# Adsorption of Cu (II) Ions from Aqueous Solution by *A.Ficoidea*

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***Abstract – The sorption characteristic of Cu (II) from aqueous solution using pre-treated Alternanthera ficoidea leaves as a low cost sorbent has been studied. The prospective of this inexpensive adsorbent was examined for effect of pH, contact time, sorbent dose and initial metal ion concentration in batch experiments. The equilibrium facts were well suited into two most typical isotherm models; Freundlich and Langmuir. The Langmuir isotherm model described the sorption isotherm best with good correlation coefficient ($R^2$ = 0.97) as compared to Freundlich isotherm model with ($R^2$=0.95). The correlation coefficient value between 0-1 implies the approving adsorption of copper on adsorbent. The equilibrium time essential for adsorption process was found to be 30 minutes and maximum pH value was determined to be 6. The outcomes indicated that pre-treated A.ficoidea leaves powder has the possibility to be utilized as the cheapest sorbent for the elimination of Cu (II) from aqueous solutions.***

***Keywords: Acetic Acid, Adsorption, Adsorption Isotherms, A. Ficoidea, Copper, Formaldehyde***

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## 1. INTRODUCTION

Substantial metals have been randomly free into the surroundings due to speedy industrial development and have generated a major global distress. These hefty metals are risks to human beings and the environment because of their poisonousness, indestructible nature and bio-accumulating capability (Volesky, 1994, El-Nady & Atta, 1996). Heavy metals are regularly distinguished in industrial wastewaters which initiate from metal coating services, mining processes, battery manufacturing methods, the making of tints and dyestuffs and the glass fabricating industry etc. (Kadirvelu, et. al., 2001a, Williams, et. al., 1998) The release of metals in surface waters has become an alarming problem in India over the last two decades. Heavy metals alike lead and cadmium; even in small concentrations, because of several properties such as mass ability, carcinogenicity, and mutagenesis is injurious to flora and fauna[5]. In recent years, using practical adsorbents has engrossed the attention of many investigators.

Several reports are presented in sewer water management by means of competitive adsorbents. The phytoremediation and biosorption using wild plant type in Thailand were examined by Pantawat *et al.* in 2007. Adsorption of copper ions on *Mangnifera* leaf powder was analysed by V. S. Sethu *et al.* in 2010 in Malaysia. Hitfsa *et al.* worked on phytoremediation of copper ions by *Calotropis procera* in 2010 in Pakistan (Mubeen, et. al., 2010). The substantial metals like copper, lead, cadmium adsorption with activated saffron leaves was investigated by Shidvash *et al.* in 2014 in Iran. Removal of nickel by fly ash was identified by Shaila Khadse *et al.* in 2014 in India. The assessment was designed to investigate the usage of low cost adsorbents as a substitute to expensive activated carbon adsorbents for eliminating Cu (II) from water and wastewater in 2014 in Nigeria. The use of altered Aloe Vera leaf powder was observed in 2015 in India for lead removal by Malik *et al.* Archana *et al.* performed the adsorption of dense metals with biomass of terrestrial weed plants in 2015. Treated leftover paper as cheap adsorbent was examined by Mohammad Hadi *et al.* in 2015 for removal of chromium.

Commencing the above studies subsequent conclusion was made. The outcomes of the research on artificial and actual models shown that the level of adsorption in actual wastewater was less than artificial wastewater. The adsorbents reviewed in some articles were found extremely competent in the removal of Cu (II), which can minimize the toxicity associated with the metal. The biomass from *E.crassipes* may be reprocessed and improved; the biomass is bio destructible and therefore the environment welcoming, it also has the prospective for metal removal and reclamation of adulterated water. The TWNP (treated waste newspaper) use on the level of adsorption of Cr (VI) was found to be satisfactory with the kinetic and isotherm model. Also, the desorption readings showed that adsorbent can be salvaged. Ordinary resources or certain discards from agricultural practice which are broadly accessible and eco-friendly may have the probability as low-cost adsorbents for remediation of waste water (Afkhami, et. al., 2008). These materials include carbonaceous substances, agricultural products, activated carbon and waste by-products which can be used as replacements for some expensive materials (Ahn, et. al., 2009, Choi, et. al., 2009, Noman & Palanisumy, 2005). The researchers make use of range of unwanted materials from nature to remediate waste water by the process of biosorption.

The procedures currently in existence for the elimination of heavy metals from wastewater are reasonably expensive including either extravagant and overpriced equipment or high rates of operation with serious disposal complications (Tsoumbaris & Tsuakali-Papadopoulo, 1994). Nevertheless, difficulties with the aforesaid explanations make it compulsory to cultivate effortlessly obtainable, cheaper, and equally operative substitutes for wastewater handling. In response to answer the problem of hefty metal contamination in the surrounding it is imperative to bring useful way out of the issue.

Adsorption is a physicochemical method which has countless prospective for treating discharges comprising disagreeable constituents, and reduces them to harmless and eco-friendly byproducts (Singh, et. al., 1988). The chief benefits of adsorption practice for water pollution control are few investments with reference to budget, simple design, smooth operation and no effect of poisonous substances (ELBS, 1978). Adsorption is generally used in water and wastewater analysis (Weber, 1972). This research is aimed at copper adsorption which is vital to human life cycle and is mandatory for various biological processes, but like all heavy metals, implicitly toxic as well. Copper deposits brain, skin, liver, pancreas and myocardium and it also leads to severe toxicological concerns (Davice, et. al., 2000).

Category *Alternanthera* is reckoned to be a sort of weed and the weeds are well-defined to, “a plant whose virtues have not been yet discovered and a plant in the wrong place.” This replicates adverse behaviour of weeds. It (family: *Amaranthaceae*) was established to be interesting from both pharmacological and phytochemical perceptions (Hundiwale, et. al., 2012). *Alternanthera philoxeroides* biomass (a kind of freshwater macrophyte), was analysed for the exclusion of Ni (II), Zn (II) and Cr (VI) from aqueous solutions. *Alternanthera bettzichiana* (Regel) Nicols plant powder (ABPP) has been explored as low cost and sustainable adsorbent ready of the removal Congo red (CR) from aqueous solution (Shrivastava and Patil, 2010). Family *Amaranthaceae* also includes *Alternanthera ficoidea* herb. The commonly occurring ornamental plant *Alternanthera ficoidea*, is being increasingly regarded as an invasive and problematic weed. The objective of this examination is to utilize hugely available wild *Alternanthera ficoidea* plant leaves as minimal effort adsorbent to dispose off copper from known concentration of copper solutions. The purpose of this work deals with certain working parameters of the technique, for example, the impact of progress in biomass amount, initial metal ion concentration, impact of pH and time on relative adsorption of copper and to inspect the positive adsorption isotherm model.

## 2. MATERIAL AND METHODS

All chemicals used were from E-Merck in which the concentration of copper sulfate was 99.8%.

### 2.1 Adsorbent Preparation

The leaves of *Alternanthera ficoidea* were collected from the roadside area of Nagpur city, Maharashtra and were washed with water to remove dust and dirt etc. and were dried in sunlight. The dried leaves were then converted into fine powder by grinding in a mechanical grinder. The powder was sieved and the <300 µm fraction was separated.

### 2.2 Chemical Pre-treatment

*Alternanthera ficoidea* was subjected to pre-treatment. For this 5 ml of (15%) aqueous formaldehyde and 100 ml of 0.1N acetic acid were mixed, to which 10 g of washed leaf powder was added. The mixture was agitated and warmed at 50˚C for 20- 22 hours until the mixture became dense slurry (Yadamari, et. al., 2011). The slurry was washed with deionised distilled water and then desiccated in an oven for 2-3 hours at 100ºC. The ready biomass were then kept in air tight glass containers to be preserved from moisture. The produced biosorbent was used in the following studies.

### 2.3 Copper adsorption experiments

Copper solution was prepared by dissolving Cu (II) $SO_4.5H_2O$ in distilled water. The pH of the solution was found to be +5. To know the effect of pH, contact time, weight of the adsorbent on copper adsorption, different series of group experiments were taken out. Copper solutions were mixed with a previously weighed amount of pre-treated *A. ficoidea* leaf powder. The concentrations, time and weight of adsorbent were varied between 10mg/L to 110 mg/L, 30 to 150 min, 0.2 to 1g/L respectively. The moving speed was continued at 100 RPM for all the batch experiments and the experiments were held at room temperature. The schedules of experiments conducted were: Effect of weight of adsorbent, initial concentration of metal ions, effect of pH and contact time.

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of weight of adsorbent on the removal of copper

The experiments were taken out changing the adsorbent dose of 0.2 g to 1.0 g in 50 ml of 100 mg/L of Cu (II) ion solution. Evaluation of residual metals was done by using the atomic absorption release test (GBC906 AA model). The effects of adsorbent on the removal efficiency of ions Cu (II) are shown. (**Fig 1)** With an increase in the dosage of adsorbent, the removal efficiency of Cu (II) increased. The adsorbent dose added maximizes the binding sites for copper adsorption. Maximum adsorption is provided by adsorbent dose 1.0 g.

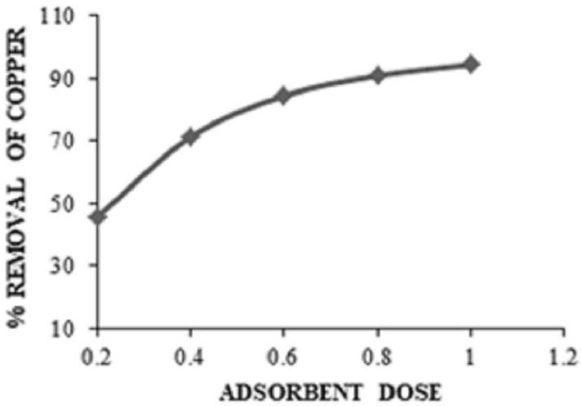


**Fig 1 Effect of adsorbent dose on adsorption of Cu (II) ion from the solution**

### 3.2 Effect of initial concentration of adsorbate on the removal of copper

The tentative studies were carried out with variable original metal ion concentration of Cu (II) ion, extending from 10 mg/L to 110mg/L using 1.0 g of adsorbent dose at pH>5. The effect of varying concentration of Cu (II) on the removal efficiency of the copper is shown. (Fig.2) As it was already expected, the removal efficiency of Cu (II) rises first and then declines as the initial Cu (II) concentration increases. This demonstrated that the amount of Cu (II) adsorption by the adsorbent is dependent upon the availability of binding sites for copper. The removal efficiency of Cu (II) could reach above 98% only when the primary concentration of Cu (II) was 50 mg/L.

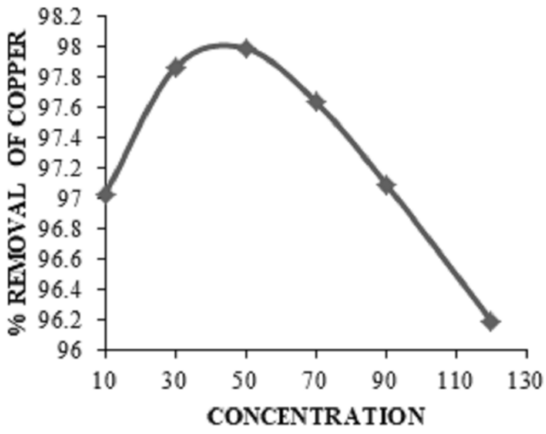


**Fig 2 Effect of initial concentration of Cu (II) ion solution on adsorption process**

### 3.4 Effect of contact time on the removal of copper

Kinetic adsorption experiments were done in order to calculate the adsorption equilibrium time. The adsorption readings were calculated using 1.0 g of adsorbent in 50 mg/L of Cu (II) ion solution at different contact time 30 min, 60 min,90 min, 120 min and 150min at pH<6. Outcomes of the effect of contact time on the maximum elimination of copper are exemplified. (Fig.3) The results indicated that Cu (II) removal occurred in the 30 min and the adsorption equilibrium was achieved in 120 min. Copper displays 98% adsorption at 30 min.

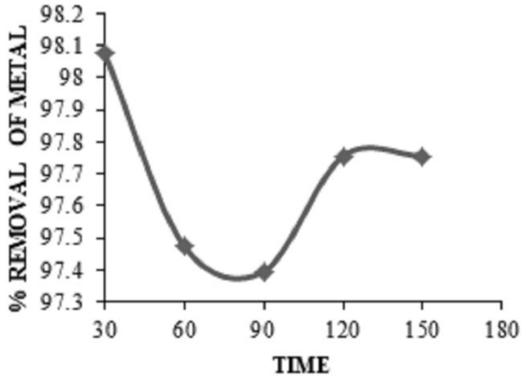


**Fig 3 Effect of contact time on adsorption of Cu (II) ion from the solution**

### 3.5 Effect of pH on the removal of copper

The parameter pH is recognized to be a huge variable which impacts the amount of particle adsorption by an adsorbent; it can control the protonation of functional groups on the adsorbent as well as the dense metal ions in the solution. (**Fig.4**) The uptake of Cu (II) ion was found to progressively increase from pH 2.0 - 4.0, and then increases sharply from 4.0 to 5.0. The effective Cu (II) extraction reached up to 97.5% at pH 6.0. These results clearly indicate that the amount of Cu (II) ion adsorption primarily governed by pH values of the adsorption medium.

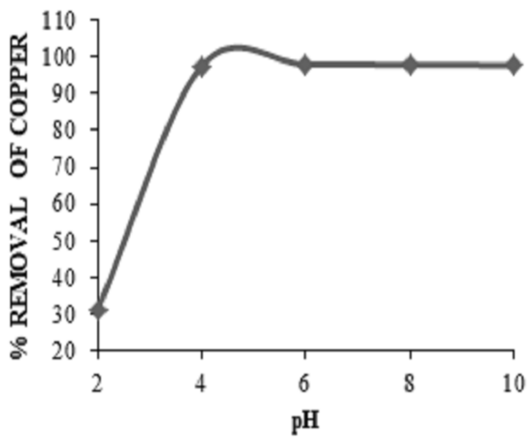


**Fig 4 Effect of pH on adsorption of Cu (II) ion from the solution**

## 4. ADSORPTION ISOTHERMS

The most general model to quantify the amount of adsorbate adsorbed is the Langmuir isotherm model (Fig.5). The Langmuir isotherm can be demonstrated in terms of a dimensionless constant RL, is interpreted as

$$RL = 1/ (1 + K_A C_o)$$

Where: $C_o$ is the initial concentration (mg/L), $R_L$ specifies the isotherm, $K_A$ is the rate of adsorption. The values of $R_L$ were found to be in 0 to 1, which implies favourable adsorption of metals under the study onto the adsorbent. The linearized Freundlich model isotherm was performed for the surface assimilation of dense metal ion (Fig.6) and is articulated as

$$Log(X/m) = Log KF + 1/n (Log Ce)$$

Where, (x/m) is the quantity of dense metal ion adsorbed at equilibrium (mg/g), $C_e$ is the equilibrium concentration of heavy metal ions (mg/L). $K_F$ and n are the invariable values calculated from the intercept and slope of the plot. The regression coefficients ($R^2$) for Langmuir and Freundlich values for Cu (II) adsorption were found to be (0-1) representing complimentary adsorption of the metal ions onto the pre-treated *A. ficoidea* leaf powder.

**Table 1 Langmuir and Freundlich adsorption isotherm constants.**

| Isotherm | $R^2$ | Qm (mg/g) | B (L/g) |
|---|---|---|---|
| Langmuir isotherm | 0.97 | 3.5 | 0.2354 |
| Freundlich isotherm | $R^2$ | $K_F$ | n |
| | 0.95 | 0.714 | 1.116 |

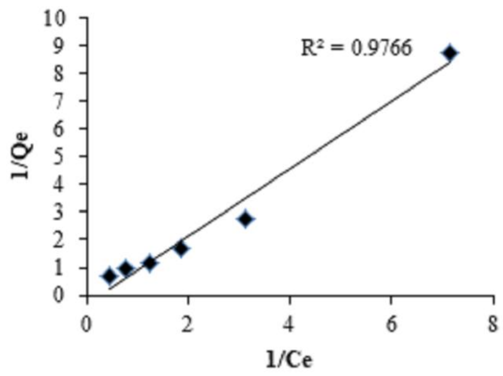


**Fig 5** Langmuir adsorption isotherm for the adsorption of Cu (II) ion on A.ficoidea

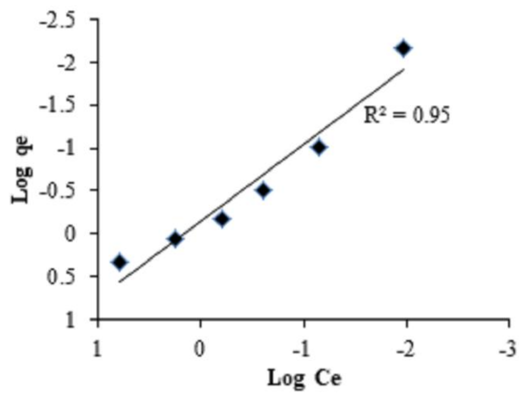


**Fig 6** Freundlich adsorption isotherm for the adsorption of Cu (II) ion on *A.ficoidea*

## 5. CONCLUSION

From the above study, it can be inferred that the adsorbent (*A. ficoidea* leaves powder) can be used competently to process Cu (II) contaminated wastewater. The proportion removal of copper was increased to increase in pH. The ideal pH was observed to be 6.0. The removal efficiency of copper decreases with initial metal ion concentration and time, maximum removal was found to be at 50 mg/L for 30 min. Adsorption of copper increased with the adsorbent dose and maximum dose was found to be 1.0g. The Langmuir isotherm model described the sorption isotherm best with good correlation coefficient ($R^2$ = 0.97) as compared to Freundlich isotherm model with ($R^2$=0.95). Thus we conclude that the altered *Alternanthera ficoidea* may be used as an inexpensive, selective, operative and effortlessly cultivable biosorbent that can be implemented in water and wastewater handling.

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