 8, and 9).   
The adsorbent was thoroughly mixed with the toxicant solution and the mixture was agitated once in 2 h. The initial concentrations of Fe were estimated in the two different effluents. The treatment was run for a period of more than 60 days. The Fe content of the effluents was estimated after 60 days of interaction with the adsorbents. The difference between the initial and final metal levels indicated the quantity adsorbed by the bioresource used.

The effect of temperature on the adsorptive potential of the materials used was estimated at   
pH 7. For assessing the effect of temperature, the reaction mixtures were allowed to interact in a 250ml Erhlen – Meyer flask. The flasks were placed inside separate incubators maintained at 42, 32, and 28oC. The experiments were continued for more than 60 days and the quantities of Fe were analyzed in the raw and partially treated effluent.

**Estimation of heavy metal (Fe)**

An Atomic Absorption Spectrophotometer (ELICO) model with Air-C2H2 flame type, with an average fuel flow rate between 0.8 –4.0 L min-1 and a support gas flow rate between 13.5.-17.5 L min-1 was used for sample analysis and operated as per the equipment manual. The single-element hollow cathode lamps for respective metals were of the ELICO Co.Ltd-L series. Calibration curves for various elements obtained from these standards were of a first-order reaction. The Fe analysis sample was aspirated with an Automatic sampler's help. The samples were finally injected into an AAS flame and the reading was directly measured.

**Result and Discussion**

Bird bone powder adsorbed the highest quantity of iron at pH 7 and when 5g of the absorbent was used leaving behind only 278.27 + 0.93ppm of Fe in the raw untreated effluent. At pH   
0.5, adsorption of Fe was minimum, and at 5g bird bone powder concentration, the Fe concentration of the raw untreated effluent was 291.15 + 0.84 ppm was left in the medium (Table 1).

The highest amount of chromium adsorbed at 5g of bird bone at 28oC was 245.30 + 0.92 and the lowest adsorption adsorbed at 1g at 42oC was 275.94 + 0.98 of iron left behind in the raw untreated effluent (Table 2).

Bird bone powder effectively adsorbed Fe from the titanium industry effluent. Higher dosages of the absorbent removed more quantities of Fe compared to low dosages, indicating the additive effect. But the effectiveness of the adsorbent is more when administered in lower dosages.

The pH influenced the adsorption of Fe by bird bone powder. At acidic pH levels, the quantity of Fe absorbed is much less compared to neutral and alkaline pH levels. Thus pH plays a vital role in determining the quantity of Fe adsorbed from the medium by bird bone powder. The pH seemed to modify the adsorption potential of bird bone powder and the pH should be maintained at 7.0 to achieve maximum adsorption of Fe.

The temperature was another significant factor determining the adsorption of heavy metals. At higher temperatures (42oC) adsorption was much less compared to lower temperatures (28oC).

Namasivayam and Senthilkumar (1998) reported that the influence of temperature on the model parameters after a certain amount of adsorbents does not increase in the adsorption reaching equilibrium.

Ibrahim *et al.* (2012) studied the effect of maximum metal ion concentration on the adsorption capacity of chromium and lead and used cow bone charcoal at 30oC. Olaniyi *et al.* (2012) study that at 30oC, cow bone has the effect of temperature for the removal of metals using an immobilized sorbent.

Moreno *et al.* (2010) found that iron removal increased quickly from 0.01 g to 0.02 g cow bone charcoal dosages. Below pH 5.1, hydrogen ions are likely to compete with iron, and at pH values above 8, iron might precipitate as hydroxides. Maximum adsorption using cow bone charcoal was observed at about pH 5.1 and the adsorption is highly pH dependent. Rana *et al.* (2009) observed the removal efficiency of chitosan for iron was found nearly 58 percent.

Chojnacka (2005) and Chen *et al.* (2006) pointed out that cow bone charcoal is used as a microporous adsorbent, metals penetrate into these pores when the size of the ion becomes small. Han *et al.* (2007) and Jain *et al.* (2009) pointed out that different chemical functional groups such as carboxyl, hydroxyl, and amide are responsible for the biosorption of metal ions. These groups are the potential sites for adsorption and the uptake of metal and their accessibility and affinity between the adsorption site and metal.

The temperature was another significant factor determining the adsorption of heavy metals. At higher temperatures (42oC), even 1 g of adsorbent has a high percent of Fe from the titanium industry effluent at the ideal pH of 7.

Ibrahim *et al.* (2012) studied the effect of maximum metal ion concentration on the absorption capacity of chromium and lead at 30oC and here cow bone charcoal was used as an adsorbent.   
Olaniyi *et al.* (2012) found that at 30oC, cow bone reported the effect of temperature for the removal of metals using an immobilized sorbent obtained from poultry waste.

**Table 1**

**Adsorption of Fe from raw treated titanium industry effluent at pH 7 by Bird bone powder   
at different temperature levels**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.**  No | Amount (in **g)** of bird bone powder | Fe in the effluent (ppm)  control | Fe concentration (ppm) in effluent | | | | | |
| pH | | | | | |
| 0.5 | 2 | 4 | 7 | 8 | 9 |
| 1 | 1 | 452.25 ± 1.02 | 317.00 ± 0.85 | 312.39 ± 0.54 | 309.55 ± 0.51 | 297.69 ±0.60  (-34.00) | 298.49 ±0.60 | 302.00 ±0.72 |
| 2 | 2 | 314.62 ± 0.65 | 307.20 ± 0.84 | 303.37 ± 0.47 | 291.16 ±0.93  (-35.44) | 296.17 ±0.76 | 298.15 ±0.99 |
| 3 | 3 | 311.65 ± 0.85 | 302.23 ± 0.65 | 296.85 ± 0.76 | 285.88± 0.73  (-36.60) | 291.41 ±0.98 | 293.68 ±0.92 |
| 4 | 4 | 311.10 ± 0.78 | 308.49 ± 0.71 | 306.98 ± 0.65 | 284.23± 0.85  (-36.96) | 286.27 ±0.81 | 289.52 ±0.93 |
| 5 | 5 | 291.15 ± 0.84 | 290.31 ± 0.79 | 286.27 + 0.81 | 278.27±0.93  (-38.28) | 281.23 ±0.80 | 283.18 + 0.86 |

Note: Percent decrease in Fe concentration in parentheses

Deviations significant at P <0.05 (t-test)

**Table 2**

**Absorption of Fe from raw untreated titanium industry effluent at pH 7 by bird bone powder at different temperature levels**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S.No | Amount (in g) of bird bone powder | Fe in effluent (ppm) control | Fe concentration (ppm) in effluent | | |
| Temperature (° C) | | |
| 28 | 32 | 42 |
| 1 | 1 |  | 263.45 ± 0.96 (-41.54) | 274.26 + 0.73 | 275.94 + 0.98 |
| 2 | 2 |  | 258.91 +0.70 (-42.53) | 269.31 ± 0.87 | 271.55 ±0.85 |
| 3 | 3 | 452.25 ± 1.02 | 253.82 +0.65 (-43.65) | 265.17 + 0.80 | 267.53 ± 0.89 |
| 4 | 4 |  | 246.39 + 0.57 (-45.29) | 259.91 + 0.72 | 261.63 ±0.92 |
| 5 | 5 |  | 245.30 + 0.92 (-45.53) | 254.71 +0.84 | 257.77 ±0.75 |

Note: Percent decrease in Fe concentration in parentheses

Deviations significant at P < 0.05 (t-test)

**References**

1. Chen, S.B., Zhu, Y.C., Ma, Y.B. and Mekay, G. 2006. Effect of bone char application on Pb contaminated soil. *Environ. Pollut.,* **39**: 433 – 439
2. Chojnacka, K. 2005. Biosorption of Cr(III) ions by egg shells. *Journal of Hazardous Materials,* **121**: 167-173.
3. Gary, U.K., Kaur, M.P., Garg, V.K. and Sud, D. 2007. Removal of hexavalent chromium from aqueous solution by agricultural waste biomass.   
   *J Hazard Mater,* **40**: 60-68.
4. Han, X., Wong, Y.S., Wong, M.H. and Tama, N.G. 2007. Biosorption and bioreduction of Cr(vi) by a microalgal isolate. *J Hazard Mater,* **146**:   
   65-72.
5. Ibrahim, O., Sunday, M. and Odoh, R. 2012. Adsorption Study of Cr (VI) and Pb (1) from aqueous solution using animal charcoal derived from cow bone. *Pelagia Research Library,* **3** (3): 648-657.
6. Jain, M., Garg, V.K. and Kadirvelu, K. 2009. Chromium (VI) removal from aqueous system using *H.annuus* stem waste. *J.Hazard Mater,* **162** :   
   365-372.
7. Kana, M.S., Halim, M.A., Safiullah, S. and Mollah, M.M. 2009. Removal of heavy metal from contaminated water by biopolymer crab shell chitosan. *Journal of Applied Sciences,* **9** (5): 2762-2769.
8. Kuppusamy, V., Jegan, J.R., Palanivelu, K. and Velan, M. 2004. Copper removal from aqueous solution by the marine green alga. *Electronic J. Biotechnol.,* **7**(11): 61-71.
9. Moreno, J.C., Gomez, R. and Giraldo, L. 2010. Removal of Mn, Fe, Ni, and Cu ions from wastewater using cow bone charcoal. *Materials,* **3**: 452-466.
10. Namasivayam, C. and Senthikumar, S. 1998. Removal of arsenic (v) from aqueous solution using industrial solid waste, adsorption rates, and equilibrium studies. *Eng. Chem. Res.,* **37** (12): 4816-4822.
11. Ofomaja, A.E., Ho, Y.S. 2007. Effect of pH on cadmium biosorption by coconut meal. *Hazard Mater,* **139**: 356-362.
12. Olaniyi, I., Moses, S. and Odoh, R. 2012. Adsorption study of Cr (VI) and Pb (11) from aqueous solution using animal charcoal derived from cow bone. *Pelagia Research Library,* **3** (3): 648-657.
13. Rana, M.S., Halim, M.A., Safiullah, S. and Mollah, M.M. 2009. Removal of heavy metal from contaminated water by biopolymer crab shell chitosan. *Journal of Applied Sciences,* **9** (5): 2762-2769.
14. Shim, J.J Park, S.J. and Rju, S.K. 2001. Effect of modificatíon with HNO3 and NaOH by pitch-based activated carbon fibers. *Carbon,* **39**: 11
15. Smiciklas, I., Dimovic, S., Sljivic, M. and Plecas, I. 2008. The batch study of adsorption by bone char. *J. Eviron. Sci. Health,* **43**: 210-217