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# Baobab Leaf Powder Efficacy as Turbid Water Treatment Biocoagulant

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ABSTRACT

The high cost of treated water makes most rural communities resort to readily available sources that are normally of low quality, which exposes them to waterborne diseases in the process. In the present study, various doses of baobab (*Adansonia digitata*) leaf powder coagulant (i.e., 0.1, 0.2, and 0.3g per 50 mL turbid water) were added to the surface water sample collected. It was found that increasing the coagulant doses results in either a decrease or increase in the measured parameters, such as pH, turbidity, and electrical conductivity (EC). At constant 30 min coagulation time, pH and EC of the turbid water samples taken were within WHO standards. However, the labeled sample fed with 0.3g of baobab leaf powder coagulant gave the lowest turbidity of 78.7 NTU. A reduction in final turbidity is a clear indication of the coagulation capabilities of baobab leave powder. With this study, baobab leave (as a potential coagulant) is a new addition to the literature, apart from its seed and pulp which have been experimented with previously. Natural coagulants contain some chemicals whose effect on the resulting treated water needs to be examined. If need be, an additional treatment unit must be set up to adsorb or remove those contaminants from the water before proper use.

## INTRODUCTION

Natural coagulants derived from forest biomass may provide a sustainable and cost-effective solution for water treatment (Salaheldin & Sabra, 2021). In water treatment processes, electrical conductivity (EC), turbidity, coagulation time, pH and coagulant dosage are important parameters to consider to bring unclean water to consumable standard. Aesthetic quality of water can be improved by reducing its turbidity, which measures the presence of suspended particles (Gauthier et al., 2003); minimizing the presence of dissolved substances or EC (Chau et al., 2001); taming water stability/corrosiveness by adjusting the pH (Dewangan et al., 2023); ensuring sufficient contact time between coagulants and particles for aggregation to occur and; regulating coagulant dose to achieve effective particle removal, while minimizing costs and avoiding overdose (El-Taweel et al., 2023).

Lots of plant-based coagulant had been examined to replace the commonly used chemical coagulants, in which the above treatment parameters were assessed. Forest residues could be an emerging coagulant in the future if investigated. Many regions of the world can boost of considerable population of baobab (*Adansonia digitata*) trees. Edogbanya et al. (2017) was the first to discover the effectiveness of utilizing baobab seeds as biocoagulant to purify surface water. Their study is followed by Ibrahim et al. (2019) and Ikya et al. (2019) who examined the use of baobab pulp as coagulant to coagulate soycheese in soybean curd making. Next, Adeniran et al. (2021) investigates the efficacy of baobab seed as coagulant in the treatment of household sewage sludge.

Extensive literature searched show that baobab coagulation-potential trial was limited and only the seed and pulp were tested on sewage sludge, soycheese and surface water. Currently, no study looked at the possibility of using the leaf of the tree plant as biocoagulant. The present study is thus, aimed at investigating the effectiveness of baobab leave powder as plant-based coagulant, an alternative to chemical coagulant. Specifically, the study goals are to use baobab leaf powder as natural coagulants in reducing turbidity levels in water, determine the optimal dosage of baobab leaf powder coagulants required to achieve maximum reduction in turbidity levels and discuss the potential health and environmental impacts of using baobab leave powder as natural coagulants. Baobab leave powder utilization may serve as an alternative to the use of synthetic (artificial) coagulants for water treatment, which is often costly and may have negative environmental impacts.

## METHODS

### Equipment/Apparatus and Materials

Major or the principal tools used in the experiment are jar test machine, pH meter, conical flask, nephelometer, motor and pestle, sieve, beaker, filter paper, measuring cylinder and electronic weighing balance. Basic materials needed for the study are baobab leave powder and a turbid water sample.

### Baobab and Water Sample Collection

Fresh baobab leaves (Figure 1a) were collected at University of Maiduguri, Nigeria, adjacent to the Geography Department. It was washed and kept under ambient room temperature for about 4 days, before crushing and grinding it to powder form, as shown in Figure 1b.


Figure 1. Baobab (a) leaf and (b) powder

About 5 L of turbid water with pH of 6.58 and turbidity of 7.60 (NTU) was collected from Maiduguri Water Treatment Plant (MWTP), Borno state, Nigeria.

### Jar Test and Conductivity Measurement

Three jars were labeled with the sample source, coagulation time and the initial water characteristics (i.e., 6.58 pH and turbidity of 7.60 NTU). This turbid water was distributed into the jars, starting with a dosage 0.1g, followed by 0.2 and 0.3g of baobab leaf powder. Each of the jar were mixed thoroughly to facilitate the coagulation using baobab leaf powder. Subsequently, the jars were allowed to settle undisturbed for a period of 30 min. It was then filtered using a filter paper. The water clarity in each jar were observed after filtration. Actually, the pH was measured using pH meters while the EC using a handheld conductivity tester. Thus, baobab leave powder dosage, final pH, final turbidity and the final EC were measured and recorded using appropriate laboratory equipment. The data were analyzed to determine the optimal baobab leaf powder dosage that will give the desired reduction in turbidity while considering the pH and EC.

**Health and Environmental Impact of the Coagulant Used**

Relevant literature was accessed to help discuss or highlight potential dangers that must be put into consideration by water treatment practitioners, when using baobab leave powder as biocoagulant.

## RESULTS AND DISCUSSION

**Treated Turbid Water Characteristics**

Table 1 shows the characteristics of the treated turbid water using baobab leaf powder as plant-based coagulant at 3 varying dosages.

Table 1. Water Quality Parameters Measured

| Water Parameter | Coagulant Dosage | | |
|---|---|---|---|
| | 0.1g | 0.2g | 0.3g |
| Coagulation Time (min) | 30 | 30 | 30 |
| Turbidity (NTU) | 101 | 162 | 78.7 |
| pH | 6.51 | 6.73 | 6.58 |
| Electrical Conductivity ($\mu$s/cm) | 23 | 10 | 17 |

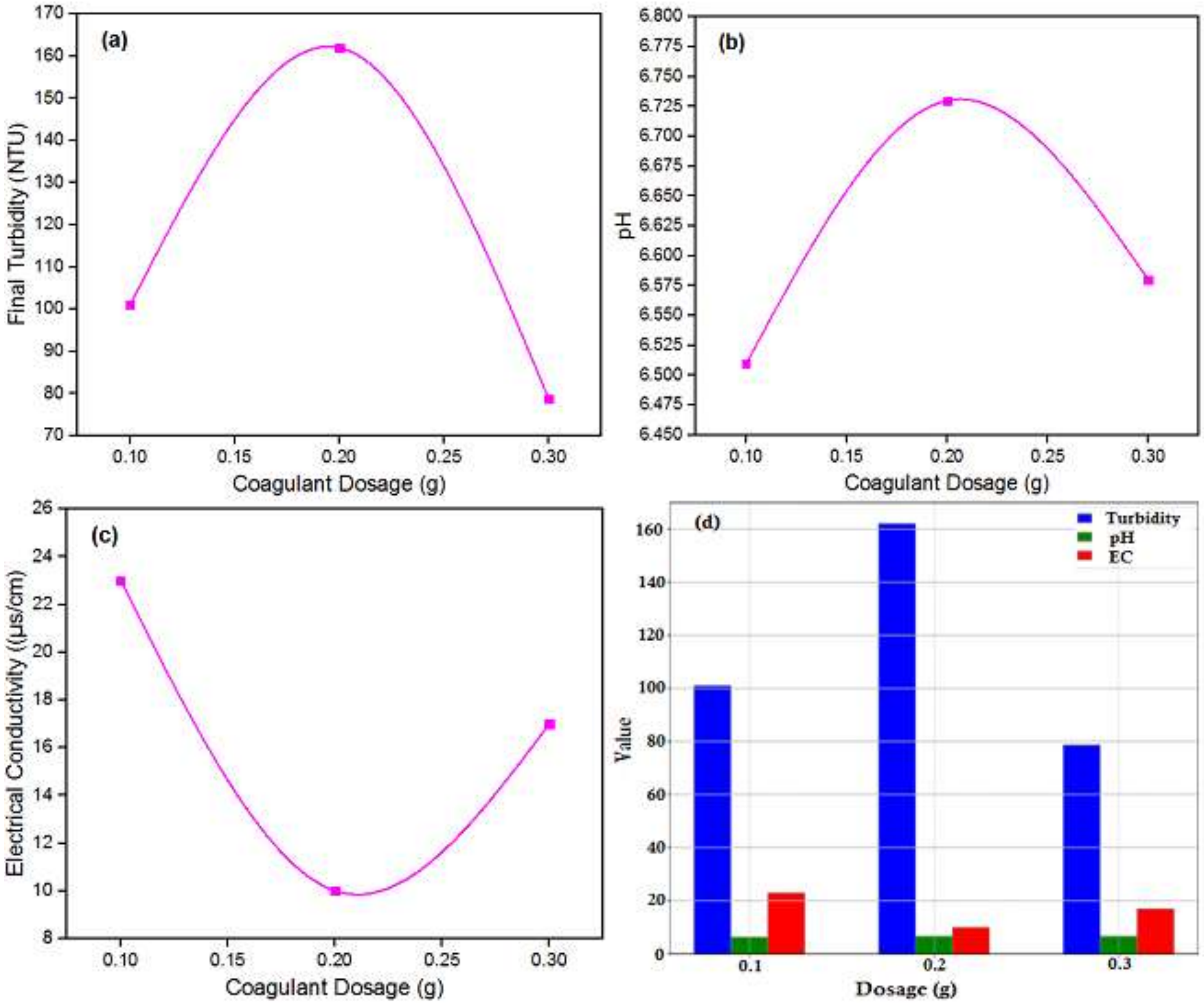


Figure 2. Effect of Changing Dosage with (a) Turbidity, (b) pH, (c) EC of the Treated Sample at 30 min Coagulation Period and (d) all Parameters

Figure 2 illustrates the relationship between each of turbidity, pH and EC, with change in the amount of coagulant added to the turbid water collected from MWTP. Figure 2 (a & b) show that the final turbidity and pH after coagulant effect is maximum when the dosage is 0.2g. In Figure 2b, both the minimum and maximum pH points in the plot, are within the recommended range of 6.5-8.5 for drinking water. In this case, EC and turbidity parameters had to be incorporated to the optimal performance/selection criteria. Normally, the dosage giving the lowest turbidity is simply the best and clearly indicate the level or extent of the dosage performance, which can be identified in Figure 2a. EC obtained in this study ranges from 10-23 $\mu$s/cm < 800 $\mu$s/cm required in clean drinking water, indicative of the presence of minimal concentrations of dissolved substances. EC values of water bodies fluctuates over a long period of time, especially MWTP raw water used in this study (whose source is a river). In that case, an optimal dosage favoring low EC would be difficult to achieve, as contained in the monthly variations of EC measured by Pal et al. (2015) in their study.

It was discovered that the jar with the lowest turbidity value is 0.3g which is 78.7 NTU, also having a pH of 6.58 and an EC = 17 $\mu$s/cm. This jar corresponds to the optimal coagulant dosage, which could be labelled as the most effective treatment for reducing suspended particle in water using baobab leaf powder. The jar with a dosage of 0.1g, whose turbidity is reduced to 101 NTU, a pH and EC of 6.51 and 21 $\mu$s/cm, were respectively obtained. This jar corresponds to the second optimal dosage, as it possesses the highest rate of EC. Lastly, the jar in which 0.2g baobab leaf powder coagulant is charged into, gave a final turbidity of 162 NTU, pH = 6.73 and EC of 10 $\mu$s/cm. It corresponds with the jar having the lowest optimal dosage. As such, the jar has the lowest EC value and highest turbidity value and pH. All the jars have their own different characteristics of the 3 measured parameters. But in all, EC ranging from 10-23 $\mu$s/cm (Figure 2c) is desirable and in agreement with the findings of Emumejaye & Daniel-Umeri (2015) who obtained a value ranging from 11.9-31.2 $\mu$s/cm in their study. Thus, this analysis is a holistic examination of turbidity, pH and EC values influence on water quality, as shown in Figure 2d.

**Influence of Biocoagulant Usage**

Baobab leaves may contain naturally occurring compounds, including alkaloids and tannins (Kamanula et al., 2018; Zagga et al., 2018). While these compounds can aid in coagulation, their presence in treated water should be monitored to ensure they do not exceed regulatory limits or pose health risks to consumers (Diver et al., 2023). Some individuals may also be allergic or sensitive to certain components of baobab leaves (Arowora et al., 2019). Exposure to these allergens through treated water could lead to adverse reactions in susceptible individuals. On the environment, issues like sustainability, ecological balance and water body quality are imminent. Utilization of baobab leaves must address sustainability problems to avoid overexploitation of natural resources and ensure the long-term viability of baobab populations. Sustainable harvesting practices should be employed in order not to deprive various organisms of their food sources and habitat. In addition, more organic matters are introduced into the aquatic environment. Proper regulatory oversight, monitoring, and adherence to best practices can help mitigate potential risks and maximize the benefits of this natural coagulant (Kurniawan et al., 2020).

## CONCLUSION

In the present study, jar test analysis was carried out to identify the optimal baobab leaf powder coagulant dosage to clarify turbid water sample collected from MWTP. As such, three dose weights performance were tracked by measuring the turbidity of the treated water after coagulant addition. The jar test analysis revealed that the jar containing 0.3g of baobab leaf powder demonstrated the highest efficiency in reducing turbidity, registering the lowest value at 78.7 NTU, alongside a pH of 6.58 and an EC equivalent to 17 $\mu$s/cm. This dosage is recommended as the optimal coagulant dosage for achieving desired water clarity, further qualifying the selected biomass powder as an efficient plant-based/natural coagulant. If a means of removing tannins and alkaloids in the treated water in which baobab leave powder was used as biocoagulant is devised, water treatment scientist will be heading towards a feasible approach of purifying water using products from natural forest biomass. Furthermore, on whether baobab leave or a host of other plant-based coagulant types have the potential of neutralizing or killing harmful microorganism in water, should be investigated.

## REFERENCES

1. Adeniran, K. A., Babafemi, O. P., & Ogundahunsi, O. E. (2021). Relative coagulation effectiveness of baobab (Adansonia digitata L.) seeds and aluminium sulphate in the purification of domestic sewage. *International Journal of Scientific & Engineering Research*

*(IJSER)*, *12*(11), 1172–1188.
2. Arowora, K. A., Yakubu, O. E., Shaibu, C., Iornenge, T. J., & Ugwoke, K. C. (2019). Chemical composition of baobab leaves and fractionation of its ethanolic extract using column chromatography. *International Journal of Science and Research (IJSR)*, *8*(7), 812–821.
3. Chau, R., Mitchell, A. C., Minich, R. W., & Nellis, W. J. (2001). Electrical conductivity of water compressed dynamically to pressures of 70-180 GPa (0.7-1.8 Mbar). *The Journal of Chemical Physics*, *114*(3), 1361–1365.
4. Dewangan, S. K., Shrivastava, S. K., Tigga, V., & Lakra, M. (2023). Review paper on the role of pH in water quality implications for aquatic life, human health, and environmental sustainability. *International Advanced Research Journal in Science, Engineering and Technology (IARJSET)*, *10*(6), 215–218.
5. Diver, D., Nhapi, I., & Ruziwa, W. R. (2023). The potential and constraints of replacing conventional chemical coagulants with natural plant extracts in water and wastewater treatment. *Environmental Advances*, 13 (100421), 1–17.
6. Edogbanya, O. P. R., Abolude, D. S., Adelanwa, M. A., & Ocholi, O. J. (2017). The efficacy of the seeds of Adansonia digitata L. as a biocoagulant and disinfectant in water purification. *Journal of Earth, Environment and Health Sciences*, *2*, 122–128.
7. El-Taweel, R. M., Mohamed, N., Alrefaey, K. A., Husien, S., Abdel-Aziz, A. B., Salim, A. I., Mostafa, N. G., Said, L. A., Fahim, I. S., & Radwan, A. G. (2023). A review of coagulation explaining its definition, mechanism, coagulant types, and optimization models; RSM, and ANN. *Current Research in Green and Sustainable Chemistry*, *6*(100358), 1–23.
8. Emumejaye, K., & Daniel-Umeri, R. A. (2015). Electrical conductivity of water in some selected areas of Delta state, Nigeria. *American Journal of Engineering Research (AJER)*, *4*(8), 104–107.
9. Gauthier, V., Barbeau, B., Tremblay, G., Millette, R., & Bernier, A.-M. (2003). Impact of raw water turbidity fluctuations on drinking water quality in a distribution system. *Journal of Environmental Engineering and Science*, *2*(4), 281–291.
10. Ibrahim, A. K., Ukeyima, M., & Ikya, J. K. (2019). Effect of some selected coagulants on the proximate and microbiological quality of cheese produced from soy milk. *International Journal of Science and Research (IJSR)*, *8*(4), 1031–1037.
11. Ikya, J. K., Ukeyima, M., & Ibrahim, A. K. (2019). Physico-chemical characteristics of Awara produced from soybeans using different coagulant. *International Journal of Science and Research (IJSR)*, *8*(4), 1025–1030.
12. Kamanula, M., Munthali, C. R. Y., Dziwapo, A., & Kamanula, J. F. (2018). Mineral and phytochemical composition of baobab (Adansonia digitata L.) root tubers from selected natural populations of Malawi. *Malawi Medical Journal*, *30*(4), 250–255.
13. Kurniawan, S. B., Abdullah, S. R. S., Imron, M. F., Said, N. S. M., Ismail, N., Abu Hassan, H., Othman, A. R., & Purwanti, I. F. (2020). Challenges and opportunities of biocoagulant/bioflocculant application for drinking water and wastewater treatment and its potential for sludge recovery. *International Journal of Environmental Research and Public Health*, *17*(24).
14. Pal, M., Samal, N. R., Roy, P. K., & Roy, M. B. (2015). Electrical conductivity of lake water as environmental monitoring- A case study of Rudrasagar Lake. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, *9*(3), 66–71.
15. Salaheldin, P. A., & Sabra, M. A. (2021). Natural coagulants from forestry trees to enhance drinking water quality and reduce microbial load. *Aswan University Journal of Environmental Studies (AUJES)*, *2*(4), 316–333.
16. Zagga, A. I., Abduljabbar, I. A., Garko, M. B. A., Tsoho, B., & Gbande, S. (2018). Phytochemical composition of Adansonia digitata L. leaf extracts. *Proceedings of 6th NSCB Biodiversity Conference [Uniuyo 2018]*, 300–304.