

Comparative Study of Natural Coagulants in Removing Turbidity from Industrial Waste Water

Lakshmi V¹, Janani R V¹, Anju G S¹, Roopa V²

U.G. Students, Department of Civil Engineering, College of Engineering & Management, Punnapra, Kerala, India¹

Assistant Professor, Department of Civil Engineering, Carmel College of Engineering & Technology, Punnapra, Kerala, India²

ABSTRACT: Water is the most vital natural resource that sustains life but industrialisation has reduced the quality of water owing to the discharge of industrial effluent into fresh water bodies. Industrial effluent needs treatment to reduce turbidity before discharging into river. Conventional treatment of waste water includes coagulation, flocculation, sedimentation and filtration. Alum is the widely used chemical coagulant but it is a strong neurotoxin and causes Alzheimer's disease. Natural coagulants work as an alternative for chemical coagulants. It performs dual function of reducing turbidity as well as it is eco friendly. Addressing the problems of turbidity calls out for a tremendous amount of research to be conducted to identify and establish new methods of purifying water at lower cost and with less energy while the same time minimising the use of chemicals and its impact on environment. The present study highlights the comparison of some natural coagulants like *Moringa oleifera* (Drumstick), *Cicer arietinum* (Chick pea), *Dolichos lablab* (Indian beans) and *Tamarindus Indica* (Tamarind) and their efficiency in reducing turbidity of waste water from rubber and dairy industries.

KEYWORDS: Coagulants, Turbidity, Alum, *Moringa oleifera*, *Cicer arietinum*, *Dolichos lablab*, *Tamarindus Indica*

I. INTRODUCTION

Water is undoubtedly the most important element among the natural resources. In India, access to clean and safe water is a crucial issue. Drinking water which should be palatable and potable is essential to the health and welfare of a community. Thus water from all sources should have some form of purification before consumption. Various methods are used to make water safe and attractive to the consumers but the method employed depends on the character and source of the raw water. Major problem with treatment of surface water is the large seasonal variation in turbidity. Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy or murky. This can increase the cost of water treatment.

Coagulation is the most commonly used method for purifying water. Coagulants can be applied in wastewater to reduce suspended solids and other pollutants. Many synthetic coagulants like aluminium sulphate (alum) and ferric chloride are widely used in conventional water treatment processes for turbidity removal. On the other hand, a portion of coagulant added in the wastewater will remain as residual Al or Fe in the treated water, and when released into nature has no effect in the functioning of living cells but presents some toxic effects in elevated concentrations.

Aluminium toxicity is an important growth-limiting factor for plants in acid soils below pH 5.0, but can also occur at pH levels as high as 5.5. Although iron is an essential element for all plants, higher iron content in acidic soils have a negative impact on nutrient and mineral uptake which leads to decrease in yield. The use of chemical coagulants can cause potential health and environmental problems. Aluminium in alum causes neurological diseases. Sludge produced is voluminous and non-biodegradable after treatment and therefore possess disposal problems leading to increase in

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

cost of treatment. Naturally occurring coagulants are generally considered safe for human health. Recent studies indicate that various natural coagulants can be produced from microorganisms, animals or plants. The research of Schulz & Okun in 1984 explains that natural polyelectrolytes of plant origin have been used for many centuries in developing countries for clarifying turbid water and recently Vimalkumar et al., 2011 made an effort to treat wastewater by means of adsorption mechanism followed by charge neutralization or by polymeric bridging effect. An attempt to compare the efficiency of natural coagulant with that of alum was also carried out by Saritha et al., 2012, Renuka et al., 2013 and Jelena et al., 2013[5].

II. MATERIALS AND METHODS

Wastewater samples collected from dairy and rubber industries were used for the study. Coagulation was carried out using natural coagulants such as *Moringa oleifera*, *Dolichos lablab*, *Cicer arietinum* and *Tamarindus indica*. The samples collected were labelled and stored at 4°C. Conventional jar test apparatus was used to carry out the experiment [10,11,12]. Initially stock solution of natural coagulants were prepared. Mature and dry *Moringa oleifera* seed pods were collected. The seeds were removed from the pods, kept for sun dry, and external shells were removed. Mature seeds showing no signs of discoloration, softening or extreme desiccation were used. The seed kernels were ground to fine powder using a kitchen blender to make it of approximate size of 600µm to achieve solubilization of active ingredients in the seed [1,2,3].

Cicer arietinum and *Tamarindus indica* seeds were also collected, dried and finely ground. The grains of powder were maintained of size approximately less than 600µm to achieve solubilisation of active ingredients in the seed. For the preparation of stock solution of *Dolichos lablab* mature seeds were taken. After sun dry, external shells were removed and seed kernels were obtained. Using grinder, the seed kernels were finely ground. Distilled water was added to the powder to make it into 1% suspension. The suspension was vigorously shaken for 45 minutes using a magnetic stirrer to promote water extraction of the coagulant proteins, and was then passed through filter paper (whatman filter paper 42, 125mm diameter). The filtrate portions are used for required dose of natural coagulants. Solutions were shaken vigorously before use. Coagulation-flocculation was carried out in jar test apparatus, as a batch test, accommodating a series of six beakers together with six spindle steel paddles as shown in figure 1. Turbidity was then measured.



Fig. 1: Jar Test apparatus

500mL of sample was taken in each of the six beakers and varying doses of natural coagulants, i.e. from 250 mg/l to 1500mg/l was added to different beakers simultaneously. The apparatus was switched on, the speed of paddles were

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

adjusted to about 350rpm, and rapid mixing was done for 1-2 minutes. The speed of paddle was now reduced to about 30 to 40 rpm and slow mixing was continued for 20 minutes. This corresponds to the process of flocculation. The motor was switched off and solution was allowed to settle for 20-60 minutes. This corresponds to sedimentation or settling of impurities. The supernatant was collected from each beaker with the help of pipette, without disturbing the sediment. The percentage of turbidity removal was measured using turbidimeter.

Turbidity removal corresponding to various dosages of natural coagulant ranging from 10 to 500 mg/l was measured and a graph between turbidity (NTU) as ordinate and coagulant dosage (mg/l) as abscissa was plotted in order to determine the least dosage producing maximum removal which was designated as optimum coagulant dose. The above process was repeated using alum and optimum dosage was determined. The results were compared to find the most effective coagulant. Optimum system pH was found by adding 75% of the optimum coagulant dosage. pH of the sample was varied from 2.0 to 12.0 and the pH value producing maximum turbidity removal (optimum pH) was determined. Reduction in coagulant dosage at optimum pH was determined by adding varying doses to the sample maintained at optimum system pH level and the least dosage producing maximum removal was determined. For evaluating removal of turbidity, sample concentrations were measured before and after the experiment by using turbidimeter and the procedure were repeated.

One of the harder decisions in jar test was what dosage levels to test in an unknown or unfamiliar water or wastewater. The following data was used as guides and starting points only. These standards were adopted according to General Chemical Technical bulletin about Jar test as shown in Table 1.

TABLE 1: STANDARDS FOR CONDUCTING JAR TEST

Coagulant (mg/l)	Turbidity (NTU)	Colour (Pt-Co)	Jar increments
<10	<10	<10	1 - 2
10 - 50	10 - 50	10 - 50	5
50 - 100	50 - 100	50 - 100	10
100 - 250	100 - 250	100 - 500	25
250 - 1500	250 - 1500	500 - 1000	50

III. EXPERIMENTAL RESULTS

A. Results of Turbidity removal of waste water from Rubber industry

Various doses of coagulants starting from 250 to 1500 mg/L were added in six beakers containing effluent from rubber industry. Initial turbidity of the sample was 465 NTU. Optimum dosage of *Moringa oleifera*, *Dolichos lablab*, *Cicer arietinum* and *Tamarindus indica* were found to be 500, 1250, 1300, 1250 mg/L respectively. For determining the optimum pH, 75 % optimum coagulant dose of each coagulants were added to six beakers and pH was varied from 2 to 12. Turbidity was found to be decreasing from initial value and optimum pH for *Moringa oleifera*, *Dolichos lablab*, *Cicer arietinum* and *Tamarindus indica* were found to be 8, 10, 8, 8 respectively. It was observed that all the coagulants have optimum pH in alkaline range.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

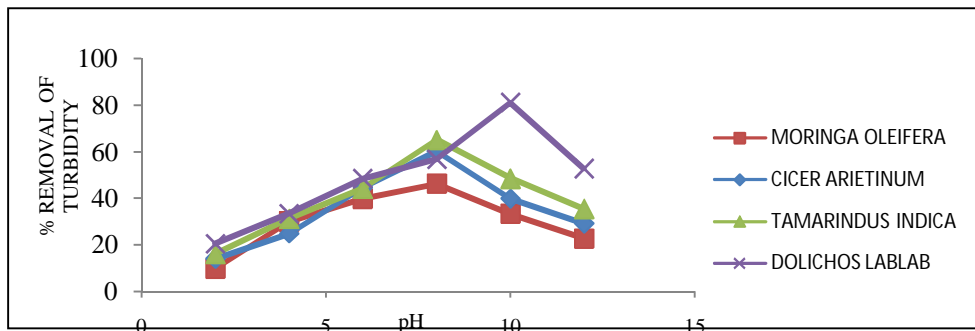


Fig.1 pH Vs %removal of turbidity for various natural coagulants for rubber industry

Among these coagulants *Moringa oleifera* require least dosage and *Dolichos lablab* need much higher pH and is clearly depicted in Figure.1. This graph compares the percentage removal of turbidity of various coagulants based on their coagulant dosage. From this graph it is clear that *Dolichos lablab* has maximum removal of turbidity and *Tamarindus indica*, *Cicer arietinum* and *Moringa oleifera* in the second, third and fourth position respectively.

The *Dolichos lablab* can reduce 81.1% of turbidity which is the most effective coagulant in treating waste water from rubber industry. The turbidity removal efficiency for *Cicer arietinum*, *Tamarindus indica* and *Moringa oleifera* were 60.2%, 65% and 45.6% respectively as shown in Figure.2.

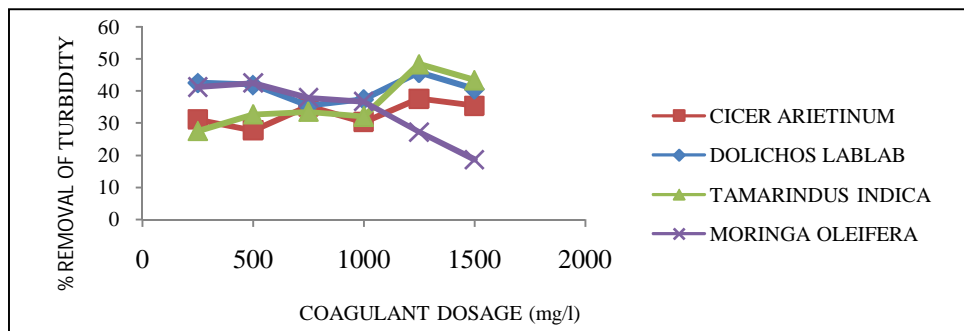


Fig. 2: Coagulant dosage Vs % removal of turbidity for various natural coagulants for rubber industry

B. Results of Turbidity removal of waste water from Dairy industry

Various dosages of coagulants starting from 10 to 110 mg/L were added in six beakers containing effluent from dairy industry. Initial turbidity of sample was 195 NTU. The least dosage which gives maximum turbidity removal was selected as optimum dosage. Optimum dosage of *Moringa oleifera*, *Dolichos lablab*, *Cicer arietinum* and *Tamarindus indica* were found to be 56, 52, 72, 52 mg/L respectively. For determining the optimum pH, 75% optimum coagulant dosage of each coagulants were added in six beakers and pH was varied from 2 to 12. Turbidity was found to be decreasing from initial value and optimum pH for *Moringa oleifera*, *Dolichos lablab*, *Cicer arietinum* and *Tamarindus indica* were found to be 6, 8, 8, 8 respectively. It was observed that all the coagulants except *Moringa oleifera* have optimum pH in alkaline range. Among these coagulants *Moringa oleifera* require least pH value while *Dolichos lablab*, and *Tamarindus indica* need much lower coagulant dosage which is clearly depicted in Figure 3. This graph compares percentage removal of turbidity of various coagulants based on pH. It is clear that *Tamarindus indica* has maximum removal of turbidity followed by *Dolichos lablab*, *Cicer arietinum* and *Moringa oleifera* in the second, third and fourth position respectively.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

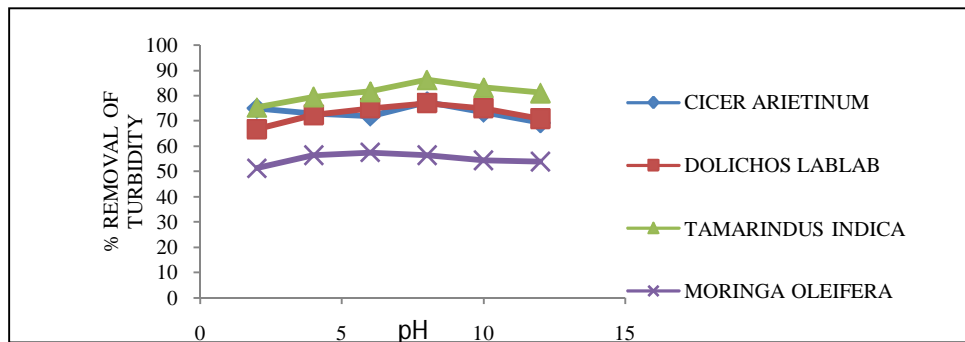


Fig.3 pH Vs %removal of turbidity for various natural coagulants for dairy industry

Tamarindus indica can reduce 86.15% of turbidity which is the most effective coagulant in treating waste water from dairy industry. The turbidity removal efficiency for *Cicer arietinum*, *Dolichos lablab* and *Moringa oleifera* are 77.44%, 76.9% and 57.45% respectively as shown in Figure 4. The study conducted by Phani Madhavi et.al, 2013 shows that turbidity removal was effective at an optimum dose of 150 mg/l with an optimum pH of 8.0 for industrial waste water. [8]

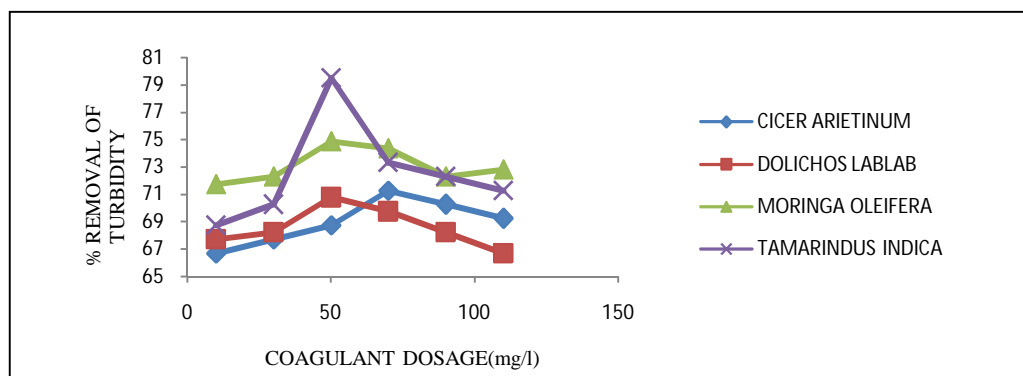


Fig. 4: Coagulant dosage Vs % removal of turbidity for various natural coagulants for dairy industry

IV. CONCLUSION

Dolichos lablab was found to be the most effective natural coagulant in reducing the turbidity of waste water from the rubber industry. The second effective coagulant was *Tamarindus indica*. The efficiency of *Dolichos lablab* was found to be 81.1% at an optimum dose of 450 mg/L and at an optimum pH of 10 while the efficiency of *Tamarindus indica* was found to be 65% at an optimum dose of 1250 mg/L and at an optimum Ph of 8. *Tamarindus indica* is the most effective natural coagulant to reduce the turbidity of waste water from dairy industry. The second effective coagulant was *Cicer arietinum*. The efficiency of *Tamarindus indica* was found to be 86.15% at an optimum dose of 48 mg/L and at an optimum pH of 8. The efficiency of *Cicer arietinum* was found to be 68% at an optimum dose of 68 mg/L and at an optimum pH of 8. Thus the present study concludes as rubber industry and dairy industry are sources of turbid waters, their turbidity removal which was a serious problem can now be solved easily by adopting natural coagulants *Dolichos lab lab* and *Tamarindus indica* respectively. The technologies involved are economical, traditional and easy to implement and ideal for rural areas. The process being biological in nature does not generate any non-treatable wastes. Sludge produced after coagulation can be used as fertilizer or as animal feed supplement. For the future development of

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

the use of plant materials for wastewater treatment, other native plants and plant materials should be investigated as coagulants for colour and turbidity removal. Future studies should focus upon the dosage of these materials to be used in water treatment. Efforts should be made to make these traditional technologies, which are already being used in rural areas, recognized and accepted globally.

REFERENCES

- [1] Eman N Ali., "Production of natural coagulant from moringa olifera seed for application in treatment of low turbidity water", Journal of Water Resource and Protection, Vol. 5, pp. 1018-1026, 2013
- [2] Defang Zeng., "Experimental Study on an Novel Environment-Friendly Coagulant for Treating Drinking Water", Open Journal of Composite Materials, Vol 2, pp.113-117, 2012.
- [3] Rajendran R., "Natural Coagulant-an Alternative to Conventional Methods of Water Purification", International Journal of Pharmaceutical Research and Bio science, 2013, Vol2(1), page no:306-314.
- [4] Nor Shazwani Daud., "Wheat Germ as Natural Coagulant for Treatment of Palm Oil Mill Effluent (POME)", International Journal of Chemical and Environmental Engineering, Vol. 5, No.2, April 2014.
- [5] Asrafuzzaman., "Reduction of Turbidity of Water using Locally Available Natural Coagulants", ISRN Microbiology, International Scholarly Research Network, Article ID 632189, 2011.
- [6] Saritha Varma., "Screening and evaluation of innate coagulants for water treatment: a sustainable approach", International Journal of Energy and Environment Engineering, 2012.
- [7] Mohd Omar Fatehah., "Comparative Study on Natural and Commercial Coagulants: Treatment of Semiconductor Wastewater in Sludge Production and Removal of Heavy Metals", International Journal of Science and Modern Engineering, ISSN: 2319- 6386, Vol.1, Issue-7, June 2013.
- [8] G Vijayaraghavan., "Application of plant based coagulants for Waste water treatment", International Journal of Advanced Engineering Research and Studies, Vol. I, Issue I, pp./88-92. October- December, 2011.
- [9] Jeleena Prodanovic., "Improvement of wastewater treatment by use of natural coagulants", Journal of Economic Development, Environment and People, Vol. 2, Issue 2, 2013
- [10] Madhukar V., "A comparative study of natural coagulants in Flocculation of local clay suspensions of varied turbidities", Journal of Civil Engineering and Technology, Vol .1, Issue 1, pp. 26-39, July-December 2013.
- [11] Sonal Choubey., "Comparison of efficiency of some natural coagulants- Bioremediation", International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, Vol.2, Issue 10, October 2012.