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Cucurbita pepo as a Coagulant Aid for Copper Removal

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Abstract: **- The accessibility and quality of drinking water are of importance to human health. Many harmful chemicals have been identified in drinking water supplies around the world which are considered potentially hazardous to human health. Metals are the most harmful of the chemical pollutants and are of particular concern due to their toxicities to humans. In the present study, Natural coagulants extract has been tested for copper removal from water. Analysis of the copper metal is performed before and after the treatment of water with Natural coagulant seed extract. The results showed that the natural coagulants have the efficiency in removing the copper from the water. The natural coagulants have proved that they can act as a best alternative source for chemical coagulants in wastewater treatment.**

Keywords: Metals; Drinking water; Public health; Natural coagulant; Metal removal.

I. INTRODUCTION

Now-a-days, due to urbanization, industrialization and mainly because of human activities the surface water bodies are getting polluted day by day. Contaminated water is a problem in many parts of the world. In many places, people have to use water from rivers, lakes, or rain, which they collect in containers. Access to water is a basic human necessity unavailable to hundreds of millions of the world's poorest people. The search for water and the effects of unsafe water and poor sanitation are enormous burdens on their daily lives, especially in the most rural communities. The lack of universal access to health, education, and water services for the world's poorest people is a big obstacle to the global targets for sustainable development set by the Earth's Summit through Agenda 21. More over, thousands of chemicals have been identified in drinking water supplies around the world and are considered potentially hazardous to human health at relatively high concentrations. Metals are the most harmful of the chemical pollutants and are of particular concern due to their toxicities to humans. Metals and metalloids with atomic weights ranging from 63 to 200.6 g/mol and densities greater than 4.5 g/cm3 are stable in nature.

The high cost of water treatment makes potable water expensive. This situation is stigmatizing, in that, on average, most people in developing countries cannot boast 25 liters of clean water a day. Aluminum salts are the most widely used coagulants in water and wastewater treatment throughout the world. Some studies have reported that aluminum remains in the water after coagulation, and may induce Alzheimer's disease. In addition, many developing countries cannot afford the cost of imported chemicals for water and wastewater treatment.

On the other hand, naturally-occurring coagulants are biodegradable and are presumed safe for human health. The use of natural coagulants in treating watewater is not new. Natural coagulants have been used to treat water for domestic household use for centuries in rural areas. Interest in the use of natural coagulants has increased over time, especially to reduce water and wastewater treatment problems in developing countries to avoid health risks.

In the present work, the efficicency of the natural coagulants in removing the copper metal from the aquatic solutions was studied. Copper is both an essential nutrient and a drinking water contaminant. It is an important trace element required by humans for its role in enzyme synthesis, tissue and bone development. However, excessive amounts of copper consumed is toxic and carcinogenic and it leads to its deposition in the liver and causes many diseases such as Wilson disease, liver and kidney failure and finally gastrointestinal bleeding. From the present study, natural coagulants had shown promising results and there by, this can give an effective, eco-friendly and feasible method for the rural communities and the people who don't have the access to municipal water supply.

II. MATERIALS

A. Preparation of Synthetic water sample

Stock solution of 1000 ppm of copper sulphate (CuSO4.5H2O) was prepared using deionized water. From the stock solution the required concentrations of 2, 4 and 6 ppm were prepared.

B. Preparation of natural coagulant

A pumpkin is a cultivar of the squash plant, most commonly of *Cucurbita pepo*, that is round, with smooth, slightly ribbed skin, and deep yellow to orange coloration. Pumpkin is easily available from the local market. The seeds are dehulled and are sun dried for 2 – 3 days. The dried seeds are pulverized into a fine powder using a pestle and mortar. The required dosage of pulverized seed material was made into a paste using a small amount of water mixed in a small amount of water and shaken for 1 min to activate the coagulant properties of the seed to form a solution.

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Fig.1. Dried pumkin seeds

Fig.2. Fine powder

III. METHODOLOGY

The jar test apparatus was used to treat the synthetic sample with natural coagulants.The experiment carried out using Paddle Jar Test apparatus equipped with six paddles rotating in a set of six beakers filled with 1000 ml of the synthetic water and known quantity of Cu from stock solution were added to 1000 ml of synthetic water to get the Cu concentration of (2, 4, 6ppm). A different doses of natural coagulant of (0.5, 1 and 2 mg/L) was added to the synthetic water, the sample was mixed with natual coagulant at 100 rpm for 30 minutes, the suspension was allowed to settle by varying settling time intervals (30, 60, 90 min.). After the settling time the sample was filtered using Whatman filter paper No: 1. The initial and final Cu concentration in the water was analyzed using AAS. A triplicate test was performed for every sample to get the average of reproducing results.

Removal Efficiency (RE) of Cu was calculated using the equation:

$$RE\% = [(Ci - Cf) / Ci] * 100,$$

Where: Ci and Cf are the initial and final concentration of Cu in water (ppm), respectively.

IV. RESULTS AND DISCUSSION

A. *Effect of Agitation time:*

The agitation time was studied with varying time intervals (15, 30, 45, 60 and 75 min). For the optimum agitation time, the sample containing metal concentration of 6ppm, 0.5 gms of natural coagulant was added and kept for jar apparatus with a stirring speed of 100 rpm for different time intervals and then the sample was kept for 30 minutes of settling time. The rate of copper removal was very rapid for first 30mins as there were large no of vacant active binding sites on the seed powder and consequently large no of copper ions were bound rapidly. There was no significant increase in adsorption after 30mins, the copper ion adsorption reached equilibrium and there after the rate of removal of copper ion is constant, as the binding site was shortly become limited and the remaining vacant sites are difficult to be occupied by copper ions due to the formation of repulsive forces between copper on the solid surface and liquid phase.

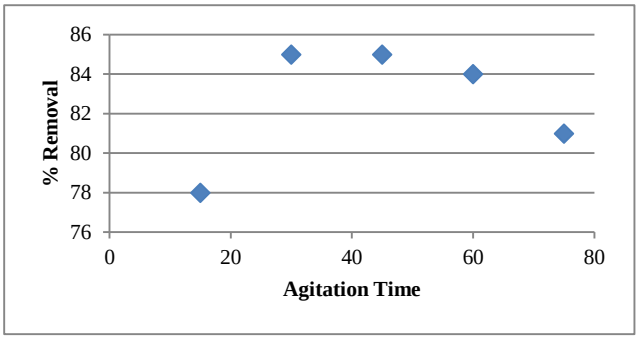

Fig.3. Effect of agitation time on the adsorption of copper by the natural coagulant (dosage of 0.5 gms, Initial metal concentration of 6ppm, agitation speed of 100 rpm,agitation time of 30min, pH 7 and settling time period of 30 min)

B. *Effect of pH:*

The effect of varying the pH (3, 7 and 9) on the copper ion adsorption was studied by keeping all other parameters constant. The copper adsorption was found to increase with an increase in pH from 3-7 (Graph 2) and attained at a maximum values at pH 7 (which is neutral), latter the adsorption capacity was declined. The result conformed that Cu ions are dominant free species below pH 7 which involved in true adsorption. The HCl ions compete with Cu for binding on adsorbent sites and it may responsible for lower adsorption capacity at low pH. At higher pH (pH 9) the removal was also low when compared to the optimum conditions because the binding site of adsorbent may not active under basic conditions [12]. Therefore, pH 7 was opted for further studies.

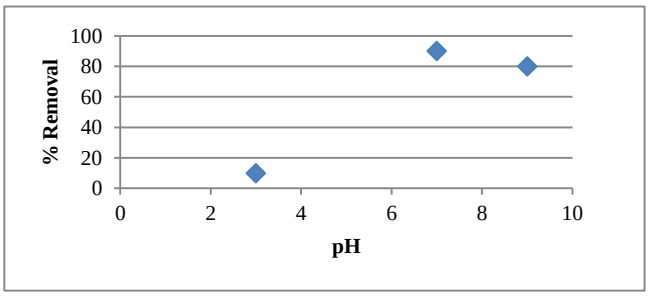

Fig.4. Effect of pH on the adsorption of copper by the natural coagulant (dosage of 0.5 gms , Initial metal concentration of 6ppm, agitation speed of 100 rpm,agitation time of 30min, and settling time period of 30 mins.)

C. *Effect of Adsorbent dosage*:

The influence of the adsorbent dosage on the adsorption of copper ions was studied by varying the mass (0.5, 1.0 and 2.0 g) of adsorbent. The adsorption percentage of copper ions drastically increased initially (Graph 3) may be due to the available active sites on the adsorbent and however, furthur increase of dosage had shown reduction in the removal of metal ions, this may be due to overlapping of adsorption sites as a result of overcrowding of adsorbent particles [13].

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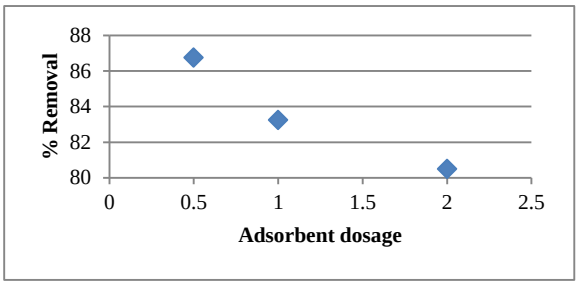

Fig.5. Effect of adsorbent dosage on the adsorption of copper by the natural coagulant (Initial metal concentration of 4ppm, agitation speed of 100 rpm, agitation time of 30 min, pH 7 and settling time period of 60 min.)

D. Effect of Initial concentration of metal:

The influence of initial concentration of copper ions was carried by varying the concentration (2, 4 and 6 ppm) of metal. From the graph 4, it is shown that the adsorption percentage of ions initially increases with the increase in concentration and shown no significant removal in furthur increasing the concentration, this can be explained based on the fact that all the adsorbents had limited number of active sites, which would have become saturated above a certain metal ion concentration. [13]

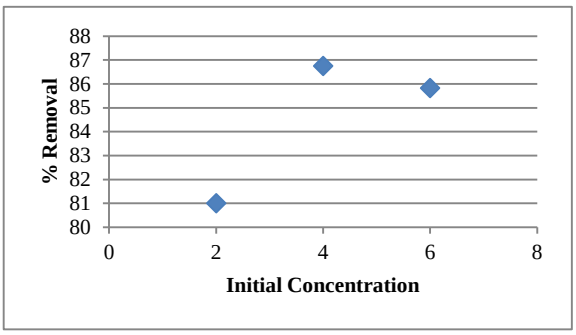

Fig.6. Effect of Initial concentration of metal on the adsorption of copper by the natural coagulant (dosage of 0.5 gms, agitation speed of 100 rpm, agitation time of 30 min, pH 7 and settling time period of 60 min.)

E. Effect of Settling time:

Effect of settling time on the adsorption of metal ions with the natural coagulant studied by keeping the samples for different time intervals (30, 60 and 90 min.) after the agitation process. The optimum percentage removal of metal ions had shown at 60 min. of settling time (Graph 5). The variance of reduction in different settling times might have occurred due to insufficient time for the reaction to complete (30-min settling time) and due to disassociation of proteins (90-min settling time). The 60- min settling time can be opted as the optimum settling time for treatment.

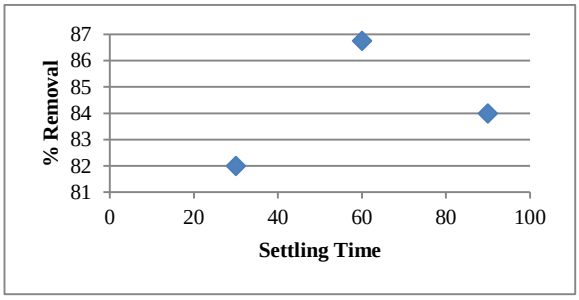

Fig.7. Effect of Settling time on the adsorption of copper by the natural coagulant (dosage of 0.5 gms, Initial metal concentration of 4ppm, agitation speed of 100 rpm, agitation time of 30 min, pH 7)

The present study indicates that removal of metals using natural coagulants from plant material (seeds) could provide a simple low-cost water treatment method for rural communities in India. Laboratory studies using artificial water samples have shown that cucurbita pepo seeds are highly effective in coagulating and removing metals from contimated surface water. At its optimum concentration, the natural coagulant seed powder does not affect the pH of the water. Moreover, coagulation activity of the seed powder with the finest size, reduced metal concentration further. The best performance of the finest seed powder could be due to its large total surface area, whereby most of the water-soluble proteins are at the solid-liquid interface during the extraction process [14]. This might have increased the concentration of active coagulation polymer in the extract, which improved the coagulation process.

V. CONCLUSION

Access to clean and safe drinking water is difficult in rural areas of India. From the present study, it is proved that the use of natural coagulants that are locally available provides a solution to the need for clean and safe drinking water in the rural communities of India and also it indicates that *Cucurbita pepo* seeds are an alternative coagulant for metal removal from contaminated waters. At optimum experimental conditions the percent adsorption of synthetic wastewater sample was found to be about 86.75.The method of adsorption developed in this study is cheap, fast and environmental friendly.

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