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EXPERIMENTAL STUDY ON REMOVAL EFFICIENCY OF BLENDED COAGULANTS IN TEXTILE WASTEWATER TREATMENT

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ABSTRACT

A preliminary investigation was carried out for the feasible use of blended coagulants to the treatment of textile waste water. In this paper, natural coagulant *Moringa oleifera* and Chemical Coagulant Alum of 10, 20, 40, 60 and 80 mL dosages were used. Floc formation in coagulation process had been studied in the laboratory scale to determine the optimum dosage of natural coagulants. Various proportions of MO: $(Al_2(SO_4)_3$ like 0:0, 100:0, 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80, 10:90 and 0:100 were used in Pre and post treated textile wastewaters with coagulants were considered to evaluate the percentage removal efficiency on the major pollutants of concern in textile effluent such as turbidity, TSS, TDS, COD and BOD. From the observed results, the blended coagulant MO: $(Al_2(SO_4)_3$ of 50:50 dosage ratio gives better removal efficiencies with respect to turbidity, TSS, TDS, COD and BOD and appears to be suitable for textile waste water treatment, when compared with other dosage ratios.

KEYWORDS: Alum, Floc, Jar Test, *Moringa oliefera*, Textile Waste Water

INTRODUCTION

Textile dyeing processes are among the most environmentally unfriendly industrial Processes, because they produce colored wastewaters that are heavily polluted with dyes, textile auxiliaries and chemicals [1]. The colored waste waters of these industries are harmful to the aquatic life in the rivers and lakes due to reduced light penetration and the presence of highly toxic metal complex dyes. Most of the used dyes are stable to photodegradation, biodegradation and oxidizing agents. [2]. Wastewater generated by different production steps of a textile mill have a high pH, temperature, detergents, oil, suspended and dissolved solids, dispersants, leveling agents, toxic and non biodegradable matter, colour and alkalinity. Wastewater from fabric and yarn printing and dyeing pose serious environmental problems both because of their color and high COD and BOD [3].

The treatment methods of wastewater include activated carbon adsorption, oxidation, chemical coagulation/flocculation; electrochemical methods, membrane techniques [4], [5] 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 wastewater [6]. 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 [7]. Each has its merits and limitations in applied Decolorization treatment operations. But coagulation- flocculation is the most common chemical treatment method for Decolorization [8]. Coagulation or flocculation process was conducted for the treatment of industrial waste water to achieve maximum removal of COD and TSS. [9]. Colloid particles are removed from water via coagulation and the flocculation processes. [10]. The coagulation and the flocculation of suspended particles and colloids result from different mechanisms including electrostatic attraction, sorption (related to protonated amine groups) and bridging (related to polymer high molecular weight) [11]. Many coagulants are widely used in conventional water treatment processes for tap water production. These coagulants can be classified into inorganic coagulants (e.g. aluminum sulfate, polyaluminum chloride, ferric chloride), synthetic organic polymers (e.g. polyacrylamide derivatives and polyethylene amine) or naturally occurring coagulants (e.g. Chitosan, plant extracts) [12].

Aluminium salts are the most widely used coagulants in water and wastewater treatment all over the world. However, the studies by several workers have raised doubts about introducing aluminum into environment [13]. However, some studies have reported that aluminum that remains in the water after coagulation, may induce Alzheimer's disease [14] Besides, many developing countries can hardly afford the costs of imported chemicals for water and wastewater treatment. On the other hand, naturally occurring coagulants are biodegradable and are presumed safe for human health. The use of natural materials of plant origin to clarify turbid raw waters is not a new idea. In time there has been more interest in the subject of natural coagulants, especially to reduce the problems of water and wastewater treatment in developing countries and to avoid some health risks.(12) Plants that were recently tested are mesquite bean (*Prosopis juliflora*) and *Cactus latifaria* in Venezuela [15], in Egypt and North Sudan various bean (*Phaseolus*), peas (*Pisum*), peanuts (Arachis) and lupines (Lupines) [16], *Cassia angustifolia* seeds [9], seeds from *Moringa oleifera* [16], etc. *Moringa oleifera* Lam (*M. oleifera*) is a multipurpose tree native to Northern India that now grows widely throughout the tropics.

Therefore, this study was carried out to analyze the effect of *Moringa oliefera* seed (MO) and *Phaseolus vulgaris* (PV) 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 oliefera* (MO) and *Phaseolus vulgaris* (PV) on pH, turbidity, TSS, TDS, COD and BOD were determined and compared with their subordinates.

MATERIALS AND METHODS

Collection and Processing of *Moringa oliefera* and Alum

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 hours. 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. Figure 1 show *Moringa oliefera* seeds and its dry powder. The commercially available Chemical Coagulant Alum was collected from local market in Erode city. Figure 2 shows the commercially available Alum.

Figure 1: *Moringa oliefera* Seed and its Dry Powder

Figure 2: Chemical Coagulant Alum

Collection of Raw Effluent from Textile Industry

The raw effluent was collected from the textile Industry in Molagowndanpalayam 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.

Preparation of Coagulant Stock Solution

Moringa oleifera stock solution: Mature seeds showing no signs of discoloration, softening or extreme desiccation were used10. The seed kernels 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 *Moringa oleifera* 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*, and Alum Dosage Using Jar Test

The optimizations for *M. oleifera* 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 DISCUSSIONS

An initial experiment was carried out to determine the preliminary characteristics of textile effluent for examiningThe effectiveness of the *M. oleifera* and Alum 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	11.65
Turbidity, NTU	175
TDS, mg/L	2800
TSS, mg/L	1348

Table 1: Contd.,

BOD, mg/L	450
COD, mg/L	1990

Effect of Floc Formation in Textile Waste Water by *M. oleifera* and Alum

The size formed with natural coagulant was superior to that produced by alum. And the flocs were never found disintegrable when subjected to rapid mixing; the natural coagulants when mixed with alum in varying combinations gave more results. Figure 3 illustrated the optimum dosage ratio 50:50 dosage ratio of *M. oliefera:* $(Al_2\,(SO_4)_3$ produces 80 mL of flocs when it was agitated with the textile effluent. Subsequently 0:0, 100:0, 90:10, 80:20,70:30, 60:40, 40:60, 30:70, 20:80, 10:90 and 0:100 dosage ratio of MO: $(Al_2(SO_4)_3$ *generates* 10mL, 20ml, 38mL, 47mL, 62ml, 71mL, 81ml, 80mL, 80mL, 80mL, 80mL and 80 mL of flocs with respect to their corresponding dosages.

Effect of *M. oleifera* and Alum on the Removal of Turbidity

Figure 4 depicted the turbidity removal (%) using various ratios of MO: $(Al_2(SO_4)_3$. The initial turbidity was recorded as 690 NTU before coagulation. The highest turbidity removal (%) was found to be 61.6% at 50:50 dosage ratio of *MO:* $(Al_2(SO_4)_3$. 21.30,29.42,39.71,43.91 and 51.88 turbidity removal (%) were obtained by 90:10, 80:20, 70:30 and 60:40 dosage ratios of *MO:* $(Al_2(SO_4)_3$ respectively. From the results it is evidently proved, 50:50 of dosage ratio of *MO*: $(Al_2(SO_4)_3$ increases the turbidity removal.

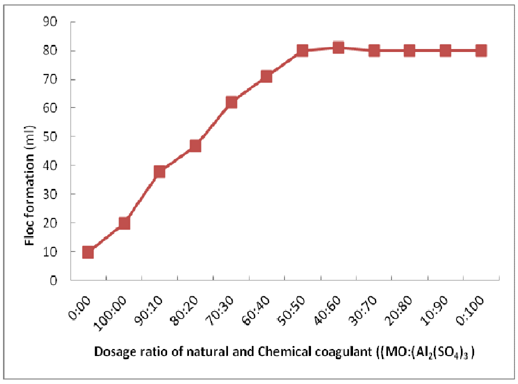

Figure 3: Effect of Floc Formation in Wastewater with Different Dosage Ratio of MO: $(Al_2(SO_4)_3$

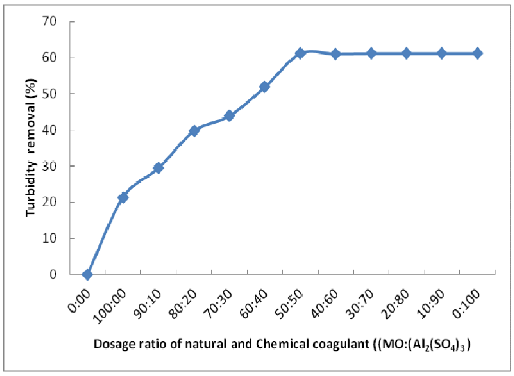

Figure 4: Effect of Turbidity in Waste Water with Different Dosage Ratio of MO: $(Al_2\,(SO_4)_3$

Effect of *M. oleifera* and Alum on the Removal of TDS

Analysis carried out on textile waste water before treatment showed that the value of total dissolved solids (TDS) of the raw sample was 2800 mg/L. A plot between TDS removal (%) and dosage ratios of MO*:* $(Al_2\,(SO_4)_3$ was shown in Figure 5. A gradual increase in TDS removal (%) of 23.07,29.21,36.86,45.29,47.82 and 60.04% was achieved by 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 dosage ratio of MO*:*$(Al_2\,(SO_4)_3$ respectively. revealed that TDS removal in textile waste water by blended coagulants are highly efficient. The maximum TDS removal (%) of 60.04 was shown by 50:50 dosage ratio of MO*:* $(Al_2\,(SO_4)_3$.

Effect of *M. oleifera* and Alum on the Removal of TSS

As seen from Figure 6, total suspended solids removal (%) of textile wastewater were gradually increased from 3.71, 11.50,14.91,38.06,41.47 and 54.15% at 0:100,100:00,90:10,80:20,70:30,60:40 and 50:50 dosage ratios of

MO: $(Al_2\,(SO_4)_3$ respectively. The present study clear that, the TSS removal (%) were registered effectively as 54.15 % at 50:50 and decreased as 42.73,34.05% at dosage ratios of 40:60 and 30:70 respectievly.33.98% of TSS removal was effectively achieved by 20:80.10:90 and 0:100 dosage ratios of of MO: $(Al_2\,(SO_4)_3$.

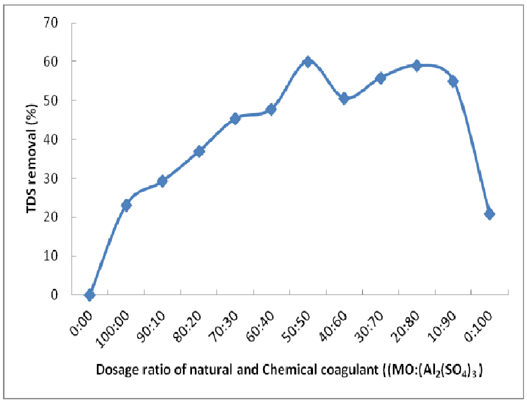

Figure 5: Effect of TDS in Waste Water with Different Dosage Ratio of MO: $(Al_2\,(SO_4)$

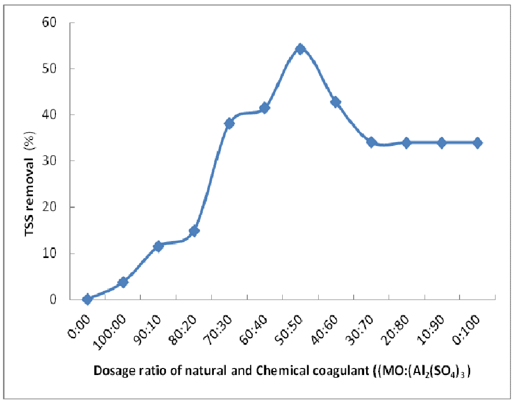

Figure 6: Effect of TSS in Waste Water with Different Dosage Ratio of MO: $(Al_2\,(SO_4)_3$

Effect of *M. oleifera* and Alum on the Removal of BOD and COD

Figure 7 and 8 depicted the removal of BOD and COD using various dosage ratios of MO*:* $(Al_2\,(SO_4)_3$ respectively. The highest BOD and COD removal (%) was found to be 80.67 and 66.73 at 50:50 dosage ratio of MO*:* $(Al_2\,(SO_4)_3$ respectively. From the results it had been proved that, the effective removal of BOD and COD was achieved by same proportions of MO*:* $(Al_2\,(SO_4)_3$.

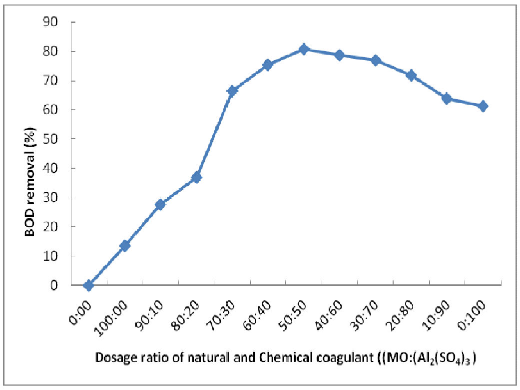

Figure 7: Effect of TSS in Waste Water with Different Dosage Ratio of MO and $(Al_2\,(SO_4)_3$

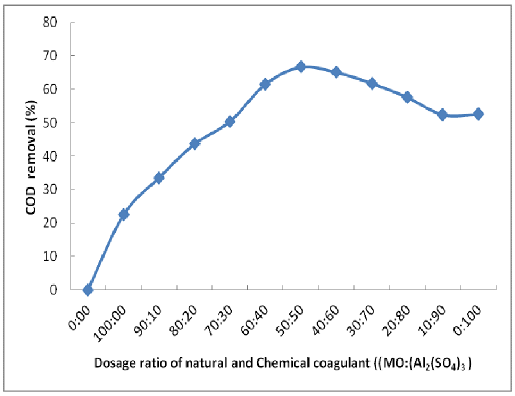

Figure 8: Effect of TSS in Waste Water with Different Dosage Ratio of MO and $(Al_2\,(SO_4)_3$

CONCLUSIONS

The textile waste water collected from Erode district was examined for the various parameters, in which Turbidity, TSS, TDS, BOD and COD were in superior limits and in demand of elimination. The feasibility in the treatment of textile waste water using natural coagulant *Moringa oliefera (MO)* and Chemical coagulant Alum $(Al_2\,(SO_4)_3$ had been taken for investigation. Optimum dosage for maximum removal (%) in turbidity, TSS, TDS, BOD and COD using *M. oliefera* and Alum was found to be 50:50 dosage ratio. when *M. oliefera and alum* was used as a coagulant in terms of percentage removal of turbidity, TDS, TSS, BOD and COD, dosage ratio of 50:50 was the most viable and reduces 61.6 %, 60.4%, 54.15%, 80.67% and 66.73% respectively. As compared to the other dosage ratios, it was observed from obtained data that 50:50 of MO: (Al_2 $(SO_4)_3$. has more potential for the removal of concern pollutants in textile waste water. Hence it is recommended to utilize the blended coagulant (MO: (Al_2 $(SO_4)_{3)}$ for the treatment of Textile effluent.

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