Feasibility Study on Application of Natural Coagulants

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Abstract: Creating nations are confronting consumable water gracefully issues because of lacking money-related assets. The expense of water treatment is expanding, and the nature of waterway water isn't steady because of a suspended and colloidal molecule load brought about via land advancement and high tempest overflow during the stormy season. Because of numerous issues made by utilizing engineered coagulants a popularity to locate an elective characteristic coagulant emerges. In this exertion, an endeavor is made to examine the likelihood of normal coagulants like Cassia Alata, Calotropis Procera, Hyacinth bean, Banana leaves, Carcia Papaya, Acacia Mearnsii, Jatropha Curecas, Cactus, and Tamarind seeds on the reduction of turbidity of water. The clump coagulation test was done to decide the ideal coagulant amount required for the evacuation of turbidity of 100 NTU and to recognize the successful coagulant out of the nine chose normal coagulants. From this study, it may be accomplished that banana leaf can be used as an effectual coagulant for low and medium turbid water, whereas for high turbid water cactus can be used as an effective coagulant. Further examinations were completed utilizing the recognized coagulant to streamline the parameters like coagulant measurements, pH, introductory turbid focus, blending time, blending rate, and settling time. The higher percentage removal of turbidity was observed when pH was maintained at 6.5, initial turbid concentration was 500NTU, rapid mixing time given was 1 minute, slow mixing time with 25 minutes, and settling time of 25 minutes.

1. Introduction.

Coagulation is an important phase in the water treatment process since it not only eliminates particles but also other pollutants like heavy metals and bacteria that are typically connected to them. In the drinking water treatment process, several chemicals, the most popular of which are alum (AlCl₃), ferric chloride (FeCl₃), and poly aluminum chloride (PAC), are added to the water to remove suspended particles [1]. Alum (aluminum sulphate) and iron salts are the most prevalent coagulants, with alum being the most often employed. Aluminum has also been linked to neurological conditions such as particle trade difficulties and pre-feeble dementia. Aluminum particle consumption has been linked to the onset of
Alzheimer's disease. After treatment, the ooze is copious and non-biodegradable. Problems with disposal have resulted in a rise in treatment costs [2].

In recent years, there has been a lot of interest in the development of natural coagulants that can be made or extracted from bacteria, animals, or plant tissues. These coagulants ought to be biodegradable and to be ok for human wellbeing [3]. These coagulants ought to be biodegradable. In expansion, regular coagulants produce promptly biodegradable and less voluminous muck that sums just 15-35% that of alum treated partner. The utilization of normal materials like Moringa oleifera, Nirmaali seeds, Tannin, Chitosan, Cactus, Calropis Procera Bentonite dirt, Strychnos Potatorum seeds of the plant starting point to explain turbid crude waters is certainly not another thought. The use of traditional coagulants to remove turbidity has a long history. For over 2000 years, natural polymers with specific qualities have been employed in India, Africa, and China as viable coagulants and coagulant aids in high-turbidity water. They could be made from plant seeds, leaves, or roots [4]. Many experts are concerned about the future of common coagulants because of their abundant source, low value, condition-friendly, multifunctional, and biodegradable nature in water purification [5]. Coagulation's goal is to change these particles in a way that allows them to stick together.

In this study, an initiative was taken to identify the effective low-cost natural coagulant able to treat water of even turbidity also. The parameters affecting the coagulant process like coagulant dosage, pH, the concentration of turbid, mixing time (rapid mixing and slow mixing), settling time were also optimized in this work according to the values obtained from the jar test.

2. Experimental Investigation

2.1 Preparation of Sample

The example water utilized for this current examination was arranged artificially in the research center by dissolving clayey soil in faucet water. Clayey soil utilized for this examination was gathered from Cuddalore territory. Around 30 g of the gathered clayey soil was broken down in one liter of refined water. The soil suspension was stirred for about an hour to achieve a consistent dispersion of clay particles. To achieve complete hydration, the clay components were allowed to settle for at least 24 hours. The supernatant suspension of the previously generated synthetic turbid water was used to make a stock solution with a turbidity of 1000 NTU. 10 NTU, 20 NTU, 30 NTU, 40 NTU, 50 NTU, 60 NTU, 70 NTU, 80 NTU, 90 NTU, and 100 NTU turbidity was achieved by diluting 1mL, 2mL, 3mL, 4mL, 5mL, 6mL, 7mL, 8mL, 9mL, 10mL, and 11mL of the standard solution in one liter of distilled water.

2.2 Preparation of coagulants

Acacia Mearnsii, Banana leaves, Cactus, Carica Papaya, Cassia Alata, Calotropis Procera, Hyacinth bean, Jatropha Curcas, and Tamarind seeds were among the nine natural coagulants employed in this study. The chosen coagulants were gathered in Krishnankoil, Tamil Nadu's Virudhu Nagar district, from the local market and nearby residential areas. Cassia Alata leaves were dried for two days at 500°C in an oven. The ground-up components were sieved using a 0.425-mm sieve after the dry leaves were crushed up [6]. Cactus was made by cutting fresh opuntia species into 1cm wide strips and drying them in the oven for 24 hours at 60°C. Then the oven-dried Dry Opuntia species was grounded in a grinder. The ground materials passing through a 0.300 mm sieve were used for further study. Peels of Hyacinth bean were separated and sun-dried for 1 week and then the same was dried in Hot Air Oven at 60oC for an hour to remove the excess moisture present in the peel. The oven-dried peels were then grinded in a grinder. The ground materials passing through a 0.300 mm sieve were used for further study. Sun-dried Calotropis Procera flowers were ground in a grinder after being sun-dried naturally. For subsequent research, grinding
materials that passed through a 0.300 mm sieve were utilized [7]. For two days, Casuaria equisetifolia, Carica papaya, and banana leaves were dried in a 500°C oven. The materials were then processed in a grinder after being oven-dried (Calotropis Procera flowers, Casuaria equisetifolia leaves, Tamarind seeds, Carica papaya leaves, Banana leaves). In this experiment, the ground materials were sieved through a 0.425 mm sieve, and the material that passed through was used as a coagulant.

Jatropha curcas seeds were defused and oven-dried for two days at a temperature of 60°C to remove the oil. After drying in the oven, the seeds were ground into a fine powder with a blender. In this experiment, the ground materials were sieved through a 0.425 mm sieve, and the material that passed through was used as a coagulant.

2.3 Batch Coagulation Test

Out of nine natural coagulants, a batch coagulation test was performed to determine which was the most effective. The batch coagulation test was performed as per standard technique, with a sample concentration of 10 NTU as the beginning concentration. The first selected coagulants were added in the range of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6 g to six 500 mL beakers containing 10 NTU synthetic turbid water [8][9]. To facilitate flock formation, the contents of a 500 ml beaker were rapidly shaken for 120 seconds at 100 rpm, followed by 20 minutes of gradual mixing at 35 rpm. To imitate settling, the flocculated suspensions were left undisturbed for 30 minutes. The amount of floc that had settled was then measured in a measuring jar. For the remaining coagulant, the same method was followed [10]. The coagulant that creates the most floc was chosen as the most effective coagulant. Similar batch coagulation studies were carried out in the future to optimize the parameter that affects the coagulation process, as described above.

3. Results and Discussion

3.1 Identification of effective

The jar test was used to determine which of the nine natural coagulants was the most effective. 500 mL of synthetic turbid water with a turbidity of 10 NTU was placed in the beakers, and one gram of each of the nine coagulants was added to the synthetic water. The jar test was then performed according to protocol. Figure 1 shows the volume of floc settling for each coagulant measured with a measuring jar and plotted. From the graph plotted above it may be concluded that banana leaves produce higher floc formation of about 2 mL followed by Papaya of 1 mL, Casuaria equisetifolia, and Jatropha of 0.8 mL, followed by Cactus of 0.6 mL and the remaining coagulant shows only 0.5 mL of floc formation. Hence Banana leaf was selected as an effective coagulant for the further batch studies. The water utilized for this current examination was arranged artificially in the research center by dissolving clayey soil in faucet water. Clayey soil utilized for this examination was gathered from Cuddalore territory. Around 30 g of the gathered clayey soil was broken down in one liter of refined water.

3.2. Effect of coagulant Dosage

The test to determine the coagulant dosage on a banana leaf was carried out in the jar test as per the standard procedure. The 500 mL of synthetic turbid water of 500 NTU were taken in the beakers and one gram of coagulants was added to the synthetic water in the beakers. Then the jar test was carried as per the procedure as follows. Immediately following coagulant dosing, the beaker contents of 500 ml were mixed rapidly for 120 sec at 100 rpm and this was followed by 20 min of gentle mixing at 35 rpm to aid in flock formation. The flocculated suspensions were allowed to stand without disturbance for 30 min to simulate settling. Then the residual turbid was measured using a turbidity meter. The same procedure was followed for the other coagulant dosages of 2, 3, 4, 5, 6, 7, 8, 9, 10 grams and the corresponding residual turbid of coagulants were measured and plotted as shown in Figure 2. From the graph plotted above it may be
concluded that 85-88% removal of turbidity when coagulant dosage of 4 g/500 ml was added. When the coagulant dosage was increased above 4 g the settled flock show deflocculating and hence there may be some reduction in removal efficiency after the optimum dosage.

3.3. Effect on pH

The test was done to investigate the effect of pH on the removal of turbidity by the coagulation process. This study was carried out on a synthetic Turbid solution of 500 NTU. The 500 mL of synthetic turbid water were taken in the beakers and the optimum dosage of 4 g/mL banana leaf identified from the previous batch study was added to the synthetic water in the beakers. The pH of the sample was modified as 2 then the jar test was carried out as per the procedure. Then the residual turbid was measured using a turbidity meter. The same procedure was followed for the varied pH 3,4,5,6,7,8,9,10,11,12 and the corresponding residual turbid of coagulant were measured. The variation of % removal of turbidity under
different pH conditions was plotted as shown in Figure 3. From the graph plotted above, it was clear the maximum percentage removal of 99% turbidity was achieved when pH was maintained at 6. When the pH was increased from 2 to 6, the floc formation was increasing and when the pH was increased beyond 6, there was a reduction in the percentage removal of turbidity.

![Figure 3. Effect on pH.](image)

3.4. Effect on the initial concentration of turbidity

The test was carried out to investigate the effect of the initial concentration of turbidity on the removal of turbidity. The 500 mL of synthetic turbid water of 100NTU, 200NTU, 300NTU, 400NTU, 500NTU, 600NTU, 700NTU, 800NTU, 900NTU, and 1000NTU were taken in the beakers and the optimum dosage of 4g/500mL of a banana leaf was added to the synthetic water in the beakers. The pH of the synthetic turbid water was maintained at 6 as obtained from the previous test. The jar test was carried out for the above varied synthetic turbid water as per the standard procedure[11]. Then the residual turbid was measured using a turbidity meter and the percentage removal of turbidity was plotted as shown in Figure 4. It was depicted from the graph plotted between initial turbid concentration and the % removal of turbidity as shown in Figure 4, the maximum 96 % of removal of turbidity was obtained for the initial turbid concentration of 500 NTU [12].

![Figure 4. Effect of Initial Turbid Concentration.](image)
3.5 Effect of Rapid Mixing Timing

The test was carried out to investigate the effect of Rapid Mixing Time on the percentage removal of turbidity. The 500 mL of synthetic turbid water of 500 NTU as obtained in the previous test was taken in the beakers and the optimum dosage of 4mg/500mL was added to the synthetic water in the beakers. The sample's pH was kept constant at 6. To facilitate flock formation, a rapid mixing time of 30 seconds at 100rpm was given, followed by 20 minutes of slow mixing at 35rpm. To imitate settling, the flocculated suspensions were left undisturbed for 30 minutes. For 60, 90, 120, 150, 180, 210, 240, 270, and 300 seconds of rapid mixing time, the same process was used. A turbidity meter was then used to measure the residual turbidity. Figure 5 shows the % reduction of turbidity as a function of Rapid Mixing Time. The percent elimination of turbidity increases as the quick mixing duration increases, reaching a high of 99 percent at 60 seconds, as indicated in the graph above. When the quick mixing duration is extended beyond 60 seconds, the settle floc deflocculates, resulting in a drop in the percentage of turbidity removed.

![Graph showing the effect of rapid mixing time on turbidity removal](image)

**Figure. 5. Effect of Rapid Mixing Time.**

3.6 Effect of Slow Mixing Time

The test was carried out to investigate the effect of Slow Mixing Time on the percentage removal of turbidity. The 500 mL of 500 NTU synthetic turbid water were taken in the beakers and the optimum dosage of 4g/500mL was added to the synthetic water in the beakers. The pH of the synthetic turbid water was maintained at 6. The jar test was carried out as per standard procedure with a rapid mixing time of 60 seconds as obtained in the previous test. In this study, the slow mixing time was varied as 10, 15, 20, 25, 30 and 35 minutes. Then the residual turbid was measured using a turbidity meter and the percentage removal of turbidity for various slow mixing times was calculated and plotted as shown in Figure 6. It shows the variation of percentage removal of turbidity with slow mixing time. as the slow mixing time increases the removal percentage also increases and reaches a maximum value of 99% at 25 minutes. When the slow mixing time increases beyond 25 minutes, the percentage removal of turbidity decreases as deflocculating of the floc takes place.

3.7 Effect of Settling Time

The test was carried out to investigate the effect of Slow Mixing Time on the percentage removal of turbidity The 500 mL of 500 NTU synthetic turbid water were taken in the beakers and the optimum dosage of 4g/mL was added to the synthetic water in the beakers The pH of the sample was maintained at 6 with the rapid mixing time of 60 seconds followed by slow mixing time of 25 minutes as obtained in the previous batch coagulation test, then the jar test was carried as per the standard procedure with settling time varied from 10,15,20,25,30,35,40,45,50,55 and 60 minutes. Then the residual turbid was measured.
using a turbidity meter and the percentage removal of turbidity was calculated and plotted as shown in Figure 7. From Figure 7 it is clear that as the settling time increases the percentage removal of turbidity increases and reaches a maximum value of 99%. The maximum removal is obtained when the settling time was 22 minutes.

4. Conclusion
The effective coagulant with the nine coagulants was used in this investigation (like Acacia Mearnsii, Banana leaves, Carcia Papaya, Jatropha Curcas, Cactus, Cassia Alata, Calotropis Procera, Hyacinth bean, Jatropha Curcas, and Tamarind seeds). It is possible to deduce from this study that banana leaf was more efficient than the other coagulants. The effect of parameters such as coagulant dosage, beginning turbidity, pH, Rapid Mixing Time, Slow Mixing Time, and settling time on the % elimination of turbidity by coagulation was investigated further in optimization experiments. According to the findings, the most turbidity can be removed when the coagulant dosage is 4g/0.5L, the pH is kept at 6, the initial turbid concentration is 500 NTU, the Rapid Mixing Period is 60 seconds, the Slow Mixing Time is 25 minutes, and the settling time is 22 minutes.
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