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Accessing the Suitability of Using Banana Pith Juice as a Natural Coagulant for Textile Wastewater Treatment

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Abstract: Textiles are among the basic needs of human being. The textile industries therefore have great economic significance by virtue of its contribution to overall industrial output and employment generation. This sector has wide spectrum of industries ranging from small scale units that use traditional manufacturing process, to large integrated mills using modern machineries and equipment. In processing of textiles, the industry uses a number of dyes, chemicals, auxiliary chemicals and sizing materials. As a result, contaminated waste water is generated which can cause environmental problems unless properly treated before its disposal. The suitability of banana stem juice as a natural coagulant for textile industrial wastewater treatment was investigated. Three main parameters were studied, namely, total suspended solids (TSS), pH, and turbidity of effluent. Coagulation experiments using jar test were performed with a flocculation system where the effects of textile industrial wastewater as well as banana stem juice dosage on coagulation effectiveness were examined at different pH levels. High EC, TS, and turbidity removal percentages by the banana stem juice were observed at pH 4 as 50, 50.1, and 97.5% respectively. Results reveal that banana stem juice has tremendous potential as natural coagulant for textile wastewater.

Keywords: Banana pith juice, textile waste water, coagulation, jar test, turbidity, suspended solids

1. INTRODUCTION

The textile industry is one of the largest manufacturing industries. In every stage of textile industry various types of dyes are used to color their products. The dye containing wastewater is usually released directly into the nearby drains, rivers, stagnant, ponds or lagoons. Such wastewater disposal may cause damage to the quality of the receiving water bodies, the aquatic eco-system and the biodiversity of environment. The dyeing industry effluents contain high BOD and COD value, suspended solids, toxic compounds and the color that is perceived by human eyes at very low concentration [6][9].

Textile industries transform fibres into yarn; convert the yarn into fabrics or related products, and dye and finish these materials at various stages of production. In processing of textiles, the industry uses a number of dyes, chemicals, auxiliary chemicals and sizing materials. As a result, contaminated waste water is generated which can cause environmental problems unless properly treated before its disposal [6]. The waste water treatment is mostly by primary and secondary processes. However, these conventional treatment systems are not very effective in removal of pollutants such as dissolved solids, colour, trace metals etc. The advance treatment methods, while reducing these pollutants also give scope for recovery and recycling of water and chemicals. Moreover, dyes may adversely affect the aquatic life because of the presence of aromatic materials, metals and chlorides etc. There are several treatment methods used to treat waste metal-cutting fluids, namely, chemical coagulation, adsorption, microfiltration, and ultra filtration, as well as biological (aerobic and anaerobic) process. Due to high energy consumption or application of variety of chemicals, this would decrease the processing efficiency and increase cost of process. For biological treatment, large are a requirement, high maintenance, long retention time, and odour problems are usually associated with pond treatment methods [10].

Coagulation is a common process in the treatment of both industrial wastewater and surface water. Its application includes the removal of dissolved chemical species and turbidity via the addition of widely used chemical-based coagulants such as alum ($AlCl_3$), ferric chloride ($FeCl_3$), polyaluminiumchloride(PAC) ,and synthetic polymer .Nonetheless, many disadvantages are associated with the usage of these coagulants such as relatively high procurement costs as well as detrimental effects on human health and environment. It is, therefore, the use of natural organic coagulant from plant- based which is cost effective may be an interesting alternative [7].

Banana is a herbaceous plant of the genus *Musa spp*. of the family *Musaceae*. Banana is one of the most widely grown tropical fruits because of its high food value and an important addition to the diet [1]. The stem from which the fruit bunches have been taken should be cut off because it will never again grow fruit. The stem will be left abundantly in the plantation and normally will just rot or

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be used as fertilizer. According to Namasivayam et al. , waste banana pith can be used effectively as an adsorbent for the removal of 87% RhodamineB from textiles wastewaters at pH 4 [3]. Another research also on colour removal showed that the pith of banana stem can effectively remove the direct red colour and acid brilliant blue from aqueous solution through adsorption. The adsorption capacities were 5.92 and 4.42 mg dye per gram of pith for direct red and acid brilliant blue, respectively [3]. Other than that, banana pith also could be a useful biosorbent in the preliminary removal of cuprum from electroplating wastes [3] [4]. The usage of banana stem juice as a natural coagulant in COD, SS, and turbidity removal, however, is known to be limited in the published literature. This paper reports on the potential of juice produced from banana stem as a natural coagulant for the removal of COD, SS, and turbidity from spent coolant wastewater. Jar test with a flocculation system was used and the effects of spent coolant wastewater pH on coagulation effectiveness were examined.

2. EXPERIMENTAL

Textile wastewater was collected from a weaving unit in Polachira,Chirkkara at Kollam district in Kerala.

Fig 1: Different units at textile weaving centre

The samples were transferred into 20L plastic containers and then closed, sealed tight, and labelled to avoid any oxidation and contamination before being transported to the laboratory.

2.1. Banana Stem Juice Preparations. Matured banana plants were collected. The thorns were removed and the pith of the stem was then separated from the foliage. 100g of small pieces of the pith were mixed with 10mL of distilled water using a mixer. The fresh juice of banana stem was stored in a refrigerator to ensure its freshness. To avoid any fermentation, the coagulation experiments using this banana stem juice as a natural coagulant were carried out on the same day.

Fig 2: Banana pith juice

3. METHODS

3.1. Coagulation Jar Test Experiments. Coagulation experiments using jar test were performed in the laboratory with a bioblock flocculation that comprises six-paddle rotor, and all tests were conducted at room temperature. The desired amount of coagulant was added to textile wastewater and stirred at speed of 30rpm for 20 minute to keep flocs particles uniformly suspended. The settling of flocs particles was then observed and recorded. The mixture was left for 1 hour and later the supernatant was collected to determine EC, TS and turbidity using the standard method. pH of wastewater samples was controlled by adding 1.0M H_2SO_4 or 1.0M NaOH.

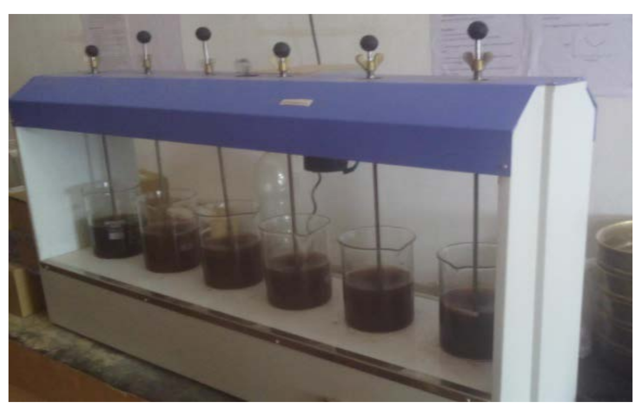

Fig 3: Jar test apparatus

3.2. Analytical Analysis.

Turbidity test was measured using portable turbidity meter. The principle of the turbidity measurement is based on a comparison of the intensity of light scattered by the sample. The sample cell was placed into the turbidity meter and the turbidity value was shown in NTU unit. The total turbidity percentage removal was calculated as follows:

Turbidity % removal ≈(A-B)/C*100

Where *A* is turbidity of raw textile wastewater (NTU), is turbidity after treatment (NTU), and *C* is turbidity of raw wastewater (NTU).

pH meter was used in this paper to measure the pH value of the sample[1].

Total Suspended solid was measured using evaporation disk method. The evaporation disks were dried in the oven at 100–105°C for one hour to remove any moisture that can affect the suspended solid measurement. The dried evaporation disk was then cooled and weighted. It was then taken 10mL of the supernatant, the disk was then dried again at 100– 105°C for one hour and weighted again after it was cooled. The total suspended solid removal percentage was calculated as follows:

suspended solid ≈A-B/C*10^6

where *A* is weight of the disk + solids (g), *B* is weight of empty disk (g), *C* is volume of sample (mL).

Electrical conductivity is measured using conductivity meter [1].

4. RESULTS AND DISCUSSION

4.1. Characterization of Textile Waste water

Table 1 shows the characteristics of textile wastewater before the coagulation pretreatment.

Table 1

Characteristics of waste water

Turbidity(NTU)	89
pH	12.62
Electrical conductivity(mS/cm)	30
Total solids(mg/l)	33.10
Total Suspended solids(mg/l)	14.42
Total Dissolved solids(mg/l)	18.68

Samples were collected and tested for basic, acidic and neutral condition under different dosages. At basic condition the sample were kept at pH 12. At neutral condition the sample were kept at pH 7. At acidic condition the sample were kept at pH 4. The pH was controlled using conc H_2SO_4. At all the conditions the different dosages provided are 10mL, 20mL, 30mL, 40mL, 50mL for 500mL of waste water. Electrical conductivity, turbidity and total solids were observed for each sample.

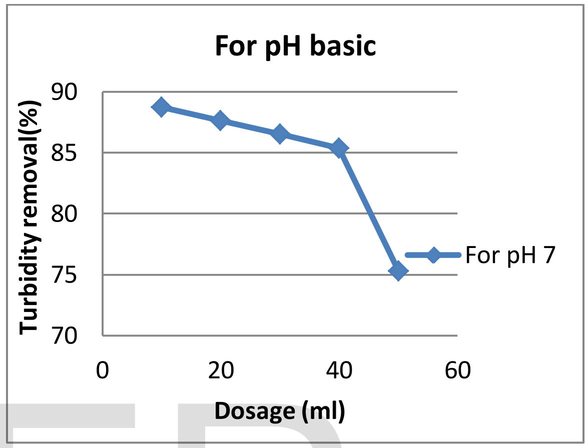

Fig 4: percentage removal of turbidity at pH 12

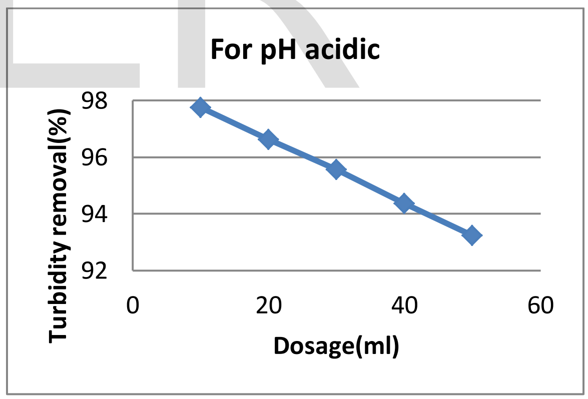

Fig 5: percentage removal of turbidity at pH 4

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Fig 6: percentage removal of turbidity at pH 7

Dosage(ml)	10	20	30	40	50
Turbidity (NTU)	2	3	4	5	6
Electrical conductivity (**m**S/cm)	22.2	22	21	20.8	20
Total solids (mg/L)	16.39	17.42	17.8	18.1	18.31

Table 2 Observation under pH 12

Dosage(ml)	10	20	30	40	50
Turbidity (NTU)	10	11	12	13	22
Electrical conductivity (**m**S/cm)	29.5	29.1	28.9	28.8	28.1
Total solids (mg/L)	28.68	20.96	15.41	25.19	22.5

Table 3 Observation under pH 7

Dosage(ml)	10	20	30	40	50
Turbidity (NTU)	5	14	8	12	13
Electrical conductivity (**m**S/cm)	22.0	21.4	20.6	20.3	20.1
Total solids (mg/L)	15.88	16.61	16.47	16.39	15.91

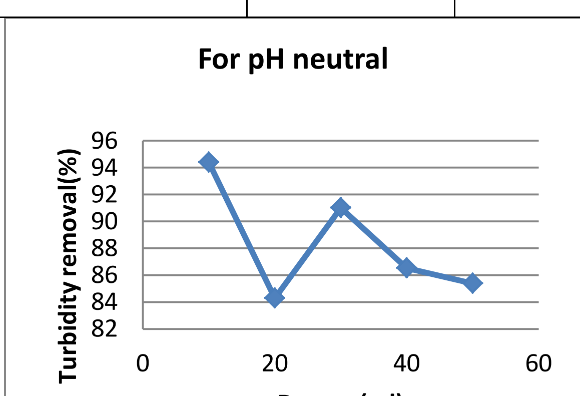

Table 4 Observation under pH 4

Effect of Banana Stem Juice

For banana stem juice, the dosages ranged from 10 to 50mL, and the volume of textile wastewater used was 500mL. Turbidity removal percentages showed marginal difference in which more than 98% removal was achieved. It appeared that the highest EC removal percentage was 50.1% (for 50ml dosage at pH) while for the suspended solid removal percentage was 52% (for 10mL dosage at pH 7).

Fig 7: Water after treatment with banana pith juice

5. CONCLUSION

Generally, the percentage of EC, TS, and turbidity removal by using banana stem juice showed tremendous potential as a plant-based natural coagulant in the treatment of textile waste water [1]. High EC, TS, and turbidity removal percentages by the banana stem juice were observed for effluent at pH 4 where percentages were 50, 50.1, and 97.5%, respectively. Banana stem juice contains polysaccharide compounds inulin (1.22016mg/mL), which is a natural polymer for bridging and entrapping the microfloc to form larger floc [1]. Therefore this will help in fast settlement of the floc for coagulation of textile wastewater. It is suggested that banana stem juice is to be used in the pretreatment stage of textile wastewater prior to secondary treatment. For future study, it is recommended that more experiment should be done such as colour removal, strength of the flocs, and density of the flocs where those parameters influence the floc velocity.

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