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"Comparative Study of Natural Coagulants for Dairy Effluent Treatment"

Kunal Taksande[1] Omkar Mangule[2], Omkar Singapure[3], Abhijeet Kawanpure[4], Rahul S. Patil[5],

1,2,3,4=Student, Pimpri Chinchwad College of Engineering & Research, Pune, Maharashtra, India.

5=Assistant Professor, Department of Civil Engineering Pimpri Chinchwad College of Engineering & Research, Pune

Abstract – Among all the natural resources, water is without a doubt the most significant. Dairy sector effluent is one of the main sources of pollution in the environment. During several phases of processing, the dairy sector is one of the largest consumers of water. This method generates wastewater with high pH, BOD, COD, and turbidity levels. About three liters of wastewater are produced for every liter of processed milk in the dairy industry, which requires enormous amounts of water to turn raw milk into dairy products. The usefulness of natural coagulants, namely sawdust, fenugreek powder, custard apple powder, neem leaf powder, and Moringa oleifera seeds, for the remediation of dairy wastewater, is investigated in this work in light of the increased emphasis on sustainable wastewater treatment.

Keywords: Fenugreek, Neem Leaves, pH, Turbidity, COD

1. Introduction:

One of the global leaders in food processing is the dairy industry. The dairy business can effectively transform milk into dairy components and products, thereby sustainably contributing to global food security. The quantity and quality of waste produced by the dairy industry can lead to major pollution issues. The sanitation and washing processes in the milk manufacturing facilities produce the majority of the wastewater produced by the milk industry. Dairy wastewater with high organic matter concentrations pollutes the surrounding area. Salts, casein/whey, oils, lipids, and detergents are also included. Wastewater from dairy plants cannot be promptly emptied into rivers, lakes, or other bodies of water for later use. Sustainable water management has received a lot of attention lately, and developing effective methods is a challenge, particularly in the dairy wastewater sector. Eliminating turbidity in the water and colloidal contaminants are the main objectives of this technique. Because of their high removal efficiency, chemical-based coagulants have been widely used in industrial wastewater treatment systems. The potential use of plant-based coagulants as cost-effective, non-toxic, biodegradable substitutes for chemical coagulants because of their reduced sludge volume, treatment costs, and affordability. Dairy effluent can be easily treated by biological treatment technology. Large amounts of hazardous sludge were also produced during the post-treatment phase following coagulation using chemical coagulants, complicating disposal; however, the final effluent produced by employing natural coagulants can be easily used for irrigation. The goal of the current investigation is to determine if physical and chemical processes specifically, coagulation using an herbal coagulant are feasible for treating dairy effluent. This study investigates the use of sawdust, fenugreek powder, custard-apple powder, neem leaf powder, and Moringa oleifera as coagulants for the treatment of dairy effluent. Wastewater from dairy farms is gathered from Katraj Dairy in Pune, Maharashtra.

This sample is utilized in experimental research to investigate the use of natural coagulants to treat dairy wastewater, making it appropriate for additional treatments and enabling safe wastewater management through on-land drainage and also in lakes, rivers, and other bodies of water.

2. Materials and Methods:

2.1 Natural Coagulants Required

2.1.1 Custard-apple Seed Powder:

Indians are the primary consumers and growers of the custard apple (Annona Reticulata tree), an evergreen plant. As a natural air filter, the tree performs its duty. There are numerous documented medical and germicidal benefits associated with each section of the tree. Custard apple seed powder, which has been finely milled, was employed as an adsorbent in this study. As a natural coagulant for the treatment of dairy effluent, custard apple powder which is made from the berries of the custard apple tree is becoming more and more popular. The way this natural coagulant works is that it binds to the impurities in the dairy effluent to create bigger, more easily settling flocs.

When compared to chemical coagulants, it offers benefits including biodegradability, little dangers to human health and the environment, and the possibility of lower costs. Custard apple powder can be added to wastewater treatment in the proper amounts to react with contaminants and make them easier to remove through filtration or settling. Nevertheless, several variables might affect custard apple powder's efficacy as a coagulant, such as temperature, pH, and wastewater quality. As a result, more investigation and optimization are required to identify the best application conditions for this powder in a range of wastewater treatment situations.

(Custard-apple Seed Powder)

2.1.2 Neem Leaves Powder:

The removal of heavy steel ions from dairy effluent has shown exceptional efficacy when neem leaf powder is used. According to a study on its adsorptive capacity, it can be used as a biosorbent to reduce the concentrations of oil in generated water. Neem leaves were gathered, and any dirt or contaminants were removed by washing them with tape water. After up to three days of sun drying, the leaves are ground to create a fine powder known as neem leaf powder. Neem leaf powder is an excellent natural coagulant for treating dairy wastewater. Its special qualities allow for the efficient coagulation and flocculation of suspended solids and pollutants in the wastewater, which makes them easier to remove. This natural coagulant reduces the need for artificial chemicals and promotes a more sustainable and environmentally friendly method of treating water. Neem leaves also have natural antimicrobial properties, which are especially useful in treating dairy wastewater because they help lower microbial loads, which ensures safe disposal and stops the spread of diseases. All things considered, neem leaf powder offers a promising solution for treating dairy wastewater that strikes a balance between environmental advantages and affordability.

(Neem Leaves Powder)

2.1.3 Fenugreek Powder:

Fenugreek can be used to treat dairy effluent because of its inherent coagulant qualities. Proteins and polysaccharides included in its seeds help in flocculation, which is the process by which particles group. This makes it easier to remove contaminants and suspended materials from wastewater. Fenugreek-based coagulation can improve the effectiveness of later treatment phases, which helps to further purify dairy effluent. When using fenugreek as a natural coagulant in the treatment of dairy wastewater, the seeds are ground into a powder and then soaked in water to form a solution. The addition of this solution to the wastewater causes contaminants to cluster together for simpler removal through the processes of flocculation and coagulation. After settling and filtering the treated water, jar tests aid with fenugreek dosage optimization and the separation of solid flocs. The efficacy of the process is ensured by monitoring for parameters such as suspended solids and turbidity, and making necessary modifications. To determine whether the final treated water quality complies with local discharge criteria, extra treatment measures could be necessary. With its economical and longlasting advantages, this environmentally friendly method is a viable treatment option for dairy effluent.

(Fenugreek Powder)

2.2 Equipment's Required

2.2.1 pH Meter:

A pH meter is a vital instrument used in chemical operations, monitoring the environment, and industrial operations to determine the acidity or alkalinity of a solution. It functions by combining the use of a pH-sensitive electrode with a reference electrode, and it often includes features for calibration, temperature adjustment, and data recording. To ensure accurate and reliable measurements, the pH electrode needs to be carefully maintained and handled. In the realm of dairy wastewater treatment, a pH meter is an essential instrument for tracking and managing the wastewater's acidity and alkalinity levels. Dairy effluent can have varying pH levels due to the addition of alkaline materials during cleaning processes, or the presence of lactic and organic acids. Therefore, the pH meter plays a critical role in preserving the efficacy and functionality of different treatment procedures. Monitoring the pH of the wastewater continually and making real-time

adjustments can help operators guarantee that flocculation, coagulation, and biological treatments occur under optimal conditions.

(pH Meter)

2.2.2 Turbidity Meter:

Turbidity meters are helpful instruments for assessing water quality and ensuring regulatory compliance in a variety of industries, including industrial applications, environmental monitoring, and water treatment. Quantifying haziness or cloudiness preserves liquid substances, transparency, pureness, and safety. When it comes to dairy wastewater treatment, a turbidity meter is a vital tool that helps make sure wastewater is managed sustainably and efficiently. Under these circumstances, turbidity a measure of the turbidity or fog of water caused by suspended particles becomes crucial. Water quality monitoring is the primary application for turbidity meters, which provide real-time data on the concentrations of microorganisms, colloids, cans, and suspended particulates in wastewater. This information is necessary to guarantee that environmental regulations are followed as well as to optimize the treatment process. By measuring turbidity, operators can enhance the removal of suspended materials by modifying the flocculation, coagulation, sedimentation, and filtration processes. Since they can quickly identify any anomalies or issues with the treatment process, turbidity meters are particularly crucial for troubleshooting.

(Turbidity Meter)

2.2.3 Jar Test Apparatus:

Jar test equipment is commonly referred to as flocculation or flaccidity testers. The jar test gadget allows for economy and efficiency. Flocculators are employed in a water testing laboratory to continuously stir samples. It helps operators determine whether they are using the right amount of chemical treatment chemicals by simulating the process of coagulation and flocculation in a facility that treats water. The jar test is frequently used in laboratories to identify the optimal operating parameters for coagulation-sedimentation treatment of water or wastewater. With the help of this technique, the performance of a large-scale treatment operation can

be predicted by adjusting pH, varying coagulation or coagulation aid dose, alternating speeds, or testing different coagulant or polymer kinds on laboratory-scale coagulation sedimentation process units. For coagulation-sedimentation experiments, a jar test apparatus was chosen. Coagulation sedimentation investigations have the following time constraints: 2 minutes for rapid mixing (100 rpm), 20 minutes for slow mixing (40 rpm), and 45 minutes for sedimentation.

(Jar Test Apparatus)

2.3 Test Procedure

2.3.1 pH Meter Test:

I. pH meter Test: - Initial pH Meter Calibration Before use, confirm that the pH meter is calibrated. Utilizing distilled water, rinse the electrode. Change the meter's settings after submerging the electrode in a pH 7 buffer solution. Using pH 4 and pH 10 buffers, repeat the calibration procedure as needed.

II. Sample preparation: - Creating Samples To treat dairy effluent with natural coagulants, get samples of the material. The samples should be brought to room temperature if necessary. Give the samples the appropriate labels.

III. Measurement procedure: - After using distilled water to rinse it, use a tiny quantity of the sample to clean the pH electrode. To stabilize the reading, submerge the pH electrode completely in the sample solution. For homogeneity, gently stir. After it stabilizes, note the pH value. For every sample used in the investigation, repeat the measurement.

IV. Data analysis: - Conduct a data analysis of the pH values acquired from the various samples that were subjected to natural coagulants. Determine whether there are any appreciable variations between the treatments and the control by comparing the pH levels.

2.3.2 Turbidity Test:

I. Sample Collection: - Before treatment, collect samples of the dairy plant's effluent. Make sure the samples reflect the type of wastewater that is being handled.

II. Preparation of Coagulants: - Source plant extracts or other organic components to serve as natural coagulants. In order to conduct tests, prepare solutions with different amounts.

III. Experimental Setup: - Assemble a regulated testing environment. This could comprise test tubes or beakers for combining coagulant solutions with wastewater.

IV. Turbidity Measurement: - Measure each effluent-coagulant mixture's turbidity using a turbidity meter. Turbidity meters quantify a fluid's cloudiness or haziness as a result of suspended particulates. To guarantee precision, take many measurements.

V. Data Collection: - For every combination of coagulant and effluent, note the turbidity readings. Make sure to record the coagulant concentration used in each experiment.

VI. Analysis: - After the effluent has been treated with various coagulants, compare the turbidity levels. Find out which concentration or coagulant reduced turbidity the most successfully.

2.3.3 Jar Test:

To ascertain the reduction in turbidity, the jar test was employed. Varying the coagulant dosage as 0.2gm, 0.4gm, 0.6gm, 0.8gm, and 1gm will get the ideal dosage of natural coagulants used. To aid in the agitation process, the jar equipment is equipped with six beakers and six steel paddles. One 800 ml beaker is filled with the diary wastewater. for two minutes at 100 rpm, and then for thirty minutes at 40 rpm. For this coagulation process, a settling time of 60 minutes is used

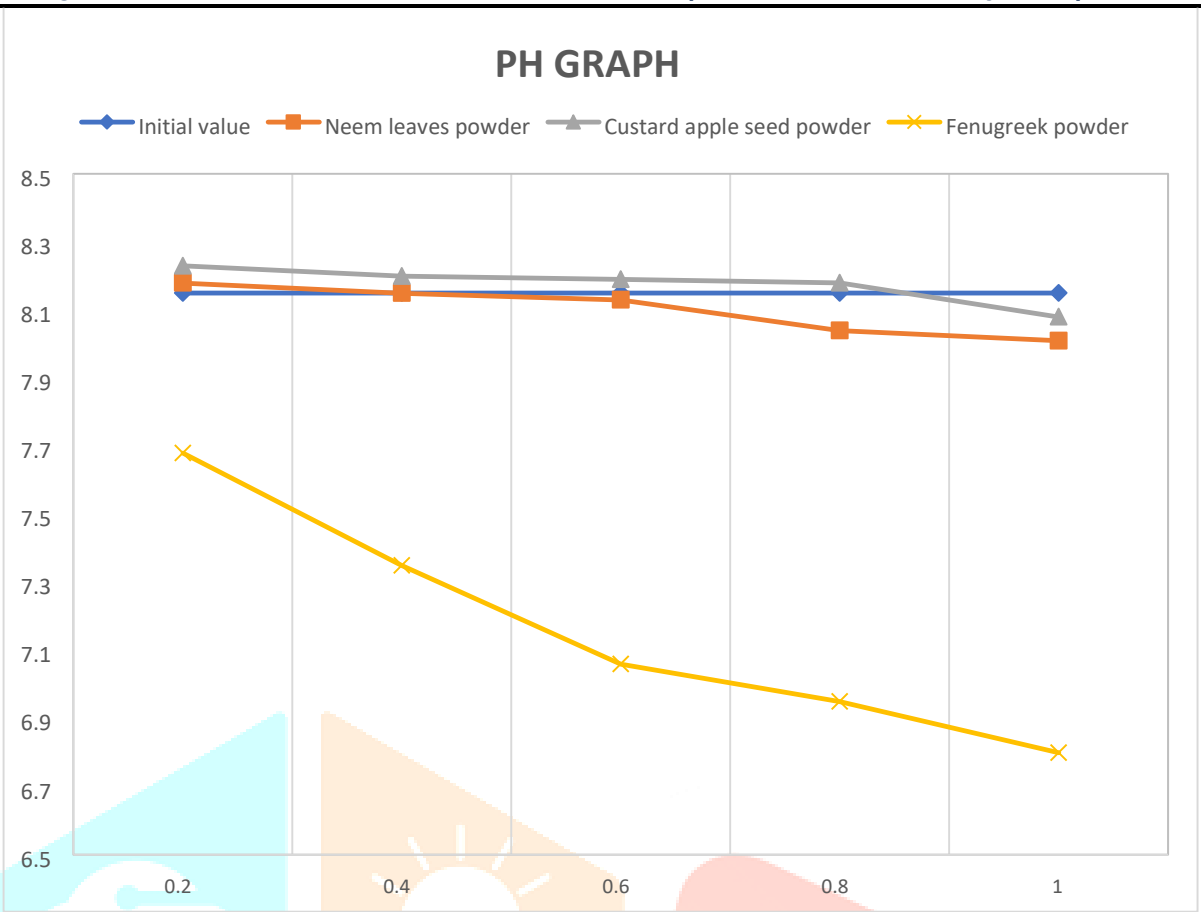
2.3.4 COD Test:

A 500 ml refluxing flask should contain 20 ml of sample. Mix in a handful of glass beads and 0.4 grams of mercuric sulfate. Cool after dissolving the mercuric sulfate with 30ml of sulfuric acid. When adding, thoroughly mix in 10ml of the 0.25N potassium dichromate solution. Once the flask is in position next to the condenser, begin cooling water. Reflux for two hours while applying heat. Using 90 milliliters of distilled water, cool and clean the condenser. Make use of a ferrous indicator (1 to 3 drops) to titrate the surplus dichromate with saturated 0.1N ferrous ammonium sulfate along with 0.2 gm of natural coagulant which is used for the titration process. The final point is shown by the color changing from blue-green to reddish. The same procedure should be used to reflux a blank made of the same volume of distilled water as the sample.

3. Result Analysis:

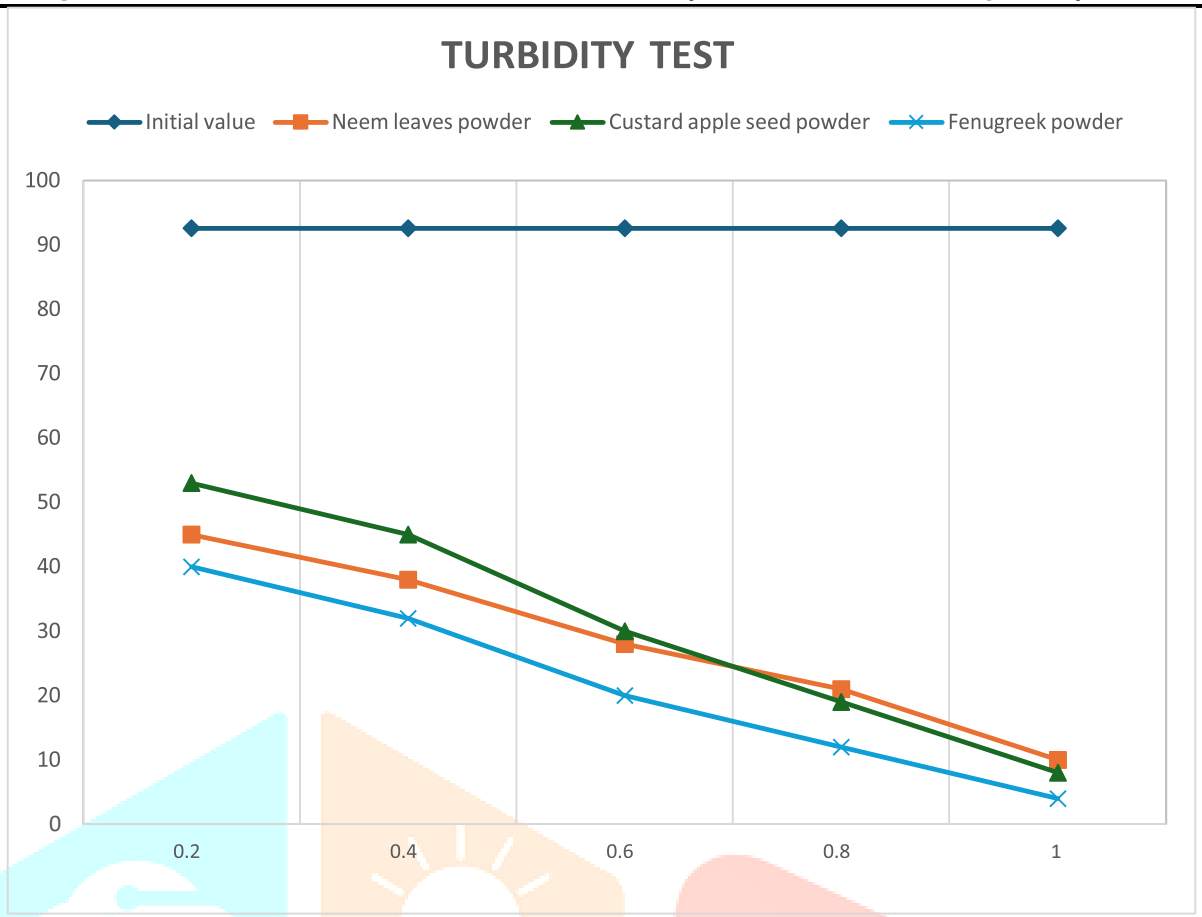
3.1 pH Test Results:

Sr.no	Dosage in gm/ml	Initial value	Neem leaves powder	Custard apple seed powder	Fenugreek powder
1.	0.2	8.15	8.18	8.23	7.68
2.	0.4	8.15	8.15	8.20	7.35
3.	0.6	8.15	8.13	8.19	7.06
4.	0.8	8.15	8.04	8.18	6.95
5.	1.0	8.15	8.01	8.08	6.80



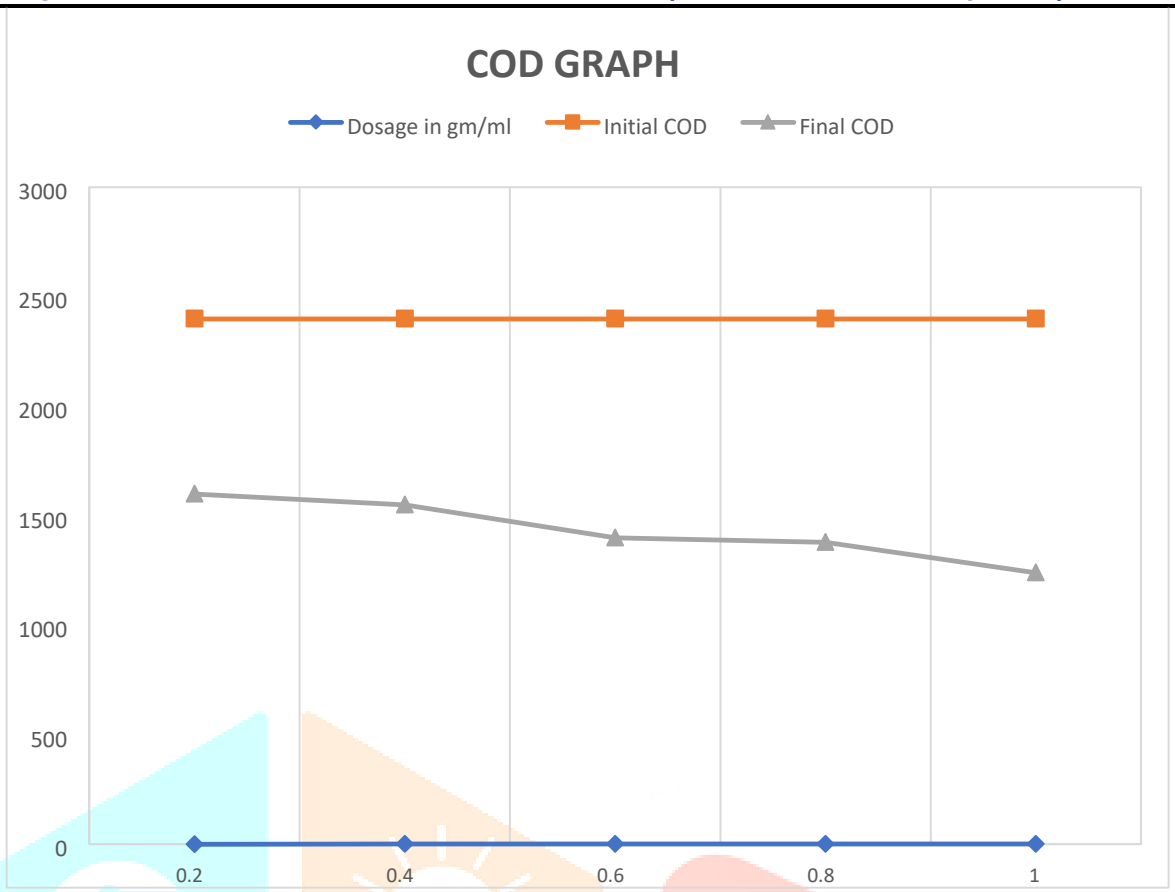
3.2 Turbidity Test Results:

Sr.no	Dosage in gm/ml	Initial value	Neem leaves powder	Custard apple seed powder	Fenugreek powder
1.	0.2	92.6	45	53	40
2.	0.4	92.6	38	45	32
3.	0.6	92.6	28	30	20
4.	0.8	92.6	21	19	12
5.	1.0	92.6	10	8	4



3.3 COD Test Results: After the pH and Turbidity Test using Neem leaf Powder, Custard Apple Seed Powder, and Fenugreek Powder, we concluded that Fenugreek is more effective than the other two, the COD test performed was done using Fenugreek Powder, and the results for Fenugreek Powder are given below.

Sr.no	Dosage in gm/ml	Initial COD	Final COD
1.	0.2	2400	1600
2.	0.4	2400	1550
3.	0.6	2400	1400
4.	0.8	2400	1380
5.	1.0	2400	1240



4. Conclusion:

The study concludes that fenugreek powder works well as a natural coagulant when treating dairy effluent. Due to its excellent coagulation efficacy, non-toxicity, and ease of availability, fenugreek is a good substitute for traditional chemical coagulants. According to the findings, fenugreek powder can considerably lower the amount of turbidity, additional contaminants, and chemical and biological oxygen demand (BOD and COD) in dairy effluent. A more environmentally friendly and sustainable wastewater treatment method is encouraged by the fact that its natural origin prevents it from releasing hazardous byproducts into the environment.

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