



## **Comparison of Efficiency of Chemical and Natural Coagulant and Blend of these Coagulant**

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### **ABSTRACT**

Natural coagulants have high potential and efficiency to treatment of turbid water. Many researches have shown in study about high efficiency of natural coagulant and its various advantages in treatment industry but still, the adoption and globally use of natural coagulants in the water industry is low. Health problems caused by alum have been in news for some time now; various article have shown the toxic effects of metal in the form of Alzheimer and allergies. Demand of Natural coagulants have been increasingly in the past few years for using it as a coagulant for treatment of raw water due to their benefits and the fact that it resolves most of the associated problems when using chemical coagulants. Moringa and Artocarpus Heterophyllus and blend of alum with aloe moringa and Artocarpus Heterophyllus (jackfruit) are used as coagulants in this study in place of regularly used chemical coagulants to reduce the turbidity raw water. Natural coagulant will be a better and sustainable solution to partly meet the present water demand in India. Different concentration of stock solution is prepared and mixed in raw water in different quantity and found the efficiency of moringa, Artocarpus Heterophyllus and blend of Alum with moringa and Artocarpus were 90.66%, 68.44%, 83.7% and 80.44% and 88.88% for alum respectively. Effect of the natural coagulant on other quality parameters such as PH, hardness, alkalinity, electrical conductivity etc was also found out. Natural coagulant has been found as an alternative of chemical coagulant, cost saving, easily available in local area and eco-friendly for environment.

**Keywords:** Natural Coagulant, Chemical Coagulant, Turbidity, Water Treatment, Raw Water.

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### **1. Introduction**

In India Groundwater is the main source of drinking water, which is under stress due to the overuse of water. Over dependence on groundwater to meet increasing population, industrialization and agricultural activities has also led to disintegration of its quality. More than 60% of irrigated agriculture and 85% of drinking water supplies are dependent on groundwater in India. All sources of drinking water must have required some type of purification before consumption. Various methods are used to treat of water in industries such as coagulation flocculation. The method to be used depends on the properties of raw water. The high variation in turbidity is one of problems associated with the treatment of surface water. Generally, to remove turbidity from water in the water treatment plant coagulation process is done by the use of a coagulant. The coagulant can be classified into inorganic and organic coagulants. Conventionally chemical coagulants, such as alum, ferric chloride, ferric sulphate, etc. are being used to carry out coagulation. Alum is effective coagulant for treatment of water but the demand of water increases day by day and due to this cost of coagulant also increase, because of the operational cost of treatment plant is increasing. Moreover, the aluminum present in the sludge generated causes disposal problems and thus requires treatment before disposal. So now a days natural coagulant is also an effective and cost - efficient alternative solutions available for coagulation process. Moringa and jackfruit seeds are some examples of natural coagulant. Present study is aimed to test natural and chemical coagulant and blend of these coagulant for treatment of water. Natural coagulant is abundantly available in India as renewable source for coagulants. The natural coagulant tested for the quality of the surface water treated by them and compare them with that of the water treated with aluminum sulphate. Natural coagulant such as moringa seeds and dried Artocarpus heterophyllus seeds and blend of these with alum have been used to examine their efficiency to remove turbidity from surface water.

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### **2. Materials And Methods**

In this study the raw water of 22.5 NTU turbidity used to test the efficiency of alum and natural coagulant. Firstly, water samples were collected from the Narmada River and then prepare stock solution for both chemical and natural coagulant. For both the coagulant jar test was used to find turbidity removal efficiency and also used other test such as turbidity, PH level, alkalinity, hardness and TDS to investigate the effectiveness of coagulants.

#### **2.1 Alum stock Solution**

1gram alum was added to 1000ml of distilled water and stirred by the use of magnetic stir. after completely dissolved in distilled water we get 0.1% weight solution. Each 1 ml of this stock solution will equal to 0.1 mg/l (ppm) when added to 1000 ml of water to be tested.

## 2.2 Natural coagulant solutions: -

**A) Moringa:** well matured and dry seeds of moringa was obtained from tree from rural area and removed seeds from moringa sticks, then seeds were de-husked manually by hand and placed in an oven at 35°C until they were dry then the dry seeds were ground into a fine powder (fig-1) using kitchen mixer, then the powder was sieved through a 500µm sieve. 1 gram of powder passed from 500µm was measured and added to 1000ml of distilled water forming a suspension, jar apparatus is used to stir suspension for 1 hour and then it was left to settle for 30 min after which it was then filtered by using filter paper to obtained a 0.1%wt moringa and ready to use as coagulant.

**B) Artocarpus Heterophyllus:** dry seeds of Artocarpus Heterophyllus (jackfruit) were collected from local market and was boiled and sundried for 24-48 hours. Then the seeds were grained to fine powder (fig-2) in kitchen mixer then the powder was sieved using 0.45 mm sieve and was stored in an airtight container to prevent the entry of moisture into it and to avoid loss of its effectiveness. Take 1 gram of fine sieved powder and add to the 1000 ml distilled water and stir for 1 hour and then left to settle for 30 min after which it was then filtered by using filter paper to obtained a 0.1%wt Artocarpus Heterophyllus as coagulant for analysis.



Fig- 1 fine powder of dry seeds of moringa



Fig-2 fine powder of dry seeds of jackfruit

## 2.3 Experimental Procedure

Coagulation activity for both chemical and natural coagulant was carried out using jar apparatus. Jar test was conducted to determine the coagulation and turbidity removal efficiency properties of the coagulant solution use in this study for demonstrate the effectiveness of chemical and natural coagulant. Six glass beaker (1100 ml) were filled with 1000ml of raw water sample. A rapid mixing of 2 min. At 100 RPM was then done slow mixing for period of 30 min at 40 RPM to allow coagulation to take place. Different dose of chemical and natural coagulant was added into beakers during rapid mixing period. The solution was then kept to stand 30 min. The sample were collected from about 2cm below the surface of water to get better result in coagulation because some colloidal particle in suspension which not participate in coagulation. All experiment were conducted at room temperature  $27 \pm 2^\circ\text{C}$ .



Fig-3 Jar Test Apparatus

Turbidity test was used before and after the jar test to analysis the quality of river water and to know the turbidity removal efficiency of natural and chemical coagulant. In this study different test were conducted such as JAR test, turbidity, PH, TDS, alkalinity and hardness, to known the efficiency and effectiveness of RBF technique and natural and chemical coagulant.

$$\text{Turbidity removal efficiency} = \frac{\text{initial turbidity} - \text{final turbidity}}{\text{final turbidity}} \times 100$$

### 3. Result and Discussion

#### 3.1 Investigation of Optimum Dose of Coagulant

Optimum dose of coagulant was one of the main parameters in this study. Optimum condition for coagulation and proper dose of coagulant determined in this investigation. If dosage is insufficient or overloaded then the desired result will not be obtained and would show poor performance in turbidity removal efficiency. So, it is very important to determine the correct optimum dose of coagulant to minimize the coagulant dose and cost of coagulant in treatment of water.

To determine the optimum dose of natural and chemical coagulant a set of experiment were conducted on raw turbid water sample of 22.5 NTU using jar test apparatus at different dosages of coagulants ranging from 50 to 80 ml /L prepared from stock solution of 1gm/L, 10gm/L, 2gm/L concentration. Different dosage of coagulants was put in different beakers filled with 1000ml of raw turbid water of 22.5 NTU after this all beakers were placed on jar apparatus. The solution of turbid water and both natural and chemical coagulant one by one is mixed at a high RPM Of 150 1 min and then lower 30-35 RPM for 30 minutes. Then the solution is allowed to settle 30 min. And then their turbidity was measured by nephelometer.

#### 3.2 Optimum Dosages of Coagulant

The test was performed using 1 gm to 20 gm of concentration in 1000ml of water get stock solution ranging from 1gm/l to 2gm/l of alum, moringa, Artocarpus Heterophyllus and blend of Alum with moringa and Artocarpus and different dosages of this stock solution is then used to find out the optimum dose of the coagulants. The dosage of moringa as a coagulant 0.60mg/l gave the optimum result with the efficiency of 90.66%, when 60 ml of the stock solution was mixed with 1 L of raw water. Similarly, alum, Artocarpus Heterophyllus and blend of Alum with moringa and Artocarpus, efficiency was 88.88%, 68.44% ,83.7% and 80.44% respectively.

Water quality paraments is an important parameter to determine the quality of water. Water quality parameters such as turbidity, PH, Alkalinity, Hardness and TDS were tested before and after coagulation of raw water which is shown in table 1, table2 and table3.

**Table -1 Table-1 before and after coagulation with alum and lime.**

Parameters	Raw water	Alum+ lime
Turbidity (NTU)	22.5	2.5
PH	7.4	7.2
Alkalinity(mg/l)	120	112
Hardness (mg/l)	140	128
TDS	130	148

**Table 2. values of raw water before and after coagulation with moringa and moringa with alum.**

Parameters	Raw water	Moringa seeds	Moringa seeds + Alum
Turbidity (NTU)	22.5	2.1	3.8
PH	7.4	6.48	6.71
Alkalinity (mg/l)	120	150	130
Hardness (mg/l)	140	135	110
TDS	130	142	154

**Table 3 values of raw water before and after coagulation with jackfruit and Jackfruit with alum.**

parameters	Raw water	Jackfruit seeds	Jackfruit seeds + alum
Turbidity (NTU)	22.5	7.1	4.4
PH	7.4	6.8	7.1
Alkalinity(mg/l)	120	90	80
Hardness(mg/l)	140	120	100
TDS	130	138	145

### 3.3 Turbidity removal efficiency

Turbidity removal efficiency is the important parameter to determine the effectiveness of any coagulant in coagulation process. Natural and chemical coagulant effectively removed the turbidity from water after coagulation process. Efficiency of moringa was very compare to other coagulants.

## 4. Conclusion

This paper highlighted the various advantages natural coagulant. The discussion revealed that moringa have high efficiency than the other coagulant, that can be used as coagulant in coagulation process of river water as well for drinking purpose of community supply. Study on natural coagulant demonstrate that alum, moringa, Artocarpus Heterophyllus and alum with both natural coagulants were effective in treatment of turbid water. The maximum turbidity removal efficiency of moringa and Artocarpus Heterophyllus and alum with moringa and Artocarpus were 88.88%, 90.66%, 68.44 %, 83.7% and 80.44% respectively.

However more study is required to obtain more information about plant based natural coagulant as these have high potential to treat turbid water.

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### References

1. MA Asrafuzzaman, and A.N.M. Fakhruddin, Reduction of turbidity of water using locally available natural coagulants, Department of environmental sciences, Jahangir Nagar University
2. Beatrice Kakoi, Banana pith as a natural coagulant for polluted river water, sustainable materials research and technology centre, Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya, 2016
3. Wei Lun Ang and Abdul Wahab Mohammed, State of the art and sustainability of natural coagulants in water and wastewater treatment, Centre for Sustainable Process Technology (CESPRO), Malaysia, 2020.
4. Ghulam Hussain, Exploring the potential of pearl millet (*Pennisetum glaucum*) and black-eyed pea (*Vigna unguiculata* subsp. *Unguiculata*) as bio-coagulants for water treatment, Institute of Environmental Engineering and Research (IEER), 2018.
5. Mukheled Al-Sameraiy, a Novel Water Treatment Approach for turbidity Removal using Date Seeds and Pollen Sheath, Environmental Research Centre, University of Technology, Baghdad, Iraq, 2012
6. Zuraisah Dollah, Ummu Habibah Abd Rahman, Nurakmal Hamzah, Daliah Hasan, Siti Rahimah Rosselli, Potential of Orange peel as a natural coagulant in Water Treatment, Faculty of Civil Engineering, University of Technology, Malaysia.
7. Maya Shamira Shaharom and Dyg. Siti Quraisyah Abg. Adenan, Potential of Orange Peel as a Coagulant for water Department of Civil Engineering and Construction, Faculty of Engineering, Science and Technology, treatment, Malaysia.
8. John. J. and Ogbuewu. I. Fifteen Borehole Water Samples from Ebonyi State, Nigeria Treated with locally produced Coagulant - disinfectant- adsorbent for Potability, Department of Industrial Chemistry, Faculty of Science, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria.
9. Chong Kian- Hen, Kiew Peck- Loo, Potential of Banana peels as Bio- flocculant for Water Clarification, Department of Chemical and Petroleum Engineering, Faculty of Engineering, UCSI University, Kuala Lumpur, Malaysia.

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10. Amir Hariz Amran, Nur Syamimi Zaidi, Khalida Muda, Liew Wai Loan, Effectiveness of natural coagulation process: A Review, Faculty of Civil Engineering, University of Technology Malaysia, 81310 Skudai, Johor, Malaysia.
  11. Antov, M. G., Šćiban, M. B., & Petrović, N. J. (2010). Proteins from common bean (*Phaseolus vulgaris*) seed as a natural coagulant for potential application in water turbidity removal. *Bioresource Technology*, 101(7), [2167-2172](#).
  12. Antov, M. G., Šćiban, M. B., & Prodanović, J. M. (2012). Evaluation of the efficiency of natural coagulant obtained by ultrafiltration of common bean seed extract in water turbidity removal. *Ecological Engineering*, 49, 48-52.
  13. Baghvand, A., Zand, A. D., Mehrdadi, N., & Karbassi, A. (2010). Optimizing coagulation process for low to high turbidity waters using aluminum and iron salts. *American Journal of Environmental Sciences*, 6(5), [442-448](#).
  14. Baptista, A. T. A., Coldebella, P. F., Cardines, P. H. F., Gomes, R. G., Vieira, M. F., Bergamasco, R., et al. (2015) Coagulation- flocculation process with ultrafiltered saline extract of *Moringa oleifera* for the treatment of surface water. *Chemical Engineering Journal*, 276, [166-173](#).
  15. Baptista, A. T. A., Silva, M. O., Gomes, R. G., Bergamasco, R., Vieira, M. F., & Vieira, A. M. S. (2017). Protein fractionation of seeds of *Moringa oleifera* lam and its application in superficial water treatment. *Separation and Purification Technology*, 180, [114-124](#).
  16. Camacho, F. P., Sousa, V. S., Bergamasco, R., & Teixeira, M. R. (2017). The use of *Moringa oleifera* as a natural Coagulant in surface water treatment. *Chemical Engineering Journal*, 313, [226-237](#).
  17. Choy, S. Y., Prasad, K. M. N., Wu, T. Y., Raghunandan, M. E., & Ramanan, R. N. (2014). Utilization of plant-based natural coagulants as future alternatives towards sustainable water clarification. *Journal of Environmental Sciences*, 26(1 1), [2178-2189](#).