IJESRT: 8(10), October, 2019 ISSN: 2277-9655

International Journal of Engineering Sciences &Research Technology

(A Peer Reviewed Online Journal)

Impact Factor: 5.164

IJESRT

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

POTENTIAL APPLICATION OF NATURAL COAGULANTS IN SMALL SCALE SEWAGE TREATMENT

Pricilla D
Assistant Professor, Dept. Of Civil Engineering, PSG Institute of Technology and Applied Research, Coimbatore, India

DOI: 10.5281/zenodo.3522837

ABSTRACT
Coagulation and flocculation provide a rather straightforward method towards water clarification. However, ongoing debates over worrying health issues linked to chemical coagulants have paved the way to develop plant based natural coagulants. Typically, the synthetic chemicals Alum ($Al_2 (SO_4).12H_2O$), Ferric chloride (FeCl3), or poly aluminium chloride (PAC) are used for coagulation processes. There are however, numerous drawbacks to using these synthetic chemicals, including inefficiency at low temperatures, associated health problems, high costs, production of large volumes of sludge and the significant effect on pH that these chemicals cause. This has caused a push for "greener" alternatives, especially for use in low- and middle-income countries. While coagulants are typically thought of for use in drinking water treatment, they are also often used for wastewater treatment. The objective of this study is to assess the possibility of using natural coagulants as an alternative to the current commercial synthetic coagulant and to optimize the coagulation process. Here in this study, the effectiveness of five indigenous plants-based coagulants were used for small scale sewage treatment. The turbidity removal efficiency for the natural coagulants Cucurbita pepo seeds, Citrullus lanatus seeds, Leucaena leucocephala seeds, Chrysopogon zizanioides powder, Azadirachta indica powder respectively were 69.7%, 40.7%, 45.72%, 78.4%, 66.8% against 64% obtained for alum.

KEYWORDS: Indigenous coagulant, zizanioides powder, Turbidity, Jar test, Coagulation, Flocculation.

1. INTRODUCTION
All around the world, it's common practice to pump enormous volumes of wastewater into rivers, oceans and streams. This has extremely negative effects on the environment, fisheries and animals. Effects of wastewater pollutants are decaying organic matter and debris can use up the dissolved oxygen in a lake so fish and other aquatic biota cannot survive; Excessive nutrients, such as phosphorus and nitrogen (including ammonia), can cause eutrophication, or over-fertilization of receiving waters, which can be toxic to aquatic organisms, promote excessive plant growth, reduce available oxygen, harm spawning grounds, alter habitat and lead to a decline in certain species; Chlorine compounds and inorganic chloramines can be toxic to aquatic invertebrates, algae and fish; Bacteria, viruses and disease-causing pathogens can pollute beaches and contaminate shellfish populations, leading to restrictions on human recreation, drinking water consumption and shellfish consumption; Metals, such as mercury, lead, cadmium, chromium and arsenic can have acute and chronic toxic effects on species.

In order to overcome this, wastewater has been treated for a variety of purposes. This is gaining increased popularity as a means of preserving scarce freshwater resources. Wastewater and greywater use are increasingly considered as a method for combining water and nutrient recycling, increased household food security and improved nutrition for poor households. Economic and environmental pressures, and the conservation ethic, have led to widespread and growing applications for recycling of wastewater, including irrigation of food and non-food crops, green spaces, recovering arid land, fire systems, industrial cooling or industrial processing, sanitation and even as indirect and possibly direct sources of drinking-water. The beneficial use of wastewater also helps to decrease the impact on the environment of disposal of sewage or industrial effluent. Decentralised treatment with reused wastewater to save drinking water also helps to reduce the amount of wastewater. Thus, adequate water treatment and sanitation are essential to remove turbidity, impurities and other pathogenic bacteria which can be guided through the addition of coagulants. Due to its simplicity and effectiveness, coagulation and flocculation are one of the most widely adopted techniques to restore the palatability and improve the aesthetic appearance of turbid water. This technique results in the destabilization of colloidal particles and subsequently, the increment in particle size for the ease of sedimentation.

In this project, it is aimed to treat a wastewater for turbidity removal using pumpkin seeds, watermelon seeds, soundal seeds, vetiver, neem leaves against alum to evaluate the changes in physicochemical parameters of the wastewater for varying coagulant dosages.

2. MATERIALS AND METHODS

A. Sample Collection

The wastewater sample used for the study was fresh sewage collected from Sewage Treatment Plant located in PSG Institute of Technology and Applied Research (Coimbatore), Tamil Nadu, India. 0.2 MLD of water has been supplied in which 0.18 MLD of wastewater has been generated in an Institution for a population of 1,500.

B. Methodology

Physicochemical parameters of wastewater:

Both chemical and physical parameters have been tested before and after coagulation. Initially the water sample is tested for its pH using pH meter. The amount of Sodium (Na) and Potassium (K) present in the wastewater sample is determined by using Flame Photometer shown in Fig.1 which works on Beer-Lambert's law. The amount of Nitrate (NO_3) and Phosphate (PO_4) present in the wastewater sample is determined by using Spectrophotometer shown in Fig.2. Calcium (Ca) content is determined by using titration method. Biological oxygen demand is also been determined by using titration method. Wastewater sample is tested for total dissolved solids and suspended solids.

Fig.1 Flame Photometer

Fig.2 Visible Spectro-Photometer

Table 1.Physicochemical parameters of the waste water

SI No	Parameter	Observed value
1	pH	8.18
2	Turbidity	85.8 NTU
3	Total Dissolved Salts	0.15 mg/L
4	Suspended Solids	0.02g

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

5	Biological Oxygen Demand	4.1 ppm
6	Sodium	149 ppm
7	Potassium	43 mg/L
8	Nitrate	9 mg/L
9	Phosphate	6 mg/L
10	Calcium	65 ppm

From this table, it is noted that the observed values for various parameters exceeds the standard value. Thus it has to be treated in order to reduce the contaminants present in wastewater sample.

Collection of Natural (Plant-based coagulants):

In contrast to chemical coagulants, plant-based natural coagulants are safe [1], eco-friendly and generally toxic free [2]. Natural coagulants have been found to generate not only a much smaller sludge volume of up to five times lower [3] but also with a higher nutritional sludge value. As such, sludge treatment and handling costs are lowered making it a more sustainable option. The raw plant extracts are often available locally and hence, a low-cost alternative to chemical coagulants. Since natural coagulants do not consume alkalinity unlike alum, pH adjustments can be omitted and this provides extra cost savings. Natural coagulants are also non-corrosive [4] which eliminate the concerns of pipe erosions.

Coagulants used:

The following are the natural coagulants (including botanical name) used in this study.

- Pumpkin seed powder (*Cucurbita pepo)*
- Watermelon seed powder (*Citrullus lanatus)*
- Soundal seed powder (*Leucaena leucocephala)*
- Vetiver powder (*Chrysopogon zizanioides*)
- Neem leaves powder (*Azadirachta indica*)

Jar test:

Jar test is carried out to find the optimum amount of various natural coagulants which will grant the effective turbidity removal. Varying dosages (1g, 2g, 3g and 4g) of coagulant concentration have been used for the test.

3. RESULTS AND DISCUSSIONS

The coagulant dosage and respective turbidity values obtained are tabulated as follows:

Table 2: Wastewater Vs Cucurbita pepo

Initial Turbidity of wastewater =78.5 NTU	
Dosage	**Turbidity**
1 g	36.6
2 g	25.5
3 g	23.8
4 g	26

Optimum coagulant content is **3g** when Cucurbita pepo powder is used which gives turbidity removal efficiency of **69.7%**

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Table 3: Wastewater Vs Citrullus lanatus

Initial Turbidity of wastewater =63.5 NTU	
Dosage	**Turbidity**
1 g	37.6
2 g	44.2
3 g	54.01
4 g	62.55

Optimum coagulant content is **1g** when Citrullus lanatus powder is used which gives turbidity removal efficiency of **40.7%**

Table 4: Wastewater Vs Leucaena leucocephala

Initial Turbidity of wastewater =77.6 NTU	
Dosage	**Turbidity**
1 g	42.12
2 g	45.23
3 g	54.54
4 g	63.55

Optimum coagulant content is **1g** when Leucaena leucocephala powder is used which gives turbidity removal efficiency of **45.72%**

Table 5: Wastewater Vs Chrysopogon zizanioides

Initial Turbidity of wastewater =76.4 NTU	
Dosage	**Turbidity**
1 g	24.5
2 g	34
3 g	18.2
4 g	16.5

Optimum coagulant content is **4g** when Chrysopogon zizanioides powder is used which gives turbidity removal efficiency of **78.4%**

Table 6: Wastewater Vs Azadirachta indica

Initial Turbidity of wastewater =85.8 NTU	
Dosage	**Turbidity**
1 g	30
2 g	28.5
3 g	29.5
4 g	30.9

Optimum coagulant content is **2g** when Azadirachta indica powder is used which gives turbidity removal efficiency of **66.8%**

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Table 7: Wastewater Vs Alum

Initial Turbidity of wastewater =83.9 NTU	
Dosage	**Turbidity**
1 g	30.27
2 g	51.89
3 g	56.22
4 g	50.16

Optimum coagulant content is **1g** when Alum is used which gives turbidity removal efficiency of **64%**

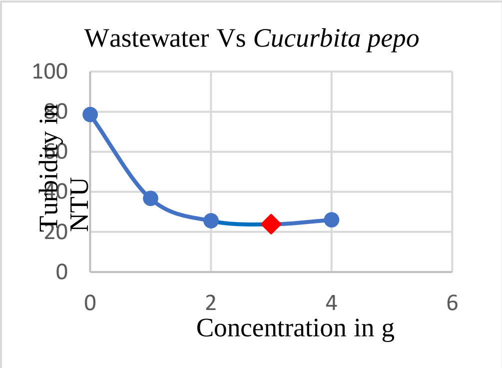

Fig.3 ***Cucurbita pepo as coagulant***

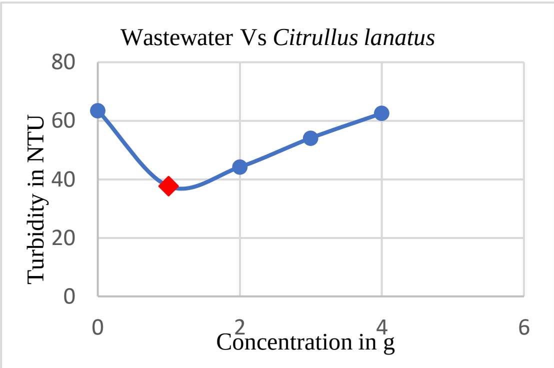

Fig.4 ***Citrullus lanatus as coagulant***

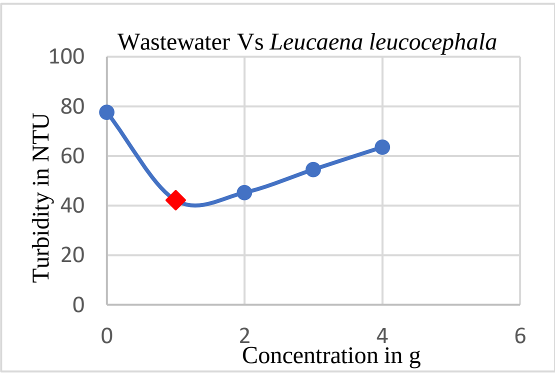

Fig.5 ***Leucaena leucocephala as coagulant***

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

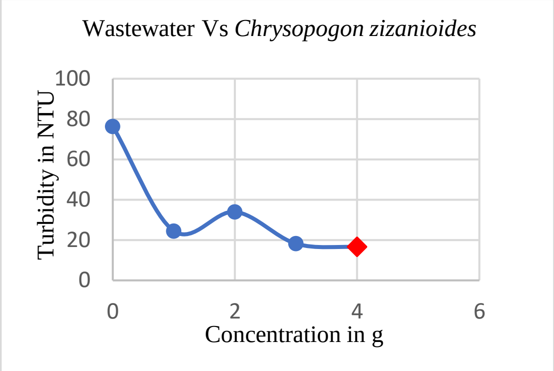

Fig.6 ***Chrysopogon zizanioides as coagulant***

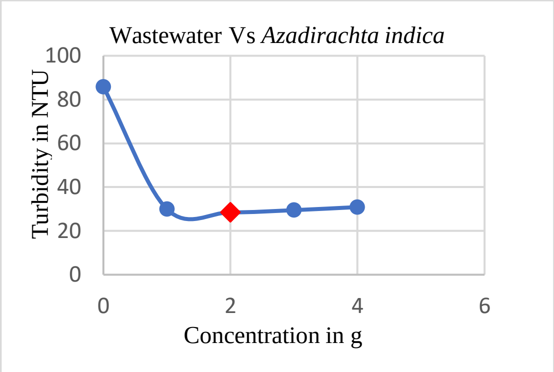

Fig.7 ***Azadirachta indica as coagulant***

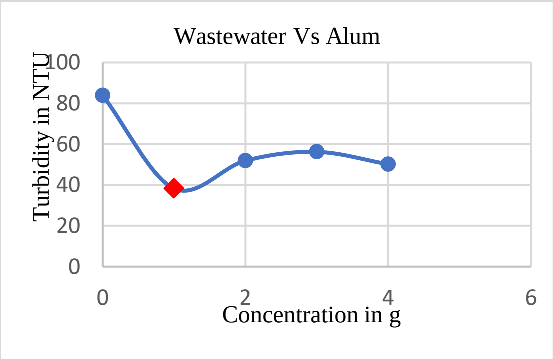

Fig.8 ***Alum as coagulant***

4. CONCLUSION

Based on the above results obtained, it was found that vetiver powder *(Chrysopogon zizanioides)* gives the maximum turbidity removal efficiency. Optimum dosage coagulant may vary for each of the test samples (natural coagulants) since they possess different chemical properties. The maximum turbidity removal efficiency for pumpkin seed powder, watermelon seed powder, soundal seed powder, neem leaves powder and vetiver powder were 69.7%, 40.7%, 45.72%, 66.8% and 78.4%. And for alum it was 64%. Comparing the performance of Pumpkin seed powder *(Cucurbita pepo)*, Watermelon seed powder *(Citrullus lanatus)*, Soundal seed powder *(Leucaena leucocephala)* and Neem leaves powder *(Azadirachta indica)*, vetiver powder *(Chrysopogon zizanioides)* was found to be more effective than others.

Since, vetiver *(Chrysopogon zizanioides)* is cheaper and easily available this can be used as coagulant for the wastewater treatment process in small scale.

REFERENCES

[1] U Asrafuzzaman, M., Fakhruddin, A.N.M., Alamgir Hossain, M., 2011. Reduction of turbidity of water using locally available natural coagulants. ISRN Microbiol. 632189. http://dx.doi.org/10.5402/2011/632189.
[2] Bratby, J., 2006. Coagulation and Flocculation in Water and Wastewater Treatment, 2nd ed. IWA Publishing, UK.
[3] Ndabigengesere, A., Subba Narasiah, K., Talbot, B.G., 1995. Active agents and mechanism of coagulation of turbid water using Moringa oleifera. Water Res. 29 (2), 703–710
[4] Swati, M., Govindan, V.S., 2005. Coagulation studies on natural seed extracts. J. Indian Water Works Assoc. 37 (2), 145–149.
[5] Aygun, A. and Yilmaz, T. Improvement of coagulation-flocculation process for treatment of detergent wastewaters using coagulant aids. International Journal of Chemical and Environmental Engineering, 2010,1(2): 97-101.
[6] Sook Yan Choy, Utilization of plant-based natural coagulants as future alternatives towards sustainable water clarification, JOURNAL OF ENVIRONMENTAL SCIENCES 26(2014)2178-2189
[7] G.Vijayaragavan, T.Sivakumar, A.Vimal Kumar, "Application of plant based coagulants for wastewater treatment", International Journal of Advanced Engineering Research and Studies, Vol I, Issue I, 2011 December.
[8] M. A. Aboulhassan, S. Souabi, A. Yaacoubi, (2008), Pollution reduction and biodegradability index improvement of tannery effluents, Int. J. Environ. Sci.Tech., 5 (1), pp 11-16, 2008
[9] Yunusa UM, Cucurbita pepo Seed Powder Reduce the Turbidity of River Water, Scholars Research Library Annals of Experimental Biology, 2017, 5 (2): 10-14
[10] Hussein Janna, Effectiveness of Using Natural Materials as a Coagulant for Reduction of Water Turbidity in Water Treatment, World Journal of Engineering and Technology, 2016, 4, 505-516.
[11] G. Vijayaraghavan, APPLICATION OF PLANT BASED COAGULANTS FOR WASTE WATER TREATMENT, International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974.
[12] G.Jayalakshmi, A Review on Native Plant Based Coagulants for Water Purification, International Journal of Applied Environmental Sciences ISSN 0973-6077 Volume 12, Number 3 (2017), pp. 469-487.
[13] Vicky Kumar, Applications of Natural Coagulants to Treat Wastewater - A Review, MATEC Web of Conferences 103, 06016 (2017) DOI: 10.1051/matecconf/20171030 ISCEE 2016.