Assessment of *Moringa oleifera* Seeds as a Natural Coagulant in Treating Low Turbid Water

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Abstract- This research examined the coagulating potential of *Moringa oleifera* seeds in treating low turbid water. The active ingredient of the seeds was extracted using Soxhlet Apparatus with hexane as the solvent, after which the coagulant was dosed from 0.03g/L to 0.4g/L and used to treat a water sample with a low Turbidity of 18.4NTU, yielding an optimum value of 4.90NTU, an optimum dose of 0.03g/L and a turbidity reduction of 100% when compared with the World Health Organization (WHO) standard which is 5NTU. The study affirms *Moringa oleifera* as an effective natural coagulant in low turbid water treatment and it is recommended for household water treatments.

Keywords- Hexane, Low turbid water, *Moringa oleifera*, Natural coagulant, Soxhlet apparatus

1 INTRODUCTION

Water is essential for all living things to survive. As a result, humans sought to settle near sources of freshwater. The world's population has grown by multiple orders of magnitude over time, but freshwater supply has stayed steady, putting an increasing strain on it. (Jain, 2010). Water quality deteriorates dramatically as a result of contamination induced by geometric population expansion, domestic and agricultural activities, modern industrialization, culture, and other geological, environmental, and geographical shifts. (Gidde, 2011). Water treatment entails a combination of processes based on quality of the water source, such as turbidity and quantity of microbial load present in the water, as well as cost and chemical availability, to achieve the required level of treatment. (Muyibi et al., 2009).

Suspended particles, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton, and other microscopic animals, generate turbidity in water. (Environmental Protection Agency, 2001), while Organic matter and inorganic salts which can come from sewage, effluent discharge and urban runoff as well as natural bicarbonates, chlorides, sulphate, nitrate, sodium, potassium, calcium and magnesium, make up total dissolved solids (World Health Organization, 2006). Purification methods such as coagulation, sedimentation, filtration, aeration and chemical treatment are useful techniques for water purification. The coagulation process is often used in water treatment to dislodge suspended particles and react with organic components in raw water, both of which are necessary for an effective disinfection and filtering process to occur (Moramudai and Fernando, 2001).

Compounds of Aluminium and Iron from sulphur and chlorine are widely used chemical coagulants (Mbaeze et al., 2017). Owing to the excessive addition of chemical-based coagulants influencing human health, maximum doses of these chemical coagulants should be identified (Malla et al., 2014). Iron residue in water induces excessive blood iron that kills cells and results in Alzheimer's disease (Leiw et al., 2006). Also, the use of chemical coagulants for water purification restricts the financial resources of most developing countries as they are imported to make treated water costly (Amagloh and Benang 2009). The discovery of other safe coagulants is needed to establish a cost-effective, environmentally safe, and more straightforward water clarification process. Many researchers have found natural coagulants to substitute chemical coagulants, and some extracts obtained from plants have shown an excellent water coagulation result (Nayana & Veena, 2019). In recent years, certain studies have been performed on natural coagulants such as *Cactus latifaria*, *Moringa oleifera* and *Prosopis juliflora* (Akshaya et al., 2012).

Natural coagulants possess many remarkable characteristics over chemical coagulants. Some of these characteristics are; they can be grown locally, and as such they are cost-effective in developing countries, they also generate considerably less sludge, human-safe, naturally degradable, can be possibly used at various doses to flocculate different colloidal suspensions (Raji et al., 2015). *Moringa oleifera* is a versatile tropical tree whose seeds contain high quality edible oil (up to 40% by weight) and water-soluble proteins that operate as excellent coagulants in water and waste water treatment (Bhuptawat et al., 2007). It is not recommended to keep water treated with crude *Moringa oleifera* extract for more than 24 hours because of the oil content (Jahn, 1988). Therefore, it is not suitable to use the crude extract from *Moringa oleifera* to treat large water supply systems with a long hydraulic residence time. Oil can be extracted from the seeds to the coagulant and eatable oil as by product (Ali et al., 2010). Sometimes, contaminants are present in small quantities; forming a low turbid water, which makes the water appear pure to the naked eyes, but could be harmful to their health if the water is consumed in its

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raw form. This research aims at extracting oil from *Moringa oleifera* seeds so as to improve the quality of the coagulant thereby increasing the storage time of the treated water and also to investigate the effectiveness of *Moringa oleifera* in improving the quality of low-turbid water.

2 MATERIALS AND METHODS

2.1 SOURCE, DESCRIPTION AND PREPARATION OF THE COAGULANT

Dry and mature seeds of *Moringa oleifera* (MO) were handpicked from MO trees in Oke – Aro, Akure, Ondo state. All seeds were prepared for use by manually sorting out the bad ones and then removing the seed shells to get the kernels. Only the brown seeds were used in the experiment because they have a higher coagulation ability than the green pods, which have no coagulation properties (Tunggolou and Payus, 2017). The kernels gotten from the seed was ground into powder using heavy duty grinding machine at the major market in Akure, Ondo state, and then sieved through the 600 μm sieve. The fine powder obtained from this process was then packed into an air-tight container.

Similar to the procedure employed by Muyibi et al. (2003), the use of the electrothermal Soxhlet apparatus was employed for the oil extraction process, and the procedure is as follows:

- 10 gm of the powdered seed was weighed and set into the thimbles of the electrothermal Soxhlet extraction chamber;
- 170 ml of Hexane was poured into the heating chamber;
- The oil was extracted from the seeds as the hexane was passed through the thimbles in cycles till it became colourless;
- The residue obtained 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 used in this study was obtained from downstream of the Ala River, located in Akure Ondo State ($7^{\circ} 15' 30.7''$ north) and ($5^{\circ} 13' 7.5''$ east). The sample bottles used for sample collection and analysis were obtained from the market and washed with distilled water and then dried. The raw water was gotten from the river into the sample bottle and immediately transported to the laboratory for treatment and analysis.

2.3 COAGULATION/ FLOCCULATION PROCESS USING A MAGNETIC STIRRING MACHINE

Different weights (ranging from 0.03g – 0.4g) of the obtained coagulant was added to 250ml of the water sample in six different beakers and then the beakers were placed on the magnetic stirring machine, one beaker at a time. The machine was set at about 120rpm for rapid mixing for 30 secs and 50rpm for 8mins for slow agitation (Ezeh et al., 2017). The samples were filtered using a filter paper and the filtered samples were kept in labelled 100ml bottles.

2.4 LABORATORY ANALYSIS

The tests carried out on the raw water and treated water samples are as follows: Turbidity test was done using a Lovibond Water Test TB 210 IR Turbidimeter. Total Dissolved Solids (TDS) and Conductivity were measured using Hanna HI9813-6 pH meter and Dissolved Oxygen (DO) using Hanna HI 3810 DO test kit.

3 RESULTS AND DISCUSSION

The raw water gotten from Ala River in Akure, Ondo state had a Turbidity of 18.4NTU, TDS of 174mg/L, Conductivity of 240 $\mu\text{S}/\text{cm}$ and DO of 6.6mg/L (Table 1).

Table 1. Effect of coagulant dosage on water properties

Dosage (g/L)	Turbidity (NTU)	TDS (mg/L)	Conductivity ($\mu\text{S}/\text{cm}$)	DO (mg/L)
0.00 (before treatment)	18.4	174	240	6.6
0.03	4.9	180	260	4.6
0.05	5.04	185	260	4.6
0.1	6.07	188	260	4.7
0.2	8.62	189	260	4.8
0.3	11.5	190	260	5.0
0.4	16.8	205	280	5.3

3.1 EFFECT OF COAGULANT DOSAGE ON TURBIDITY

The effect varying the doses of MO (0.03 – 0.4g/L) on the low turbid water sample shows that at a dose of 0.4g, the turbidity reduced an initial value of 18.4 to 16.8NTU, while at a dose of 0.03g the turbidity reduced to 4.9NTU. With respect to the permissible limit of 5NTU by WHO, the optimum dose of the coagulant for turbidity removal was 0.03g/L. As reported by WHO (2006), MO's turbidity-lowering process is mostly based on seed proteins. The lowest dose of the coagulant was more effective in reducing the turbidity because the raw water contained little number of dispersed particles.

Fig. 1: Effect of coagulant dosage on Turbidity.

3.2 EFFECT OF COAGULANT DOSAGE ON DISSOLVED OXYGEN

The DO value of the raw water sample was 6.6 mg/L before treatment, this value increased from 4.6 mg/L when a dose of 0.03g/L was used to 5mg/L at 0.3g/L and finally to 5.3 mg/L at a dose of 0.4g/L (Figure 2). The

obtained optimum dose that improved the DO to the recommended WHO value (5mg/L) was 0.3g/L.

Fig. 2: Effect of coagulant dosage on DO

3.3 EFFECT OF COAGULANT DOSAGE ON CONDUCTIVITY

The initial conductivity value was 240 μ S/cm. After dosing, the conductivity of the treated water sample increased from 240 μ S/cm to 280 μ S/cm. Although the coagulant added increased the value of conductivity by 17%, it is still within the permissible limit. Increasing the coagulant dosage in the solution led to an increase in conductivity, this is owned to the formation of ions in the water samples during the coagulation process. Figure 3 shows the obtained results after each dosage.

Fig. 3: Effect of coagulant dosage on Conductivity

3.4 EFFECT OF COAGULANT DOSAGE ON TOTAL DISSOLVED SOLIDS (TDS)

The initial TDS value of the raw water was 174 mg/L. After treating with a dose ranging from 0.03g/L to 0.4g/L, the TDS of the water samples increased from 180mg/L at a dose of 0.03g to 205mg/L at a dose of 0.4g, which is within the preferred range of WHO standard (< 300mg/L) as seen in Figure 4.

Fig. 4: Effect of coagulant dosage on TDS.

4 CONCLUSION

From the results obtained from the research, *Moringa oleifera* is an effective coagulant in the treatment of low turbid water. This agrees with the results obtained from other research works (Tunggolou and Payus, 2017; Ali, et al., 2009). Therefore, a strong recommendation is made for the use of the right quantity of *Moringa oleifera* in the treatment of low turbid water at household level.

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