Wastewater Treatment Using Bio-Coagulant as Cactus Opuntia Ficus Indica

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ABSTRACT

Reusing wastewater by effective treatment can contribute to counter the water scarcity. Conventional metal based coagulant treatment methods may prove inadequate to apply in aspects such as non-biodegradability and altered pH in post• treatment. There has been an extensive research on the use of biological plant material such as agricultural waste, Chitosan, Moringa Oleifera, Eichhornia crassipes, bark of acacia, Surjana seed, Maize seed, Tannin and Ciceraretinum etc. as a coagulant. In this study, the effectiveness of cactus as bio-coagulant for turbidity removal from municipal wastewater effluent has been studied. Effect of treatment on parameters such as pH, COD, and Suspended solids was also studied. The amount of dosage of cactus added was correlated with turbidity of wastewater. Depending upon turbidity of wastewater turbidity removal varies from 70 to 90% for dosage 30 to 100 mg/L. From this study, high turbidity removal indicates that cactus has the potential for wastewater treatment application.

Keywords: *Bio-coagulation, Cactus Opuntia Ficus Indica, Natural Coagulant, pH implication, Reuse Wastewater, Waste water treatment, Turbidity, COD, Alum.*

1 INTRODUCTION

The rapid increase of industrialization and urbanization in the last few decades had caused a dramatic increase in the demanded water, as well as significant deteriorations in water quality throughout the world. When particles are slow to settle or are non-settling. The process is speeded up by coagulation and flocculation through the addition of certain chemicals (Alum, Polyaluminium chloride) known as coagulants. These processes are effective at removing fine suspended particles that attract and hold bacteria and viruses to their surface. The effec tiveness of these chemicals as coagulants are well noted, there are, nonetheless, disadvantages linked with usage of these coagulants such as comparatively high cost, harmful effects on human health as well as affect ecosystem also the fact that they appreciably affect pH of treated water. High level of residual aluminium sulphate has been linked to several medical disorders including osteomalacia, dialysis encephalopathy syndrome, Alzheimer's disease and renal failure. [35] As a consequence of the above-mentioned drawbacks, there is a need to develop alternative, cost-effective and environment-friendly coagulants.

Many researchers from the world have done their studies on various naturally derived coagulants. Natural coagulants of plant origin have been used for water treatment for many centuries. Strychons Potatorum (Nirmali seeds) was used as a clarifier between 14 th and 15th centuries BC. Natural coagulants are biodegradable and cost-effective for developing countries since they can be loc ally grown and have a wider range of effective dosage and they produce much lower sludge volume for flocculation of various colloidal suspension. The current study deals with the application of natural coagulants such as Cactus *Opuntia* in reduction of turbidity.

2. MATERIAL AND METHOD

Various natural materials of biological origin (bean, moringa, maize etc.) had been investigated for their potential used for wastewater treatment.

2.1 Cactus

Cactus was an abundant natural product, cost-effective, safe for human health and biodegradable, offering various options (coagulant/flocculant, biosorbent, etc.) for the treatment of wastewater.

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Figure 1: Cactus *Opuntia Ficus Indica* at Bamboo Garden, Amravati (MH)

2.2 Cactus Mucilage

The *Opuntia* species in the cacti family had been known for its large production of mucilage, a complex used by the cactus to store water. The mucilage from the *Opuntia fic us• indica* had been previously studied as a natural flocculants [25, 42, 47]. Mucilaginous cells containing mucilage were identified to exist in both the peel and pulp of the cathodes, particularly the pads. Different methods are developed toextract the mucilage from the cactus cladodes.

2.3 **Chemical Composition and properties of cactus mucilage**

A. Belayneh and W. Batu compared chemical composition of Cactus and Moringa olifera . Following Table 1 shows Chemical composition of cactus and moringa olifera. The Carbon percentages of both shelled and non-shelled Moringa olifera were almost twice the percentage of cactus [8].

Table1: Chemical Composition of Natural Coagulants

Content	Cactus	Moringa Olifera	
		Shelled Seeds	Non- Shelled Seeds
Nitrogen	2.30	6.10	5.0
Carbon	29.40	54.80	53.30
Hydrogen	1.7.	8.50	7.70

2.4 Collection of Wastewater Sample

Sample was collected from Amba Nala near Amba Peth, Amravati (MH). It was observed that the sample was highly turbid and dark black in colour. Sample was collected and stored in clear plastic containers.

Figure 2: Wastewater Sample collection site

C. Nirmala Rani and Jadhav M. V. found that Cactus *Opuntia* contains carbohydrates such as L-

arabinose, D galactose, L-rhamnose, D-xylose and galacturonic acid. Also report that galacturonic acid was possibly the active ingredient that affords the coagulation capability of *Opuntia* species through it should be noted that it only accounts for only 50% of turbidity removal. [14].
Luis G. Torres, Carlos Orozco, et al. reported that *Opuntia* mucilage contains polygalacturonic acid and five sugars. Cactus was use in the treatment of waters, using either the mucilage or the whole cladode powder. Water treatment without Fe/Al + synthetic polymers would yield water with less toxicity [28] [43]. Highlighted part in Fig. shows mucilage of cactus

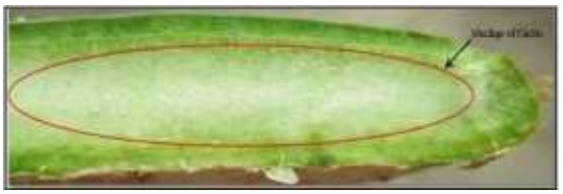

Figure 3: Mucilage of cactus

2.5 Preparation of coagulant
The Cactus *Opuntia ficus indica* collected from Bamboo Garden, Amravati **(MH).** Clalodes were stored in refrigerator at 4 °C. Wash that cactus cladodes with tap water and remove the thrones on it. Outer part of cactus peeled off using knife.

The ilmer part mucilage was sliced and dried at 60 °C for 24 hours in Hot Air Oven. The dried cactus mucilage was milled using Mixer-grinder into powder or amorphous form. Sieved that amorphous form mucilage and used as a coagulant in wastewater treatment.

3 EXPERIMENTAL WORK

Jar test equip ment with multiple spindle stirrers and 1000 ml beakers was used in experiment. Sample were mixed thoroughly and agitated for a rapid mixing speed for different quantity of coagulant dosage for each beaker then lowered to slow mixing for flocculation after which sample were allowed to settle. The supernatant sample was collected and tested for turbidity and pH using turbidity meter presented in Nephelometric w1its (NTU) and pH meter respectively [1].

1. Preparing six beakers (1000 ml each) with raw wastewater sample from the Amba Nala which delivers raw wastewater to Sewage wastewater treatment plant, Lalkhedi (Amravati).
2. Measuring the initial turbidity using HACH 2100Q Turbidity meter and pH level using sensION+ PH3.
3. Adding six different doses of the coagulant.
4. Placing the six beakers in the jar testing apparatus and rapid mixing at 150 rpm for 3 minutes.
5. Slow mixing at 50 rpm for 20 min
6. Stopping the mixing and settle the beakers for settling period of 30 min.
7. Taking samples from the middle using a pipette and measuring the residual turbidity. This is called the clear water turbidity.
8. Drawing the curve between the coagulant dose and residual turbidity to decide the optimum dose which gives the minimum residual turbidity.

Turbidity values determined using HACH 2100Q turbidity meter and initial turbidity found to be 267 NTU.
pH values determined using HACH sensION+ pH meter and initial pH found to be 7.76.

4 RESULTS

4.1 Effect of coagulant dosage on Turbidity

It was observed that initial turbidity of Amba Nala, Amravati was 468 NTU. Turbidity removal efficiencies after treatment at a various dosage range from 70 to 85%. The optimum dosage of cactus *Opuntia* used for turbidity removal (468 NTU) was 70 mg/L shown in fig. In this study, the highest removal efficiency reached 83.70%.

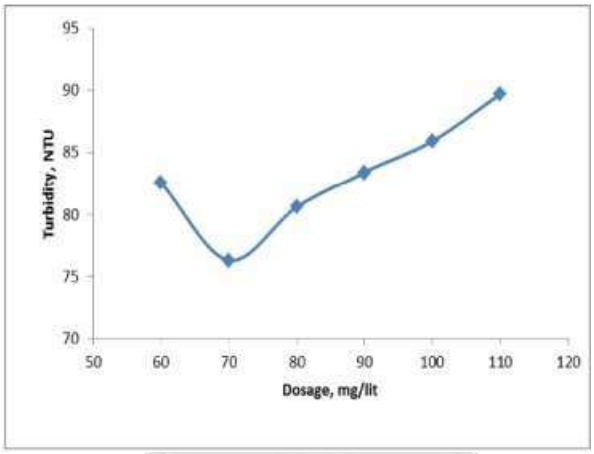

Figure 4: Effect of dosage of cactus powder on turbidity

4.2 Effect of coagulant dosage on pH

Also, it was observed that pH remained constant after use of cactus *Opuntia ficus indica* in wastewater. After treatment pH changes from 7.8 to 7.95. Percentage change of pH was found to be 0.75% which is very small.

4.3 Effect of coagulant dosage on COD

Due to an application of coagulant on wastewater observed that significant removal in COD. Initial COD of collected sample found to be 440 mg/lit. After, treatment in laboratory the COD removal at optimum dosage was at 120 mg/ lit with removal efficiency 72.73%.

5.CONCLUSION

The result from this study indicates that powdered cactus *Opuntia ficus indica* was *very* effective in removing turbidity and COD from wastewater.

1. Turbidity removal efficiencies obtain 70% - 85%.
2. Cactus dosage does not vary **pH** of treated water signifies that pH adjustment unit not required after treatment of wastewater.
3. COD after treatment is also ranges in disposal standards as per *The Environment (Protection) Rules, 1986,* as :s
   250 mg/lit.

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