



EVALUATION OF *DELONIX REGIA* SEEDS AS A NATURAL COAGULANT IN THE TREATMENT OF LOW TURBID WATER

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ABSTRACT

This research aims at evaluating the effectiveness of Delonix regia as a natural coagulant in treating low turbid water. The active ingredient of the coagulant was extracted using Soxhlet Apparatus with Hexane as the solvent. The water sample was obtained from the famous Ala river in Akure, Ondo state. The water from this river is oftentimes used by the residents without treatment because it appears clean to them, this river had a turbidity of 18.4NTU which is above the standard (5NTU) required by the World Health Organization (WHO) for safe usage. After treating with different doses (0.03g/L to 0.4g/L) of the coagulant, an optimum value of 6.12NTU at an optimum dose of 0.03g/L and a turbidity reduction of was obtained 66.74%, alongside an improvement in other water parameters such as Conductivity, dissolved oxygen and total dissolved solids. This result proves the effectiveness of Delonix regia as a natural coagulant in treating low turbid water. However, treatment with Delonix regia is not sufficient to improve the quality of low turbid water to WHO acceptable limits for potable water.

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1.0 INTRODUCTION

Water is a vital component of life. Water is required for the survival of all living organisms on the planet. Water, on the other hand, might be a problem if it isn't available in the appropriate conditions. Humans utilize water for various purposes; consequently, the cleanliness of the water ingested is critical, as contaminated water has been shown to have a detrimental effect on human health (Hendrawati *et al.*, 2016). Contaminated drinking water is a vital factor in quality of life and the transmission of disease; hence it is a significant health concern. It's a severe problem in the Tropics, where access to safe

drinking water or poor sanitation leads to a substantial portion of disease (Campbell, 2021). Aside from quantity and regularity, the quality of clean drinking water must match the required specifications. Some desirable qualities of water are clarity, colourless, tasteless, odourless, pathogen-free, hazardous chemical-free, and non-corrosive. Coagulation-flocculation is a popular procedure used in the water treatment process to attain this requirement. Coagulation is one of the most frequent methods for reducing pollutant levels in water bodies, such as; Turbidity, suspended solids, colour, and organic matter (Hendrawati *et al.*, 2016).

A billion people do not have access to safe drinking water. Diarrhoea, which is caused by contaminated water, kills around 6,000,000 people (approximately 2,000,000 children). Importing chemicals such as poly-aluminium chloride (PAC) and alum is expensive for developing countries (Yarahmadi *et al.*, 2009). The goal of creating simple, practical, low-cost, and easy-to-use technology to reduce organic, inorganic, and microbial water contamination is to solve this global problem (Garcia-Fayos *et al.*, 2010). Before the advent of chemical salts, natural coagulants of vegetable and mineral origin were utilized in water treatment, but they could not compete successfully due to a lack of knowledge of the science of their efficiency and mode of action. Natural coagulants for water treatment have recently seen a return of attention in underdeveloped countries (Bazrafshan *et al.*, 2012). Water treatment using regular coagulants has become a serious struggle due to several very demanding standards such as quality, reliability, economy, and sustainability (Saleem & Bachmann, 2019). Natural coagulants have been confirmed to possess many remarkable characteristics over chemical coagulants. Some of these characteristics are; they can be grown locally, and as such, they are cost-effective for developing countries, they generate considerably less sludge and are human-safe, they degrade naturally, they can be used at various doses to flocculate different colloidal suspensions (Raji *et al.*, 2015). Talbot *et al.* (1995) reported that natural coagulants could form tight bonds with molecules of other substances and saponins, proteins, and tannins are the effective coagulating ingredients in them.

The leaves of *Delonix regia* are fernlike, and 30.5-50.8 cm long, with 20-40 pairs of primary leaflets separated into 10-20 pairs of secondary leaflets, it also possesses a flat, woody, dark brown pods of about 61 cm long and 5.1 cm broad (Abulude *et al.*, 2018). In literature by Judith *et al.* (2014), With an initial turbidity of 520 NTU, the *Delonix regia* seeds have a strong potential for coagulation of turbid water. As a result, up to 92 percent% of the turbidity was removed. The *Delonix regia* seed extract from NaCl solution has a higher turbidity removal capacity due to its coagulation activity. With an ideal dosage of 160 mg/L and a pH of 2, the turbidity of the raw water was reduced up to 30 NTU. This research is aimed at assessing the effectiveness of *Delonix regia* as a natural coagulant in water treatment. The effect of coagulant dose on water parameters such as Turbidity, Total Dissolved Solids (TDS), Conductivity and Dissolved Oxygen (DO) were studied.

2. MATERIALS AND METHODS

2.1 Source and Preparation of the Coagulant

Dry and matured *Delonix regia* seeds were obtained from the Federal University of Technology Akure, Ondo State, Nigeria. The preparation and extraction process were carried out using the following steps: removal of the seeds from the pods, after which the seeds were dried and ground into powder. 10g of the seed powder was weighed and set into the thimbles of the electrothermal Soxhlet extraction chamber; 170 ml of Hexane was added to the heating chamber;

The Hexane was evaporated within three

cycles each to ensure the extraction of oil from the seed (until the hexane became colourless). The seed cake residue from the Soxhlet thimbles was dried and weighed. The dried sample was used as the coagulant.

2.2 Raw water collection

The raw water sample for this research was collected downstream of the Ala river in Akure, Ondo State (7° 15' 30.7" north) or (5° 13' 7.5" east). The water sample was collected in a clean bottle and immediately taken to the laboratory for treatment and analysis.

2.3 Coagulation/Flocculation Process

The coagulant was added to 250ml of water sample in various weights (varying from 0.03g to 0.4g) as seen from literatures (Judith *et al.*, 2014; Ernest *et al.*, 2017), and then the beakers were placed on the magnetic stirring machine, one at a time. The machine was set to 120rpm for quick mixing for 30 seconds and 50rpm for slow mixing for 8 minutes. The samples were filtered using filter paper and stored in labelled 100ml bottles. Each sample was subjected to a test to determine each water parameter.

2.4 Laboratory Analysis

According to research by Shanmukha *et al.* (2011), the seeds of *Delonix regia* contains saponins and galactomannan. A Lovibond Water Test TB 210 IR Turbidimeter was used to conduct the turbidity test. Total Dissolved Solids (TDS) and Conductivity were determined using a Hanna HI9813-6 pH meter, and Dissolved Oxygen (DO) was

determined using a Hanna HI 3810 DO test kit.

3. RESULTS AND DISCUSSION

Coagulation dose is one of the most significant factors to consider when choosing the best conditions for coagulant performance. In essence, underdosing or overdosing would result in poor flocculation performance. As a result, determining the optimal dosage is critical to reduce dosing costs and sludge production while simultaneously achieving the best treatment results (Bazrafshan *et al.*,

Table 1: Initial properties of raw water sample

Parameter	Initial result
Conductivity ($\mu\text{S}/\text{cm}$)	240
Dissolved Oxygen (mg/L)	6.6
Total dissolved solids (mg/L)	174
Turbidity (NTU)	18.4

2012).

Figure 1, shows the effect of varying the doses of *Delonix regia* (0.03 g/L – 0.4 g/L) on the Conductivity of the water sample. The initial conductivity value of the raw water sample was 240 $\mu\text{S}/\text{cm}$, the dose of the coagulant that had a substantial effect on the quality of the water was found to be 0.1 g/L, this dose increased the conductivity of the water to 260 $\mu\text{S}/\text{cm}$ with a percentage increase of 8.33%. In spite of this increase, the conductivity value still fell within the WHO maximum permissible limit of 300 mg/L. The process of using *Delonix Regia* as a coagulant had minimal effect on the conductivity in this research because they reacted as positively charged natural polymer coagulants (Tunggolou & Payus, 2017).

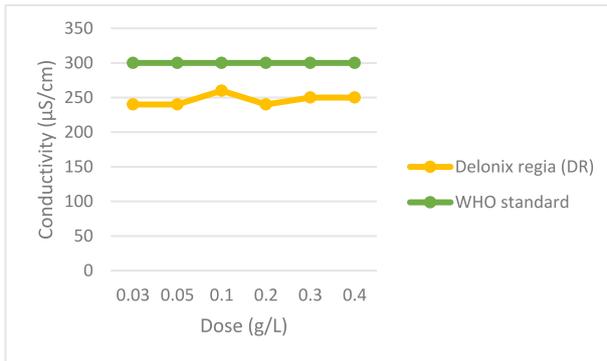


Figure 1: Effect of coagulant dosage on Conductivity

Figure 2, represents the effect of the various doses of the coagulant (0.03 g/L – 0.4 g/L) on the Dissolved Oxygen (DO) of the water sample. High dosage of *Delonix regia* increased the initial DO of the water samples from 6.6 mg/L to 10 mg/L but a decrease in the dosage of this natural coagulant reduced the DO significantly to 5.4 mg/L with a percentage reduction of 18.8%. It can be deduced that the optimum dose of the coagulant is 0.03 g/L. The coagulant can be said to improve the DO value of the sample to a value close to the WHO permissible limit of 5mg/L.

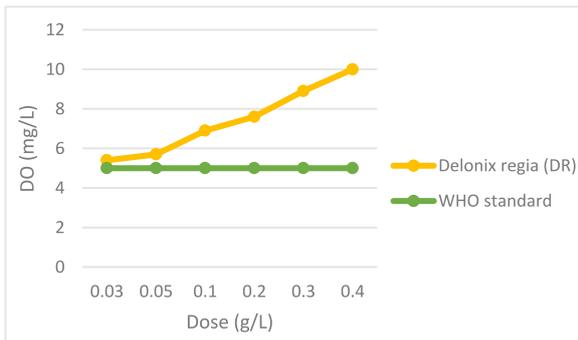
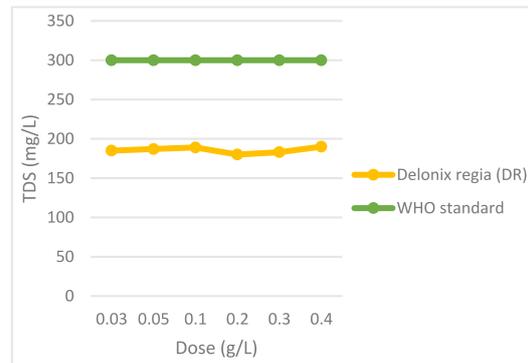


Figure 2: Effect of coagulant dosage on DO

The initial TDS value of the raw water sample was 174 mg/L. Addition of *Delonix regia* to the water increased the TDS to 190 mg/L at 0.1 and 0.4 g/L as shown in Figure 3. Even though

the addition of *Delonix regia* increased the TDS of the water samples, the increase did not exceed the WHO maximum permissible limit of 300 mg/L.

Figure 3: Effect of coagulant dosage on TDS



The effect of varying the doses of *Delonix regia* (0.03 g/L – 0.4 g/L) on the turbidity of the low turbid water sample is shown in Table 2 and a comparison with WHO standard for potable water is shown in Figure 4. A dose of 0.4g/L increased the turbidity of the water drastically from 18.4 NTU to 33.3 NTU. There was noticeable reduction in the turbidity of the water with decrease in dosage of the coagulant. An optimum concentration of 0.03 g/L greatly reduced the turbidity to 6.12 NTU with a percentage removal of 66.74%. Although this is not up to the acceptable level by WHO (5 NTU), however, from the experiment carried out, *Delonix Regia* has proven to have the ability to reduce turbidity at low dosage. When the dose of *Delonix regia* exceeds the optimum, the turbidity of the water will increase because the coagulant did not react with oppositely charged colloidal particles (Hendrawati *et al.*, 2016).

Table 2: Initial properties of raw water sample

Dose (g/L)	Turbidity (NTU) after Treatment
0.4	33.3
0.3	26.0
0.2	15.3
0.1	12.9
0.05	9.78
0.03	6.12

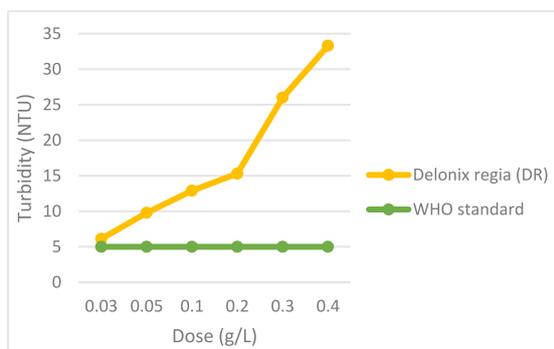


Figure 4: Effect of coagulant dosage on Turbidity

4. CONCLUSION

From the results obtained, it can be concluded that *Delonix regia* can be used as a natural coagulant for low turbid water treatment because the quality of the water improved significantly after treatment with *Delonix regia*. However, treatment with *Delonix regia* in the doses evaluated, is not sufficient to improve the quality of low turbid water to WHO acceptable limits for potable water. It is recommended that more study the use of *Delonix regia* seed as a coagulant and alum as a coagulant aid be conducted also, more natural sources should be studied for possible coagulation potential.

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