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UTILIZATION OF MORINGA OLEIFERA SEED AS A NATURAL ABSORBENT FOR WASTEWATER TREATMENT

Vaishali D. Jaysingpure[1], Dr. Preeti Gajghate[2], Shruti Bodele [3], Supriya Bhagat [4], Pratiksha Yadav[5], Kalyani Ghemad [6]

[1,2]Assistant Professor, Dept. of Civil Engineering, JSPM's Rajarshi Shahu College of Engineering, Tathawade-411033, Pune, Maharashtra, India.
[3,4,5,6]Final Year Students, Dept. of Civil Engineering, JSPM's Rajarshi Shahu College of Engineering, Tathawade-411033, Pune, Maharashtra, India.

Abstract -Domestic Wastewater Contains Suspended Solids, Dissolved Impurities, And Harmful Microorganisms. These Pose Significant Environmental And Public Health Risks, In Developing Regions With Limited Treatment Options. Traditional Methods Often Rely On Chemical Coagulants Like Alum Which Can Be Expensive And May Lead To Secondary Pollution And Sludge Disposal Issues. So There Is A Need For An Economical And Environmentally Friendly Alternative. This Study Examines The Effectiveness Of Moringa Oleifera Seed Powder As A Coagulant For Treating Domestic Wastewater. In This Investigation Mature Moringa Oleifera Seeds Were Collected, Cleaned, Dried, And Ground Into Powder. The Coagulant Was Applied To Wastewater Samples At Dosages Using A Jar Test Method Under Controlled Laboratory Conditions. Key Parameters Like Ph, Turbidity, Total Dissolved Solids, Total Suspended Solids, Hardness, And Alkalinity Were Analyzed Before. After Treatment Using Standard Methods. The Results Indicated That Moringa Oleifera Seed Powder Significantly Improved Water Quality. There Was A Reduction In Turbidity And Suspended Solids Demonstrating Effective Coagulation And Flocculation. Also Decreases In Total Dissolved Solids, Hardness, And Alkalinity Were Observed, Reflecting The Removal Of Dissolved And Colloidal Impurities. The Ph Of Treated Water Approached Neutral Levels, Making It Safe For Discharge. Treatment Efficiency Depended On Coagulant Dosage With Performance At Specific Concentrations. Overall Moringa Oleifera Seed Powder Serves As A Cost-Eco-Friendly And Sustainable Option For Wastewater Treatment In Resource-Limited Areas.

Key Words: Coagulation, Moringa Oleifera Sustainable Treatment, Turbidity, Wastewater Treatment

1. INTRODUCTION

Domestic Wastewater Contains A Lot Of Suspended Solids Dissolved Contaminants, And Pathogenic Microorganisms, Which Pose Serious Risks To Environmental Sustainability And Public Health. This Problem Is Critical In Developing Regions Where Advanced Wastewater Treatment Infrastructure Is Lacking. Traditional Wastewater Treatment Processes Often Use Chemical Coagulants Like Alum. Their Continuous Use Comes With High Operational Costs, Large Sludge Generation And Potential Secondary Environmental Contamination. Therefore There Is An Increasing Need For Cost-Effective, Sustainable. Eco-Friendly Alternatives To Conventional Chemical Coagulants. This Study Investigates The Coagulation Efficiency Of Moringa Oleifera Seed Powder As A Coagulant, For Domestic Wastewater Treatment Aiming To Improve Water Quality While Minimizing Environmental Impact. Water Contamination Is a Problem For Our Environment. This Is Because Of The Growth Of Industries, Cities And Farms. Domestic Sewage, Waste And Farm Runoff Are Putting Bad Things Like Organic Matter, Heavy Metals, Dyes And Pathogens Into Our Water Bodies. This Is Making The Water Quality Bad And Threatening The Ecosystems And Our Health. This Problem Is Very Severe In Developing Countries. They Do Not Have The Infrastructure And The Cost Of Treatment Is Very High. Chemical Coagulants Like Aluminum Sulfate And Ferric Chloride Are Commonly Used.. They Have Some Problems Like Making Sludge, Metal Toxicity, Corrosion And Health Risks. These Problems Have Made Us Look For More Sustainable Alternatives. Recently People Have Started Looking At Plant-Based Coagulants. They Are Biodegradable, Renewable And Good For The Environment. Moringa Oleifera And Moringa Stenopetala Seeds Have Water- Cationic Proteins And Bioactive Compounds. They Help In Removing Impurities By Neutralizing Charged Particles And Making Floc Formation Easier. Studies Have Shown That Moringa Seed Powder Can Remove 85–99% Of Turbidity And Cut Down Suspended Solids And Heavy Metals In Wastewater. The Process Works Best At a Range Of 5 To 8. Naturally Dried Seeds Gave The Results With Up To 95% Turbidity Removal.

This Study Aims To Reduce Turbidity In Wastewater Collected From The Canteen Of Rscoe Using a Coagulant Made From Moringa Seeds. Matured Moringa Oleifera

Seeds Were Collected And Processed To Create a Fine Powdered Coagulant. The Prepared Natural Coagulant Was Then Applied To Wastewater Samples In Varying Dosages. Treatment Efficiency Was Assessed By Measuring Physicochemical Characteristics Of The Wastewater. Parameters Such As Ph, Turbidity, Total Suspended Solids Were Determined Before. After The Coagulation Process.

2. OBJECTIVES

To analyze the wastewater sample for various parameters To treat the collected waste water sample with experimental setup.Comparative study through detail analysis of the before and after result.

3 MATERIALS AND METHODS

Moringa oleifera seeds were used in this study. The seeds were. Dried. Then they were turned into powder. This powder was used to clean wastewater. We used equipment like a pH meter and a turbidity meter. We did tests to see how well the Moringa oleifera seed powder worked.

3.1 RAW MATERIAL USED :

Moringa oleifera seeds were the main material used in this study.

In this study we collected wastewater samples from the college food court and domestic sources to try out a method for treating wastewater. We looked at types of wastewater including domestic wastewater, river water and commercial wastewater from the food court. Based on what we saw at first and the characteristics of the contamination we chose to focus on treating wastewater from the food court.

Seed preparation:

To prepare the Moringa oleifera seeds we first collected the seeds. Removed their outer shells. Then we dried the seeds properly to get rid of any moisture. After drying we ground the seeds into a powder using a grinder. We sieved the powder to remove any particles and get a uniform size. Finally we stored the seed powder in an airtight container to use later in the cleaning process.

3.1.2 Equipment used :

For the analysis of wastewater samples, the following tests were conducted using standard laboratory equipment refer table 3.1 :

Table3.1 list of Equipment Used for Wastewater Treatment and Water Quality Analysis.

Sr. no	Name of the Test	Equipment	Purpose
1.	pH Test	pH Meter	To measure the acidity or alkalinity (pH value) of the wastewater samples before and after treatment.
2.	Turbidity Test	Turbidity Meter	To determine the turbidity level of the wastewater and evaluate the removal efficiency of suspended particles.
3.	Coagulation – Flocculation Test	Jar Test Apparatus	To perform coagulation and flocculation experiments using Moringa oleifera seed powder under controlled mixing conditions.
4.	Drying Process	Hot Air Oven	To conducting total solid test.
5.	Weight Measurement	Digital Weighing Machine	To accurately measure the required dosage of Moringa oleifera seed powder and other materials used in the experiments.

3.2 MAJOR TREATMENT:

In this study we treated wastewater using Moringa oleifera seed powder as a natural cleaner. We did experiments to see how well the treatment reduced parameters like turbidity, pH and total solids. The treatment process involved coagulation and flocculation which we did using the jar test method under controlled laboratory conditions. After mixing and settling we analyzed the treated samples to see how much the water quality improved and how well Moringa oleifera seed powder worked as an eco- cost-effective cleaner.

3.3 EXPERIMENTAL ANALYSIS :

For the analysis of wastewater samples, the following laboratory tests were conducted it is discussed in detail in the following sections.

3.4 METHOD ADOPTED :

To analyze the wastewater samples we did the following tests:

3.4.1 pH Test-

In this analysis a digital pH meter to see how well Moringa oleifera seed powder stabilized the pH of the wastewater. took 500 milliliters of wastewater. Measured its initial PH.

Then we added different amounts of Moringa seed powder and mixed it well. After settling we measured the pH again. Recorded the final values. The initial pH of the wastewater was 10.13, which's very alkaline. After adding Moringa oleifera seed powder the pH gradually moved towards neutral. The best result was at 0.40 grams of powder where the pH reached 7.17. This shows that Moringa seed powder effectively stabilized the pH of the wastewater.

3.3.2 Turbidity Test:

In this analysis, the turbidity test was conducted using a Turbidity Meter to evaluate the removal of efficiency of suspended particles.

We did a turbidity test using a turbidity meter to see how well the treatment removed suspended particles. We measured the turbidity of the wastewater and then added different amounts of Moringa seed powder. After mixing and settling we measured the turbidity again. Calculated the removal efficiency. The initial turbidity was 5 NTU. After treatment it reduced to 1.1 NTU, which is an 86.6% removal. The best result was at 0.40 grams of powder.

3.3.3 Jar Test:

In this analysis, the Coagulation–Flocculation Test was conducted using a Jar Test Apparatus to evaluate the removal of efficiency of suspended particles. A coagulation-flocculation test was conducted using a jar test apparatus to see how well the treatment removed suspended particles. We took wastewater samples. Added required amounts of Moringa seed powder. We mixed the samples rapidly. Then slowly and after settling we observed floc formation.

3.3.4 Total Solid test-

In this analysis, the Total solid Test was conducted using a oven to evaluate the removal of efficiency of suspended particles. Took the wastewater sample and evaporated it to dryness. The sample was then dried completely to remove moisture. The remaining residue indicated the total solids present in the wastewater.

The total solids (TS) of the water sample were determined with an initial dish weight of 34.25 mg and a sample volume of 500 ml. After evaporation, the increase in weight was used to calculate TS values, which ranged from 200 mg/L to 800 mg/L. It was observed that the total solids increased with an increase in the final weight of the residue. The average TS value was found to be 500 mg/L, indicating a moderate presence of dissolved and suspended solids in the water sample.

4. RESULTS AND DISSCUSION

The results were analyzed to evaluate the effectiveness of Moringa oleifera seed powder in wastewater treatment. Parameters such as pH, turbidity, jar test performance, and total solids showed significant improvement after treatment. The findings confirm that Moringa seeds act as an effective natural coagulant for improving water quality.The results of the experiments are shown in the following sections.

4.1 PH Test-

Balancing Water pH Using Natural Moringa Seeds Checking how the seeds help turn alkaline water into neutral water which is shown below The results of the experiments reshowninthe following sections.

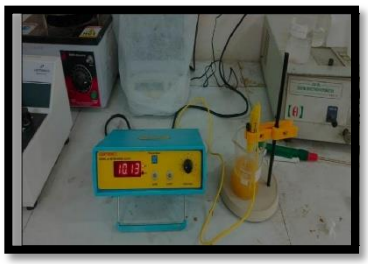

Fig 4.1.1 photo showing

Fig 4.1.2 photo showing Initial pH
Final Ph

The wastewater samples were tested to check what the pH levels were at the initial and final stages. We used a pH meter to do this test the results in Fig 4.1.1 and 4.1.2 .The wastewater sample that was not treated had a pH of 10.13 which means it was very alkaline. After we added Moringa oleifera seed powder to it the pH level reduced to 7.2. This shows that using Moringa oleifera seed powder helped to reduce the alkalinity of the wastewater and made it closer to neutral.

- The volume of the water sample we used was 500 ml, which's the same as 0.5 L.
- The coagulant we used was Moringa oleifera seed powder.

Using Moringa oleifera seed powder as a coagulant worked well to adjust the level of the wastewater. This makes the wastewater more suitable for discharge or, for

treatment. The Moringa oleifera seed powder really helped to make the wastewater better.

Table 4.1 Results showing ph reduction

Trial	Dosage of moringa powder	Initial PH	Final PH	PH Reduction	%PH Reduction
1.	0.10	10.13	8.9	10.13 - 8.9 = 1.23	12.14 %
2.	0.20	10.13	8.1	10.13 - 8.1 = 2.03	20.04 %
3.	0.30	10.13	7.6	10.13 - 7.6 = 2.53	24.98 %
4.	0.40	10.13	7.2	10.13 - 7.2 = 2.93	28.92 %
			∑pH =		
AVG pH = ∑pH/4=7.95					

Average Final pH Calculation:

Avg pH = ∑Ph /No of Samples ..... Eq (1)

Average pH = ∑(8.9 + 8.1 + 7.6 + 7.2) / 4 = 7.95

The final pH level was observed in the desired range, around 7.95 (shown in equation 1).

Table 4.1 shows the results of the test.. The initial pH was 10.13 and after treatment it reduced to 7.2. The best result was at 0.40 grams of powder. The average final pH was 7.95 which is within the desired range.

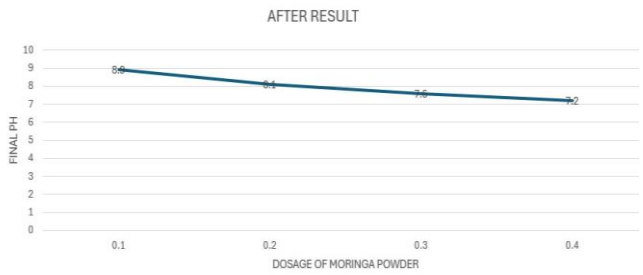

Fig 4.1.3 Graph showing varation of pH with respect to dosage of Moringa Powder.

Fig 4.1.3 The graph shows how the pH of the wastewater changed with the addition of Moringa oleifera seed powder. The pH decreased from 10.13 to 7.2 as the amount of powder increased from 0.10 grams to 0.40 grams. The biggest drop happened at 0.40 grams, which seems to be the amount for treating wastewater. The Moringa oleifera powder we added, the more the pH of the wastewater decreased.

This graph shows that Moringa oleifera seed powder works well in reducing pH. Moringa oleifera dosage helps in treatment of wastewater by reducing pH.

4.2 Turbidity Test:

The figure 4.2.1 and 4.2.2 shows a lab setup with a machine that measures how turbid water is. This machine is called a nephelo turbidity meter. It measures the turbid levels of water samples. The numbers it gives are around 5 to 1.1 NTU. This means the water has particles floating in it. These particles help with checking the quality of the water. In this study Moringa oleifera seed powder is used to make the water less turbid . We use this powder because it helps the particles in the water stick. The Moringa oleifera seed powder is used to remove turbid from the water.

Fig 4.2.1 photo showing initial turbidty

Fig 4.2.2 photo showing final turbidity

In this study, Moringa oleifera seed powder was used as a natural coagulant to reduce turbidity. The seed powder caused suspended particles to coagulate and settle at the bottom, which improved the clarity of the treated water. The results indicated that the application

of the optimum dosage of Moringa seed powder effectively enhanced water quality by reducing turbidity levels.

Table 4.2 results showing percentage turbidity removal

Sr. No	Moringa Dose (g/500 ml)	Turbidity Before (NTU)	Turbidity After (NTU)	%Turbidity Removal
1.	0.10 g	5	2.9	42%
2.	0.20 g	5	1.1	78%
3.	0.30 g	5	1.8	64%
4.	0.40 g	5	2.6	48%
% Turbidity Removal = (Initial Turbidity – Final Turbidity) / Initial Turbidity × 100				

% Turbidity Removal = (Initial Turbidity – Final Turbidity) / Initial Turbidity × 100 .....Eq 2

The table 4.2 show that using Moringa oleifera seed powder to remove turbiity works when we increase the dose but only up to a point. After that it does not work well. When the water was highly turbid at 5 NTU using 0.20 grams of Moringa oleifera seed powder in 500 milliliters of water removed the turbid a total of 78 percent. Made the water much clearer at 1.1 NTU. If you use Moringa oleifera seed powder, like 0.10 grams or more like 0.40 grams it does not remove much turbid only 42 percent and 48 percent respectively. This means there is an amount of Moringa oleifera seed powder to use to remove turbid from the water.

a seed powder to use to remove turbidity from the water.

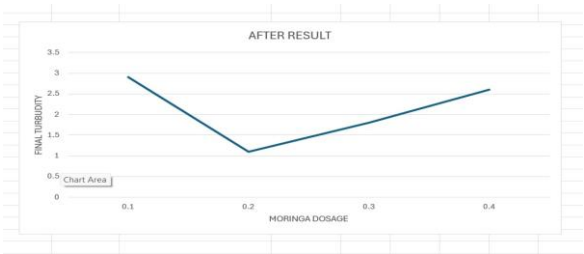

Fig 4.2 Graph showing varation of turbidity with respect to dosage of Moringa Powder.

The fig 4.2 graph shows that the final turbidity gets decreases as adding Moringa oleifera from 0.1 g to 0.2 g. It reaches its point, around 1.1 NTU. If we add more, than this dose, the turbidity starts to increase again at higher dosages, like 0.4 g. This means it does not work well. This graph confirm that 0.2 g/500 ml of Moringa oleifera is the required dose to remove maximum turbidity.

4.3 Jar Test:

Jar test is performed in the laboratory and the results are shown in fig 4.3.1 and fig 4.3.2

Fig 4.3.1 photo showing Rapid mixing

Fig 4.3.2 photo showing after Treatment Results

The figure 4.3.1 shows a jar test apparatus in a laboratory. It has containers that are mixed at the time but at different speeds. First the sample was mixed at a speed of 150 rpm for 30 minutes followed by mixing at 60 rpm for another 30 minutes. After mixing the sample was allowed to settle for 30 minutes to complete the settling process. The goal is to see how well Moringa oleifera seed powder works in making the water clearer. The test is done with amounts of Moringa oleifera seed powder to find out which one works best. The figure 4.3.2 shows water samples after they were treated with amounts of Moringa oleifera. It shows a difference in how clear the water's. The samples that got the dose of Moringa oleifera are much clearer. The water samples that got the dose of Moringa oleifera look very clear which shows that Moringa oleifera is very good at removing stuff from the water.

Table 4.3 Coagulation-Flocculation Results showing Percentage Removal Efficiency at Different Moringa Seed Powder Dosages

Sr. No	Jar. No	Moringa Dose	Initial Turbidity	Final Turbidity	% Removal
1.	Jar 1	0.10 g	8.2	2.9	64.6 %
2.	Jar 2	0.20 g	8.2	1.1	86.6 %
3.	Jar 3	0.30 g	8.2	1.8	78 %
4.	Jar 4	0.40 g	8.2	2.6	68.3 %
% Turbidity Removal = (Initial Turbidity – Final Turbidity) / Initial Turbidity × 100					

The table 4.3 shows how well Moringa oleifera removes turbid at amounts. We used 0.10 to 0.40 g of Moringa oleifera. The water was really cloudy to start with at 8.2 NTU. When we used 0.20 grams of Moringa oleifera it removed the turbid , a total of 86.6 percent. If we used more or less Moringa oleifera it did not work well. This study gives the amount of Moringa oleifera to use to get the best results.

4.4 Total solid test-

Total solid test is performed in the laboratory by measuring and drying samples to find solids.

Fig 4.4.1 photo showing Incremental Sample Weighing on Analytical

Fig 4.4.2 photo showing Drying of Samples in Laboratory Oven

Fig 4.4.1 show an evaporating dish on a balance at different stages. The balance shows weights: 0.100 g, 0.200 g, 0.300 g and 0.400 g. These weights are the solids left after evaporation. The weights tell us how much solids are in each water sample. The solids are what is left behind after the water dries. We call these solids or TS. The weights go up with each sample. This means each sample has solids than the last one. These solids are. Suspended in the water. The samples have more solids. The balance shows this with weights. The weights are for solids, in each water sample. This fig 5.4.2 shows dishes being dried in a hot air oven in a lab: The samples get heated to a temperature usually around 103 to 105 degrees Celsius, to get rid of the moisture. After they dry only the solid leftovers are. Then we weigh them. This step is really important, for figuring out the Total Solids because it makes sure all the water is gone from the samples.

After oven drying at 105°C, the dry solids obtained were:

TS = (W2 – W1) × 10^6 / Volume of Sample (ml) ……..eq (5)

W1= 34.25 mg (Initial wt) and the Volume of sample is 500 ml

Table 4.4.1 showing results of Total Solids (TS) in Water Samples

Sr no	Initial wt.	Final wt.	W2 - W1 (mg)	TS (mg/l)
1.	34.25	34.35	(34.35 – 34.25) × 10^6 / 500	200
2.	34.25	34.45	(34.45 – 34.25) × 10^6 / 500	400
3.	34.25	34.55	(34.55 – 34.25) × 10^6 / 500	600
4.	34.25	34.65	(34.65 – 34.25) × 10^6 / 500	800
TS = (W2 – W1) × 10^6 / Volume of Sample (ml)				

The table 4.4.1 shows us the calculation of Total Solids in four water samples using the method. We have the weight of the evaporating dish. It is always the same at 34.25 grams. The final weight of the evaporating dish is different each time. It goes from 34.35 grams to 34.65 grams. This means that there is residue left after drying each time. We calculate the Total Solids by finding the difference in weight. We do this by subtracting the weight from the weight. This gives us the Total Solids in milligrams per liter.

4.5 Discussion

The results obtained from the experiments indicate that Moringa oleifera seed powder can be effectively used as a coagulant for wastewater treatment. The pH test results showed that the initial pH of 10.13 decreased gradually to 7.2 as the dosage of Moringa powder increased. This change in pH indicates that the alkaline nature of the wastewater was reduced and the treated water moved closer to a condition, which is desirable for safe disposal.

The cloudiness test also showed improvement in water clarity after treatment. The cloudiness value reduced from 5 NTU to 1.1 NTU with the removal efficiency of 78% observed at a dosage of 0.20 g. When the dosage was increased beyond this level a slight decrease in efficiency was observed. This may be due to overdosing, which can disturb formed particles and reduce settling efficiency. These results indicate that selecting the dosage is important for achieving better treatment performance.

Observations from the jar test showed the formation of flocs and clearer water in treated samples confirming that coagulation and flocculation processes were successfully carried out. The highest cloudiness removal of 86.6% was observed at a dosage of 0.20 g, which was considered the level. The total solids test showed values ranging from 200 mg/L to 800 mg/L indicating that impurities were separated and settled during treatment. Based on these findings Moringa oleifera seed powder can be considered a low-cost and environmentally friendly alternative to chemical coagulants for wastewater treatment especially in small-scale applications.

CONCLUSIONS

i. The study confirmed that Moringa oleifera seed powder is an effective natural coagulant for wastewater treatment.

ii. The pH of wastewater improved from 6.30 to 7.17,with the application of optimum dose of coagulant 7.95 bringing it closer to the neutral range and making the treated water more suitable for safe discharge.

iii. A significant reduction in turbidity was observed, decreasing from 8.2 NTU to 1.1 NTU, achieving approximately 86.6% turbidity removal efficiency, which indicates effective removal of suspended particles.

iv. The jar test results showed proper coagulation and floc formation, confirming the effectiveness of the treatment process.

v. The optimum dosage of Moringa oleifera seed powder was found to be approximately 20 g per 500 ml, beyond which treatment efficiency slightly decreased due to particle destabilization.

vi. The total solids test indicated increased sludge formation with higher dosages, confirming the successful settling of impurities during treatment.

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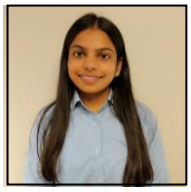
BIOGRAPHIES

Final Year Students, Dept. of Civil Engineering, JSPM's Rajarshi Shahu College of Engineering, Tathawade-411033, Pune, Maharashtra, India.
Email:supriyabhagat400@gmail.com



Final Year Students, Dept. of Civil Engineering, JSPM's Rajarshi Shahu College of Engineering, Tathawade-411033, Pune, Maharashtra, India.
Email:-
kalyanighemad04@gmail.com

Final Year Students, Dept. of Civil Engineering, JSPM's Rajarshi Shahu College of Engineering, Tathawade-411033, Pune, Maharashtra, India.
Email:-
bodeleshruti663@gmail.com

Final Year Students, Dept. of Civil Engineering, JSPM's Rajarshi Shahu College of Engineering, Tathawade-411033, Pune, Maharashtra, India.
Email:-
pratikshayadav0007@gmail.com