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BIOSORPTION OF Cr (III) AND Pb (II) FROM AQUEOUS SOLUTION BY WOOD MUSHROOM BIOMASS 'AGARICUS SILVICOLA'

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Abstract

The use of fungi such as mushrooms to remove metal ions from aqueous solutions is gaining popularity in the treatment of water pollution by heavy metals. The purpose of this study was to see how well mushrooms (*Agaricus silvicola*) adsorb Pb (II) and Cr (III) from aqueous solutions. The equilibrium experiments are conducted in a batch process and involve a variety of process factors such as contact time, adsorbent dose, shaking velocity, and aqueous solution pH. For the elimination of Pb (II) and Cr (III), the ideal pH for the aqueous solution was 4 and 6, respectively. For each of the two metals, the contact time and shaking speed was 60 minutes and 300 rpm. The removal efficiencies of Pb (II) and Cr (III) were biosorbent dependent and increased with the increase in shaking velocity and biosorbent dosage. Comparative investigations into the sorption of two heavy metals by the mushroom have found that lead uptake is higher than chromium. These results suggest that *Agaricus silvicola* are good adsorbents for removing heavy metals especially Pb (II) from contaminated water.

Key words: Agaricus silvicola, Lead, Chromium, Sorbent and Sorbate

Introduction

The elimination and regeneration of heavy metals from contaminated water is critical for human health and environmental protection (Vimala, 2009). Lead contamination exists in an insoluble state in the ecosystem, and the poisonous metals offer substantial health risks to humans. Lead serves no functional use in the human body. It can get into the internal organs via food, water, or air. To reduce heavy metals, many procedures have been developed and used, including coagulation/flocculation, membrane filtration, lime sedimentation, membrane filtering, and activated carbon adsorption (Li, 2011). Because of many drawbacks, such as selective removal, high chemical costs, and energy demands, proper management of toxic waste products necessitated the development of novel cost-effective methods such as the sorption process, which is highly effective at extracting metals from wastewaters (Demirbas, 2000).

In recent decades, biosorption has arisen as an alternative model for removing heavy metals from waste fluids, and it is seen as a groundbreaking tool for its promising applications in environmental protection. Low cost, great efficiency, less chemical and biological sludge, metal recovery and biosorbent regeneration are all benefits of bio sorption over conventional treatment techniques.

According to new research, bacteria can collect significant levels of metals. Microorganisms such as fungus, bacteria and algae, are examples of biomass that have surface selectivity for heavy metal sorption (Matheickal, 1997; Vimala, Charumathi, Das and Desalination., 2011). Toxic metal resistance is lower in bacteria than in algae and fungus. Because algae are autotrophic creatures, they require a steady supply of oxygen and carbon. Furthermore, algae and bacteria are difficult to collect due to their small size and necessitate arduous solid liquid phase separation.

Because several fungal species have been shown to have significant biosorptive potency, the fruiting bodies of macro fungi (mushrooms) are regarded as excellent for evaluation as biosorbents. Mushrooms have been proven in research to minimize the effect of heavy metal contamination via biosorption of lead and chromium (Vimala, Charumathi, Das and Desalination, 2011).

The Agaricus silvicola mushroom is the type of mushroom employed in this investigation. Several research revealed that mushrooms generally has analgesic, anti-inflammatory, and antipyretic effects (Suseem, 2011). It's also employed by many researcher as a powerful antibacterial agent, free radical scavenger and antiplatelet, and (Suseem, 2013). This research will look into the significance and usefulness of mushrooms in the sorption system on heavy metals in order to analyze this specimen for heavy metal ecosystem detoxification. The goal of this research is to see if heavy metals like lead and chromium can be absorbed by the Agaricus silvicola mushrooms.

Sample Collection and Preparation

The mushrooms (Agaricus silvicola) were havested from a forest in Ilaro, Ogun State Nigeria, and properly cleansed with distilled water to eliminate contaminats. It's also dehydrated for 16 hours at 60 °C and powdered with a mill and pestle. The biosorption research was carried out using the granulated sample.

Preparation of Stock Solution

1.9212 g of chromium trioxide, 1.5986 g of lead nitrate, and 1L of de-ionized water are used to make stock solutions of lead and chromium. To obtain suitable standard solutions, an initial stock solution with a concentration of 1000 mg/L was diminished with a suitable amount of distilled water. The biosorption experiment's resultant concentrations of lead and chromium ions were measured using flame Atomic Absorption Spectrometry.

Biosorption Experiment

Batch biosorption tests were carried out to explore the impact of different parameters on metal biosorption onto the biosorbent, as well as to evaluate the biosorbent's metal absorption capacity. The experiment was carried out on a mechanical shaker at room temperature. The samples were obtained, filtered, and AAS was used to determine the residual metal concentrations in the filtrates. Using equation 1, metal removal efficiency (R) was estimated.

$$R = (Ci - Cf) / Ci \times 100.$$

Ci and Cf are the initial and the equilibrium concentrations in mg/L, respectively,

Impact of Contact Duration

At starting 50 ml of 4 mg/L lead and chromium concentrations , a sorbent dosage of 0.4 g, and agitation at 300 rpm, the impact of contact duration on sorption of Pb (II) and Cr (III) was investigated. The mechanical shaker was use to carried out the research for 5 hours, with samples collected and separated by filtering every 30 minutes interval (30, 60, 90, 120, 150, 180, 210, 240, 270, and 300) and residual metal concentrations was analysed in the filterate.

Impact of Sorbent Dosage

With sorbent mass ranging from 0.4 to 1.2 g in 50 ml of 4 mg/L chromium and lead solutions, the impact of sorbents dosage was examined. The rest of the experiment followed the same pattern as the contact duration impact investigations.

Impact of pH

In batch biosorption tests, the impact of pH on heavy metal removal by the Agaricus silvicola was investigated on pH range of 2 to 7 for Pb (II) and Cr (III) at a concentration of 4 mg/L. The pH of the solution was changed as needed with 0.2 M HNO_3 and NaOH, and digital pH meter was utilized to measure the pH. Metal solutions (50 mL) was calibrated to varied pH levels and 0.4 gram of biosorbent make up the reaction mixture. To explore the influence of pH, a 5 hours contact duration was chosen because it was long enough to attain equilibrium. The sorbents were separated after extensively agitated the mixture on a mechanical shaker at 300 rpm. The residual metal concentration in the solutions was also determined.

Impact of Shaking Velocity

The impact of shaking velocity was investigated by increasing the velocity from 50 to 300 rpm for the two metals, Pb (II) and Cr (III) while retaining the other factors constant, such as biosorbent dosage of 0.4 g, metal ion concentration of 50 mL metal solution (4 mg/L), and contact duration of 3 hours. The rest method followed the same pattern as contact time impact investigations.

Result and Discussion

The mushrooms (Agaricus silvicola) were used as the sorbent, and Pb (II) and Cr (III) solutions were used as adsorbates. The effectiveness of Agaricus silvicola as a sorbent for removing Pb (II) and Cr (III) from aqueous solutions is described in this study. Contact duration, pH, agitation velocity, and sorbent dosage are all being optimized as part of this research.

Impact of Contact Duration

The biosorption effectiveness of all two metals by Agaricus silvicola is highest at 60 minutes and decreases later. It was discovered that the maximum percentage of Pb (II) and Cr (III) removal at 60 minutes was 92.5% and 35.6 %, respectively. Figure 1 depicts the uptake of Pb (II) and Cr (III) by the biosorbent Agaricus silvicola at various contact duration.

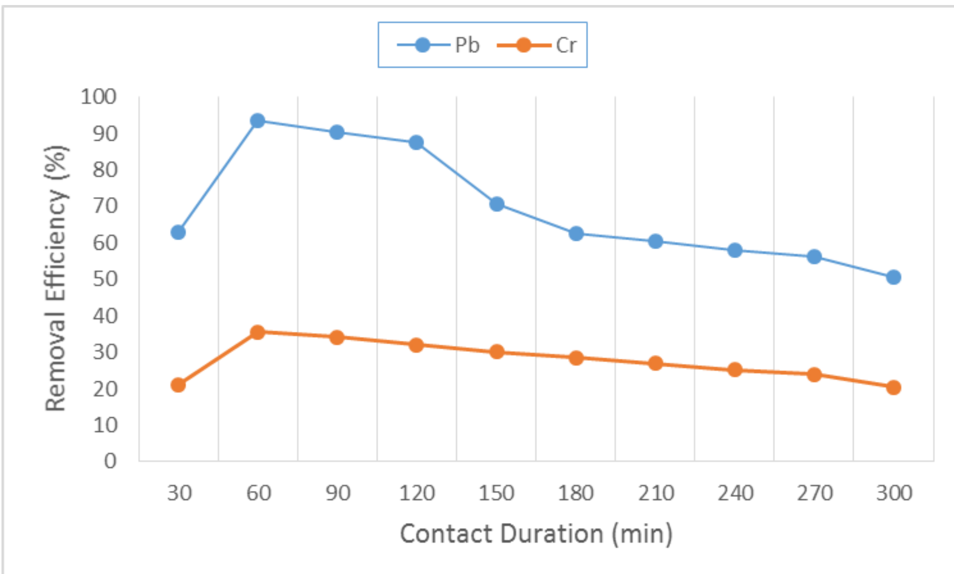

Figure 1.

Impact of Biosorbent Dosage

At steady state, the impact of adsorbent dosage on removal efficiency of Pb (II) and Cr (III) are shown in Fig. 2. With various adsorbent dosages, the quantity of Pb (II) and Cr (III) uptake was shown to differ. As the adsorbent dosage is increased from 0.2 to 1.2 g, the amount of chromium adsorbed increases (from 25.4 to 38.9 %). At 4 mg/L concentration of aqueous solution of both metals, the percentage Pb (II) removal was greatly enhanced from 75.2 % to 97.6 % by increasing the adsorbent dosage from 0.2 to 1.2 g. The increase in biomass surface area causes an increase in the amount of adsorption. Using mushroom Pleurotus eous and Azadirachta indica as an adsorbent, a similar trend was reported for removal of Pb (II) and Cr (III) (Overah, 2011; Mary Saral, 2014).

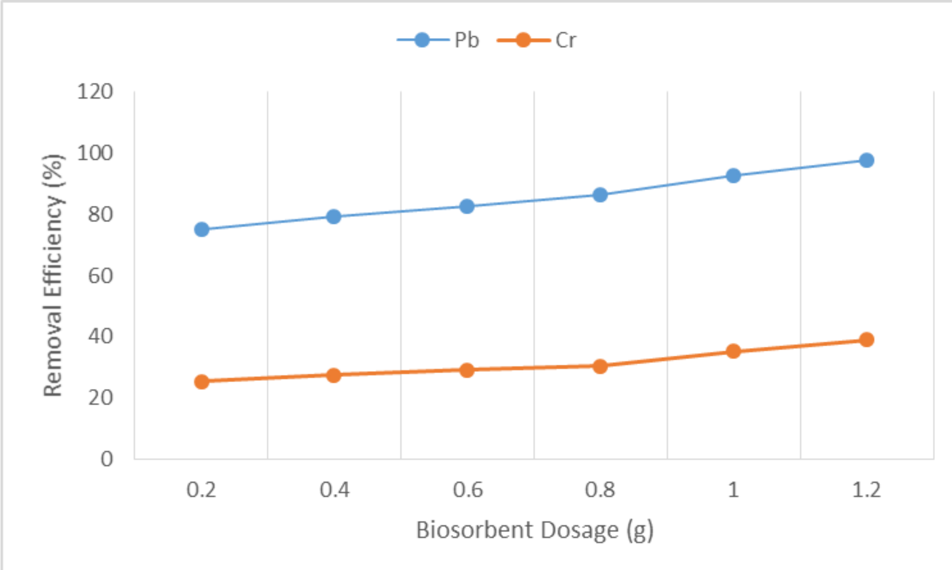

Figure 2 depicts the uptake of lead and chromium by the biosorbent mushrooms at various sorbent dosage.

Impact of pH

In sorption mechanisms, the pH of an aqueous media affects the uptake of metal ions by biosorbent. When it comes to Cr (III), as the pH rises, so does the biosorption, which peaks at pH 6 and then progressively falls. When Agaricus silvicola was tested at pH 2 to 7, the maximum percentage of Pb (II) removed was 93.5 %. According to the findings, Pb (II) has the highest biosorption effectiveness, which is seen at pH 4 and then steadily diminishes. Figure 4 depicts the uptake of Pb (II) and Cr (III) by the biosorbent Agaricus silvicola at various pH settings.

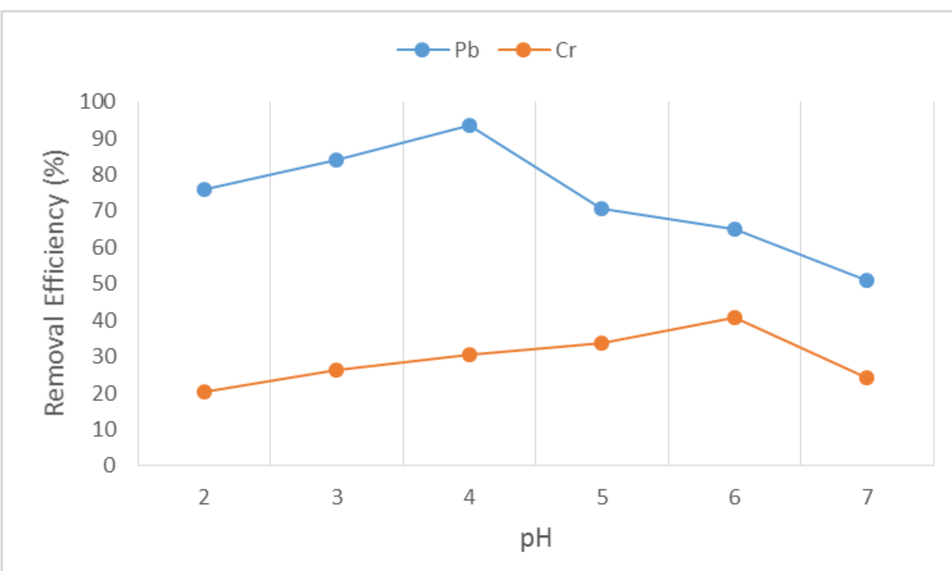

Figure 3

Impact of Shaking Velocity on Biosorption

When the spinning velocity (rpm) of all two metals, Pb (II)and Cr (III), is increased to a range of 300 rpm, the removal efficiency increases rapidly. The maximum percentage of lead and chromium removal at 300 rpm for Agaricus silvicola was reported to be 97.3 % and 38.9 %, respectively. Figure 4 shows the absorption of lead and chromium by the biosorbent Agaricus silvicola at varying rpm.

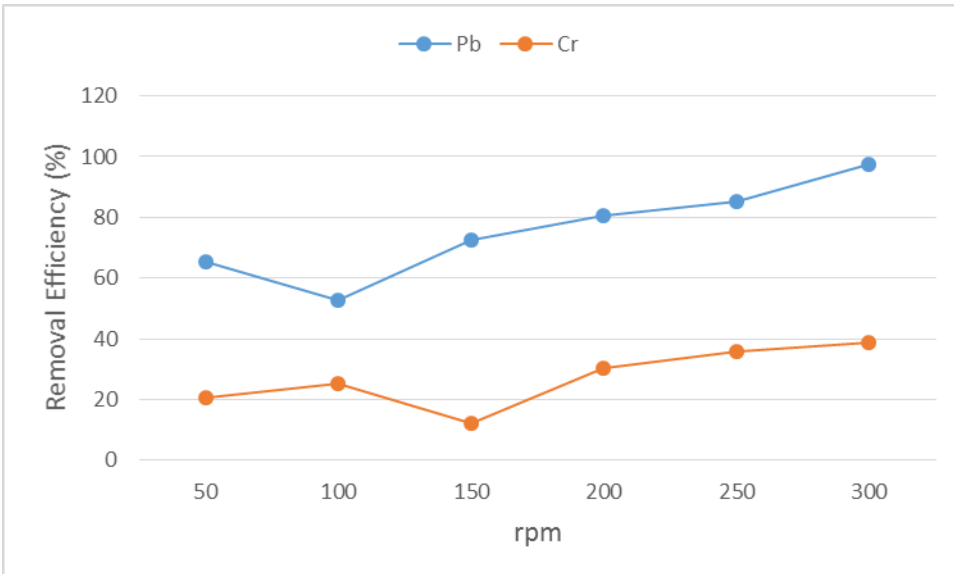

Figure 4

Sorption Potency of Mushrooms on Heavy Metals in Comparison Studies

Agaricus silvicola sorption effectiveness on heavy metals Pb (II) and Cr (III), was compared utilizing optimal conditions with pH of 4 and 6 agitation velocity of 300 rpm, biomass of 0.4 to 1.2 g, and a contact period of 5 hours. Pb and Cr biosorption efficiencies were determined to be 97.5 % and 38.9 %, respectively. Among the two metals, the Agaricus silvicola removed more of Pb (II) and than Cr (III). The effectiveness of Agaricus silvicola biosorption on heavy metals Pb and Cr is indicated in Figure 5.

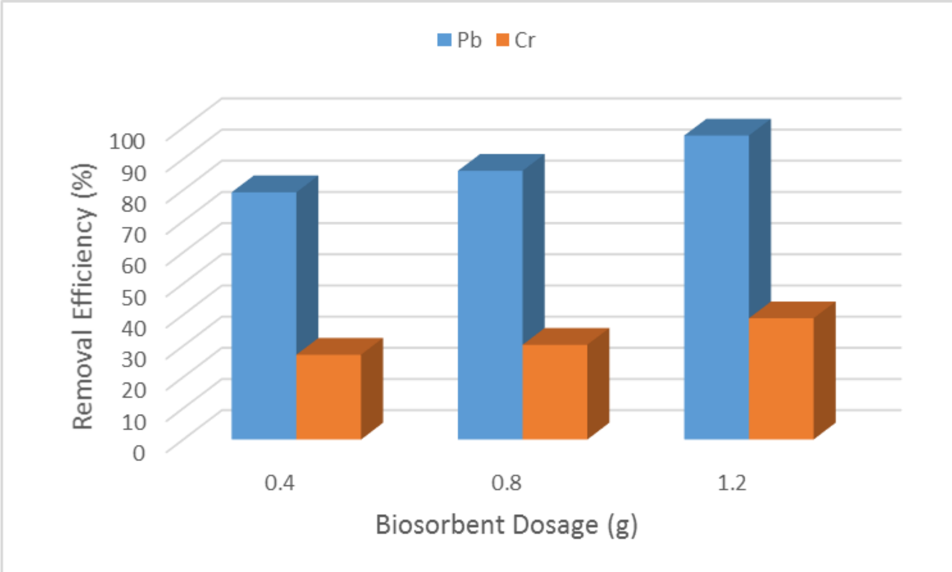

Figure 5

Conclusion

According to the findings of this investigation, the ideal pH for optimal removal of Pb (II) and Cr (III) was found at a pH of 4 and 6 respectively. Sorption capacity was also attained at 60 minutes of adsorbate contact duration with the adsorbent and shaking velocity of 300 rpm. When comparing the biosorption effectiveness of mushrooms for the heavy metals Pb (II) and Cr (III), it is found that Pb (II) has a higher biosorption efficiency (97.5%) than Cr (38.9 %). Agaricus silvicola is a fungus that has the highest uptake of Pb (II) (93.2%) when compared to Cr (III). As a result of its ability to adsorb heavy metals, the study indicates that Agaricus silvicola growing is environmentally friendly and reduces pollution especially lead.

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