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REMOVAL OF REACTIVE YELLOW DYE USING NATURAL COAGULANTS IN SYNTHETIC TEXTILE WASTE WATER

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ABSTRACT

Wastewater treatment is one of the major problems faced by textile industries. Treatment of wastewater is one of the biggest problems faced by textile manufacturers. By using natural coagulants, considerable savings in chemicals and sludge handling cost may be achieved along with production of readily biodegradable and less voluminous sludge that amounts only 20-30% that of alum treated counterpart. The present study, discusses about the usage of natural coagulants extracted from *Moringa oleifera* and *Strychnos potatorum*. These coagulants are very effective for the removal of colour in the synthetically prepared textile waste water. The percentage colour removal for the dye solution using natural coagulants was found out and it was compared with the commercially used coagulant, alum. The maximum percentage of colour removal using alum, *Moringa oleifera* and Strychnos *potatorum* was found to be 83%, 89% and 93%, respectively. From these results, it is evident that the natural coagulants are more effective than the commercially used coagulants.

Key words: Natural coagulant, Reactive yellow dye, Jar test.

INTRODUCTION

Access to safe drinking water is a human right. However, now-a-days more than 1100 million people live without access to safe drinking water, especially in developing countries. Solution to this global problem is aimed to develop simple, effective, low-cost and easy to use technologies, which are able to reduce organic, inorganic and microbiological water contamination[1]. Textile industries are one of the most common and essential sectors in the world. On the other hand, high volume of water consumption and varying wastewater characteristics due to many products, such as dyes, biocides, carriers, detergents, etc. used in the process are the major factors that have caused a continuous effort to find appropriate

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technologies to treat textile industry wastewater[2]. The removal of dyes from aqueous solutions can be carried out through several chemical and/or physical methods. One of the most popular processes in water treatment is coagulation[3]. Typical coagulant agents are inorganic salts, such as $Al_2(SO_4)_3$ or $FeCl_3$, as well as synthetic polyacrylamides[4]. New coagulanting agents are needed and, therefore, to overcome the drawbacks that traditional chemicals seem to present. The history of the use of natural coagulants is quite long. Natural organic polymers have been used for more than 2000 years in India, Africa, and China as effective coagulants and coagulant aids at high water turbidities. They may be manufactured from plant seeds, leaves, and roots[5].

EXPERIMENTAL

Materials and methods

Preparation of coagulant

The husk covering the *M. oleifera* seeds were manually removed, good quality seeds were selected, and the kernel was ground to a fine powder using an ordinary electric blender. The active component from coagulant was extracted using sodium chloride (NaCl) or potassium chloride (KCl) salt solution[6]. A concentration of 4% (4 g of powder in 100 mL salt solution) was used throughout the study after several trials. The whole mixture was stirred for 30 min at room temperature using a magnetic stirrer. The suspension was filtered using Whatman filter paper. The resultant filtrate solution was used as a coagulant[7]. A fresh solution was prepared every day for reliable results. Similarly *Strychnos potatorum* coagulant extract will be prepared.

Preparation of synthetic textile wastewater

Synthetic textile wastewater for coagulation tests was prepared by adding dye suspension into tap water. Dye suspension contained 1 g in 1 L of distilled water.

Coagulation test

Coagulation activity of each seed extract was determined by the jar test. The synthetic turbid water (300 mL) of different initial turbidities was filled into the beakers (600 mL) and mixed at 200 rpm and constant room temperature 21^{o}C. Various doses of seed extracts were added into the beakers and mixed for 1 min. The mixing speed was then reduced to 80 rpm and kept for another 30 min. Then the suspensions were left for sedimentation. After 1 h of sedimentation, clarified samples were collected from the top of the beakers, and residual turbidity was measured –T_S. The same coagulation test was conducted with no coagulant as a blank. The residual turbidity in the control was defined as T_B. Coagulation activity was calculated as:

$$\text{Coagulation activity (\%)} = (T_B - T_S) \times 100 \backslash T_B \quad \ldots(1)$$

Coagulation studies

The coagulation studies were performed using Jar test apparatus, which allowed for six 1 L beakers to be agitated simultaneously and rotational speed could be varied between 0 and 100 rotations per minute (RPM). The beakers were filled with 1000 mL dye sample. During rapid mixing at 100 RPM for 2 min, coagulant dosage was added into each beaker and was followed by slow mixing at 40 RPM for 30 min. The duration of sedimentation was kept constant at 30 min. The supernatant after sedimentation was filtered using Whatman No. 42 filter paper. The filtrate was analyzed for absorbance using UV-spectrophotometer at a maximum wavelength 526.5 nm. Color removal efficiency was measured as a decrease in optical density measurement at 475 nm. The readings were taken in triplicate for each individual solution to check repeatability. The coefficient of variation obtained was not more than 4% for the three determinations.

Preparation of dye solution

Stock dye solution was prepared by dissolving weighed quantities of dye in distilled water. A solution having concentration of 100 ppm was prepared and used for the experiment. 1000 mL of the prepared solution was taken in a 1 L beaker.

Standardization of pH

The pH value was analyzed using a digital pH meter (Digisun Electronics) with a glass membrane electrode. The variation of pH over time during the course of the experiment was analyzed using the pH meter. The pH was initially calibrated using buffer solutions of pH values 3.0, 5.0, 7.0 and 9.0 under suitable conditions.

Jar test

The coagulation studies were performed using Jar test apparatus, which allowed for six 1 L beakers to be agitated simultaneously and rotational speed could be varied between 0 and 100 rotations per minute (RPM). The beakers were filled with 1000 mL prepared dye sample. During rapid mixing at 100 RPM for 2 min coagulant dosage (10 mL, 20 mL, 30 mL, 40 mL, 50 mL, and 60 mL) was added into each beaker and was followed by slow mixing at 40 RPM for 30 min. The duration of sedimentation was kept constant at 30 min. The supernatant after sedimentation was filtered using Whatman No. 42 filter paper[8]. The filtrate was analyzed for absorbance using UV spectrophotometer at a maximum wavelength 475 nm. Color removal efficiency was measured as a decrease in optical density measurement at 475 nm. The readings were taken in triplicate for each individual solution to check repeatability. The coefficient of variation obtained was not more than 4% for the three determinations.

RESULTS AND DISCUSION

Effect of coagulant dosage

Dosage was one of the most important parameters that has been considered to determine the optimum condition for the performance of chitosan in coagulation and flocculation. Basically, insufficient dosage or overdosing would result in the poor performance in flocculation. Therefore, it was crucial to determine the optimum dosage in order to minimize the dosing cost and obtain the optimum performance in treatment.

Absorbance measurement

For reactive yellow dye, the reference frequency was found to be 397.2 nm by using UV visible spectrophotometer. Based on the reference frequency, the absorbance was measured for various known concentrations of dye solutions. The calibration curve (Fig. 1),

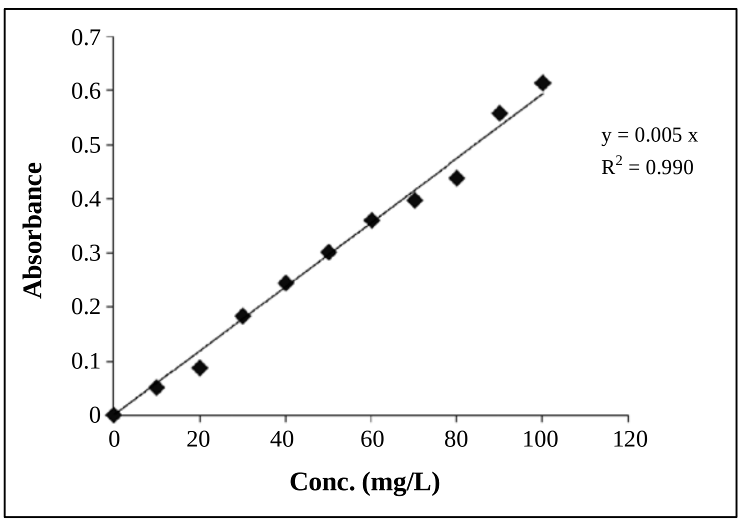

Fig. 1: Concentration vs. Absorbance for reactive yellow dye

for reactive yellow dye was drawn using these values. With this calibration curve, we can easily find out any unknown concentration of dye solution.

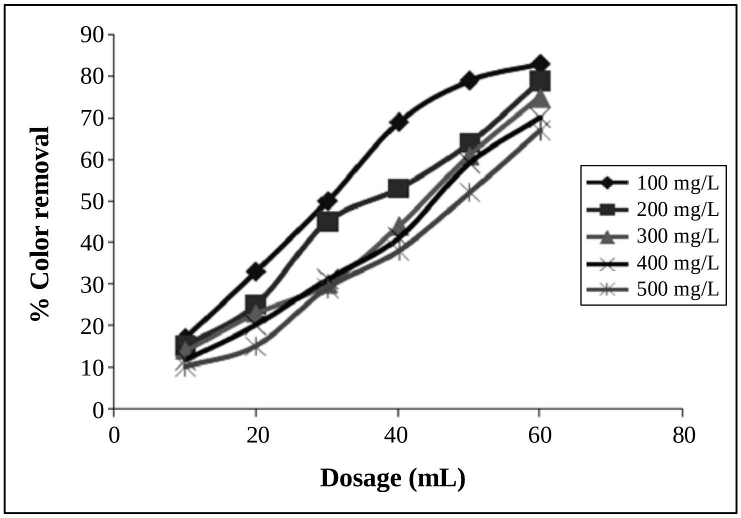

Fig. 2: Effect of alum on color removal of prepared dye solution using reactive yellow dye

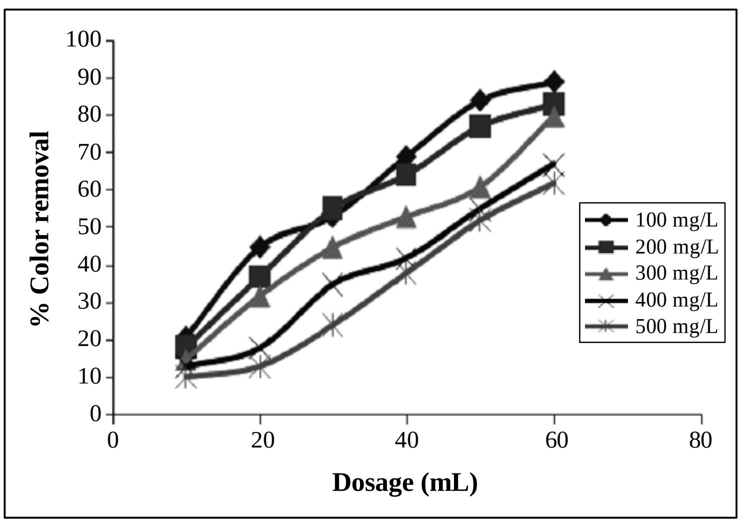

Fig. 3: Effect of coagulant dosage (*Moringa oleifera)* on color removal of prepared dye solution using reactive yellow dye

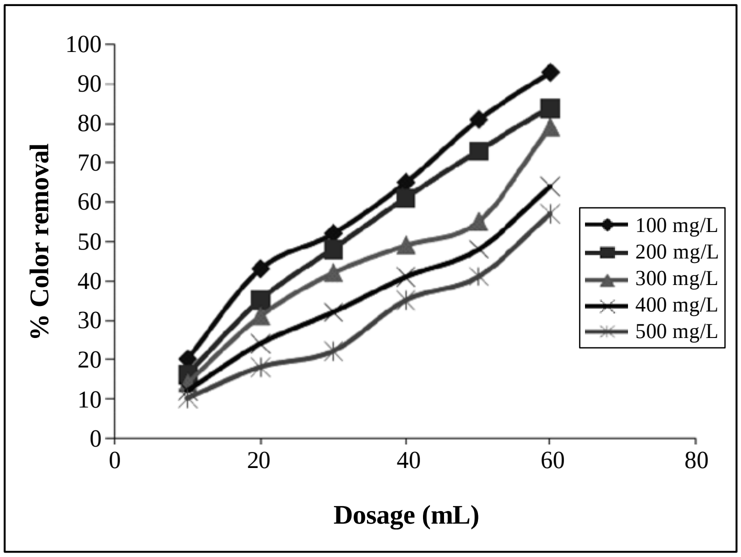

Fig. 4: Effect of coagulant dosage (*Strychnos potatorum*) on color removal of prepared dye solution using reactive yellow dye

CONCLUSION

Textile effluents are highly polluted. Such polluted effluents must be treated properly before their discharge into the drainage channel to minimize the effect of various pollutants on the environment. The purpose of this study was to investigate the ability of some natural coagulants for the purpose of color removal. The present study clearly demonstrates a good scope for use of natural coagulants for treatment of textile wastewater. The color removal of spent wash is complex and requires a sequential treatment using various techniques like adsorption, electro coagulation and ozonation.

By using Jar test experiment, the percentage color removal for various dosages of natural coagulants were determined. Thus, the use of alum solution for 60 mL coagulant dosage the % color removal for lemon yellow dye was 83% (Fig. 2). By using *Moringa oleifera* coagulant extract at 60 mL coagulant dosage, the % color removal for lemon yellow dye is 89% (Fig. 3) while by using *Strychnos potatorum* coagulant extract at 60 mL coagulant dosage, the % color removal for lemon yellow dye is 93% (Fig. 4). This study compared the performance of two different natural coagulants, *Moringa oleifera* and *Strychnos potatorum* with the alum (chemical coagulant).

REFERENCES

1. B. García-Fayos, J. M. Arnal, G. Verdú and M. Sancho, Aquapot Project: Potential of *Moringa Oleifera* Seeds and its Application in Drinking Water Treatment, Int. Conference on Food Innovation at Universidad Politecnica De Valencia (2010) pp. 25-29.
2. G. Eremektar, H. Selcuk and S. Meric, Investigation of the Relation between COD Fractions and the Toxicity in a Textile Finishing Industry Wastewater: Effect of Preozonation, Desalination, **211**, 314-320 (2007).
3. J-W. Lee, S-P. Choi, R. Thiruvenkatachari, W-G. Shim and H. Moon, Evaluation of the Performance of Adsorption and Coagulation Processes for the Maximum Removal of Reactive Dyes, Dyes Pigments, **69(3)**, 196-203 (2006).
4. S. Papic, N. Koprivanac and A. L. Bozic, Metes A Removal of some Reactive Dyes from Synthetic Wastewater by Combined Al (III) Coagulation/Carbon Adsorption Process, Dyes Pigments, **62(3)**, 291-298 (2004).
5. S. Kawamura, Effectiveness of Natural Polyelectrolytes in Water Treatment, J. Amer. Water Works Assoc., **83(10)**, 88-91 (1991).
6. M. A. A. Hassan, T. P. Li and Z. Z. Noor, Coagulation and Flocculation Treatment of Wastewater in Textile Industry using Chitosan, J. Chem. & Nat. Resour. Engg., **4(1)**, 43-53 (2009).
7. S. H. Lin and C. F. Peng, Continuous Treatment of Textile Wastewater by Combined Coagulation, Electrochemical Oxidation and Activated Sludge, Water Res., **30(3)**, 587-592 (1996).
8. S. Kim, C. Park, T. H. Kim, J. Lee and S. W. Kim, COD Reduction and Decolorization of Textile Effluent using a Combined Process, J. Biosci. & Bioengg., **95**, 102-105 (2003).

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