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Removal of Chromium (VI) from Aqueous Solution by using Mango, Neem and Eucalyptus Tree Parts

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ABSTRACT:

Water is one of the most vital natural resource, and is crucial for survival of all living organism. In developing countries, most of the industries are operated in small and medium scales. These small units generate a large amount of pollution load which in many cases is discharged into environment without any pre-treatment. Leather and Electroplating industries are the major source for the high influx of chromium to the Biosphere. The large quantity of chromium salts discharged into electroplating & tannery waste has raised several ecological concerns. Chromium has been considered as one of the most toxic pollutants due to its carcinogenic and teratogenic nature. Several methods have been adopted for the removal of Cr(VI) from aqueous phase [4]. These include chemical reduction and precipitation, ion exchange, evaporation and concentration, electrolysis and electroplating, ion flotation, activated sludge process and carbon adsorption. Adsorptive removal of pollutants by activated carbon is found to be the most effective, particularly for the removal of metal ions at low concentrations.

In the present study, Barks, Leaves & Saw Dust of Eucalyptus, mango & neem trees are used. After activating by concentrated Sulphuric acid these barks are used as adsorbent for Cr(VI) removal from aqueous solutions. Batch adsorption experiments were conducted for determining the performance of activated adsorvents for removal of Cr (VI). The effect of various important parameters such as dosage of adsorbent for the removal of Cr (VI), pH and effect of contact time, are studied. These adsorbents give their optimum result in 180 min at pH 2. For Bark & Saw dust optimum adsorbent dose is 3 gram and for leaves it is 2 gram. Mango Saw Dust carbon gives only 58.71 % Cr removal and Eucalyptus Bark carbon gives 99.01 % Cr removal, which is maximum among all the 9 adsorbent.

Keywords: Adsorption, Chromium(VI), Activated Eucalyptus, Neem & Mango

1 INTRODUCTION:

The main concern about Cr (VI) compounds is associated with their mobility, which can easily lead to the contamination of both surface and ground waters [1]. Cr(VI) can be toxic for biological systems [8], and water-soluble Cr(VI) is extremely irritating and toxic to human body tissue owing to its oxidizing potential and easy permeating of biological membranes [5]. It leads to liver damage, pulmonary congestion, and skin

irritation resulting in ulcer formation. Chromium (VI) is toxic to numerous plants, animals, bacteria and as a confirmed human carcinogen, poses a great threat to human health and environment [3]. Trivalent chromium on the other hand, present mainly as relatively insoluble, immobile and non-toxic hydroxides and oxides [6]. The toxicity of trivalent chromium is 500 to 1000 times less to a living cell than hexavalent chromium [2]. Hexavalent chromium has been recognized as more toxic among heavy metals and hence it receives much more attention. Bioadsorption plays an important role in Removal of Chromium (VI) from aqueous solutions. The main advantage of the bioadsorption technology is its effectiveness in reducing the concentration of Chromium (VI) to very low levels and the use of inexpensive bioadsorbent materials.

2.0 METHODS AND MATERIALS:

2.1 Preparation Of Adsorbents: Bark, Leave & Saw Dust of Eucalyptus, Neem & Mango tree were collected from the local area. These were washed with deionized water and then dried. These were grounded to small particles. For Leave and Saw dust, samples were prepared by soaking it in Sulphuric acid (1:1). The sample was pyrolyzed at 150^0 C for 0.5 hr in N_2 atmosphere and activated at 450^0 C for 1 hr in N_2 atmosphere. The sample was cooled overnight in N_2 atmosphere. The sample was washed with deionized water until the pH of the filtrate was more than 4.5. To avoid, the release of color by bark in to the aqueous solution during adsorption, it was treated with formaldehyde [7]. For this 5 mL of aqueous formaldehyde was added to 100 mL of (1:1).H_2SO_4 and then 10 g of grounded and washed bark was added to this solution. After that same procedure mentioned above for leave and saw dust was used.

2.2 Preparation Of Chromium Solution: Stock solution of 1000 ppm of Cr(VI) was prepared by dissolving 2.828 g $K_2Cr_2O_7$, in 1 liter deionised, double-distilled water. Then it is diluted for preparation of different concentration solutions.

2.3 Determination Of Chromium Content: The chromium concentration in raw and treated effluent was determined by SL-218 UV/VIS Spectrophotometer. For this purpose, $K_2Cr_2O_7$ solutions of different concentrations were prepared and their absorbance recorded by using a UV-spectrophotometer. A calibration plots for Cr(VI) were drawn between % absorbance and time.

2.4 Experimental Work: All the batch adsorption studies were carried out using 200 mL solution of 100 ppm Cr concentration by dilution of the stock solution. Requisite quantity of adsorbent was added to 500 mL beakers. The beaker was placed on magnetic stirrer. The speed of stirrer was kept at moderate level. At different intervals of time samples were drawn & filtered through a filter paper. The filtrate was analyzed for pH and final chromium concentration using pH meter & spectrophotometer respectively. The removal of Cr (VI) was studied by using different adsorbents. For all these runs first the adsorbent dose was varied at constant pH 3 for 30 minutes. After finding optimum adsorbent dose, pH was varied from 1 to 4 for 30 minutes at optimum dose. After getting optimum adsorbent dose and pH, the contact time in batch was varied from 5 minutes to 210 minutes at optimum pH & dose.

The removal percentage (R%) of chromium was calculated for each run by using Eq.

$$\% \text{ Removal } (\% R) = [(Ci - Ce)/Ci] \times 100$$

Where Ci and Ce were the initial and final concentration of chromium in the test solution, respectively.

3.0 RESULTS AND DISCUSSION:

3.1 Effect Of Adsorbent Dose (For Different Bark): The percentage removal of Cr (VI) ions by different barks was studied at different adsorbent doses (1,2,3,and 4 gram) , keeping pH = 3 ,Temperature =Room Temperature, Contact time =30 minute, initial Cr (VI) ions concentration of

100 ppm (Part Per Million) & 200 ml solution. The result shows that maximum removal was achieved with adsorbent dose of 3.0 gram. The results are given in fig 1.

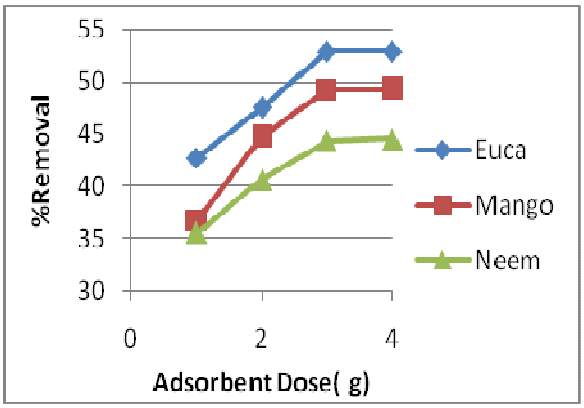

FIGURE 1: Adsorption Of Cr By Eucalyptus, Mango & Neem Bark At Different Adsorbent Doses (At pH 3 & 100 ppm Cr Solution)

3.2 Effect Of The pH (For Different Bark): The pH of the solution controls the adsorption of the metal ions at the solid water interface. Hence, the influence of pH on the adsorption of Cr (VI) ions onto different bark was examined in the pH =1, 2, 3 and 4. The result shows that maximum removal of Cr (VI) ions by adsorbents for contact time 30 minutes was achieved at pH =2, for 200 ml solution of 100 ppm concentration at 3 g adsorbent dose. The results are given in fig 2.

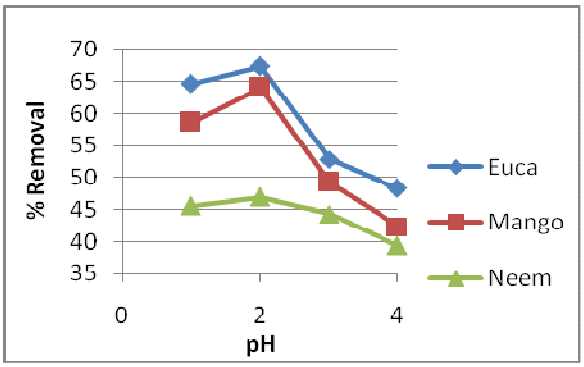

Figure 2: Adsorption Of Cr By Eucalyptus, Mango & Neem Bark At Different pH (At 3g Dose & 100ppm Cr Solution)

3.3 Effect Of Contact Time (For Different Bark) : At optimum pH 2 & adsorbent dose 3g the effect of contact time on Cr(VI) adsorption was investigated to study the rate of Cr(VI) ions removal. The result shows that at 180 minute maximum removal achieved. The results are given in fig 3.

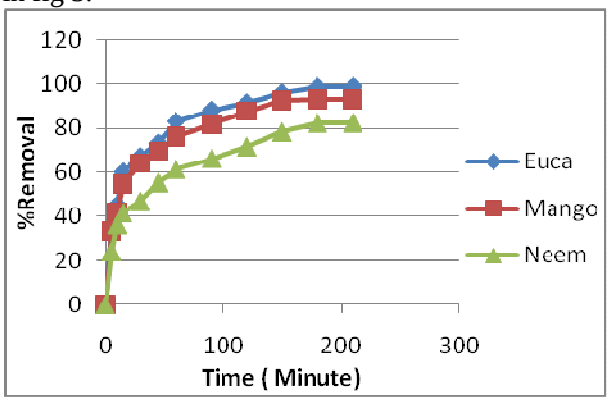

FIGURE 3: Adsorption Of Cr By Eucalyptus, Mango & Neem Bark (At pH 2 , 3g Adsorbent Dose & 100 ppm Cr Solution)

3.4 Effect Of Adsorbent Dose (For Different Leaves): The percentage removal of Cr (VI) ions by different leaves were studied at different adsorbent doses (1,2,and 3 gram) , keeping pH = 3 ,Temperature =Room Temperature, Contact time =30 minute, initial Cr (VI) ions concentration of 100 ppm (Part Per Million) & 200 ml solution. The result shows that maximum removal was achieved with adsorbent dose of 2.0 gram. The results are given in fig 4.

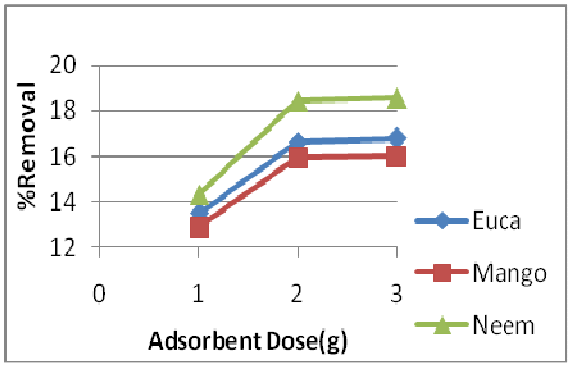

Figure 4: Adsorption Of Cr By Eucalyptus, Mango & Neem Leaves At Different Adsorbent Doses (At pH 3 & 100 Ppm Cr Solution)

3.5 Effect Of The pH (For Different Leaves): The influence of pH on the adsorption of Cr (VI) ions onto different leaves was examined in the pH

=1, 2, 3 and 4. The result shows that maximum removal of Cr (VI) ions by adsorbents for contact time 30 minutes was achieved at pH =2, for 200 ml solution of 100 ppm concentration at 2 g adsorbent dose. The results are given in fig 5.

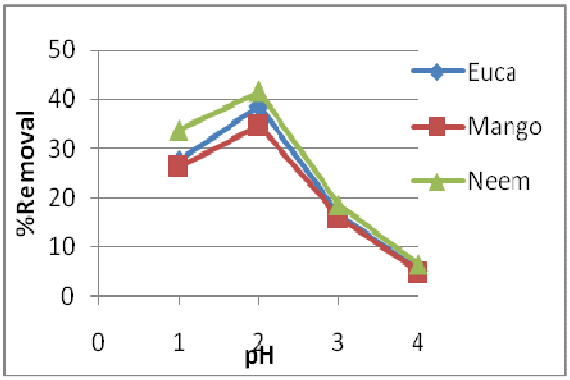

Figure 5: Adsorption Of Cr By Eucalyptus, Mango & Neem Leaves At Different pH (At 2g Adsorbent Dose & 100 Ppm Cr Solution)

3.6 Effect Of Contact Time (For Different Leaves) : At optimum pH 2 & adsorbent dose 2g the effect of contact time on Cr(VI) adsorption was investigated to study the rate of Cr(VI) ions removal. The result shows that at 180 minute maximum removal achieved. The results are given in fig 6.

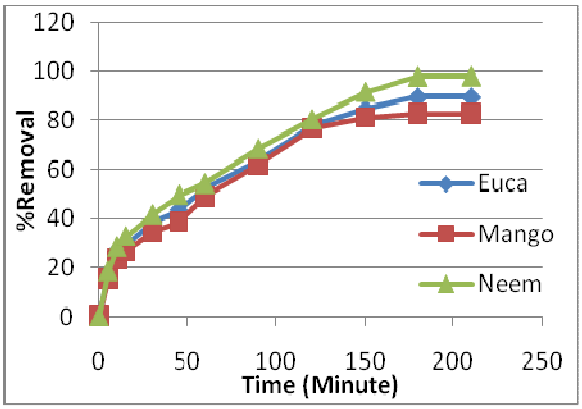

Figure 6: Adsorption Of Cr By Eucalyptus, Mango & Neem Leaves (At pH 2, 2g Adsorbent Dose & 100 Ppm Cr Solution)

3.7 Effect Of Adsorbent Dose (For Different Saw Dust): The percentage removal of Cr (VI) ions by different saw dust was studied at different adsorbent doses (1,2,3 and 4 gram) , keeping pH = 3 ,Temperature =Room Temperature, Contact time =30 minute, initial Cr (VI) ions concentration of 100 ppm (Part Per Million) & 200 ml solution. The result shows that maximum removal was achieved with adsorbent dose of 3.0 gram. The results are given in fig 7.

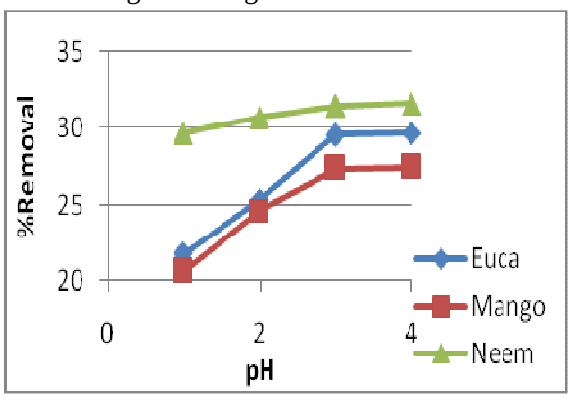

Figure 7: Adsorption Of Cr By Eucalyptus, Mango & Neem Saw Dust At Different Adsorbent Doses (At pH 3 & 100 Ppm Cr Solution)

3.8 Effect Of The pH (For Different Saw Dust): The influence of pH on the adsorption of Cr (VI) ions onto different saw dust was examined in the pH =1,2,3 and 4. The result shows that maximum removals of Cr (VI) ions by adsorbents for contact time 30 minutes was achieved at pH =2, for 200 ml solution of 100 ppm concentration at 3 g adsorbent dose. The results are given in fig 8.

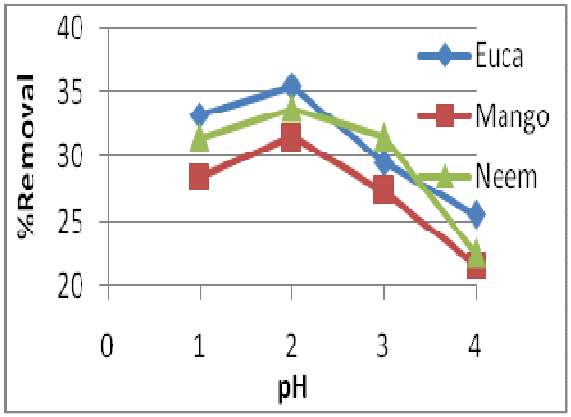

Figure 8: Adsorption Of Cr By Eucalyptus, Mango & Neem Saw Dust At Different pH (At 3g Adsorbent Dose & 100 Ppm Cr Solution)

3.9 Effect Of Contact Time (For Different Saw Dust) : At optimum pH 2 & adsorbent dose 3g the

effect of contact time on Cr(VI) adsorption was investigated to study the rate of Cr(VI) ions removal. The result shows that at 180 minute maximum removal achieved. The results are given in fig 9.

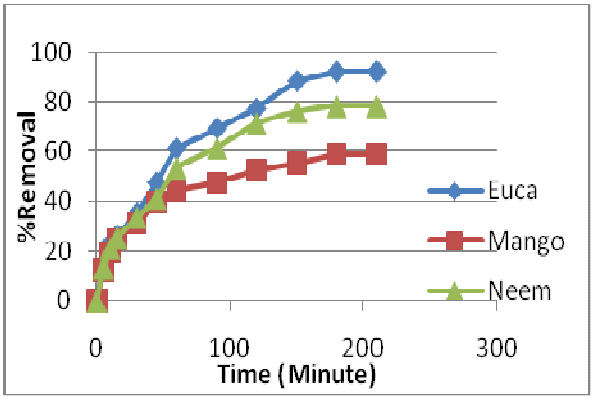

Figure 9: Adsorption Of Cr By Eucalyptus, Mango & Neem Saw Dust (At pH 2, 3g Adsorbent & 100ppm Cr Solution)

4.0 CONCLUSION:

In order to improve the quality of effluent water, the study is carried out by using bark, leaves & saw dust of eucalyptus, mango & neem trees. It is ecofriendly and bioadsorbent which is efficient in controlling chromium (VI) in water. This study identified eucalyptus, mango & neem tree parts (barks, saw dust & leaves) as suitable biosorbent for chromium (VI) removal in batch experiments. The percentage removal is increased with increase in contact time. All the three barks give their optimum result in 180 min at pH 2. For Bark & Saw dust optimum adsorbent dose is 3 gram and for leaves it is 2 gram.. Bark of Eucalyptus, Neem & Mango removes 99.01%, 82.43% & 93.17% Cr respectively. Leaves of Eucalyptus, Neem & Mango removes 89.63%, 97.8% & 82.57% Cr respectively. Saw Dust of Eucalyptus, Neem & Mango removes 92.31%, 78.53% & 58.71% Cr respectively. Mango Saw Dust carbon gives only 58.71 % Cr removal, so it is not advisable to use. Eucalyptus Bark carbon gives 99.01 % Cr removal, which is maximum among all the 10 adsorbent, so it should be preferred.

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