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***Limonia acidissima* and *Acacia nilotica* used as Low Cost Adsorbents to Scavenge Cadmium from Artificial Wastewater**

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ABSTRACT

*This compendium of research paper narrates the proficiency of *Limonia acidissima* and *Acacia nilotica* which are used as low cost adsorbents for taking away Cadmium - a heavy metal found in industrial effluents. Latest study investigates Cadmium adsorption by inexpensive low cost *Limonia acidissima* and *Acacia nilotica* used as adsorbents which are found in abundance as an agro-forestry by-product. An array of sample solution using batch method with artificial Cadmium effluent demonstrates a high level of adsorption by the used adsorbents. A correlative study of these two adsorbents also finds out the adsorption capacity.*

Keywords: Aqueous industrial discharges, *Limonia acidissima*, *Acacia nilotica*, Cadmium poisoning, Activated carbon

INTRODUCTION

Cadmium contaminant along with other heavy metals remains omnipresent in aqueous untreated industrial effluents degrading our natural streams of water [1]. This pollution which makes water toxic makes it unfit for human, animal and flora-fauna consumption [2]. The untreated water if consumed causes cancer, mental disorder, bodily dysfunction; jaundice, bone disorder and many other irreversible diseases [3-5]. In severe cases it is instant death specially affecting small children who have less immunity. Especially in Cadmium poisoning it causes Itai- Itai/ Ouch-Ouch disease so that bone becomes fragile [6-11]. We cannot stop our industrial and developmental activity which is contaminating our natural resources [12]. The solution to this problem is to treat this industrial effluent by using several different methods-use of membranes, electroplating technique, ion-exchange technique, coagulating the chemicals and adsorption [13-18]. In all these the cost effective technique is adsorption through activated carbon [19-20]. The present study finds eco-friendly inexpensive adsorption technique which is part of our nature [14, 21]. The waste material *Limonia acidissima* and *Acacia nilotica* a part of agro-forestry and agricultural operations are available in rich quantity having little economic value is used to treat the aqueous industrial discharges [15, 22-23]. In this way the products of agro-forestry are recycled, reused and reduced [23].

MATERIALS AND METHODS

The seeds of agro-forestry product a natural porous material such as *Limonia acidissima* and *Acacia nilotica* were selected as an adsorbent and sun-dried washed with distilled water so that all unknown particles get removed from the seed. The seeds were then dried and crushed. A particular size was separated from the crushed seeds by using a sieve shaker provided by Jayant Test Series based at Mumbai, India and collected in clean petri-dish. The dried seeds were kept for cooling in desiccators which had anhydrous calcium chloride or silica gel. The stock solution of 0.0001 M of Cadmium ion was prepared by dissolving vital amount of $\text{CdCl}_2 \cdot \text{H}_2\text{O}$, (Loba Chemie) in double distilled water [24]. A series of sample solutions of $\text{CdCl}_2 \cdot \text{H}_2\text{O}$ was prepared using first stock. The absorbance characteristic in all systems at 520 nm was measured by Double beam UV 2700 Spectrophotometer made by Chemito [25]. Standard Beer's law curve was constructed spectrophotometrically using series of cadmium solutions using Dithizone, Potassium-sodium tartrate and NaOH [26]. A mathematical equation developed was used to estimate the residual concentration of cadmium ions [24].

In the present work all reagents used were of A grade (Loba-chemie and Merck). To carry out the adsorption of Cadmium ion, 500 ml solution at a pH=6 was stirred for 5 hrs. The 5 flat bottom flask of borosilicate of 1000 ml capacity were used at invariable steady temperature of $25 \pm 1^\circ\text{C}$ with different weights of adsorbents using a mechanical Remi stirrer. The concentrations of cadmium ion in milligram/liter were estimated using Beer's Law. To get the accuracy in the results experiments were repeated twice.

RESULTS AND DISCUSSION

The theory of Langmuir and Freundlich isotherms of Cd^{2+} ion adsorption were put into effect with the result found [25, 27]. These results which were discovered make a profound relation between the concentrations of surface and liquid phase at equilibrium. The quantity of Cadmium so adsorbed on the adsorbents were anticipated using the equation given below

$$q_e = (C_0 - C_e) \times V/W \quad (1)$$

Describing the formula,

Cadmium ion concentration adsorbed in mg/gm= q_e ,

Cadmium ion initial concentration in solution in mg/L= C_0

Cadmium ion final concentration solution in mg/L= C_e

Volume of sample solution in liters= V

Different weights of low cost adsorbent= W

Figure 1 reflects the results of adsorption isotherms by plotting graph between C_e versus q_e of adsorbents *Limonia acidissima* and *Acacia nilotica*. The equation of Langmuir is supposed to be derived as [28-30]

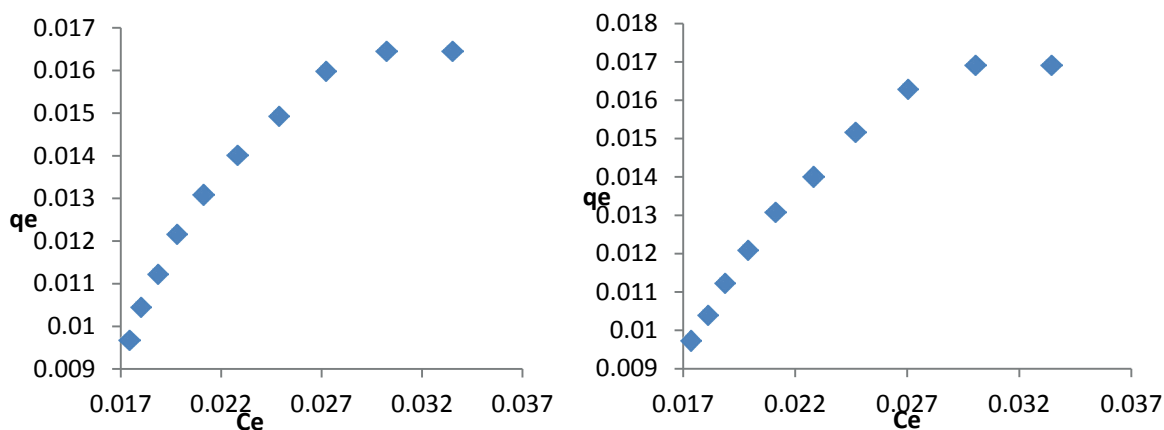


Figure 1: (a) Results of Adsorption isotherm **System:** *Limonia acidissima* Cd^{2+}

(b) Results of Adsorption isotherm **System:** *Acacia nilotica* Cd^{2+}

$$q_e = Q^0 b \times C_e / (1 + bC_e) \quad (2)$$

Describing the formula,

The formation of monolayer indicating the quantity of Cadmium adsorbed per unit weight of the adsorbent= Q_0

Langmuir constant= b

Rearranging equation (2)

$$1/q_e = 1/Q^0 \quad b \times 1/C_e + 1/Q^0 \quad (3)$$

A linear graph obtained while plotting of $1/C_e$ versus $1/q_e$. The expressions of Freundlich equation is supposed to be derived as

$$q_e = k \cdot C_e^{1/n} \quad (4)$$

Freundlich constants are k and $1/n$ which were experimentally found. Taking log of both sides

$$\text{Log } q_e = \text{Log } K + 1/n \text{ Log } C_e \tag{5}$$

Freundlich equation graph of $\log(C_e)$ versus $\log(q_e)$ displays the outcome over fixed concentrations. The graph shown in **Figures 2 and 3** demonstrates Langmuir and Freundlich isotherms for *Limonia acidissima* and *Acacia nilotica*. The Langmuir model linear applicability is demonstrated in the graph of $1/q_e$ versus $1/C_e$. The sorption capacity of the Langmuir constants relates with the parameters Q_0 and b .

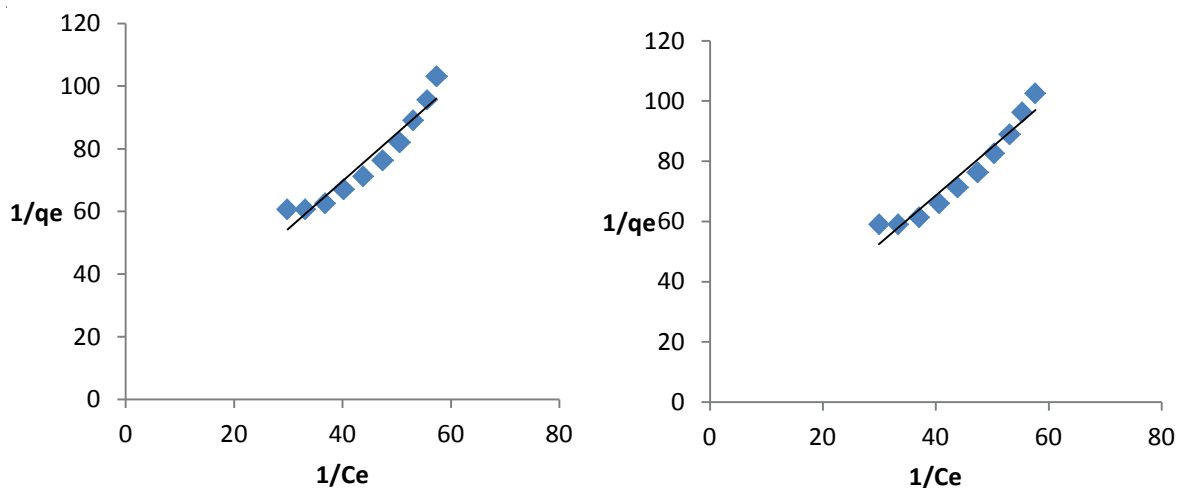


Figure 2: (a) Results of Langmuir adsorption isotherm **System:** *Limonia acidissima* Cd²⁺
 (b) Results of Langmuir adsorption isotherm **System:** *Acacia Nilottica* C

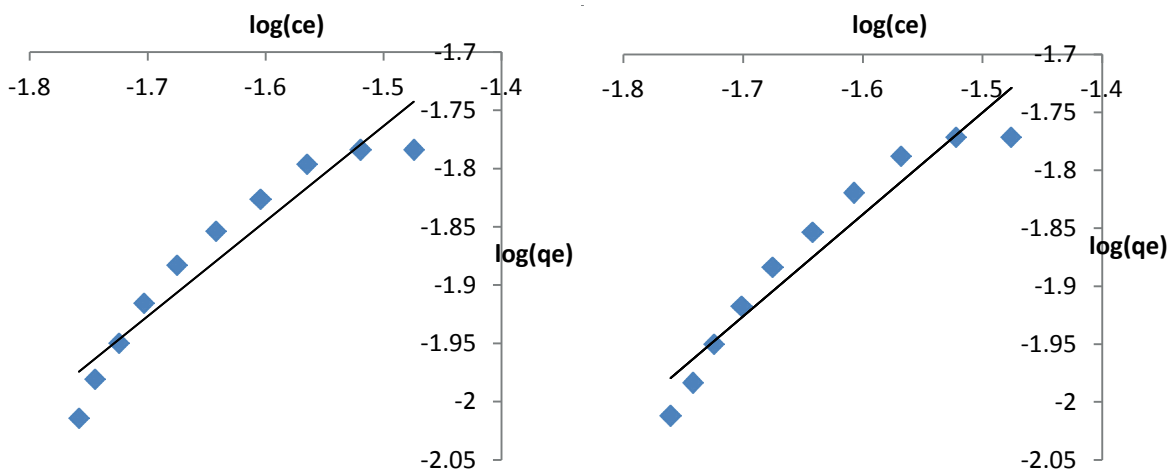


Figure 3: (a) Results of Freundlich adsorption isotherm **System:** *Limonia acidissima* Cd²⁺
 (b) Results of Freundlich adsorption isotherm **System:** *Acacia nilottica* Cd²⁺

Q_0 is determined in the graph of $1/q_e$ versus $1/C_e$ where the occupied surface area by Cadmium ion on *Limonia acidissima* and *Acacia nilotica*. Formula to find surface area of Cadmium adsorption

$$S' = N_a Q_0 A \tag{6}$$

Describing the formula,

The formation of monolayer indicating the quantity of Cadmium adsorbed per unit weight of the adsorbent = Q_0

Adsorbed surface area in $\text{cm}^2/\text{g} = S'$

Avogadro number = N_a and

Cross-sectional area of the adsorbent molecule, $\text{cm}^2 = A$

The technique of adsorbing Cadmium on adsorbents *Limonia acidissima* and *Acacia nilotica* at the saturation level which forms a single-layer of the Cadmium would over the entire surface of the adsorbent. The single layer Cadmium ion is determined by S using the value of A. In this by using Brunauer and Emmet formula the value of A has been calculated

$$A=4 \times 0.866 [M/4\sqrt{2.Na.d}]^{2/3} \quad (7)$$

Describing the formula,

Atomic weight of the Cadmium is M

The Avogadro number is Na

The density of the Cadmium is d

Calculating value of S by using A, q_{e-max} and Q_0 are in **Tables 1 and 2.**

Table 1: Values Q_0 , A, S and q_{e-max} for a systems *Limonia acidissima*_Cd²⁺ and *Acacia nilotica*_Cd²⁺

Sr. No.	System	Q_0	A(cm ²)	S(cm ² /gm)	q_{e-max} (mg/gm)
1	<i>Limonia acidissima</i> _Cd ²⁺	0.1129	8.4563×10^{-16}	0.0743×10^3	0.0164
2	<i>Acacia nilotica</i> _Cd ²⁺	0.2357	8.4563×10^{-16}	0.0765×10^3	0.0169

Table 2: Values of Langmuir's adsorption isotherm and Freundlich's adsorption isotherm.

Sr. No.	System	For Langmuir constant			For Freundlich constant		
		Value of Q_0	Value of b (cm ²)	Value of R ²	Value of K_f	Value of 1/n	Value of R ²
1	<i>Limonia acidissima</i> _Cd ²⁺	0.1129	5.8171	0.92	0.29	0.8172	0.9064
2	<i>Acacia nilotica</i> _Cd ²⁺	0.2357	2.6333	0.9371	0.3706	0.8794	0.9232

CONCLUSION

The current study indicates that Cadmium is effectively adsorbed by the low cost natural adsorbents. The low cost adsorbents *Limonia acidissima* and *Acacia nilotica* are effectively used to remove the heavy metals from aqueous industrial discharges which were artificially prepared. The data reveals that as C_e increases q_e also increases. However, at the same time permeation level of q_e remains constant when C_e value is increased due to the structure of a single-layer of Cadmium ion on adsorbents exterior side. The Langmuir and Freundlich adsorption isotherm remains advantageous when investigational data were analyzed. The adsorption characteristic of Cadmium ion was determined by using important reagent Dithizone. It was revealed by quantitative determination that *Acacia nilotica* adsorbs Cadmium ion to a greater proportion as compared to *Limonia acidissima*. It may be due to big dynamic spots on the outer side of *Acacia nilotica* used as adsorbent.

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