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Formulation of Natural Elite Dye Remover from Textile Effluent

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ABSTRACT

Introduction: The dyes used in the textile industry poses a major problem to wastewater sources and the environment. Common ways of wastewater treatment containing dyes include adsorption, sedimentation, chemical analysis, chemicoagulation, biological methods, and advanced oxidation procedures.

Objective: To produce the papaya seed, banana pith and pineapple peel powder and treat textile synthetic wastewater with these natural coagulants.

Methods: Papaya seed, Banana pith and Pineapple peel were dried at a particular temperature and ground into powder. Coagulation and flocculation tests were carried out using the jar test apparatus in which 500mL of raw water sample was treated with different concentration of natural coagulants. BOD and COD were determined, FTIR analysis was made to know the functional group of natural coagulants which is responsible for efficient dye removal.

Results: The turbid remaining vs. coagulant dosage graph has been plotted. The treated textile wastewater sample is tested for the presence of BOD; initially, the value was 337.25mg/L with dark blue colour and after 5 days of incubation the colour reduces and brownish precipitate forms with a value of 185.43mg/L. Treated textile wastewater is tested for the presence of the chemical oxygen demand, after 2 hours of digestion, titration is carried out, which showed the change in bluish-green colour to red colour. The result indicates initially COD value as 480mg/L which is reduced to 323mg/L.

Conclusion: The FTIR results showed the presence of potential functional group which is responsible for dye removal. The initial value of BOD and COD was reduced from its original value. Hence, natural coagulants play a potential role in the treatment of Dyes in textile effluent.

Key Words: Papaya seed, Banana pith, Pineapple peel, Natural coagulant, Textile colouring water

INTRODUCTION

Textile industries produce a huge amount of coloured wastewater which contains pollutants such as heavy metals, chemicals, and various dyes. Waterbody pollution is considered as a serious life threat environmentally across the globe. Discharge of untreated wastewater to water bodies causes various types of problems to the marine and terrestrial ecosystem.^{1,2} Throughout year Textile industries release massive amount to wastewater, these effluents are highly resistant to pH, light, microbial attack and this makes them stable for a longer period in environment.^{2,3} In India, around 80% or 1,30,000 tons of dyes consumes in the textile industry due to elevated demand for cotton and polyester. These harm-

ful dyes effectively create a bad impact on photosynthetic function in plants, due to penetration of low light and consumption of oxygen creates a huge impact on aquatic life and also decreases the capacity of oxygen and food production in algae.^{1,4,5}

The reuse of textile wastewater, efficient treatment is necessary to achieve water scarcity. Globally several studies have been undergone for the treatment of textile dye waters through Advanced oxidation with biological oxidation, Granular activated carbons, Coagulation-electro-oxidation, Adsorbent, Wet oxidation, Fenton's reagent.⁶ The mentioned techniques work in the mechanism of production of hydroxyl free radical (HO) that destroys the chemical bond of dyes

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and thus lowering the concentration value of BOD and COD. Another most effective technique used for the treatment is Membrane-filtration. However, these conventional methods have some of the disadvantages such as high cost, more number of by-products, generation of more sludge, high cost of operating, limited to pilot scale. So far, Synthetic conventional techniques have certain disadvantages researchers done another way of treatment using inorganic coagulants. Aluminium sulfate, ferric chloride, poly aluminium chloride effectively acts as the remover of dyes in wastewater, But still, there are certain potential causes of serious health issues. Due to drawbacks of synthetic conventional techniques and inorganic coagulants paves a way for the another safer, eco-friendly techniques for the treatment of wastewater is that Natural coagulants.^{7,8} Natural coagulants can be extracted from the plants, animals and microorganisms.⁹ Natural coagulants satisfy the drawbacks of synthetic treatments, in contrast, it produces a very limited amount of sludge production and also higher nutritional sludge value.^{8,10}

In the present study, we explore the effectiveness of natural coagulants of plant³ and non-plant based and showed the results of the effectiveness of three combinations of fruit waste powders (Plant-based) such as papaya seed,^{6,11} Banana pith and Pineapple peels that are mixed with the certain ratio which acts as natural coagulants. These combinations of different natural coagulants owing to the multifunctional characteristics are facilitated by polyelectrolyte interactions, which form the precipitation of synthetic dyes and heavy metals present. *Carica papaya* (Papaya) is a tropical fruit found in Asia and South America. Papaya seeds have been used to treat turbid water can be used to treat turbid water with faecal bacteria. *Anana scomosus* (Pineapple) also a tropical fruit found in Costa Rica are found in South America.^{12,13} Due to the production of adsorbent Pineapple used for removal of dye and also prevents disposal cost.⁷ *Musa* (Banana) a tropical fruit widely found in Tamil Nadu and Kerala. Banana pith is a natural polyelectrolyte which is acting as a good natural absorbent in the treatment of textile colouring water.⁵ From the present research of this combination samples, used for the treatment of textile synthetic wastewater and then results were confirmed and characterized using intensity difference, the effect of pH and coagulant dosage, % of BOD and COD.^{7,8}

MATERIALS AND METHODS

Collection of water sample and preparation

Textile coloring water was collected from the RATHI TEX DYEING manufacture situated in the Tirupur district, Tamil Nadu.

Papaya, Banana pith and Pineapple were purchased from the local market Annur locality. Desired portions from the

fruits were separated as such Papaya seeds, Banana pith and Pineapple peels were washed thoroughly using distilled water and dried at a temperature of Papaya seeds (110°C for 10 hours), Banana Pith⁴ (60°C for 6 hours) and Pineapple peels (105°C for 2 to 3 hours), ground and then sieved to obtain powder in the mesh size of 10–20 mm. Then the powders were stored in the airtight containers for further use.

Coagulation Test

Jar Test

Coagulation and flocculation tests were studied using a jar test apparatus. Three Jars were filled with 500mL of the raw water sample. The pH was adjusted using NaOH or sulphuric acid to different pH such as 5.0, 5.5, 6.0, 6.5, 7.0, and 7.5. Different concentrations of powdered coagulant samples were added to each jar containing raw water samples of 5, 10, 15 and 20mg/ml. Each jar rapidly mixed at 100-150 rpm for 5 minutes. Later, the stirring speed was reduced to 25-30 rpm and mixing was continued for 15-20 minutes. The mixers were turned off and allowed flocs to settle for 30-45 minutes. The final residual turbidity in each sample was measured.

Evaluation of Biological Oxygen Demand

100mL raw water sample was filled in a BOD bottle without making air bubbles. 2mL of Manganese sulphate and Alkali-iodide azide reagent were inserted by pipette just below the surface of the water. Formation of a brownish precipitate indicates the presence of oxygen. Finally, 2mL of concentrated sulphuric acid was added and closed. The bottle was incubated for 5 days. Later, the titration was carried out using sodium thiosulphate which changes the colour to pale yellow and 2mL of starch was titrated and changes the colour to blue and finally, readings were noted.

Evaluation of Chemical Oxygen Demand

The raw water samples were diluted to 1:250 ratios, from the diluted sample 2.5mL was taken and prepare blank to which 1.5mL of potassium dichromate and 3.5mL of sulphuric reagent was added to the COD tube. Now, each turbid water samples of 2.5mL were taken in different tubes and 1.5mL of potassium dichromate and 3.5mL of sulphuric reagent was added to each tube and subjected to COD digester for 150°C for 20 minutes. After attaining strong heating point the tubes were left at 150°C for 2 hours. In the end, the titration was carried out using 0.1N FAS, 2 drops of ferroin indicator, which changes the green to red in the colour end product to find the difference in the intensity of the sample and graph were plotted.

Statistical Analysis

All the experiments were performed in triplicates. The statistical significance was measured using one way ANOVA.

The 'P-value' was found to be <0.05 , which is considered to be significant¹⁴.

RESULTS

Preparation of three different fruit powders

Papaya seed was collected and oven-dried for 2 days at 106 °C and ground into a powder that contains 10g totally and stored at desiccators. Banana pith or stem was collected and oven-dried for 2 days at 62 °C and ground into a fine powder that contains 12g. Pineapple peel was collected and oven-dried for 4 days to remove the complete moisture at 112 °C and ground into a powder form that weighs about 20g and stored at containers. All these powders are taken with different grams to proceed with various analysis which can be utilized as a natural coagulant to treat the textile wastewater.

FTIR analysis

FTIR analysis is done to observe functional groups that are present in natural coagulants. The FTIR spectra of papaya seed powder are presented in Figure 1, Banana pith are presented in Figure 2, Pineapple peel are presented in Figure 3. From the results papaya seed has a highest sharp peak at 2923.17 cm^{-1} , indicating the presence of N-H stretching, and a peak indicated the presence of symmetrical and asymmetrical C-H stretching at 2923.17 cm^{-1} and 2853.73 cm^{-1} . Banana pith has the highest sharp peak at 1016.50 cm^{-1} and 1619.27 cm^{-1} indicating the presence of C=O stretching. Pine apple peel has a highest sharp peak at 1047.36 cm^{-1} and 3331.12 cm^{-1} indicating the presence of C=O stretching and O-H stretching bonds. Thus the above results indicate that different functional groups are present in the samples that contain potential poly-electrostatic interaction.

Coagulation and flocculation test by the jar test method

Each jar contains water sample was treated with different concentrations of natural coagulants¹¹ papaya seed, banana pith and pineapple peel powders with help of mechanical agitation the formation of the floc was developed and leads to dye removal.¹² The turbid remaining vs. coagulant dosage graph has been plotted in Figure 4, Figure 5 And Figure 6 respectively.

From the above results 8 mg of papaya seed sediment 9.6 mg/L, 13mg of banana pith sediment 5.7 mg/L and 12mg of pineapple peel sediment 6.1 mg/L of dye in the treated wastewater. The above three sample combinations were mixed and used for treating the textile wastewater.¹³

Biological Oxygen Demand (BOD)

The treated textile wastewater sample is tested for the presence of BOD; initially, the value was 337.25mg/L with dark

blue colour and after 5 days of incubation the colour reduces and brownish precipitate forms with a value of 185.43mg/L. Thus the reduction of BOD in the sample indicates the efficient role of natural coagulants in (Figure 7).

Chemical Oxygen Demand (COD)

Treated textile wastewater is tested for the presence of the chemical oxygen demand, after 2 hours of digestion, titration is carried out, which showed the change in bluish-green colour to red colour. The result indicates initially COD value as 480mg/L which is reduced to 323mg/L (Figure 8).

DISCUSSION

The results of FTIR analysis showed the presence of potential functional groups present in the natural coagulants which are responsible for the removal of dye concentration in wastewater.^{9,10} The determination of BOD and COD level for the treated wastewater reveals the natural coagulants decreased the value to 185.43 mg/L and 323mg/L respectively.^{13,14} Thus the present study concludes, the removal of colour dye from textile wastewater is attained by treating with the combination of three different fruit wastes such as papaya seeds, banana pith and pineapple peel powders in the concentration of 8mg, 13mg, and 12mg respectively, which acts natural coagulants and harmless to living organisms (Table 1 and 2).

CONCLUSION

Removal of dye from textile effluent was confirmed when natural coagulant gave the decreased value of 185.43 mg/L BOD and 323mg/L COD level. FTIR results ensure the presence of functional groups which are responsible for dye degradation. The concentration of natural coagulants papaya seeds, banana pith and pineapple peel powders found in 8mg, 13mg, and 12mg respectively.

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Author Contribution: Sri Sowmitha Ramesh & Komala Devi S performed the work, Moni Philip Jacob K, Rajaseetharama S & Jeyavel Karthick P performed the collection of samples and BOD, COD analysis and wrote the manuscript, Ragamathi S & Pavithra MKS performed and interpreted the FTIR data, Tamilselvi S guided the work, prepared and reviewed the manuscript.

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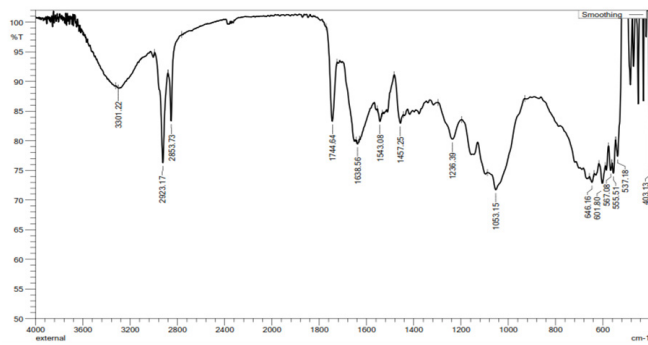


Figure 1: FTIR of the functional groups present in papaya seed.

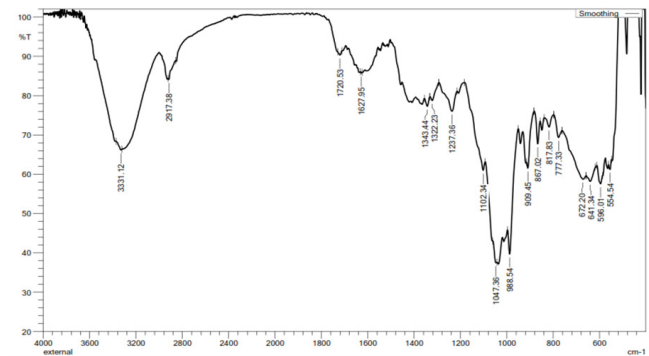


Figure 3: FTIR of functional groups present in Pineapple peel.

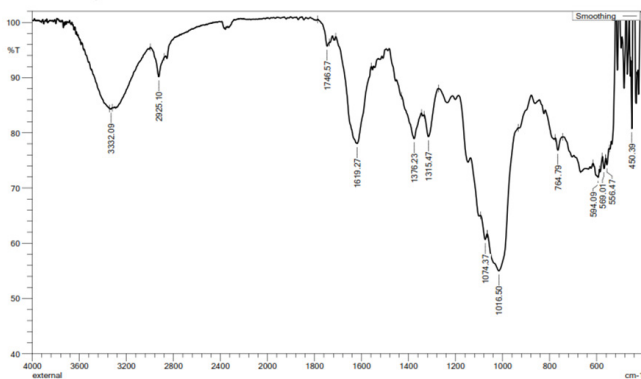


Figure 2: FTIR of functional groups present in Banana pith.

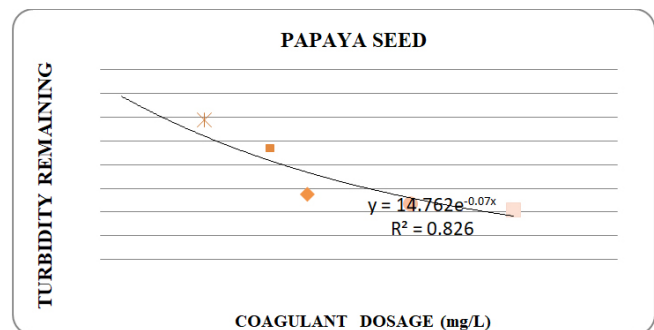


Figure 4: Graphical representation of turbidity remaining against coagulant dosage of papaya seed powder.

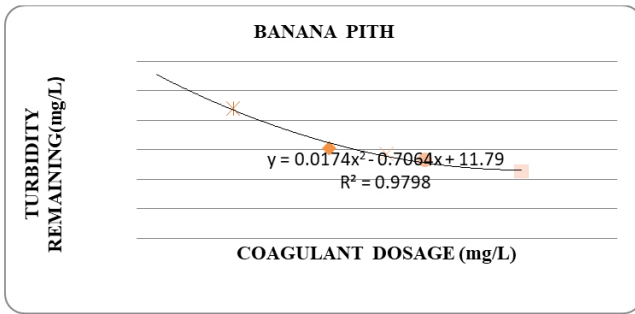


Figure 5: Graphical representation of turbidity remaining at various coagulant dosages using Banana pith powder.

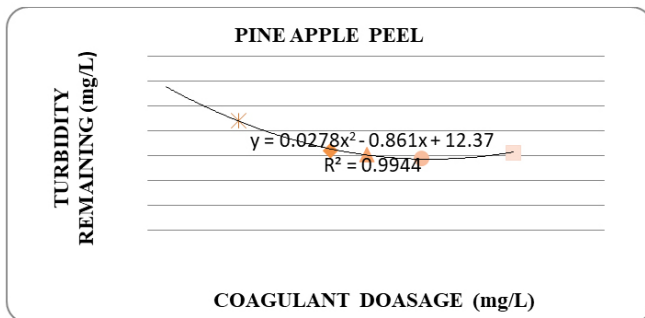


Figure 6: Graphical representation of turbidity remaining against coagulant dosage of Pineapple peel powder.



Figure 7: Presence of brownish precipitate in treated wastewater.



Figure 8: Formation of brown precipitate in treated wastewater.

Table 1: Turbidity removal composition of papaya seed, banana pith and pineapple peel powders at various coagulant dosages

S.no	X (Coagulant dosage) mg/L	Y (Turbidity remaining)		
		Papaya seed	Banana pith	Pineapple peel
1.	5	11.8	8.8	8.8
2.	8	9.6	6.1	6.4
3.	10	5.5	5.7	6.1
4.	15	4.7	5.3	5.8
5.	20	4.2	4.35	6.25

Table 2: Titration readings and its end product % based on treated waste water sample

S. No	Raw water sample	Titration readings		% difference	Indication end point
		initial	final		
1.	Untreated waste water	0	2.3	89.06	Red color
2.	Treated waste water	2.3	4.7	51.26	Red color