

Treatment of Textile Effluent by Natural Coagulants in Erode District

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A preliminary investigation was carried out for the feasible use of natural coagulants for the treatment of textile waste water in Erode district of Tamil Nadu (India). In this paper, different natural coagulants like *Moringa oleifera*, *Tamarina indica*, *Strychnomous potatorum* of 10, 20, 40, 60 and 80 mL dosages were used to spot the suitable one as primary coagulant. Floc formation in coagulation process had been studied in the laboratory scale to determine the optimum dosage of natural coagulants. Pre and post treated textile wastewaters with natural coagulants were considered to evaluate the percentage removal efficiency on the major pollutants of concern in textile effluent such as pH, turbidity, TSS, TDS, COD and BOD. From the observed results, the natural coagulant *Moringa oleifera* gives better removal efficiencies with respect to turbidity, TSS, TDS, COD and BOD and appears to be suitable for textile effluent treatment in Erode district, when compared with *Tamarina indica* and *Strychnomous potatorum*.

Keywords: *Moringa oleifera*, *Tamarina indica*, *Strychnomous potatorum*, Textile effluent.

INTRODUCTION

India is the world's second major manufacturer of textiles and garments after china. The textile and garment industry in India is one of the oldest manufacturing sectors in the country and is currently it's largest. The textile and garment industry fulfils a pivotal role in the Indian economy. Especially Tamilnadu is famous for dyeing, knit wearing, silk sarees, RMG, surgical textiles and for blankets. Erode district in Tamilnadu is situated at the centre of the South Indian peninsula between 11° 19.5" and 11° 81.05" North latitude and 77° 42.5" and 77° 44.5" East longitude. Recently, it was observed that Erode district in Tamilnadu were experiencing severe environmental problems due to textile dyeing, leather tanning, paper and pulp processing, sugar manufacturing industries, etc.

Textile industry involves wide range of raw materials, machineries and processes to trick the required shape and properties of the final product. The main cause of generation of this effluent is the use of huge volume of water either in the actual chemical processing or during re-processing in preparatory, dyeing, printing and finishing. Textile wastewater pollutants are generally caustic soda, detergents, starch, wax, urea, ammonia, pigments and dyes that increase its BOD, COD, solid contents and toxicity¹. The treatment methods of wastewater include activated carbon adsorption, oxidation, chemical coagulation/flocculation, electrochemical methods, membrane techniques^{2,3} and biological treatment processes are frequently

used to treat textile effluents. These processes are generally efficient for Biochemical oxygen demand (BOD) and suspended solids (SS) removal, but they are largely ineffective for removing color from the wastewater⁴. Depending on the wastewater characteristics, COD of a textile effluent can be reduced between 50 and 70 % after optimizing the operating conditions such as pH, coagulant and flocculants concentration. Coagulation is an essential process in the treatment of industrial wastewater. Its application includes removal of dissolved chemical species and turbidity from water *via* addition of conventional chemical-based coagulants, namely alum, ferric chloride and polyaluminium chloride⁵. The disadvantages associated with usage of these coagulants such as ineffectiveness in low-temperature water, relatively high procurement costs, detrimental effects on human health, production of large sludge volumes and the fact that they significantly affect pH of treated water⁶. To counteract the aforementioned drawbacks, it is enviable to reinstate these chemical coagulants with natural coagulants.

Polymeric coagulants can be cationic, anionic or nonionic, in which the former two are collectively termed as polyelectrolyte. Many studies concerning natural coagulants referred to them as 'polyelectrolytes' even though many of these studies did not actually conduct in-depth characterization to determine their ionic activity⁷. Plant-based natural coagulants may be derived from seeds, leaves, fruits, roots and barks. However, the most common plant part used is the seed of plants^{7,8}.

Although many plant-based coagulants have been reported, only four types are generally well-known within the scientific community, namely, Nirmali seeds, *Moringa oleifera*, tannin, cactus bean seed, etc⁶. Natural coagulants are popular due to their availability, cost effective, biodegradable, non-toxic, renewable and for production of less sludge^{9,8}. In addition, natural coagulant has a wider effective dose range and does not alter the pH of treated water⁸.

Therefore, this study was carried out to analyze the effect of *Moringa oleifera* seed, *Tamarina indica* and *Strychnomous potatorum* seed as a primary coagulant in clarifying textile wastewater in coagulation process at its optimum dosages. The optimum dosage and its removal efficiencies of seed on *Moringa oleifera*, *Tamarina indica* and *Strychnomous potatorum* on pH, turbidity, TSS, TDS, COD and BOD were determined and compared with their subordinates.

EXPERIMENTAL

The raw effluent was collected from the textile industry in Moolagowndanpalayam of Kasipalayam panchayat in Erode Taluk, Erode district. Grab sampling technique was used to collect the effluent. Twenty liters of samples were collected and preserved at 4 °C in the laboratory incubator for further use.

Collection and processing of *M. oleifera*, *T. indica* and *S. potatorum*: *Moringa oleifera* seeds were collected from farms in Odanchathiram village of Dindukkal district and from Erode market. The seeds are allowed to dry in the laboratory oven at a temperature of 50 °C for 24 h. A rice husk removing machine was used to remove the hulls and wings from the kernels. The kernels were ground in to medium fine powder with domestic food blender.

Tamarina indica seeds used in this study was collected from the kitchen as a waste material. It was soaked in water for 1 h to remove the adhering pulp, washed well with tap water and then with double distilled water, dried in an air oven at 110 °C for 1 h, micronized in a four mill¹⁵.

Strychnos potatorum seeds were collected from the local market in Erode city. *Strychnos* seeds, due to their hard structure, could not be powdered in a grinder. The seeds were kept immersed in 50 mL water containing 2mL conc. HCl. After a week, the mixture was mashed to a soup-like solution, which was washed through a nylon cloth and the material retained on the cloth was oven dried for 24 h at 103 to 105 °C and weighed.

Preparation of Coagulant stock solution

Mature seeds showing no signs of discoloration, softening or extreme desiccation were used¹⁰. The seed kernels of *M. oleifera*, *T. indica* and *S. potatorum* were ground to fine powder of approximate size 600 µm to achieve solubilization of active ingredients in the seed. Tap water was added to the powder to make 2 % suspension (2 g of *M. oleifera*, *T. indica* and *S. potatorum* powder in 100 mL water). The suspension was vigorously shaken for 0.5 h using a magnetic stirrer to promote water extraction of the coagulant proteins and this was then passed through Whatman no. 1 filter paper^{11,12}. Fresh solutions were prepared daily and kept refrigerated to prevent any ageing effects. Solutions were shaken vigorously before use^{10,13,14}.

Physiochemical analysis of textile effluent: The wastewater was exemplified in terms of pH, turbidity, SS, TDS, COD and BOD. These parameters were determined following analytical methods given in the series of standard methods for the examination of water and wastewater. Methods -,2130 -B, 2540-C, 2540-D, 5210-B and 5220-D were used for the measurement of turbidity, TSS, TDS, COD and BOD, respectively¹⁶. pH was measured using digital SCHOTT pH metre model C G824 (accuracy pH ± 0.1).

Optimization of *M. oleifera*, *T. indica* and *S. potatorum* dosage using jar test: The optimization for *M. oleifera*, *T. indica*, *S. potatorum* and alum dosage were performed using the jar test apparatus. The apparatus permitted four beakers to be agitated all together. 0.5 L of textile wastewater were dosed with 10, 20, 40, 60 and 80 mL of natural coagulants were stirred rapidly for 10 min at 180 rpm, followed by 10 min slow stirring for flocculation. The coagulant dosage can be selected depending on the turbidity of wastewater. Floc formation can be observed throughout this time. Flocs were permitted to settle for one hour before obtained for samples analysis. These procedures are performed for several times so that the optimum pH and dosage of coagulant can be calculated^{17,18}. After settling, 30 mL of the sample was taken from the middle of each beaker using a pipette and placed in small beaker for further analysis.

RESULTS AND DISCUSSION

An initial experiment was carried out to determine the preliminary characteristics of textile effluent for examining the effectiveness of the *M. oleifera*, *T. indica* and *S. potatorum* as a coagulant. The characteristics of raw textile effluent were presented in Table-1.

TABLE-1
CHARACTERISTICS OF RAW TEXTILE EFFLUENT

Parameters	Textile effluent
pH	9.73
Turbidity, NTU	5700
TSS (mg/L)	5450
TDS (mg/L)	3235
BOD (mg/L)	765
COD (mg/L)	2100

Effect of floc formation on optimum dosage of *M. oleifera*, *T. indica* and *S. potatorum*: Coagulant actions onto colloidal particles take place through charge neutralization of negatively charged particles. If charge neutralization is the predominant mechanism, a stoichiometric relation can be established between the particles' concentration and coagulant optimal dose. Fig. 1 illustrated the optimum dosage 40 mL solution of *M. oleifera* produces 82 mL of flocs when it was agitated with the textile effluent. Subsequently 10, 20, 60 and 80 mL dosages of *M. oleifera* generate 43, 52, 63 and 36 mL of flocs with respect to their corresponding dosages. It was evidently understood from the Fig. 1, 60 mL of *T. indica* solution produces 76 mL of floc formation and has been designated as the optimum coagulant dosage. 28, 49, 57 and 25 mL of floc was achieved by the 10, 20, 40 and 80 mL dosages of *T. indica* solutions. The jar test apparatus data articulate that on all dosage

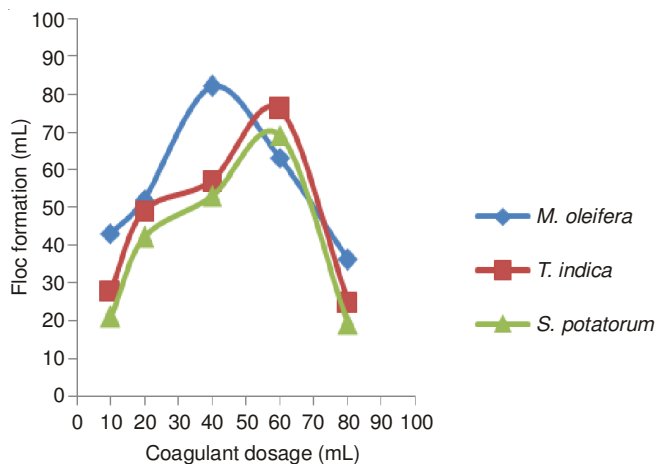


Fig. 1. Floc formation on optimum dosage of *M. oleifera*, *T. indica* and *S. potatorum*

of *S. potatorum*, 69 mL of the floc is optimum for 60 mL dosage. 21, 42, 53 and 19 mL of floc were produced with respect to 10, 20, 40 and 80 mL dosages.

Effect of pH on the removal of turbidity using optimum dosage of *M. oleifera*, *T. indica*, *S. potatorum*: The effect of pH value on the removal of turbidity using *M. oleifera*, *T. indica*, *S. potatorum* as a coagulant is shown in Fig. 2. The volume of textile effluent that has been used was 500 mL, while the optimum dosage of *M. oleifera* was taken as 40 mL and 60 mL for *T. indica* and *S. potatorum*. It can be evidently seen that the optimum range of pH in term of percentage removal of turbidity is 6. In the pH range 4-7, turbidity reduces below 82%. The results are in conformity with those reported by Zhang *et al.*¹⁹, who prove that the use of *M. oleifera* does not alter pH and it is not easy to confirm the optimum pH. The turbidity removals show a decrease at pH 7 to 9 and above which particle size of textile effluent become complex to destabilize. This could be due to the charges of particles are neutralized by positively charged coagulants hydrolysis species in which zero point of charge (ZPC) is shifted to acidic region for raw water due to the increased charge of dissolved organic matter²⁰. In the present work, it is recommended that the pH value of 6 is the best in terms of turbidity which are found to

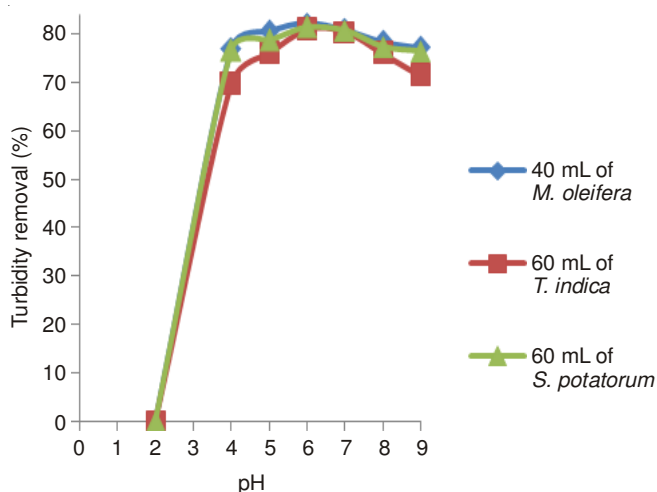


Fig. 2. pH effects on the removal of turbidity using *M. oleifera*, *T. indica* and *S. potatorum*

be around 82.1, 80.8 and 81.4 %, respectively when *M. oleifera*, *T. indica*, *S. potatorum* is used as a coagulant in coagulation process.

Effect of *M. oleifera*, *T. indica*, *S. potatorum* dosages on the removal of TDS: Analysis carried out on textile effluent before treatment showed that the values of total dissolved solids (TDS) of the raw sample was 3235 mg/L. A plot between % TDS removal and dose of *M. oleifera*, *T. indica*, *S. potatorum* (mL) shown in Fig. 3, revealed a sharp increase up to 40 mL dosage of *M. oleifera* and 60 mL dosages of *T. indica* and *S. potatorum* followed by decreasing rates at higher dosages in the removal of TDS. The reduction in TDS in case of 40 mL dosage of *M. oleifera* is 70.51 %. At 60 mL dosage the percentage removal of *T. indica* is 41.85 and 52.30 for *S. potatorum*.

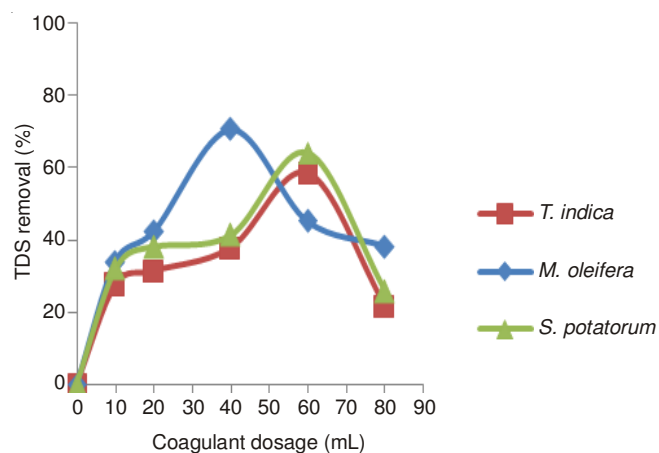


Fig. 3. Effect of *M. oleifera*, *T. indica* and *S. potatorum* dosages on removal of TDS

Effect of *M. oleifera*, *T. indica* and *S. potatorum* dosages on the removal of total suspended solid: As seen from Fig. 4, the *M. oleifera*, *T. indica* and *S. potatorum* dosage increases, total suspended solids removal percentage increases and suddenly it diminishes after attaining optimum dosage 40 mL (*M. oleifera*) and 60 mL (*T. indica* and *S. potatorum*). The present study clear that, the percentage removal of TSS were registered effectively as 80.56, 77.28 and 75.72 % at 40 mL dosage of *M. oleifera* followed by 60 mL dosage of *S. potatorum* and *T. indica*.

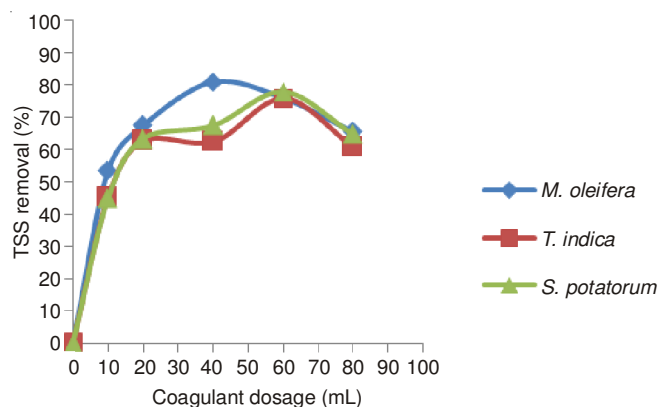


Fig. 4. Effect of *M. oleifera*, *T. indica* and *S. potatorum* dosages on the removal of TSS

Effect of *M. oleifera*, *T. indica*, *S. potatorum* dosages on the removal of BOD and COD: Figs. 5 and 6 depicted the percentage removal of BOD and COD using various dosages of *M. oleifera*, *T. indica* and *S. potatorum*, respectively. The highest percentage removal of BOD was found to be 72.29 % at 40 mL dosage of *M. oleifera*, 57.52 and 65.36 % at 60 mL dosage of *T. indica*, *S. potatorum* respectively. For COD, highest percentage removal was found to be 79.34, 68.9 and 72.71 with 40 mL of *M. oleifera* and 60 mL of *T. indica* and *S. potatorum*, respectively. It can be exposed that constant percentage removals of BOD and COD were found using all these above mentioned coagulants. From the results it had been proved that *M. oleifera* followed by *S. potatrum* and *T. indica* were more effective to remove the BOD and COD.

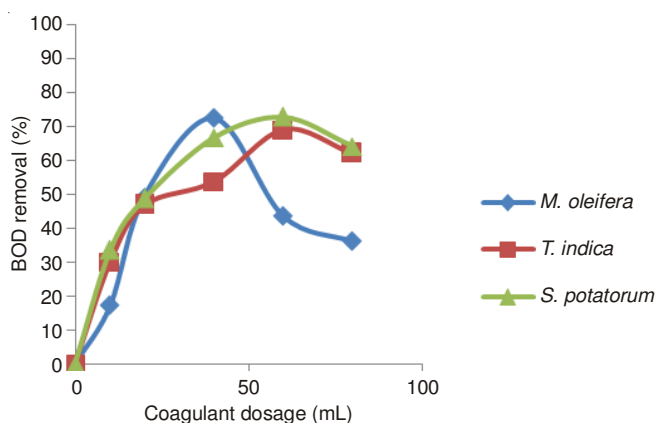


Fig. 5. Effect of *M. oleifera*, *T. indica* and *S. potatorum* dosages on the removal of BOD

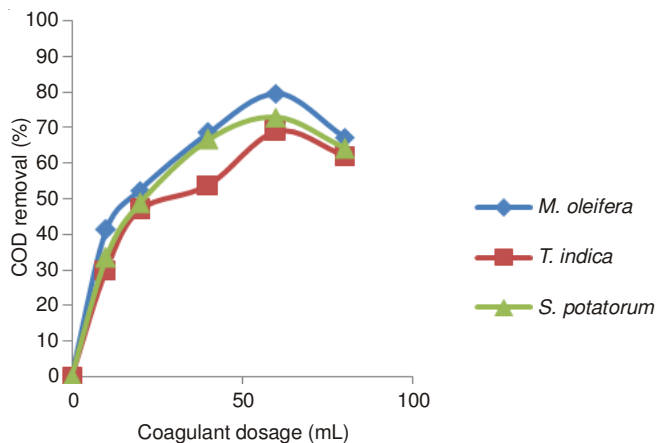


Fig. 6. Effect of *M. oleifera*, *T. indica*, *S. potatorum* dosages on the removal of COD

Conclusion

The textile effluent collected from erode district was analyzed for the various parameters, wherein turbidity, TSS,

TDS, BOD and COD were in superior limits and in demand of elimination. The feasibility in the treatment of textile effluent using natural coagulants like *Moringa oleifera*, *Tamarina indica* and *Strychnomous potatorum* had been taken for investigation. Optimum dosage for highest % reduction in TSS, TDS, BOD and COD using *M. oleifera*, *T. indica*, *S. potatorum* was found to be 40 and 60 mL. when *M. oleifera*, *T. indica*, *S. potatorum* was used as a coagulant in terms of percentage removal of turbidity, pH value of 6 was the most viable and were found to be around 82.1, 80.8 and 81.4 %, respectively. As compared to *T. indica* and *S. potatorum* it was observed from obtained data that *M. oleifera* has more ability for the removal of TDS and TSS. *M. oleifera* has more potential followed by *S. potatorum* and *T. indica* to remove the BOD and COD. *Moringa oleifera* gives the promising removal efficiency among the two natural coagulants elected for investigation. Hence it is recommended to utilize the natural coagulant *Moringa oleifera* for the treatment of textile effluent.

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