Practicability Study on Application of Natural Coagulants

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***Abstract*—Due to suspended and colloidal molecular load caused by land advancement and excessive overflow during the stormy season, the cost of water treatment is rising. Multiple problems caused by using engineered coagulants, there is a growing demand for an optional characteristic coagulant. In this study, the effects of natural coagulants such as Neem leaves, Okra seeds, Watermelon seeds, Papaya seed, Aloe Vera, and Cactus on water turbidity reduction are investigated. The clump coagulation test was used to determine the ideal coagulant amount needed to evacuate 100 NTU of turbidity and to identify the successful coagulant among the six coagulants. It can be concluded from this study that neem leaf can be used as an effective coagulant for low and medium turbid water, whereas aloe Vera used as an effective coagulant for high turbid water. Further tests were carried using the recognized coagulant to streamline factors such as coagulant readings, pH, turbidity induction, blending time, blending rate, and settling time. When the pH was kept at 6.5, the starting turbid concentration was 500NTU, the rapid mixing time was 1 minute, the slow mixing time was 22 minutes and the settling period was 27 minutes, the higher percentage of turbidity was removed.**

Keywords: - Coagulation, Natural Coagulants, Optimization, Neem, Aloe Vera

I. INTRODUCTION

Coagulation is a crucial step in the water treatment process since it removes not only particles but also other pollutants such as heavy metals and bacteria that are commonly associated with them. Several chemicals, the most common of which are alum, ferric chloride, and poly aluminium chloride, are added to the water during the drinking water treatment process to remove suspended particles [1]. The most common coagulants are alum and iron salts with alum being the most commonly used. Aluminum has also been related to neurological problems like particle trade problems and prefeeble dementia. The ingestion of aluminium particles has been connected to the development of Alzheimer's disease. The ooze is thick and non-biodegradable after treatment. Treatment expenses have risen as a result of disposal issues [2]. Natural coagulants, which can be manufactured or taken from bacteria, animals, or plant tissues, have sparked a lot of attention in recent years. These compounds should be biodegradable and safe for human consumption [3]. Biodegradable coagulants should be used. Regular coagulants, on the other hand, produce quickly biodegradable and less voluminous muck that is only 15-35 percent that of the alum-treated companion. The use of common materials like as Moringa oleifera, Nirmaali seeds, Tannin, Chitosan, Cactus, Calropis Procera Bentonite dirt, and Strychnos Potatorum seeds as a starting point to explain murky crude waters is surely not a new idea. Traditional coagulants have a long history of being used to eliminate turbidity. Natural polymers with certain properties have been used as viable coagulants and coagulant aids in high-turbidity water in India, Africa, and China for over 2000 years. Plant seeds, leaves, or roots could be used to make them [4]. Because of their abundant source, low value, condition-friendly, multifunctional, and biodegradable character in water purification, many specialists are concerned about the future of common coagulants [5]. The purpose of coagulation is to alter these particles in such a way that they cling together.

In this work, the goal was to find a low-cost natural coagulant that could treat water with even turbidity. The parameters that affect the coagulant process, such as coagulant dosage, pH, turbidity concentration, mixing time (fast and slow mixing), and settling time, were also improved in this study based on the results of the jar test.

II. EXPERIMENTAL INVESTIGATION

A. Preparation of Sample

The example water used in this study was created in the lab by dissolving clayey soil in tap water. The clayey soil used in this experiment came from a college campus. In one litre of filtered water, 30 g of the obtained clayey dirt was broken down. To produce a constant dispersion of clay particles, the soil suspension was agitated for roughly an hour. The clay components were allowed to settle for at least 24 hours to ensure complete hydration. A stock solution with a turbidity of 1000 NTU was made from the supernatant suspension of the previously manufactured synthetic turbid water. Diluting 1mL, 2mL, 3mL, 4mL, 5mL, 6mL, 7mL,8mL,9mL,10mL, and 11mL of the standard solution in one litre of distilled water yielded 10 NTU, 20 NTU, 30 NTU, 40 NTU, 50 NTU, 60 NTU, 70 NTU, 80 NTU, 90 NTU, and 100 NTU turbidity.

B. Preparation of Coagulants

The six natural coagulants used in this investigation were neem leaves, okra seeds, water- melon seeds, papaya seed, aloe Vera, and cactus. The chosen coagulants were collected from the local market and neighboring residential areas in Amravati, Maharashtra. Neem leaves were dried in an oven for seven days at 100^0C. After crushing the dried leaves, the ground-up components were sieved with a 0.425-mm sieve [6]. Fresh opuntia species were sliced into 1cm broad strips and dried in the oven for 24 hours

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at 60◦C to make the cactus. After that, a grinder was used to grind the oven- dried Dry Opuntia species. For subsequent research, grinding materials that passed through a 0.300 mm sieve were utilized. Watermelon seeds were separated and sun-dried for one week before being dried in a Hot Air Oven at 60^0C for an hour to remove any remaining moisture. After that, the oven-dried seeds were ground in a grinder. For subsequent research, grinding materials that passed through a 0.300 mm sieve were utilized. Sun-dried after being sun-dried naturally, papaya seeds were pulverized in a grinder. Grinding materials that went through a 0.300 mm sieve were used in later study [7]. Okra seeds were dried in a 500 C oven for two days. After being oven-dried, the materials were ground in a grinder (Neem leafs, Watermelon Seeds, papaya Seeds, Aloe Vera, cactus). The ground materials were sieved through a 0.425 mm sieve in this experiment, and the material that made it through was utilized as a coagulant. To remove the oil, the aloe Vera was defused and oven-dried for three days at 60 C. The peels were ground into a fine powder with a blender after drying in the oven. The ground materials were sieved through a 0.425mm sieve in this experiment, and the material that made it through was utilized as a coagulant.

C. Batch Coagulation Test

A batch coagulation test was used to identify which of six natural coagulants was the most effective. The batch coagulation test was carried out according to conventional procedure, starting with a sample concentration of 10 NTU. The initial coagulants were introduced to six 500 mL beakers containing 10 NTU synthetic turbid water in amounts ranging from 0.1, 0.2, 0.3, 0.4, 0.5, 0.6g [9]. The contents of a 500 ml beaker were forcefully shaken for 120 seconds at 100 rpm, followed by 20 minutes of gentle mixing at 35 rpm to aid flock formation. The flocculated fluids were left undisturbed for 30 minutes to simulate settling. In a measuring jar, the amount of floc that had settled was measured. The same procedure was used for the remaining coagulant [10]. The most effective coagulant was chosen as the one that produces the most floc. In the future, similar batch coagulation experiments will be conducted to optimize the parameter that affects the coagulation process, as mentioned above.

III. RESULTS AND DISCUSSION

A. Identification of Effective

The jar test was done to see which of the six natural coagulants worked the best. The beakers were filled with 500 mL of synthetic turbid water with a turbidity of 10 NTU, and one gram of each of the six coagulants was added to the synthetic water. The jar test was then carried out in accordance with the protocol. Figure 1 shows the volume of floc settling measured with a measuring jar and plotted for each coagulant. According to the graph above, Neem leaves produce the most floc (approximately 2 mL), followed by Aloe Vera (1 mL), Watermelon, and Papaya (0.8 mL), Cactus (0.6 mL), and Okra (0.5 mL). Hence For the subsequent batch trials, Neem leafs and Aloe Vera were chosen as an efficient coagulant. The example water used in this study was created in the lab by dissolving clayey soil in tap water. The clayey soil used in this experiment came from College grounds. In one litre of filtered water, 30 g of the obtained clayey dirt was broken down.

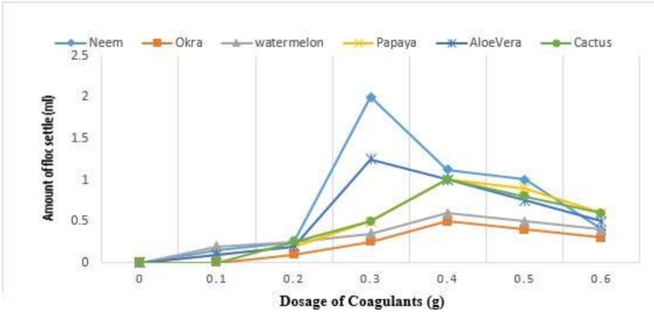

Fig. 1 Amount of floc produced by various coagulants

B. Effect of Coagulant Dosage

The conventional approach for determining the coagulant dose on neem leaves was carried out in the jar test. 500 mL of 500 NTU synthetic turbid water was placed in the beakers, and one gramme of coagulants was added to the synthetic water. The jar test was then performed according to the following technique. Following coagulant dosing, the contents of a 500ml beaker were rapidly mixed for 120 seconds at 100rpm, followed by 20 minutes of gentle mixing at 35rpm to aid flock formation. To imitate settling, the flocculated suspensions were left undisturbed for 30 minutes. A turbidity meter was then used to measure the residual turbidity. The equivalent residual turbid of coagulants was measured and plotted as shown in Figure 2 for the various coagulant dosages of 2,3,4,5,6,7,8,9,10 gram. The graph above shows that when a coagulant dosage of 4 g/500 ml was administered, 86- 89 percent of the turbidity was removed. The settled flock deflocculated when the coagulant dosage was increased above 4 g, suggesting that there may be some loss in removal efficiency after the optimal dosage.

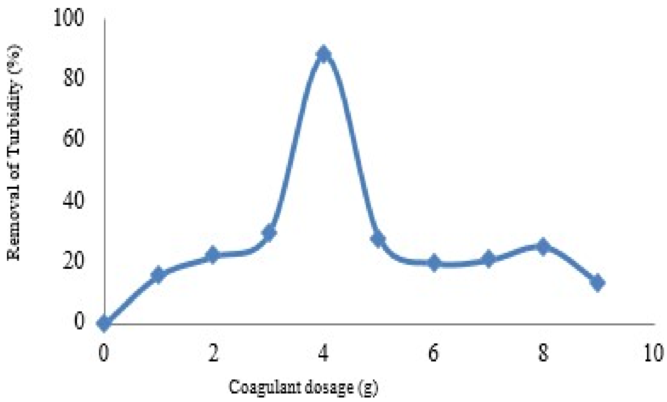

Fig. 2 Effect of Coagulant Dosage

C. Effect on pH

The purpose of the experiment was to see how pH affected the turbidity removal by the coagulation process. This experiment was done out using a 500 NTU synthetic Turbid solution. The beakers were filled with 500 mL of synthetic turbid water, and the optimum dosage of 4 g/mL neem leafs from the previous batch research was added to the synthetic water. The pH of the sample was changed to 2, and the jar test was performed as directed. A turbidity meter was then used to measure the residual turbidity. The matching residual turbidity of coagulant was measured using the same approach for pH 3,4,5,6,7,8,9,10,11,12. The variance in percent turbidity removal under different pH settings was presented in Figure 3.

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The maximum percentage elimination of 99 percent turbidity was attained when pH was maintained at 6.5, as seen in the graph above. When the pH was raised from 2 to 6.5, the floc production increased, but when the pH was raised beyond 6.5, the percentage of turbidity removed decreased.

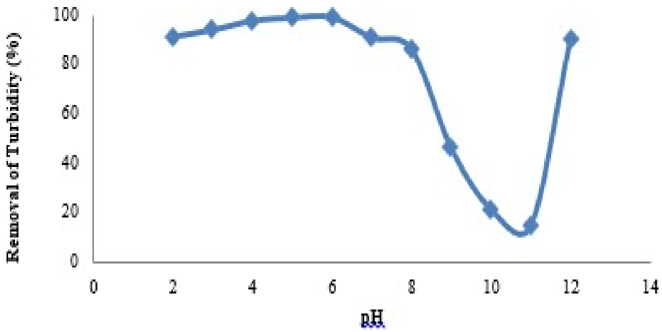
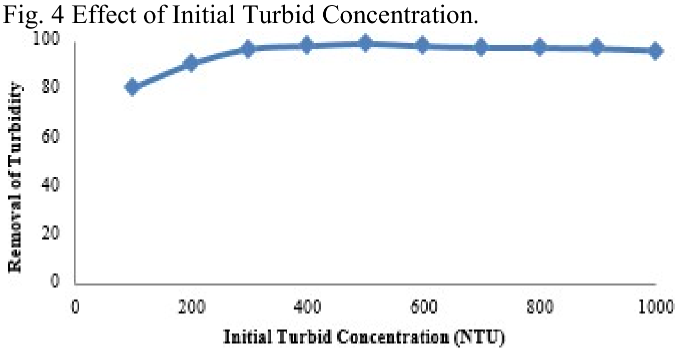


Fig. 3 Effect on pH

D. Effect on the Initial Concentration of Turbidity

The purpose of the experiment was to see how the starting concentration of turbidity affected the removal of turbidity. The beakers were filled with 500 mL of synthetic turbid water containing 100NTU, 200NTU, 300NTU, 400NTU, 500NTU, 600NTU, 700NTU, 800NTU, 900NTU, and 1000NTU, as well as the optimum dosage of 4g/500mL of neem leaves. The pH of the synthetic turbid water was kept at 6, as determined in the prior experiment. The jar test was performed as per usual method for the several synthetic turbid water samples mentioned [11]. The residual turbidity was then measured with a turbidity meter, and the percentage of turbidity removed was represented in Figure 4. The highest 96 percent removal of turbidity was reached for the initial turbid concentration of 500 NTU, as indicated in the graph plotted between initial turbid concentration and percent removal of turbidity in Figure 4. [12].

Fig. 4 Effect of Initial Turbid Concentration.



E. Effect of Rapid Mixing Timing

The purpose of the experiment was to see how Rapid Mixing Time affected the percentage of turbidity removed. The beakers were filled with 500 mL of 500 NTU synthetic turbid water acquired in the previous test, and the optimum dosage of 4 mg/500 mL was applied to the synthetic water in the beakers. The pH of the sample was maintained at 6. A quick mixing time of 30 seconds at 100rpm was given, followed by 20 minutes of gentle mixing at 35rpm, to aid flock formation. The flocculated fluids were left undisturbed for 30 minutes to simulate settling. The same procedure was utilized for 60, 90, 120, 150, 180, 210, 240, 270, and 300 seconds of rapid mixing time. The residual turbidity was then measured using a turbidity meter. The percent reduction in turbidity as a function of Rapid Mixing Time is shown in Figure 5. As the rapid mixing period rises, the percent eradication of turbidity increases, reaching a peak of 99 percent at 60 seconds, as shown in the graph above. The settle floc deflocculates when the rapid mixing time is extended beyond 60 seconds, leading in a reduction in the percentage of turbidity eliminated.

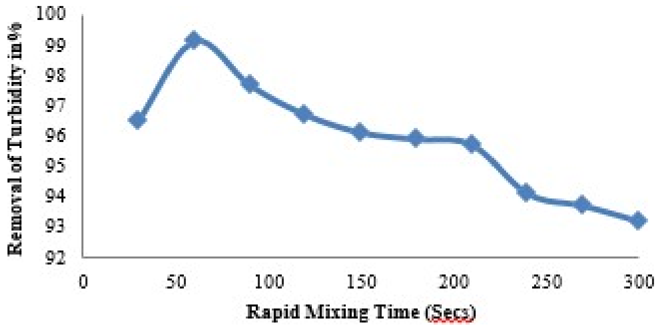


Fig. 5 Effect of Rapid Mixing Time

F. Effect of Slow Mixing Time

The goal of the experiment was to see how slow mixing time affected the percentage of turbidity removed. The beakers were filled with 500 mL of 500 NTU synthetic turbid water, and the optimum dosage of 4g/500mL was added to the synthetic water. The pH of the synthetic turbid water was kept at a constant of 6. The jar test was performed according to protocol, with a rapid mixing duration of 60 seconds, as in the prior test. The slow mixing period was modified in this study from 10, 15, 20, 25, 30, and 35 minutes. Then, using a turbidity meter, the residual turbidity was measured, and the percentage reduction of turbidity for various slow mixing durations was calculated and plotted, as shown in Figure 6. It depicts the percentage of turbidity removed as a function of mixing time. The elimination percentage increases as the slow mixing duration increases, reaching a high of 99 percent after 22 minutes. As the slow mixing period exceeds 22 minutes, the proportion of turbidity removed drops due to deflocculation of the floc.

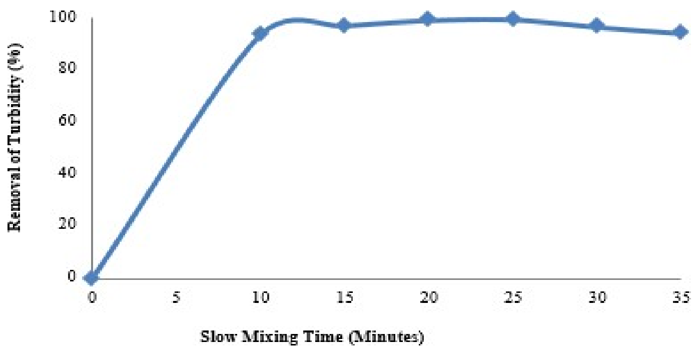


Fig. 6 Effect of Slow Mixing Time

G. Effect of Settling Time

The purpose of the experiment was to see how slow mixing time affected the percentage of turbidity removed. The beakers were filled with 500 mL of 500 NTU synthetic turbid water, and the optimum dosage of 4g/mL was added to the synthetic water. As in the previous batch coagulation test, the pH of the sample was maintained at 6 with a rapid mixing time of 60 seconds followed by a slow mixing time of 22 minutes, and then the jar test was carried out as per standard procedure with settling times ranging from 10,15,20,25,30,35,40,45,50,55, and 60 minutes. The residual turbidity was then measured with a turbidity meter, and the turbidity reduction percentage was calculated and plotted as shown in Figure 7. Figure 7 shows that as the settling time increases, the percentage of turbidity removed increases, reaching a maximum of 99 percent. When the settling time was 27 minutes, the maximum removal was attained.

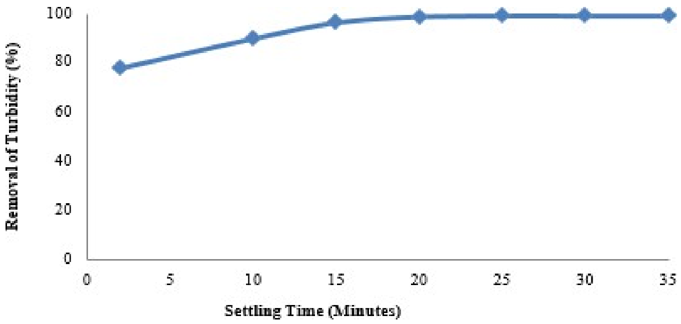


Fig. 7 Effect of Settling Time

IV. CONCLUSION

In this study, the most effective coagulant out of the six was used (Neem leafs, Okra Seeds, Watermelon Seeds, Papaya Seed, Aloe Vera and Cactus). This study suggests that Neem leaf and Aloe Vera are more effective coagulants than the others. In optimization tests, the effect of parameters such coagulant dosage, starting turbidity, pH, Rapid Mixing Time, Slow Mixing Time, and settling time on the percent elimination of turbidity by coagulation was studied further. The researchers discovered that when the coagulant dosage is 4g/0.5L, the pH is kept at 6.5, the initial turbid concentration is 500 NTU, the Rapid Mixing Period is 60 seconds, the Slow Mixing Period is 22 minutes, and the settling time is 27 minutes, the most turbidity can be removed.

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