TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 5686 - 5690

Effectiveness of Using Milled Moringa Oleifera Seeds as a Natural Coagulant in Waste Water Treatment

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Article Info
Volume 82
Page Number: 5686 - 5690
Publication Issue:
January-February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 27 January 2020*

Abstract:
This research was conducted with the aim of investigating the performance of milled moringa oleifera seeds as a natural coagulant in waste water treatment. Operating parameters such as pH, temperature and total suspended solids were tested at different water turbidities. Elemental analysis of raw Moringa Oleifera seeds showed that iron was the predominant element. The percentage turbidity removal for Moringa Oleifera seeds on low, medium and high turbidities were 84.6%, 94.8%, and 72% respectively. Generally, the turbidity removal increased with an increase in Moringa Oleifera dosage. Lower speeds promote the floc formation rate on low turbid water and the results also revealed that the dosage of Moringa Oleifera does not affect the pH of water as the final pH for all the experiments was within the required standard of 6.5-9.5. Moringa oleifera seeds showed a greater potential to be applied as a natural coagulant.

Keywords: *Bentonite clay, Moringa, Natural coagulant, Waste water.*

I. INTRODUCTION

Good quality water is a major problem that needs serious attention considering the fact that water is used for numerous purposes, therefore the cleanliness of water consumed is very important for human health [1]. Good quality water has become expensive, because many water sources are polluted by waste coming from various waste human activities such that provision of clean drinking water is compromised as it does not meet quality standards [2]. The use of alum and calcium hypochlorite for water purification constrains in most developing nation's financial resources since they are imported making treated water to be expensive [3]. This research aims at providing a simplified alternative and low cost clarification process by using Moringa oleifera seeds as a natural coagulant more especially for people living in rural, pre-urban and remote areas where treated water is a scarce resource. It will also help impart knowledge to people living in rural communities and remote areas where treated water is a scarce resource on how to prepare their own Moringa Oleifera coagulum. The sole purpose for this knowledge imparting is due to the fact that these communities cannot afford readily available water treatment technologies which uses imported chemical coagulants which are expensive to procure and not easily accessible. During the rainy seasons, the turbidity levels of water increases and the demand for water treatment chemicals increase as well, leading to

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increased cost of treatment which the water treatment companies cannot sustain [4]. Therefore, it is of great importance to find a natural and locally available material as an alternative coagulant for water treatment to reduce the turbidity of water. Natural coagulants are expected to be safer to use in water treatment than synthetic coagulants because they maintain the neutral state of water after treatment [2][5]. The proposed natural coagulant used in this study was Moringa Oleifera seeds.

II. EXPERIMENTAL METHODS

A. Materials

Moringa oleifera seedpods were harvested within the Palapye area after being allowed to mature and dry naturally to a brown colour. Mozambique Bentonite, a natural clay which comprises of the clay mineral montmorillonite and silica in the form of cristobalite was used to prepare the synthetic turbid water used in the jar test experiments.

B. Equipment

An X-ray fluorescence spectrometry (XRF) was used to determine the elemental composition of milled Moringa Oleifera seeds. A TL23 series benchtop turbidity meter was used to measure the turbidity of different water samples. A Jenco pH 6810 – Handheld pH/mV/Temperature meter was used to measure the pH of the solution.

C. Preparation of Synthetic turbid water

Jar test experiments were conducted with the aim of determining the required dosage of the coagulant (Moringa Oleifera seeds) to reduce the total suspended solids (TSS) of the raw synthetic turbid water.

Synthetic turbid water was prepared by adding 10 g of Bentonite clay in a 1000 ml beaker and making up to the mark with distilled water. The solution was stirred for 60 minutes at 200 rpm using an overhead stirrer to obtain a uniform dispersion of clay particles. After stirring, the solution was left to settle for 24 hours to allow for complete hydration of bentonite particles. This formed the stock solution which was used in the coagulation jar tests experiments.

D. Moringa Oleifera Coagulum Preparation

Moringa oleifera seeds were collected and left to dry. The seeds were removed from its kernels manually and crushed to a fine powder using a pestle and mortar. The milled Moringa Oleifera seeds powder were sieved using 212 – 220 µm sieve to a finer powder and the powder was then used as a coagulant.

Fig. 1: (a) Dried Moringa Oleifera seeds being removed from its seeds kernels (b) Pestle and mortar used to crush Moringa Oleifera seeds

E. Jar Tests experiments

Turbid water samples with low (100 mg/l), medium (250 mg/l), high (550 mg/l) total dissolved solids from the turbid water stock solution prepared in section 2.3.1 was used for conducting the jar test experiments The initial turbidity of the solutions was measured. Different doses of Moringa oleifera seeds at 0.02 g/l, 0.04 g/l, 0.06 g/l, 0.08 g and 0.10 g/l were

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extracted using oral syringes and dosed to each sample solutions as per different jars.

F. Effects of Moringa Oleifera on water turbidity of 100 mg/L, 250 mg/L, and 550 mg/L

Six beakers were loaded with *100 mg/L, 250 mg/L and 550 mg/L* of turbid water and the initial pH, total suspended solids and turbidities for all the six jars were measured. Jars 2, 3, 4, 5 and 6 respectively were dosed with moringa oleifera seeds whereas jar 1 was used as a control jar and was not dosed with the coagulum. The solution was mixed rapidly at 230 rpm for 2 mins and slow mixed at 40 rpm for 15 mins. During this rapid mixing and slow mixing the floc formation and flocs sizes were observed. Each jar was given 30 mins settling time while observing the settling rate. The final pH and final turbidities in all the jars were measured. The same process was repeated using a synthetic chemical coagulant (Alum) for comparison purposes.

III. RESULTS AND DISCUSSION

A. X-Ray Fluorescence Spectroscopy analysis

X-Ray Fluorescence spectroscopy was used to detect the chemical elemental composition of the material. *Fig. 2* shows the elements present in the coagulant for which Iron has the highest composition of 402 PPM. Therefore from the x-ray Fluorescence spectroscopy characterization, it can be concluded that Moringa oleifera seeds can be classified under Iron based natural coagulants.

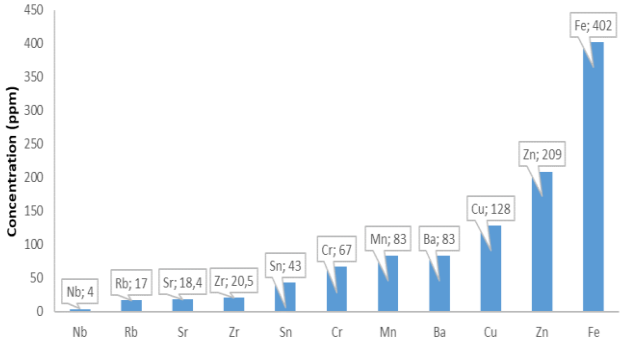

Fig. 2: Elemental composition of milled Moringa oleifera seeds in PPM

B. Effect of Moringa Oleifera seeds dosages on coagulation process

Fig. 3 shows results obtained when varying the dosage of Moringa Oleifera seeds on water samples with initial turbidity values of 20, 50, and 80 NTU. An increase in dosage shows an increase in turbidity reduction for all the three concentrations. According to the World Health Organisation (WHO), the standard turbidity after adding a coagulant should be less than 5 NTU and as shown in *Fig. 3*, the lower turbid water reached the allowable turbidity value of 5 NTU at 0.08 g/l, while for the medium turbid water it occurred at 0.04 g/l of Moringa dosage. The highly turbid water needed a further increase in dosage because at 0.1 g/l of Moringa seeds it had achieved a turbidity value of 22.52 NTU from 80 NTU which is still higher than the standard value.

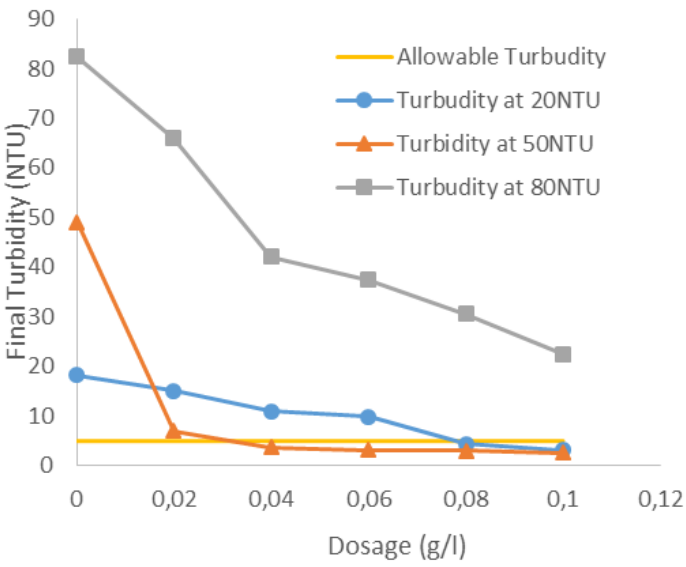

Fig. 3: Effects of varying the dosage of Moringa Oleifera seeds on water turbudity. Stirring speed; 250 rpm for 2 mins and 100rpm for 15 mins then 30mins setting time

C. Effect of Aluminium sulphate (Alum) dosages on coagulation process

Alum as a chemical coagulant was also used to reduce turbidity in water and *Fig.* 4 shows results obtained when varying the dosage of Aluminum Sulphate (Alum) on the water samples of low,

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medium and higher turbidities. The standard turbidity value of 5 NTU as prescribed by WHO was achieved at all the three concentrations at a dosage of 0.04 g/l. In comparison to Moringa oleifera, alum gave a better removal. The choice of use of the two will not only be based on the results of coagulation but also in that Moringa has been tested to contain anti-microbial properties making it a candidate for disinfection of water.

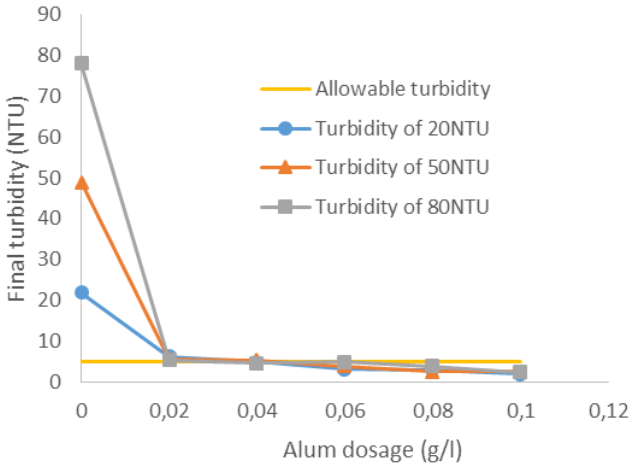

Fig. 4: Varying dosage of Aluminium sulphate on for turbidity of 20, 50 and 80 NTU Speed; 250 rpm for 2 mins, 100 rpm for 15 mins then 30 min settling time.

D. Effect of stirring speed on coagulation process

The study was conducted based on Moringa oleifera seeds only and *Fig.*5 shows the effects of different stirring speeds on coagulation process. The different speeds tested were 50 rpm, 100 rpm, 150 rpm and 200 rpm. A stirring speed of 50 rpm (lower speed) gave the highest turbidity reduction at the different concentrations used because a lower speed promotes floc formation whereas higher speeds may break up the formed flocs leading to lower turbidity reduction.

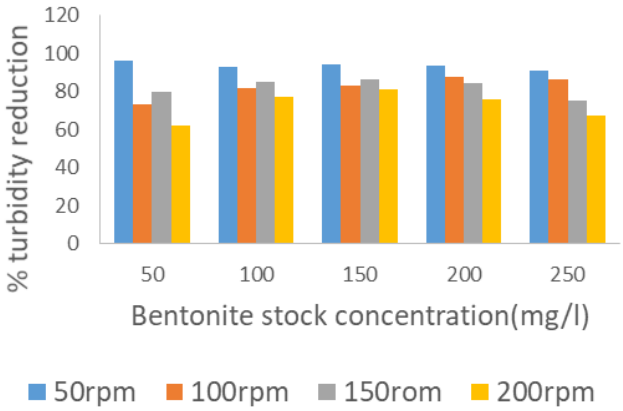

Fig.5: Effect of varying stirring speed on different Bentonite stock solution concentrations

E. Effects of Moringa Oleifera dosage on pH

Fig. 6 shows a brief overview of the pH trend when increasing the dosage of Moringa Oleifera seeds. The standard pH for portable water as per the World Health Organization (WHO) should be between 6.5 – 9.5 and all the tests showed conformity to the standard pH which shows that Moringa has no influence on the pH of water at any given turbidity.

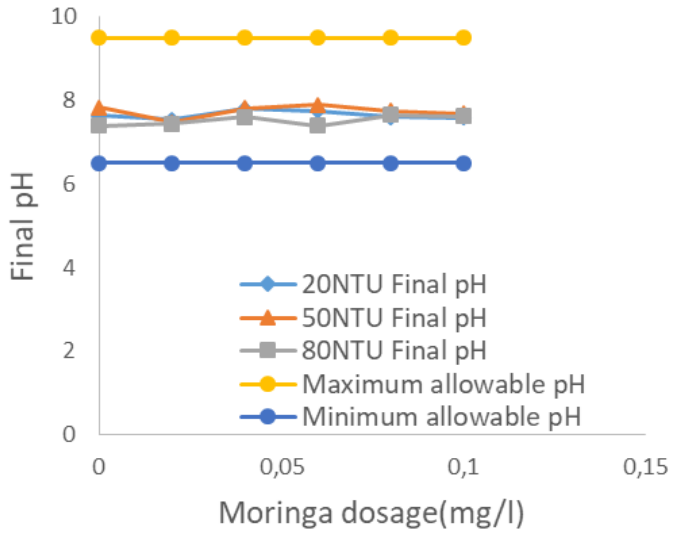

Fig. 6: Effects of Moringa Oleifera Dosage on pH potential.

CONCLUSION

MO has shown greater removal of total suspended solids at low and medium turbidity. It was concluded that is an iron based natural coagulant due to its larger

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concentration of iron on the elemental analysis. When MO was compared to alum, alum gave a better removal but the preference is given to MO because it is cheaper and easily accessible. Moringa coagulum is locally produced therefore its use in water purification should be encouraged as this is likely to reduce the high cost of the current water treatment processes brought about by imported chemical coagulants.

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