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USE OF NATURAL COAGULANTS FOR TURBIDITY REMOVAL OF WATER

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ABSTRACT
The expense of treating water is increasing because of the suspended and colloidal molecular load brought on by land expansion and excessive overflow during the rainy season. There is an increasing need for an optional characteristic coagulant due to the various issues that using manufactured coagulants has caused. This study examines the impact of natural coagulants on reducing water turbidity, including chickpeas, neem leaves, and aloe vera. The ideal coagulant amount required to remove 80 NTU of turbidity and the successful coagulant among the three coagulants were both determined using the jar test. This study suggests that while chickpeas are an excellent coagulant for highly turbid water, aloe vera is good for low to medium-turbidity water. To streamline variables including coagulant readings, blending duration, blending rate, and settling time, additional tests were conducted utilizing the identified coagulant. The greater proportion of turbidity was eliminated with a one-minute rapid mixing time, a twenty-minute gradual mixing time, and a twenty-five-minute settling period.
Keywords: Nephelometric Turbidity unit, Turbidity, Chickpea, Jar test apparatus, Coagulation, Flocculation

I.Introduction
The removal of particles and other pollutants, including germs and heavy metals, frequently linked to them, is achieved through coagulation, an essential stage in the water treatment process. To get rid of suspended particles, drinking water treatment involves adding several chemicals to the water, the most popular being polyaluminum chloride, ferric chloride, and alum.[3] Around the world, alum is utilized in developing nations to treat water by flocculation and coagulation. Neurological disorders like Alzheimer's disease can arise from the ongoing use of alum in water treatment. Additionally, some hazardous unreacted monomers were left in the treated water by the alum.[5]
The use of natural coagulants as effective coagulants for raising turbidity in water dates back more than 2000 years to India, Africa, and China. They could be made from the seeds, leaves, and roots of plants. There are numerous listed plant-based operational coagulants:[2] The purifying process has historically involved the use of the plant's seeds, leaves, roots, barks, fruit peels, and vegetable peels. Natural coagulants have several advantages, including less sludge collection, lower costs, adjustable pH levels in filtered water, non-toxicity, and environmental friendliness.[7]
It is not a novel concept to use natural coagulants derived from plants to remove turbidity from water; many scientists have investigated various plant extracts to determine whether they may be used for this purpose. Aloe Vera powder proved to be an effective coagulant replacement. Aloe vera proteins give off a positive charge when they come into contact with water, which electrostatically attracts negatively charged water molecules to one another. Studies show that aloe vera is nontoxic, less costly than chemical coagulants, environmentally benign due to its biodegradability, and creates less sludge.[1]
Powdered neem leaf is converted into a natural coagulant resource. Azadirachta indica, a member of the Meliaceae family of mahogany trees, is often called neem, nim tree, or Indian lilac. It is found in some regions of Africa and the Indian subcontinent. It is one of the two variants of the plant Azadirachta. Typically, tropical and semi-tropical climates are where it is grown. Neem leaf treats leprosy, bloody nose, intestinal worms, eye disorders, upset stomach, appetite loss, skin ulcers, heart illnesses, blood vessels, fever, diabetes, gum disease, and liver problems. Neem trees also yield a large

volume of surplus biomass. Neem leaves, flowers, seeds, fruits, roots, bark, and seeds are among the parts of the tree that can be used extensively researched, and employed as adsorbents in water treatment to remove various pollutants.[7]
A member of the Fabaceae family of legumes is the chickpea (Cicer arietinum). Its numerous varieties go under different names, such as Bengal or Gram. A large amount of the world's total chickpea production is produced on the Indian subcontinent. In Africa, where there are few clean water supplies, it is also available. There, the use of chickpeas may alter evolutionarily. It can be applied in the coagulation tanks during the treatment process, and the results of this study indicate that chickpeas function well as coagulants. [6]

1 Materials and Methods

1.1 Synthetic Turbid Solution Preparation

Clay materials were added to tap water to create artificially turbid water for the jar testing. Two grams of the clay materials (around 12 g for high turbidity of 80 NTU and 2 gm for low turbidity of 30 NTU) were added to 2.5 liters of tap water. To ensure the clay particles were evenly distributed, the suspension was agitated for around an hour. After that, it was left to settle for a minimum of twenty-four hours to allow the clay ingredients to fully hydrate. Just before coagulation, the sample water was mixed with the synthetic turbid water supernatant suspension to attain the appropriate turbidity. [8]

1.2 Aloe-Vera Juice Solution Preparation

Aloe Vera juice, a naturally occurring coagulant, was derived from aloe leaves. To drain the yellow liquid known as aloin, the bottommost well-grown aloe leaves were chopped off, and the container was left tilted for a few minutes. The entire leaf was then chopped into different parts, and the gel portion was removed from the leaf. The gel portion was then ground in a conventional mixer grinder. The pure Aloe Vera juice was ready. 1 milliliter of aloe vera juice was combined with 99 milliliters of purified water to create 1% aloe solution.[3]

1.3 Neem Powder Solution Preparation

Local neem trees provided the leaves, which were then collected and cleaned with tap water. After that, the leaves are sun-dried for a period of five to six das. After that, the leaves were finely powdered in a food processor that is typically used in a kitchen. A 500-gram batch of organic neem leaf powder was produced. Once 1 ml of aloe vera juice and 99 ml of distilled water were combined to create 1% aloe solution. Making a solution with chickpea powder.[4]

1.4 Chickpea Powder Solution Preparation

To eliminate contaminants, a large amount of water was used to wash the seeds of the Kabuli Chickpea anionic coagulant (Cicer arietinum L). After that, it was sun-dried for two days. The material was crushed in an Oster mixer, and the resulting powder was sieved through a No. 200 sieve to produce an extremely fine powder that could be stored in plastic containers to prevent hydration and then used to prepare the coagulant solutions. Following the addition of 1 milliliter of chickpea powder to 99 milliliters of distilled water to create 1% aloe solution.[6]

1.5 Jar Test Experiment

Figure 1 Jar Test apparatus

Figure 2 Turbidity meter

The most popular experimental technique for determination is the jar test. The substance was thoroughly mixed before performing the jar test. We gave the beakers varying dosages of aloe vera and alum. A variety of speeds were used to agitate the beakers: 30 minutes for settling, 15 minutes for gentle mixing (30–40 rpm), and two minutes for vigorous mixing (100–150 rpm). Once the material had settled, residual turbidity was assessed by taking a pipette-full sample from the center of the supernatant.[11]

2 Results and Discussion

2.1 Alum's Coagulant Effect for Turbid Water of 80 NTU Turbidity

Alum was used as a coagulant in experiments with high turbid water. A range of 10 to 60 mg/l of aloe-vera was used. Based on the results, The greatest removal efficiency with alum doses of 15 mg/l was determined to be 81.25% for high turbid water. Figure 3 illustrate how an alum dose affects high turbid water.

Table 1 Showing result 80 NTU alum solution

High turbid 80NTU solution			
Sr.	Alum dose (mg/l)	Residual turbidity (NTU)	Percentage removal of turbidity
1.	10	30	62%
2.	20	25	68.75%
3.	**30**	**15**	**81.25%**
4.	40	18	77.50%
5.	50	23	71.25%
6.	60	25	68.75%

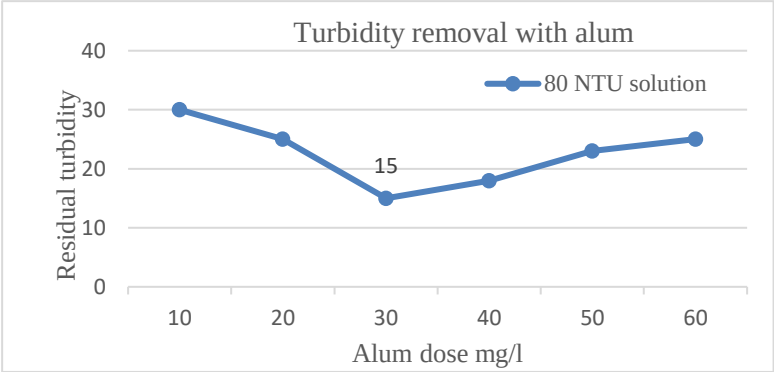

Figure 3 Showing optimum dose of Alum solution for 80 NTU turbid water

2.2 Aloe-vera's Coagulant Effect for Turbid Water of 80 and 30 NTU Turbidity

Aloe vera was used as a coagulant in experiments with both high and low-turbid water. A range of 1 to 100 mg/l of aloe-vera was used. Based on the results, a high aloe-vera dose was needed for successful turbidity removal. The greatest removal efficiency with aloe-vera doses of 29 mg/l and 15 mg/l was determined to be 76.25% for high turbid water and 83.66% for low turbid water. Figures 4 and 5 illustrate how an aloe vera dose affects both high and low-turbidity water.

2.3 Neem's Coagulant Effect for Turbid Water of 80 and 30 NTU Turbidity

Neem was used as a coagulant in experiments for both high and low-turbid water. The dosage of neem was adjusted between 1 and 50 mg/l. Based on the results, a high neem dose was needed for successful turbidity removal. Maximum removal effectiveness was obtained at 16.25% for high turbid water and 51.67% for low turbid water with neem doses of 19 mg/l and 19 mg/l, respectively. The laboratory

analysis revealed that the neem coagulant did not remove enough turbidity, indicating that it is not a good coagulant.

Figures 6 illustrate how different neem dosages affect high and low-turbidity water.

Table 2 Result of 80NTU Aloe-vera solution

High turbid 80NTU solution			
Sr. no.	Aloe-vera dose (mg/l)	Residual turbidity (NTU)	Percentage removal of turbidity
1	1	50	37.5%
2	3	54	32.5%
3	5	56	30%
4	7	59	26.25%
5	9	59	26.25%
6	11	47	41.25%
7	13	46.4	42%
8	15	44.7	44.12%
9	17	43.9	45.12%
10	19	41.3	48.35%
11	21	22.2	72.25%
12	23	22.8	71.5%
13	25	20.8	74%
14	27	22	72.5%
15	**29**	**18.99**	**76.25%**

Table 3 Result of 30 NTU Aloe-vera solution

For low turbid 30NTU solution			
Sr. no.	Aloe-vera dose (mg/l)	Residual turbidity (NTU)	Percentage removal of turbidity
1	3	8.4	72%
2	7	6.5	78.33%
3	11	10.7	64.33%
4	**15**	**4.9**	**83.66%**
5	19	3.6	88%
6	21	13.5	45%
7	23	13.4	44.66%
8	25	12.5	41.66%
9	27	12.8	42.66%
10	29	14.2	47.33%

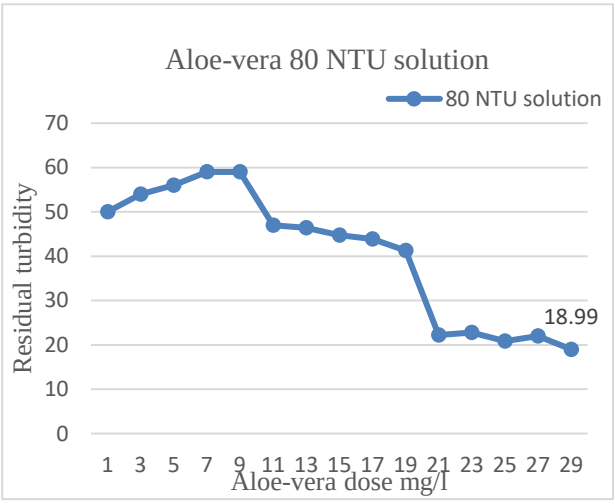

Figure 4 Showing optimum dose of Aloe-vera solution for 80 NTU turbid water

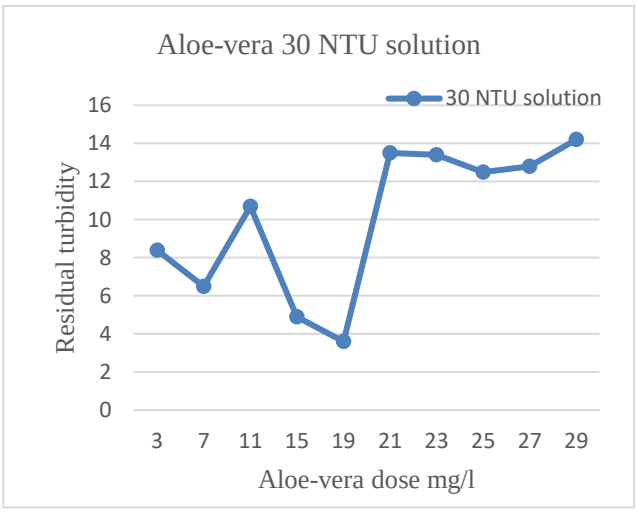

Figure 5 Showing optimum dose of Aloe-vera solution for 30 NTU turbid water

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Table 4 Result of 80NTU Neem solution

High turbid 80NTU solution			
Sr. no.	Neem dose (mg/l)	Residual turbidity (NTU)	Percentage removal of turbidity
1	5	74.5	6.3%
2	10	76.5	3.53%
3	15	76.7	3.27%
4	20	77.5	2.26%
5	25	80	It is not suitable as coagulant.
6	30	70	12.5%
7	35	70.5	11.37%
8	40	67	16.25%
9	45	73	8.75%
10	50	72	10%

Table 5 Result of 30NTU Neem solution

Low turbid 30NTU solution			
Sr. no.	Neem dose (mg/l)	Residual turbidity (NTU)	Percentage removal of turbidity
1	5	14.5	51.67%
2	10	19.5	35%
3	15	21.3	29%
4	20	24.5	18.33%
5	25	29.5	1.67%
6	30	27	10%
7	35	30	It is not suitable as coagulant.
8	40	30.5	0.05%
9	45	33	-10%
10	50	35	-16.61%

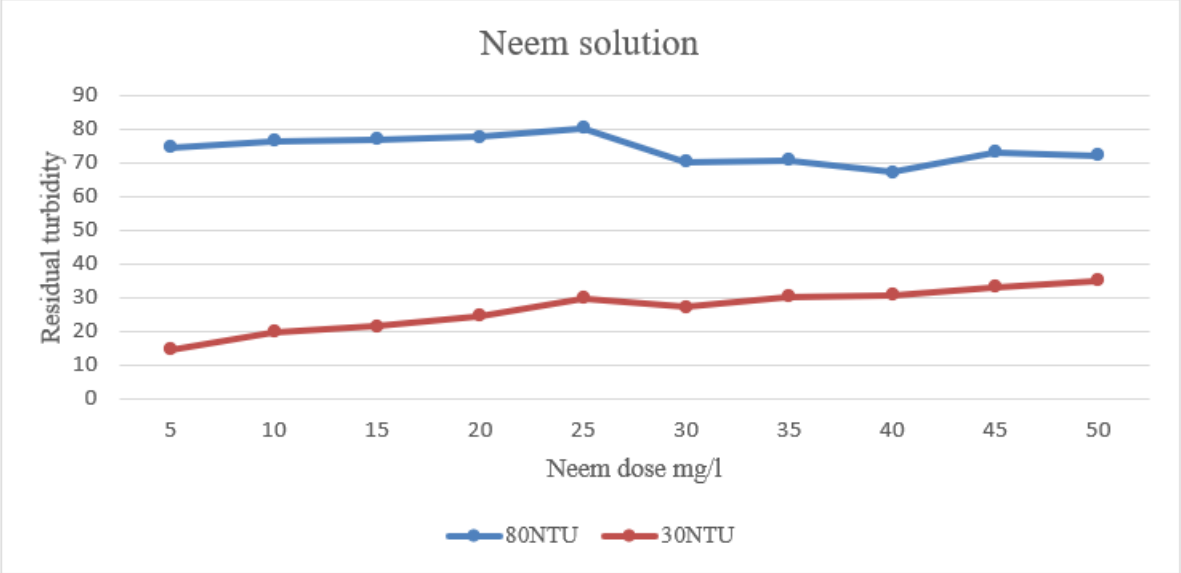

Figure 6 Showing optimum dose of Neem solution for 80 & 30 NTU turbid water

2.4 Chickpea's Coagulant Effect for Turbid Water of 80 and 30 NTU Turbidity

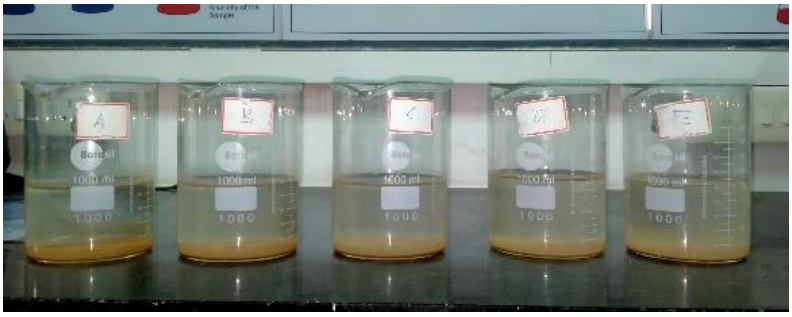

Figure 7 Sedimentation of chickpea solution

Chickpeas were used in experiments as a coagulant in both high and low-turbid water. The range of the chickpea dosage was 1 to 75 mg/l. Based on the results, a high chickpea dose was needed for

successful turbidity removal. As a result, residual turbidity was discovered. The highest removal efficiency of chickpea at doses of 3 mg/l and 5 mg/l was determined to be 80% for high turbid water and 78.92% for low turbid water, respectively. Figures 8 and 9 illustrate how different chickpea dosages affect high and low-turbidity water.

Table 6 Result of 80NTU Chickpea solution

high turbid 80NTU solution			
Sr. no.	chickpea dose (mg/l)	Residual turbidity (NTU)	Percentage removal of turbidity
1.	1	20	75%
2.	**3**	**16**	**80%**
3.	5	10.6	86.75%
4.	7	7.7	90.37%
5.	9	6.7	91.62%
6.	10	4.8	93.6%
7.	20	1.8	97.6%
8.	30	3.5	95.33%
9.	40	6.4	91.47%
10.	50	4.8	93.6%
11.	55	3.5	95.33%
12.	60	2.7	96.4%
13.	65	3.8	94.93%
14.	70	4.4	94.13%
15.	75	2.8	96.27%

Table 7 Result of 30NTU Chickpea solution

low turbidity 30NTU solution			
Sr. no.	chickpea dose (mg/l)	Residual turbidity (NTU)	Percentage removal of turbidity
1	1	8.5	69.64%
2	3	9.5	66.07%
3	**5**	**5.9**	**78.92%**
4	7	3.9	86.07%
5	9	4.1	85.35%
6	11	6.2	77.85%
7	13	5.3	81.07%
8	15	8.2	70.74%
9	17	7.8	72.14%
10	19	4.1	85.35%

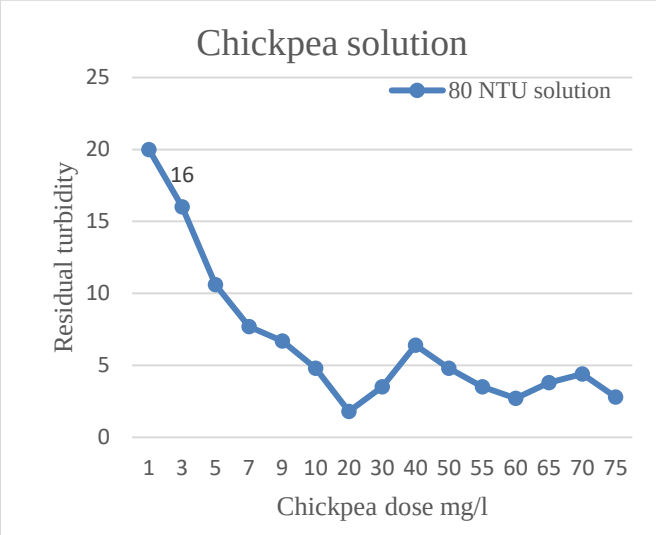

Figure 8 Showing optimum dose of chickpea solution for 80 NTU turbid water

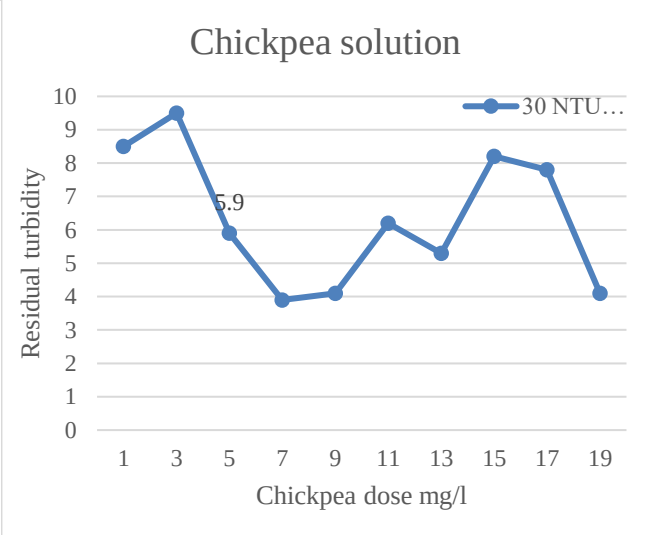

Figure 9 Showing optimum dose of chickpea solution for 30 NTU turbid water

2.5 Comparative Economic Analysis Of Chickpea And Alum Coagulant For Treatment Of 1 Lakh Liter Water (For Turbid Water Having 80 NTU Turbidity)

Chickpea	**Alum**
Optimum dose =3 mg/l for 80% turbidity removal	Optimum dose =30 mg/l for 81.25% turbidity removal
Cost 100 Rs/kg	Cost 10 Rs/kg
For 1000*100= 1 Lakh liter	For 1000*100= 1 Lakh liter
=3mg/ Liter =3000mg/1000 liter =3gm/1000 Liter =300 gm /1 Lakh Liter = 30Rs/ 1 Lakh Liter	=30 mg/Liter =30,000 mg/1000 liter =30 gm/1000 Liter =3000 gm /1 Lakh Liter = 3 Kg/1 lakh Liter = 30Rs/ 1 Lakh Liter

Although chickpeas and alum are equally expensive, chickpeas are superior to alum because they guard against Alzheimer's Disease. As a result, chickpea seems to be a superior coagulant.

II. Conclusion

1. Hence from laboratory study, it is confirmed that chickpea coagulant is a suitable alternative to the alum coagulant. Since it gives approximately the same percentage of removal of turbidity and will not cause Alzheimer's disease. However, there is scope for commercial use of chickpea coagulant, for large-scale water treatment purposes.
2. The results of the laboratory experiment clearly show that the ideal dose of chickpea coagulant for turbid solutions with high turbidity of 80 NTU is 3 mg/l, and turbidity elimination is 80.0% at this level. The ideal dose of chickpea coagulant for turbid solutions with low turbidity of 30 NTU is 5 mg/l, and at this dose, turbidity is removed to the extent of 78.92%. The ideal dosage of Aloe vera coagulant for a turbid solution with a high turbidity of 80 NTU is 29 mg/l, and at this dose, turbidity elimination is 76.25%. An aloe vera coagulant dose of 15 mg/l is optimal for turbid solutions with low turbidity of 30 NTU, as it removes turbidity by 83.66%. Neem coagulant was determined to be an inappropriate coagulant since it did not remove enough turbidity in laboratory research.

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