Quality Analysis of *Moringa Oleifera* Seed as Coagulant for Water Treatment

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Abstract

Quality analysis of Moringa oleifera seed as coagulant for water treatment was conducted along with that of Aluminium Sulphate. The result from laboratory analysis for the parameters tested in term of turbidity, PH, conductivity and temperature indicates that Moringa oleifera coagulant is very effective in water purification than using Aluminium sulphate coagulant. The highest turbidity value of 70.69% was obtained at 55 mgL^{-1} dose for aluminium sulphate while the highest turbidity value of 92.08% was obtained at 15 mg L^{-1} dose of Moringa oleifera. Moringa oleifera coagulant gave the highest pH of 5.67 to 6.85 while samples treated with aluminium sulphate coagulant have the pH value with a range of 3.27 to 4.56. Both coagulants shows similar trend of increasing conductivity though within the permissible limit of conductivity (0-3000 µS) and their temperature is still in the normal range for water reading of World Health Organization (WHO) for drinking water.

Keywords: **Water, Purificaaation, Coagulant, Moringa, alum.**

I. Introduction

Water is used for several purposes by humans for consumption, agriculture, industrial uses and many others. The level of purity of the water being consumed is very crucial since it has a direct effect on health (Amagloh and Benang, 2009). Water is essential for human consumption, agriculture and for industrial uses. Drinking water should be free from contaminants as children bear the greatest health burden associated with unsafe water supplies through preventable diseases (Sridhar and Oloruntoba, 2008). In developing countries about 2 million people die every year due to diarrhoeal disease; most are children of less than 5 years of age (WHO, 2006). Numerous nations that are as yet inadequate with regards to water treatment system can't appear to provide their residents with adequate quality that meets the minimum requirements of a drinking water.

In Nigeria, most of the urban water pipes are old, leaky and are laid in drains which causes back siphonage, and thus, pollution of the source with its attendant threat to the health of the consumers unless there is further treatment at the household level. Nand *et al*. (2012) reported that poorly treated water resulting from lacking water treatment facilities has been said to cause waterborne diseases that kills people every day while others suffers from the side effects. Waterborne diseases are known as those diseases that arise due to the directly transmitted pathogenic microorganisms when the contaminated water is consumed.

Ali *et al*. (2009) stated that, in the past, among the most used water treatment method in the water treatment industry before distributing them to the consumers is coagulation-flocculation that is followed by

sedimentation, filtration and disinfection, which is usually done using chlorine. But nowadays, in the water treatment latest technology, they are using chemicals such as aluminum sulphate which is a synthetic coagulant to enhance the water purification. Majority of the expanding and growing countries drinking water source was limited mostly to river water and the treatment processes is heavily depended on the chemicals that is used as water treatment agents such as aluminum sulphate which are mostly imported and are expensive.

The usage of aluminum sulphate as coagulant also causes the water to be acidic (Adejumo *et al*., 2013) and hence to neutralize the water, lime will be needed to balance the pH of the water. This is known as pH adjustment where it is added to the water during treatment process and is regarded as another added cost for water treatment companies. Other than its cost, among the reasons why there should be a plant based coagulant to replace synthetic coagulants is due to aluminum sulphate threatening properties in drinking water. Coagulants that occurred naturally are regarded as safe in terms of health for human while synthetic coagulants, especially aluminum salt, has probability of inducing Alzheimer's disease. This is supported by other studies where rising health risks was mentioned from drinking the water with residual aluminum left in it such as neurodegenerative illness (Adejumo *et al*., 2013).

Surface waters have been treated traditionally using herbs as natural coagulants in India for centuries. Ripe seeds of *Strychnos potatorum*, wiry roots of the rhizome of *Vetiveria zizanioides*, seed coats of *Elettaria cardamomum* and leaves from *Phyllantus emblica* were popular (Sadgir, 2007). Moringa oleifera is one of such plants that can be used for water treatment due to its better properties in terms of water turbidity removal and its numerous health benefits compared to aluminum sulphate. Among other great properties of *Moringa oleifera* are such as anti-ulcer, hepatoprotective, anti-bacterial, anti-fungal, anti-hypertensive, anti-tumor, anti-cancer activities and last but not least, diuretic and cholesterol lowering activities (Amagloh and Benang, 2009). As a solution to the problems arising from the use of chemical coagulants mentioned earlier, Moringa oleifera as an alternative to replace synthetic aluminum sulphate needs to be studied. Hence, the study investigates the quality analysis of moringa oleifera seed as coagulant for water treatment.

II. Materials and Methods

Study Area

The study was conducted at Oke-Ogun Polytechnic, Saki (TOPS) located in Saki, Saki West Local Government Council Area of Oyo North Senatorial District, Saki, Oyo State, Nigeria. Saki is on latitude 8^{o} 40 N and 3^{o} 24' E longitude and has an annual rainfall of about 900-1000 mm on wet days, 72.7% relative humidity and temperature range of 21.8 to 31.2 ^{o}C (OYSADEP Annual Report, 2015). The vegetation within the study area is a typical Guinea Savanna Vegetation zone. Modern Saki is an exporter of cotton, swamp rice, teak, and tobacco while yams, cassava, maize, sorghum, beans, and okra are grown for subsistence. Cattle raising is increasing in importance, and there is a government livestock station. There are vast cattle ranches at Saki and the town houses the Headquarter of the Oyo State Agricultural Development Agency (OYSADA). The availability of drinking water for domestic consumption, industrial

and for agricultural uses has been a serious problem to the town despite the fact that the town is one of the biggest town in Oyo state.

Source of water sample

Water samples were collected from Oge Dam located in Saki town Oge dam water is the main source of drinking water for the people of Saki and its environment. The samples were collected from the storage tank prior to treatment.

Preparation of coagulants used

Two different types of coagulants were used in the study, a naturally occurring coagulant, which was prepared from *Moringa oleifera* seed which was obtained from botanical garden of the Oke-Ogun Polytechnic, Saki (TOPS) and aluminum sulphate coagulant which is a synthetic (laboratory grade) coagulant which was purchased from gbawojo market in Saki. Some quantity of matured dried Moringa oleifera pods were harvested from the tree and the seeds were manually extracted from the pods. It was ensured that only the seeds that are brown in colour were used throughout the experiment due to their higher coagulation activity as compared to the green pods which has no coagulation properties (Yusuf *et al*., 2015).

The extracted seeds were air-dried at 40 ^{O}C for 2 days as recommended by Megersa *et al*. (2016). The kernels were then removed from the seed coats manually and the remaining kernel were grounded using pestle and mortar soon afterwards to convert them into powder. Aluminum sulphate was used as a synthetic coagulant and was grounded into fine powder using pestle and mortar was used for comparison in terms of treatment efficiency with Moringa oleifera.

Jar Tests Study

The jar tests was carried out using Junke and Kunkel jar test (Lovibond ET 730) apparatus as described by Yusuf *et al*. (2015). The parameters were tested before and after the treatment given. The first three beakers were filled with 1000 mL of water in each beaker, while the fourth beaker is left untreated for control. The different coagulant concentration and amount was then added to the water sample to be tested. After the addition of the coagulant, the water was mixed rapidly using 125 rpm for 5 min and then slowed down to 50 rpm for 30 min. It was then left undisturbed to settle for 1 h. After the settlement of the water treatment, the water was taken and measured

Parameters Tested

The four important parameters that were tested in this study according to the drinking water quality guidelines are turbidity, pH, conductivity and temperature. Turbidity was tested using turbidity meter (HACH 2100P), pH was tested using pH meter (Digimed DM-2), conductivity was tested using conductivity meter (EC 500) while temperature was measured using basic thermometer. All the parameters were tested accordingly and the data obtained were used to determine which of water treatment system

using Moringa oleifera or Aluminium sulphate is in the range of the water quality and fit most for domestic consumption.

Data Analysis

Data obtained from the experiments are analyzed using Microsoft Excel Office Professional Plus 2013 and Pearson correlation. The p value was also determined to show if there was a significant difference with either ($p>0.05$).

III. Results and Discussions

Turbidity

The effect of moringa oleifera and aluminum sulphate coagulants treatments on turbidity of the water samples at different doses is presented in Figure 1. It was observed from the figure that the highest turbidity removal value of 70.69% was obtained at 55 mg L^1 dose for aluminium sulphate while the highest turbidity value of 92.08% was obtained at 15 mg L^1 dose of moringa oleifera. Similarly, the lowest turbidity values of 17.80 and 44.09% were recorded at 35 and 10 mg L^1, respectively for aluminium sulphate and moringa oleifera. The result shows that Moringa can be adopted for water purification. The patterns of turbidity removal for both coagulants from the graph were clearly seen to increase and decrease gradually which shows that both of them utilizes adsorption and neutralization process to balance out the charges on the colloidal and hence showing similar trend of increasing turbidity when overdosing occurred as well. Zand and Hoveidi (2015) stated that over dose of coagulant cause an increase in the cost of water treatment and this is not financially reasonable, thus Moringa oleifera is more efficient.

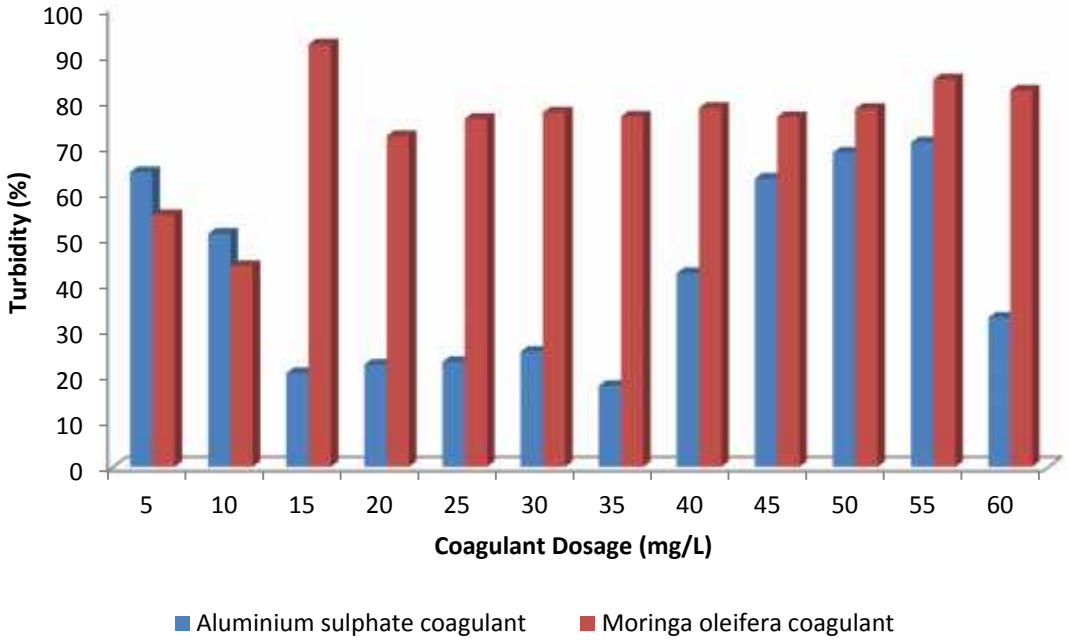

Figure 1: Graph showing the dosage (mg L^{-1}) against turbidity (NTU) for both coagulants

pH

The effect of aluminium sulphate and moringa oleifera coagulants on water purification is presented in Figure 2. It was observed from the figure that water samples treated with moringa oleifera coagulant gave the highest and favourable pH range of 5.67 to 6.85 while water samples treated with aluminium sulphate coagulant has the PH value with a range of 3.27 to 4.56. It was equally observed from the figure that pH value of water samples treated with moringa oleifera increases favourably with increasing concentrations of the Moringa coagulant while decreasing for water samples treated with aluminium sulphate as doses increases.

In comparison, the pH value recorded for water samples treated with moringa oleifera falls within the recommended acceptable range of pH for drinking water specified by WHO (2006) between 6.0 and 8.0. The lower pH values recorded for water samples treated with aluminium sulphate was attributed to the fact that the alum in the treatment procedure produced sulphuric acid which lowered the pH levels but the reverse was observed with the Moringa oleifera water samples treatment. Megersa *et al*. (2016) reported that the action of Moringa oleifera as a coagulant lies in the presence of water soluble cationic proteins in the seeds. This suggests that in water, the basic amino acids present in the protein of Moringa would accept a proton from water resulting in the release of a hydroxyl group making the solution basic. This accounted for the basic pH values observed for Moringa treatments compared with alum treatments.

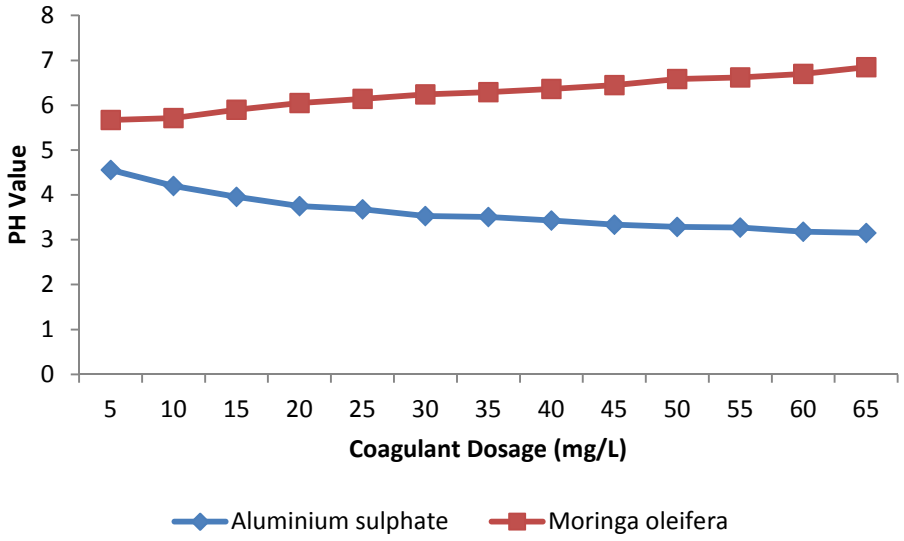

Figure 2: Graph showing the dosage (mg L^{-1}) against pH for both coagulants

Conductivity

The effect of Moringa oleifera and aluminium sulphate coagulants on water purification is illustrated in figure 3. It was observed from the figure that there was significant increase in conductivity of water samples treated with aluminium sulphate coagulant while a slightly increased in the value of conductivity was noticed with the water samples treated with moringa oleifera coagulant. The permissible limit of conductivity reading of World Health Organization (WHO) for drinking water is 0-3000 µS and hence the

both of the coagulants are in the permissible limit allowed. It can be seen from the conductivity graph, that with an increased in dosage, the conductivity reading also increased generally. Both of the coagulants, aluminum sulphate and Moringa oleifera show similar trend of increasing conductivity. But the increase in the conductivity reading was expected as a result of the ions formation in the water during the coagulation process. Formation of the ions also contributed to the overall conductivity.

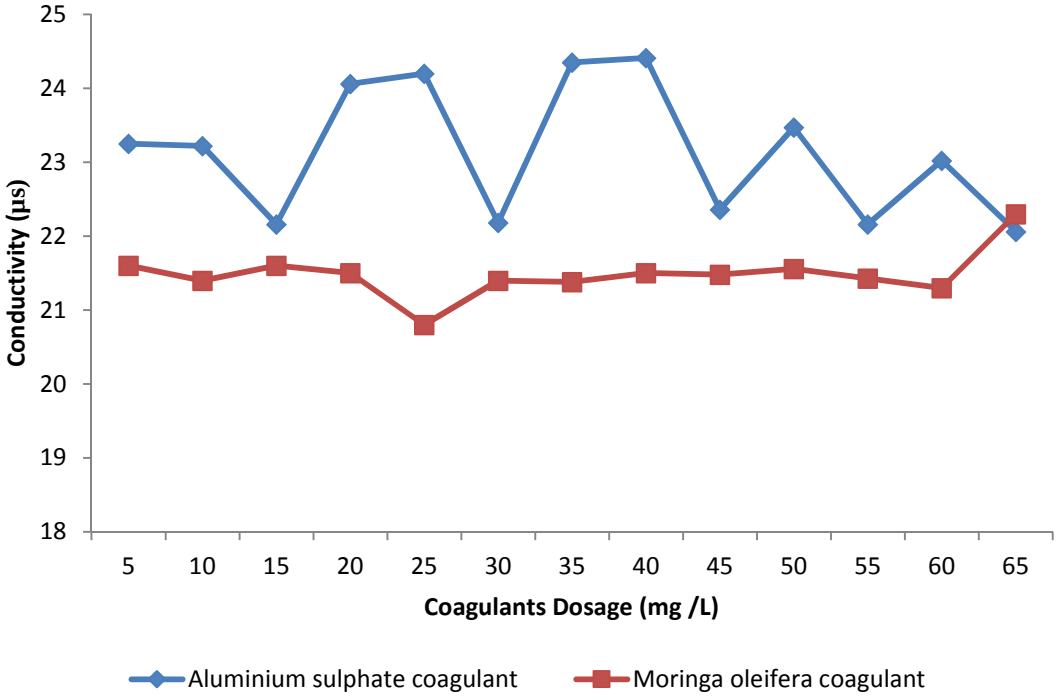

Figure 3: Graph showing the dosage (mg/L) against conductivity (°C) for both coagulants

Temperature

The effect of Moringa oleifera and aluminium sulphate coagulants treatments on temperature of water samples is presented in Figure 4. The initial temperature of the water samples before imposition of the treatment was 27.39 °C. The highest temperature of 27.68 °C was observed after the addition of aluminium sulphate at 40 mgL^{-1} meanwhile the highest temperature of 26.85 °C was recorded for Moringa oleifera at 50 mgL^{-1}, respectively. Both of the coagulants readings are however still in room temperature range. Generally, it can be concluded from the study that the use of the coagulant in water purification does not affect the water temperature drastically as their temperature is still in the normal range for water. Hendrawati *et al*. (2016) on similar experiment reported an increase in temperature of ground water when treated with Moringa oleifera coagulant from 28.4°c to 29.0°C. The study has stated that after the addition of the powdered Moringa oleifera seeds when used as coagulant in the water purification and treatment processes, the initial reading of the groundwater sample of 28.40°C only reached 29.0 °C at their highest. Tunggolou and Payus (2017) also reported an increase in water temperature when treated with Moringa oleifera as water purifier from 22.07 to 24.97°C.

Thus, it was concluded in the study that the use of the coagulant in the process does not affect the water temperature drastically as their temperature is still in the normal range for water. Othman *et al*. (2008), submits that the efficiency of coagulation was reduces when temperature of wastewater was increased from 30-70 ^{o}C. This is most probably caused by the temperature effects where charge destabilization of the suspended solids in the wastewater occurred. It might also be due to particles collision rates and also through the viscosity (concentration) effects in the water. Since increasing in the temperature decreases the floc strength, the floc can be easily broken and hence decreases the efficiency rates.

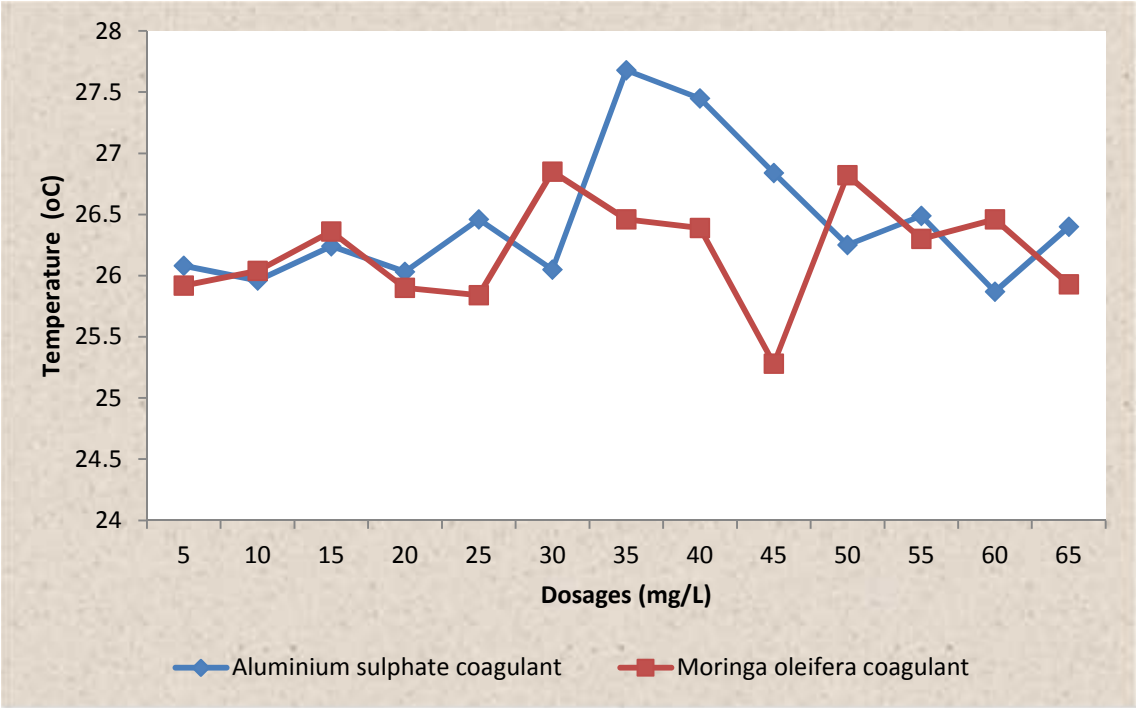

Figure 4: Dosage (mg LG1) against Temperature (^{o}C) for both coagulants

IV. Conclusion

Quality analysis of Moringa oleifera seed as coagulant for water treatment has been investigated and the result from the laboratory analysis for all the parameters tested in term of turbidity, PH, conductivity and temperature indicates that Moringa oleifera coagulant is very effective in water purification than using aluminium sulphate coagulant as water purifier. The highest turbidity value of 70.69% was obtained at 55 mgL^{-1} dose for aluminium sulphate while the highest turbidity value of 92.08% was obtained at 15 mg L^{-1} dose of Moringa oleifera. Moringa oleifera coagulant gave the highest range pH of 5.67 to 6.85 while water samples treated with aluminium sulphate coagulant has the pH value with a range of 3.27 to 4.56. Both of the coagulants, aluminum sulphate and Moringa oleifera shows similar trend of increasing conductivity though within the permissible limit of conductivity reading of World Health Organization (WHO) for drinking water (0-3000 µS) and the two coagulants in water purification does not affect the water temperature drastically as their temperature is still in the normal range for water. Conclusively, Moringa oleifera gave favourable results on all the properties tested while Aluminium sulphate was more acidic after treatment.

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