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Adsorption of Oxalic Acid on Adsorbents Prepared from Pineapple Waste

Kshitija Ravindra Bhosekar.[1]
Student: Department of Biochemistry
Ramnarain Ruia Autonomous College,
Matunga, India.

Aditi Patwardhan.[2]
Guide: Assistant Professor, Department of Biochemistry.
Ramnarain Ruia Autonomous College,
Matunga, India.

Abstract:- **Pineapple (Ananas comosus L.) is a tropical fruit belonging to the Bromeliaceae family. Pineapple contains a 60% edible half while the remaining 40% non-edible half consists of peel and leaves. Generally, after harvesting, the non-edible part is removed contributing to major wastes. Agro-industrial waste has the potential to act as a supply for the assembly of helpful products if treated properly. An eco-friendly approach to tackle this waste is to recycle into useful biodegradable products. Over the past few years, bioadsorption has been the foremost counseled technology for the removal of industrial pollutants. Adsorption using natural adsorbents is economically sustainable and comes under green chemistry. As compared to other physiological treatment techniques, adsorbents are easy to operate, generate less sludge, nonhazardous, and efficient. The employment of Pineapple wastes as biosorbent is an effective alternative from the both economical and environmental point of view.**

The adsorption of oxalic acid on powdered pineapple peel and leaves was investigated and also the share sorption capability was calculated volumetrically. The current study includes an evaluation of the effects of different concentrations while keeping other operational parameters such as contact time, adsorbent dose, and pH constant. The most capability was found once the magnitude relation of adsorbent to the substance adsorbable is larger. The same ideology of adsorption can be extrapolated for the effective removal of dyes and metals from wastewater.

Keywords:- *Pineapple Waste, Oxalic Acid, Low-Cost Adsorbents, Adsorption, Wastewater Treatment, Sustainable Technologies.*

I. INTRODUCTION

Pineapple (*Ananas comosus L*) is a member of the Bromeliaceae family (Monocot). The fruit is known as "Queen of fruits" due to its splendid flavour and taste.[1,5] The Pineapple fruit contains Bromelain enzyme which is a mixture of many proteolytic enzymes like phosphatases, some cysteine thiopeptidases (comosain and ananin), peroxidizes and cellulases.[3,7,9,10] The fruit consists of a 60% edible half which is flesh and remaining 40% non-edible half which is peel and leaves. The non-edible part is commonly discarded as wastes. Over the decades, land disposal remains as major method for handling the waste produced from agricultural activities. Generated wastes from agricultural activities have negative impact on the environment. Thus, lack of proper method for managing these wastes and dumping has been attributed to environmental pollution. Agro-industrial by-product has the potential to act as a supply for the assembly of helpful product if treated properly.[4] One among the effective ways that to use the waste is to use it as low-cost bio-adsorbent. The pineapple wastes contain lignin, cellulose, hemicelluloses, and pectin. Therefore, pineapple wastes can be reused for effluent treatment application.

The quality of water is deteriorating due to rapid industrialization, population growth, unplanned urbanization, and unskilled utilization of natural water resources. Many organic acids are released into wastewater as by-products during the synthesis of different products.[4] Oxalic acid is reported to be hazardous to human health. [11] Excessive release of industrial effluents like heavy metals, organic acids, dyes into wastewater poses a great problem worldwide. A variety of treatment technologies are available to control and minimize water pollution. However, most of the methods are complicated, high operational and high maintenance costs. Comparatively, the adsorption process is considered a better alternative in wastewater treatment because of convenience, ease of operation, and simplicity in design.[4]

Adsorption is a mass transfer process that involves the accumulation of substances at the interface of two-phases.[4] The adsorption process is the most preferred method applied for the removal of dissolved pollutants that remain in the water after various chemical treatments. Activated carbon is the most commonly employed adsorbent.[6,8] Its widespread use is often restricted due to its higher cost. Agricultural wastes are one of the rich sources of low-cost adsorbents due to abundant supply..[2] A large variety of low-cost adsorbents have been examined for their ability to remove various types of pollutants from wastewater. Pineapple waste is a kind of agricultural waste that can be used as an adsorbent. It will notably replace the use of conventional treatments in terms of cost effectiveness, economical and environment friendly. The present study used pineapple wastes as adsorbents to determine the sorption capacity using oxalic acid as the adsorbate.

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II. MATERIALS AND METHODS

A. Adsorbent Preparation

Pineapple peels and leaves were collected from the local fruit market in Mumbai, India. Pineapple leaves and peels were washed and cut into small pieces. The peels and leaves activated in the oven at 50℃-60℃ for 24 hours. The dried leaves and peels were smoothed using the blender and sieved through the mesh. The dried peel and leaf powder were used for further study. The control used for this study was activated charcoal. Oxalic acid was used as an adsorbate.

Chemicals- Sodium hydroxide, phenolphthalein indicator, and distilled water. All the chemicals used were of analytical grade.

B. Procedure

In flasks, oxalic acid, and distilled water were additional in increasing concentrations (50mM, 150mM, and 250mM). 5ml of the solution from each flask is titrated separately against NaOH using the Phenolphthalein indicator. The endpoint obtained was colourless to pink colour. The adsorption process of oxalic acid was performed by contacting 1g of dried peel and leaves powder with known concentrations of the acid in respected flasks. The mixture in the flasks was incubated for one hour with gradual shaking at room temperature. After incubation, the solutions were filtered through filter paper. The amounts of the acid after equilibration were quantified by titrations of the filtrate solutions against NaOH using phenolphthalein indicator. The resulting solution turned to a pink colour. The commercially available activated carbon was used as a control by using a similar procedure mentioned above. The percentage adsorption capacity was determined and estimated.

III. RESULTS AND DISCUSSIONS

Sample / concentrations	Pineapple leaves	Pineapple peel	Activated Charcoal
50mM	61.53%	72.00%	60.01%
150mM	87.50%	94.40%	87.20%
250mM	94.11%	97.95%	96.25%

Table 1:- Percentage Adsorption capacity on pineapple waste and activated charcoal.

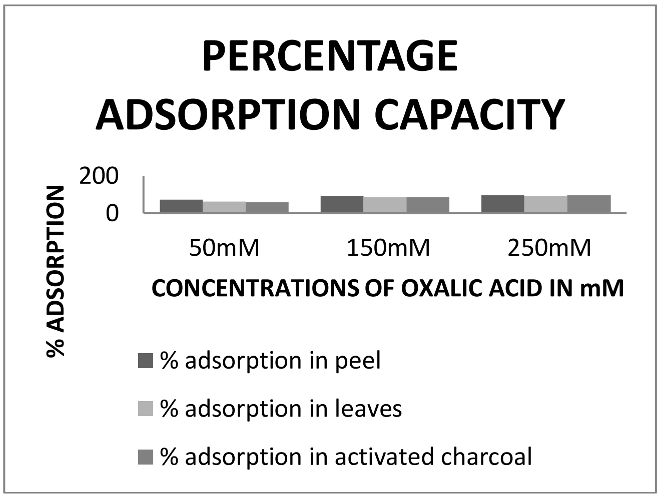

Fig 1:- Percentage Adsorption Capacity of Pineapple peel, leaves, and activated charcoal.

At maximum concentration, the percentage adsorption capacity is highest 97.95% in pineapple peel while least 94.11% observed in leaves.

Sample	Average	SE
Peel	81.05	9.94
Leaves	88.12	8.12
Activated charcoal	81.15	10.89

Table 2:- Average percentage adsorption capacity of Pineapple peel, leaf and activated charcoal.

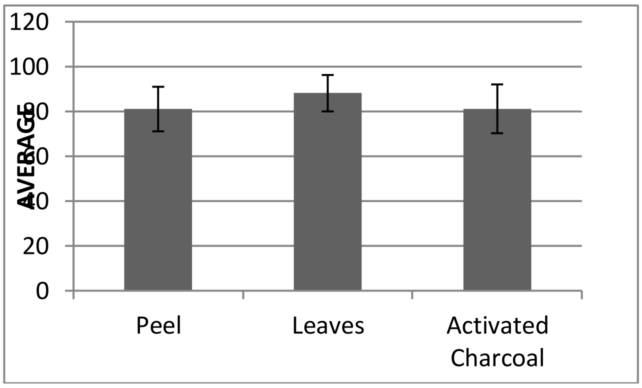

Fig 2:- Average percentage capacity of all three adsorbents.

A one way between subjects ANOVA was conducted to compare the effect of adsorbents on oxalic acid. It was concluded that there were not significant differences on the effect of sorbents using pineapple waste and activated charcoal at $P > 0.05$ level.

The biosorption of oxalic acid using natural sorbents prepared from Pineapple waste and activated charcoal was studied. The present study determined the percentage adsorption capacity of oxalic acid from aqueous solution at different concentrations (50mM, 150mM, and 250mM) keeping other parameters like contact time, adsorbent dose and pH constant. Bio-adsorbents provide surface area and adsorption sites. A fixed mass of adsorbents can adsorb only a certain amount of oxalic acid and equilibrium is attained between solute concentration in the solution and the surface of adsorbents. The results in fig 1 presented that percentage adsorption capacity increases as concentration increases. Maximum adsorption capacity was found in pineapple peel 97.95%. As it was observed that in 150mM solution, percentage adsorption capacity in leaves and activated charcoal was found to be similar 87.50% and 87.20% respectively whereas, the percentage adsorption capacity in activated charcoal is slightly greater than in the leaves in the 250mM solution.

The statistical analysis was conducted to compare the effect of sorbents on oxalic acid. It was observed that the statistical analysis do not show significant difference on the effect of all 3 adsorbents at the $P > 0.05$ level. In fig 2, it was observed that the average percentage capacity in both pineapple peel and activated charcoal was found to be similar. Although adsorbents from Pineapple waste and activated charcoal showed similar effect, it was noticed that the natural adsorbents are more useful than the activated charcoal. It was also concluded that the natural sorbents were suitable at room temperature for binding of oxalic acid molecules on the surface of adsorbents. Therefore, adsorbents prepared from Pineapple waste are cost-effective and environment friendly alternative to commercially available activated charcoal.

IV. CONCLUSION

The performance of pineapple peel and leaves in the adsorption of oxalic acid has been studied. The adsorbents using pineapple wastes represented a promising green technology. The given experiment was done at a lab-scale and potentially can be applied at full-scale wastewater treatment. In order to take into account the new frontiers of research, the regeneration of the novel adsorbents as well as the study of their shelf life should be carefully evaluated.

V. FUTURE PROSPECT

The use of pineapple leaves and peel as adsorbents can be further used as commercial sorbents for the removal of many industrial effluents. This will also provide an advantage in reducing agricultural wastes.

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