Custard apple leaf powder as an Efficient Biosorbent for the removal of Acidic Pollutants from Water

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Abstract:

In present time, as the human population is rising to the extremities, there is also an increase in the amount of supplies which is causing the industries to produce the respective products in a large scale. This is causing a huge amount of waste being generated from these industries into our water bodies causing water pollution [1]. Hence, there is a need to remove this waste from our water bodies. Among the various pollutants emitted out from the industries; acids are one of such pollutants being generated by the industries. These are water soluble and colorless in nature and hence get unnoticed but causes a negative impact on our environment. The method of removal of acids is by the Biosorption [2] of Custard apple (Anonna squamosa) leaves as they are easily available and cost effective. The concentration of the acids is being determined using simple neutralization titrations. The Custard apple leaves used here as a biosorbent are found to be effective in the removal of acids at room temperature. The experimental data is verified by the Freundlich and Langmuir adsorption isotherms.

Keywords: Biosorption, Adsorption techniques, Volumetric analysis, Adsorption isotherms, biosorbents, Custard apple leaves, Neutralization titrations.

Introduction:

The increasing demand for certain products are causing the industries to generate a huge amount of waste into our water bodies [3], causing the pollution of water. Among the pollutants generated from the industries; Acidic pollutants are causing a negative impact on the aquatic ecosystems. These acidic pollutants are generated as waste from various industries in large quantities [4].

Acetic acid is the pollutant which is generated from various industries and is emitted into our water bodies causing a hazardous impact on the aquatic life and inturn causing an adverse affect to human life. Similarly the Oxalic acid is being generated as a pollutant from the fertilizer industry; this when reaches our water bodies causes clogging of water which causes the depletion of aquatic species.

We know that these acids have various uses; but in excess quantity they have their respective harmful properties and hence they must be removed from water [5]. These acids being water soluble and colorless are hard to remove from water. So the technique involved for the separation of these acidic pollutants is biosorption and the method for the determining the concentration of these acidic pollutants is through simple neutralization titrations.

Here, we are using biosorbents instead of the commercially available adsorbents. Biosorbents in nature are the discarded waste of natural or plant products. These are being identified as potential biosorbents as they have the capacity to accumulate waste from contaminated water [6]. Biosorbents are making a great impact in the modern world compared to their synthetic counterpart as they are easily available and are cost effective [7]. In our present study the identification of the custard apple leaves as an effective biosorbent is being made by the adsorption studies of the Acetic and Oxalic acid using custard apple leaves as the biosorbent. The verification of our experimental data is being carried out through the study of the Freundlich and Langmuir adsorption isotherms in accordance with our experimental data at room temperature.

Materials and Method:

The adsorbates used in this study are some acidic pollutants like Acetic and Oxalic acids. The stock solutions of 0.5M Acetic and Oxalic acid and 0.1M Sodium hydroxide were made [8]. The adsorption studies were done by making the stock solution into different dilutions. The Custard apple leaves were collected from the neighborhood and was washed with distilled water, dried in a hot air oven, powdered finely and is stored. As the biosorption is carried out on the acids which are highly soluble in water and are colorless; the method of determining the concentration of these acids is done through simple neutralization titration. Phenolphthalein indicator is used as a color indicator in this titration.

Experiment:

First the Custard apple leaves which were stored were taken up for the production of activated charcoal. This was done by taking the Custard apple leaves powder in a china dish and placing it in a muffle furnace at 300^{o}C [9]. Now the residue formed was taken as the adsorbent and was used up for the adsorption studies of Acetic and Oxalic acids. This adsorbent was taken in 0.2g/100 ml of the respective acids [10]. The test for the adsorption characteristics of Custard apple leaves was done after a time period of 24 hrs by simple neutralization titration. In this titration 0.1M sodium hydroxide solution was taken in a burette and the dilutions of different acids were filtered and 10 ml of the respective filtrates were taken in separate conical flasks. 2-3 drops of Phenolphthalein indicator was added. The sodium hydroxide solution was allowed to enter the conical flask drop wise; the burette readings were noted down as the base neutralizes the acid present in the flask which is marked by the appearance of pink color in the flask.

Results and Discussion:

The studies of the adsorption characteristics of the Custard apple leaves against Acetic and Oxalic acids were done by using the Freundlich and Langmuir adsorption isotherms.

The Freundlich adsorption equation is

$$\log\frac{x}{m} = \log k + \frac{1}{n} \times log\ Ce$$

The Langmuir adsorption equation is

$$\frac{C_e}{x/_M} = \frac{1}{k_1 \times k_2} + \frac{C_e}{k_2}$$

Where k_1 and k_2 are Langmuir constants. The Freundlich adsorption isotherm which is the graph between log x/m on y-axis and log Ce on the x-axis, using Custard apple leaves for the removal of Acetic and Oxalic acids yielded a straight line with an intercept. The Freundlich and Langmuir plots for Acetic and Oxalic acids are given in respective figure1, figure 2 and fig 3. The 'log k' and 'n' values are noted in table 1. The Langmuir adsorption isotherm which is the graph between Ce/x/m which is on the y-axis and Ce which is on x-axis yielded a straight line with an intercept which is in accordance to the Langmuir adsorption isotherm. The Langmuir constants k_1 and k_2 of Acetic and Oxalic acids were calculated and are noted down in table 2.

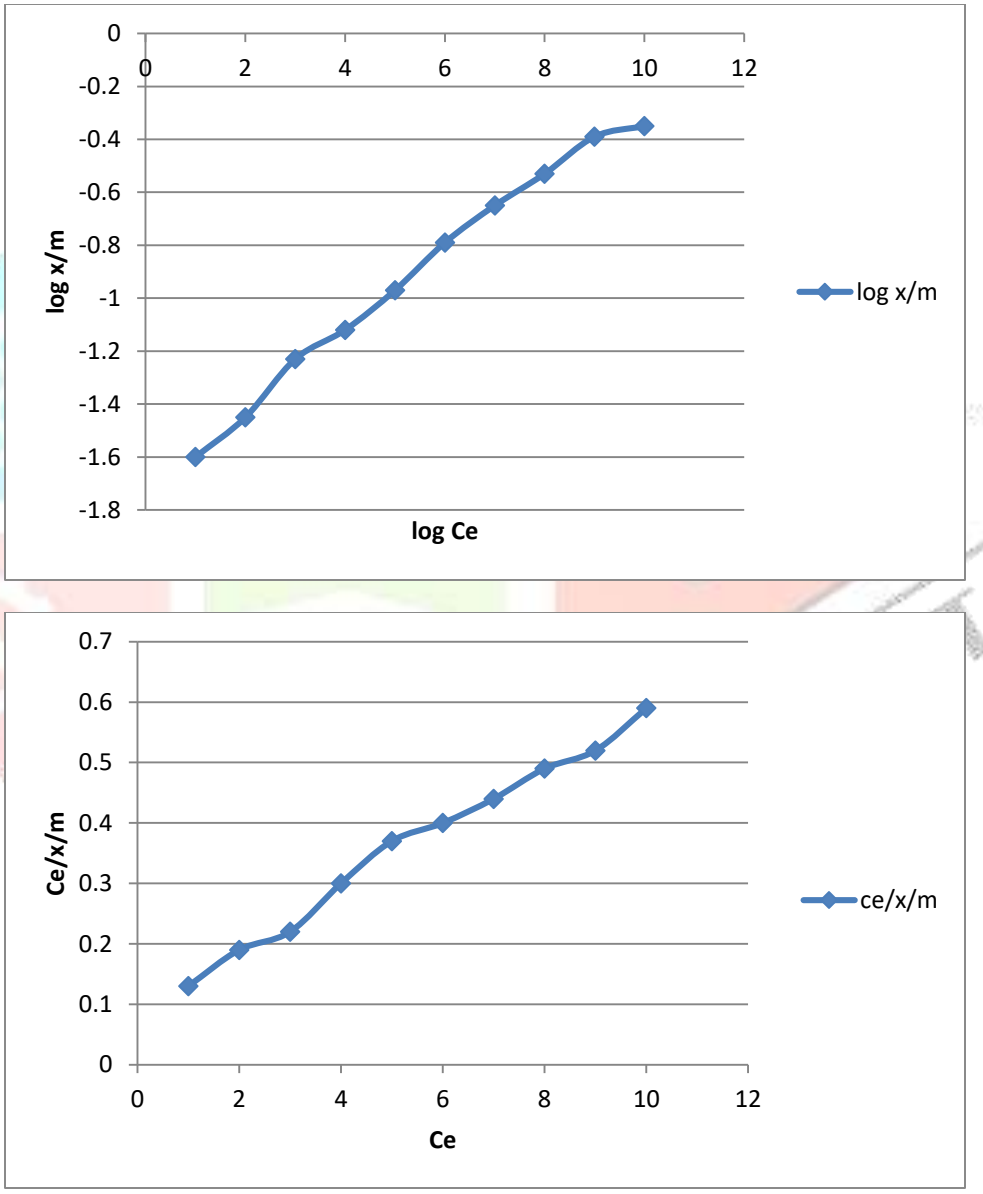
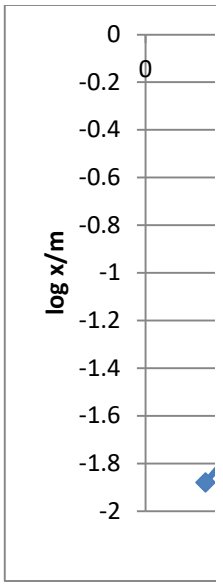


Fig 1: Freundlich and Langmuir isotherms for Acetic Acid with 0.2g Custard apple leaves



Acid	k_1	k_2

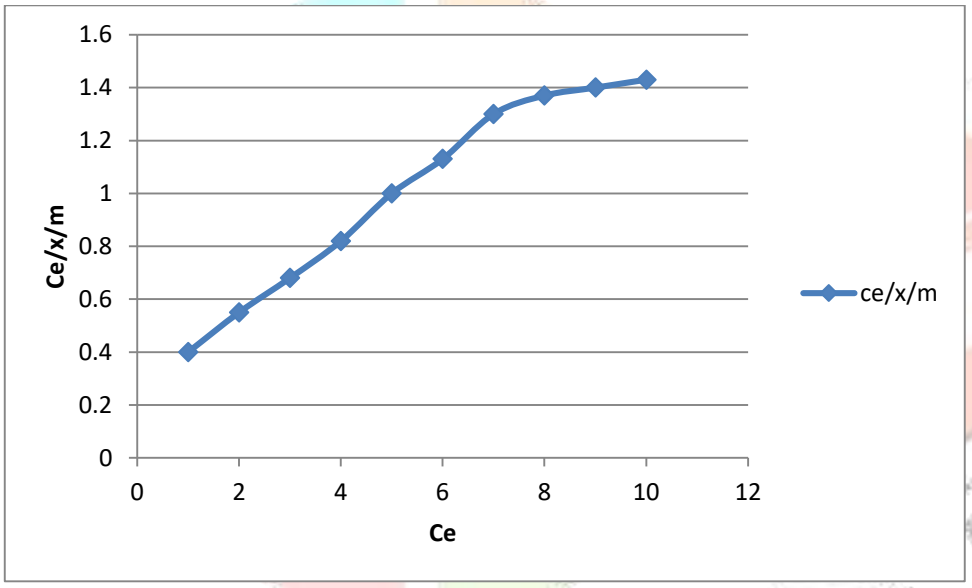


Fig 2: Freundlich and Langmuir isotherms for Oxalic acid with 0.2g Custard apple leaves

Table 1: log k and n values obtained from the Freundlich plot of different acids

Acid	Log k	n
Acetic Acid	-1.8	7.69
Oxalic Acid	-1.8	7.40

Table 1: k_1 and k_2 values obtained from the Langmuir plot of different acids

Acetic Acid	6.89	18.18
Oxalic Acid	0.77	6.45

Conclusion:

The results obtained from the studies of the adsorption characteristics of Custard apple leaves are in accordance with the Freundlich and Langmuir adsorption isotherms. The values of 'log k' and 'n' obtained from the Freundlich plot and the values of 'k_1' and 'k_2' obtained from the Langmuir plot suggest that the Custard apple leaves has a great adsorption potential for Acetic and Oxalic acid.

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