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Application of Natural adsorbents for Wastewater treatment

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ABSTRACT:

Water is the prime and essential source for human life. Anthropogenic activities are polluting water with many wastes which are harmful for human and ecological sustenance. To combat the pollutants proper treatment is required for the reuse/ recycling of the precious limited water resource. The treatment facilities are difficult and also expensive. So there is an increased demand for the innovative, low maintenance and energy efficient technology for water treatment. One such type of technology is the use of low cost adsorbents such as "Moringa oleifera" "Nirmali" "strychnos" "Tamarindus indica" etc. out of which Tamarindus indica" seeds are used for the removal of metals from waste water. Insitu analysis was carried out by varying the dosage of adsorbent, PH, temperature, and contact time. The results showed that Tamarindus indica in the powdered form act as a good absorbent with 90% efficiency. Thus providing an economically feasible and eco-friendly technology useful for improving the quality of life for rural peoples.

Keywords: Water; Efficient Technology; Low-Cost adsorbents; Tamarindus indica; Eco-friendly Technology

Introduction:

Water is the most ubiquitous material in nature and most vital for domestic purposes such as drinking, cooking, washing, bathing etc. 75% of human body is water because of which only his /her specific gravity. (Amit Bhatnagar et al. 2011). Environmental pollution is currently one of the most important issues facing by humanity. It was increased exponentially in the past few years and reached alarming levels in terms of its effects on living creatures (Renge et al. 2012). Increased industrial and agricultural activities have resulted in the generation of various types of toxic pollutants, which are the main cause of water pollution on a global scale. However, years of increased industrial, agricultural and domestic activities have resulted in the generation of large amount of waste water containing number of toxic pollutants which are polluting the available fresh water continuously (Amit Bhatnagar et al. 2011). Due to the discharge of non-biodegradable heavy metals such as cadmium, nickel, copper, chromium, zinc, etc. into water stream, the Industrial pollution is continuously said to be a potential threat affecting the water. Consumption of such polluted water causes various health problems. As they are carcinogenic and cause adverse health conditions, water is to be treated thoroughly before consumption. Many conventional methods for heavy metal removal from aqueous solution were found which includes chemical precipitation (Mahmood et al. 2011), reverse osmosis (Tomáš Bakalár et al. 2009), electrodialysis (Delimi et al. 2013), solvent extraction (Joanna Konczyk et al. 2013), ion-exchange (Gaikwad et al. 2010),

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Coagulation & Flocculation (Johnson et al. 2008), filtration (Swaminathan et al. 2013), adsorption (Dimple Lakherwal 2014), microbial reduction (Ronald 2006). The major disadvantage that we come across with these conventional processes is that the processes are expensive and not eco-friendly. Other disadvantage includes incomplete metal removal, high reagent and energy requirements generation of toxic sludge and other waste products that require careful disposal. Amongst several water and wastewater treatment technologies, adsorption is considered as the most versatile process. Adsorption has been found to be a very promising and versatile technique and is commonly used for the removal of diverse types of pollutants from water and wastewater [Amit Bhatna et al. 2011, Bansal , Goyal 2005]. Many researchers had worked on Tamarindus indica seeds to check the efficiency of the locally available seeds in wastewater treatment [Edwin Vasu 2008, Ahalya et al. 2008, Suneel Kumar et al. 2010, Rajeshkannan 2011, Shanthi, Mahalakshmi 2012]. Tamarindus indica seeds as a adsorbent has proved best preliminary coagulant in the removal of pollutants and has become to be a boon for developing economic and eco-friendly waste water treatment process (Sasmita sabat et al. 2012). The advantage of plant based coagulants as water treatment materials are apparent as they are economically feasible, easily available and easy to store. Hence the present study is on the available resource material - tamarind seed powder.

The main objective of the work is using the natural coagulants for the treatment of waste water which is an economically feasible and eco-friendly technology. This would provide potable water by means of natural treatment especially for underdeveloped communities.

Materials and Methodology

Preparation of Natural coagulant: Tamarindus indica ripen pods (figure 1 & 2) are collected from Ramachandrunipeta, Yellandu Mandal, Khammam district. The seeds are washed thoroughly under tap water in order to remove the dust particles and are kept for drying in sunlight for 4 to 5 days. The dried seeds are ground to fine powder using mortar and pestle. The fine powder (figure 3) was made into paste with little amount of water and dissolved in the distilled water to make it to a solution.

Figure 1: Ripen pods with seeds

Figure 2: Fine powder of Tamarind seeds

Preparation of stock solution:

All the reagents were used of AR GRADE. Copper stock solution was prepared by dissolving 3.9291gms of copper sulphate in 1000ml volumetric flask. This 1ml solution contains 1mg of copper.

Methodology:

Different concentrations ranging 5-25ppm were prepared from stock solution, the dosage of adsorbent varying (0.5-2.5gms), the rpm of 100 is maintained constant throughout the study and by varying the agitation time (15-75mins) and allowed the sample to settle for 30mins . After the settlement the sample was filtered and 50ml of sample was taken to estimate the concentration of copper ion. As per neocuprine method 50ml of sample was taken in a 125ml separating funnel add 0.1ml of HCL which provides acidic conditions followed by 5ml of hydroxylamine HCL which reduces the copper and add 10ml of sodium citrate which removes interferences of other ions and 10ml of neocuprine was added. A yellow color complex is formed which is separated using chloroform as a solvent and the total volume of separated sample is made up to 50ml using isopropyl alcohol and yellow color intensity was measured at 457nm using spectrophotometer.

Results and Discusions:

The preparation methods are key factors for any type of bio-adsorbent because morphological properties such as particle size and shape binding surface area and overall removal capacity depends on it. Easy to prepare and use. Hazard free and environmental friendly treatments are requirement for sustainable preparation of bio-adsorbent. Many variables can influence metal bio-sorption and experimental parameters such as pH, dosage of adsorbent ionic strength and competition between metal ions have a significant effect on metal binding to adsorbent. The biomass also influence the adsorption process because as the adsorbent dose increases, the number of adsorbent particles also increases and there is a greater availability of metal sites for adsorption. Some of the important factors affecting metal binding are discussed below.

Effect of pH

pH is an important factor controlling the process of adsorption as it affects surface charge of the adsorbents, the degree of ionization and the species of adsorbate (Venkateshwarlu et al. 2007).The pH variation was carried under acidic neutral and basic conditions by varying dosage of adsorbent and agitation time. The percentage of removal of copper increased from80- 90% for one gram of adsorbent at 75mins of agitation time under neutral conditions. When the pH of the solution decreased from 7-3which is acidic no removal of copper ions was observed when the pH increased from 7-9(basic) the percentage of removal of copper ion increased from 80-85% for two grams of adsorbent at 15mins of agitation time. The copper adsorption was found to increase with an increase in pH from 3-7 and attained at a maximum values at pH-7 (which is neutral) latter the adsorption capacity was declined. The result conformed that cu+2 ions are dominant free species below pH7 which involved in true adsorption. The HCL ions compete with cu+2 for binding on adsorbent sites and it may responsible for lower adsorption capacity at low pH. At higher pH the removal was also low when compared to the optimum conditions because the binding site of adsorbent may not be active under basic conditions (Hossain et al. 2012).

Effect of Agitation Time

Experiments for agitation time were conducted with five initial copper concentrations.(5-25mg/l)with a doses of (0.5-2.5gms) of tamarind seed powder at 100rpm with varying agitation times(15-75mins) (16) the rate of copper removal was very rapid for first 45mins and there after the rate of removal of copper ion is constant. There was no significant increase in adsorption after 60mins. As the copper ion

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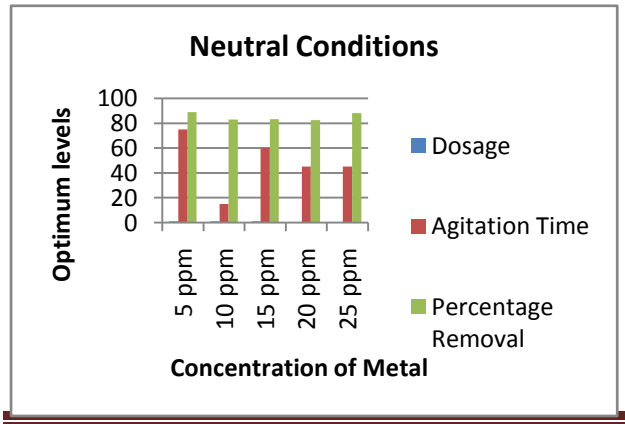
adsorption reached equilibrium after one hour initially there were large no of vacant active binding sites on tamarind seed powder and consequently large no of copper ions were bound rapidly on tamarind seed powder. The binding site was shortly become limited and the remaining vacant sites are difficult to be occupied by copper ions thus reducing the binding capacity. (Hossain et al. 2012).

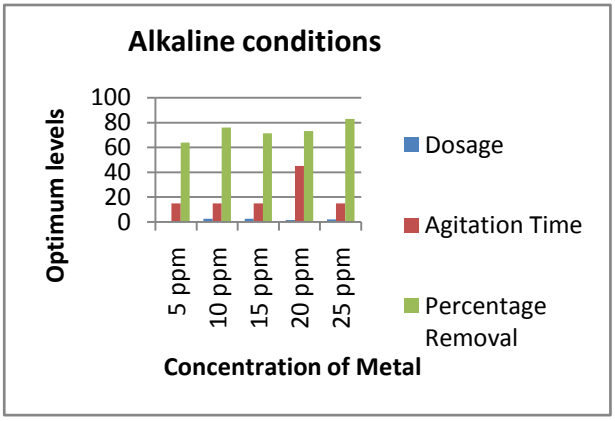
Effect of Dosage

The effect of doses was investigated with five copper concentration sets (5-25mg/l) in 1000ml of water by adding 5doses for each set. The percent of removal of copper ion was increased with increase in the dosage of adsorbent higher copper removal is 80-89% for initial copper concentration of 5-15mg/l respectively with the dosage of 1.5gms of adsorbent. Thereafter the removal of copper was declined with increasing in dosage of adsorbent for all five sets and then remained constant. The partial aggregation among the available active binding sites may acts for less removal of copper at higher doses and also due to the lack of active binding sites also responsible for lower binding of copper ions (Hossain et al. 2012).

The optimum adsorbent dosage and agitation time for the metal removal using tamarind seeds under neutral conditions and alkaline conditions had shown 90 % removal capacity (Graph 1 & 2).



Graph 1: Removal of metal at optimum adsorbent dosage, agitation time and Metal concentration under Neutral conditions.



Graph 2: Removal of metal at optimum adsorbent dosage, agitation time and Metal concentration under Alkaline conditions.

Conclusion:

It is concluded from the study that Tamarindus indica in the powdered form act as a good metal absorbent with 90% efficiency. Quite clearly, Tamarindus Indica is the most researched plant-based coagulant for its medicinal values and its efficiency in removing the pollutants form the polluted water. Thus providing an economically feasible and eco-friendly technology useful for improving the water quality for rural peoples.

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