



Preliminary Study on Combined Use of Moringa Seeds Extract and PAC for Water Treatment

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Abstract

Moringa oleifera has been proven as an active, safe and inexpensive alternative for conventional coagulants that can be widely used for the drinking water treatment. Experiments were carried out in completely randomized design for drinking water sampled from Yangpu river at Shanghai city to investigate the effect of Moringa extract and its combined use with Poly aluminum Chloride (PAC) on turbidity and TOC removal. A jar test apparatus was employed for the tests, with the optimum pH level maintained between the ranges of 7 to 7.5, and initial water turbidity of 61 NTU. The optimum dosages of PAC and Moringa were 30 mg/L and 300 mg/L respectively, while half dosage of each was employed for the combined use. The results of turbidity removal were found to be 96.1%, 68.6% and 95.7% to attain final turbidity of 2.4, 19.2 and 2.7 NTU for PAC, Moringa and their combination respectively. Whereas for TOC removal, various dosages of Moringa were applied at 0, 200, 300, 400, 500 and 600 mg/L and the results showed that concentration of TOC in water increased considerably with the increase in Moringa dosages, whereas the combination of Moringa and PAC minimized the negative effect of Moringa on TOC in water significantly.

Keywords: Moringa, coagulation-flocculation, turbidity, water treatment, TOC.

Introduction

Access to clean and healthy water is one of the biggest problems faced by many communities in some developing countries. Another more challenging issue is the relatively high cost of the chemical coagulants used for the water treatment and the health problems associated with the use of these chemicals.

In some developing countries such as Sudan, rural people are used to employ moringa seeds powder¹ to remove the turbidity, which is typically in the form of suspended organic and inorganic particles such as clays, microorganism, and other decomposed plant residues.

Research on natural coagulants has received attention from researchers worldwide primarily because of its abundant nature, low cost, multifunction behavior, availability, and environment friendly².

Moringa oleifera is one of the most studied natural coagulants and it has been investigated for its effectiveness on water treatments. It was proved that Moringa can be a viable total or partial replacement for the other chemical products used for water treatment; such as aluminum sulfate and iron chloride^{3,4}. Results of some researches evidenced that Moringa doesn't release toxic materials in the treated water⁵, bears antimicrobial properties against *S. typhii*, *V. cholerae* and *E. coli* and it could be a promising natural antimicrobial agent with potential application in controlling bacteria that cause water borne diseases⁶. And the most advantageous over chemical coagulants

is the stability of the pH during the coagulation and flocculation process. However, some researches⁷ pointed out that Moringa affects the concentration of TOC negatively in the water which might be one of the reasons that hinders the use of Moringa in large scale. Therefore, the aim of this research is to investigate the effect of Moringa extract and its combined use with poly aluminum chloride (PAC) on total organic carbon (TOC) and turbidity removal.

Material and Methods

Preparation of Moringa Solution: The dry *Moringa oleifera* seeds samples were obtained from Sudan. The outer two coats were removed manually, after selection of high quality seeds their respective kernels were grounded to fine powder. 1 gm of seeds' powder was weighed and mixed with 100 ml distilled water for 3 minutes. The solution was then stirred for 30 minutes using a magnetic stirrer, and finally filtered through fiberglass filter. Resulting stock solution was having approximate concentration of 1000mg/L (1%). Fresh stock solution was prepared every day for the experimental run in order to avoid ageing effects.

Preparation of PAC solution: The PAC solution was prepared by dissolving 1 g of PAC in distilled water until a volume of 100 ml was reached. 1 mL of this stock solution gives concentration of 10 mg/L when added to 1 L of water.

Experimental design: A Completely Randomized Design was used for this experiment. The treatments given were the varying

concentrations of Moringa extract for TOC, and PAC, Moringa seeds extract and the combination of both for turbidity. Each treatment was carried out in triplicates.

Jar Test Operations: A conventional jar test apparatus was used for this experiment to coagulate water samples collected from the Yangpu River at Shanghai. Series of experiments for determining turbidity removal by PAC, Moringa extract and their combination, effect of Moringa dosage on TOC, and final pH were conducted and repeated three times to confirm the obtained results.

All tests were carried out with 1 L sample in 1.5-L beakers. These beakers were filled with 1000 mL of water with identical turbidity level, and placed on each slot in a jar tester. Moringa extract stock solution which was prepared previously was added into beakers in either combination with PAC or in sole use for testing turbidity and TOC. The water samples were mixed homogeneously before the operation. All beakers were agitated at 150 rpm for 1 min, and then mixing speed was reduced to 40 rpm for 7.5 min and 20 rpm for 7.5 min. The pH level was kept with constant range at 7.0-7.5 by adding 0.1 HCl or 0.1 M NaOH in all coagulation tests. After sedimentation for 30 min, a sample of the treated water from the mid depth of the beaker was used for analysis.

Analytical Methods: Turbidity Measurement: Turbidity measurements were conducted using a Turbidity Meter instrument (Model-2100 P, HACH, USA). After the sedimentation phase, samples of turbidity measurements were collected from the upper depth of the water samples. Sample vial was washed with distilled water and then with the treated water before recording the turbidity. In order to eliminate any differences in turbidity due to different sedimentation times, two samples were taken according to the following order: 1-2-3-4-5-6-6-5-4-3-2-1, and the average value was recorded.

TOC Measurement: Shimadzu Total Organic Carbon Analyzer (TOC-VCSH, Japan) was used for TOC determination.

pH Measurement: The pH of water was measured by using a pH Meter (Model-sensION2, HACH, USA).

Data Analysis: Analysis of variance (ANOVA) was conducted to assess the significance among all treatments and their effectiveness. Multiple mean comparisons using least significant difference (LSD) were computed to ascertain where the differences existed. Analysis of data was computed by using SAS program 2006⁸.

Results and Discussion

Turbidity Removal: The coagulation activities of *M. oleifera*, and PAC and their combination were compared by using the jar tests apparatus; the formation of flocs and decrease in turbidity

indicate that the coagulation activity of Moringa seeds extract was sufficient for water treatment. Results indicated that the coagulation activity of moringa seeds extract is less significant than PAC at $P \leq 0.01$. However, the combined use of half dosage of each performed equally as PAC, with no significant difference at $P \leq 0.05$.

Other researches in the topic indicate that the efficiency of Moringa increases as the turbidity in the water increases, yielding comparable results to inorganic coagulants, such as PAC⁹. The initial turbidity of water used in this study was 61 NTU (table 1), which is considered relatively low; where, Moringa performed less effectively as shown in figure 1, and the efficiency was 68.6 % to attain the final turbidity 19.2 NTU, which is not acceptable according to WHO¹⁰. The chemical coagulant PAC and the combination of Moringa and PAC performed effectively and recoded an efficiency of 96.1% and 95.7% to attain final turbidity of 2.4 and 2.7 NTU respectively.

Table-1
 Characteristics of water

Parameter	Value
Turbidity	61 NTU
pH	7.4
Electrical conductivity (E.C)	529 μ S/cm
TOC	4.143 mg/l
Temperature	28.5 °C

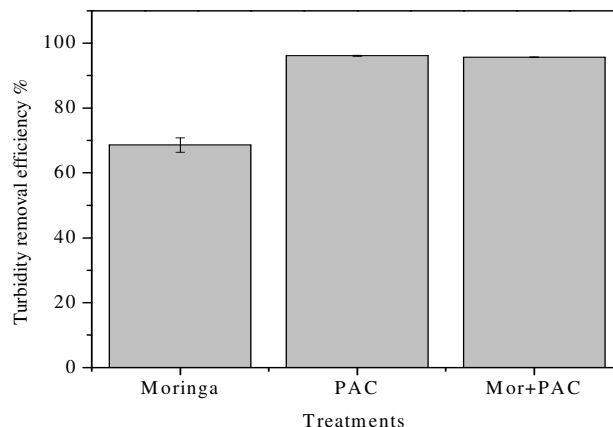


Figure-1
 Effect of Moringa, PAC and their combination on turbidity removal

Effect of Moringa on TOC: Different concentrations of Moringa extract 0, 200, 300, 400, 500, and 600 mg/L were added to water samples in the beakers of jar test apparatus. Samples of aliquot were taken after the completion of sedimentation time and analyzed for TOC. The results showed gradual increase in TOC concentration according to increase in Moringa extract dosages, figure-4, while the combined use of Moringa and PAC decreased the amount of TOC in the treated

water significantly, figure-5. This study is in line with¹¹ who found that increase in moringa dosage increased the concentration of TOC. In contrast¹², found that the application of 1 mg/L of moringa extract reduced TOC concentration in water samples containing 9 mg/L carbon as humic acid. The increase of TOC might be attributed to the presence of tiny particles of Moringa seeds which remained in the treated water, thus increased the TOC. This reason could be evidenced by the steady increase of TOC with increasing dosage of Moringa extract.

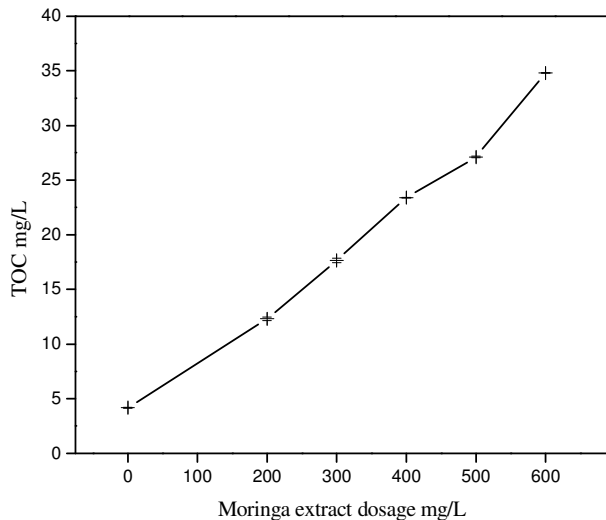


Figure-2
 Effect of various dosages of Moringa extract on TOC

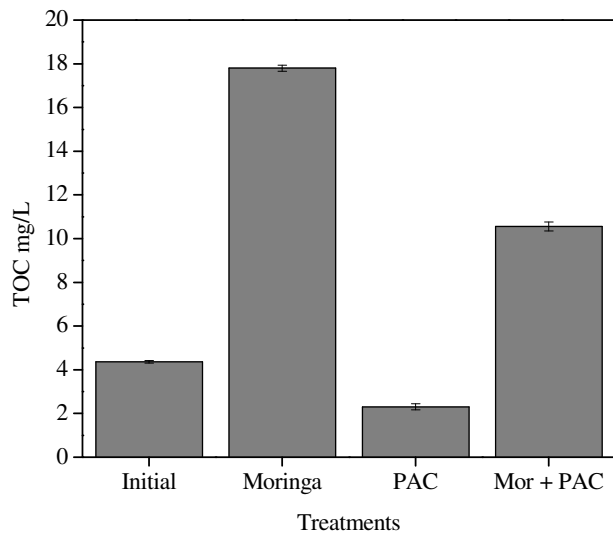


Figure-3
 Effect Moringa and PAC on TOC

Effect of different Moringa on the pH: The various concentrations of Moringa extract did not significantly affect the pH-value, whereas slight decrease was observed with increase of dosages examined. This result is in line with study conducted by¹³ in which *M. oleifera* use did not cause alteration in pH.

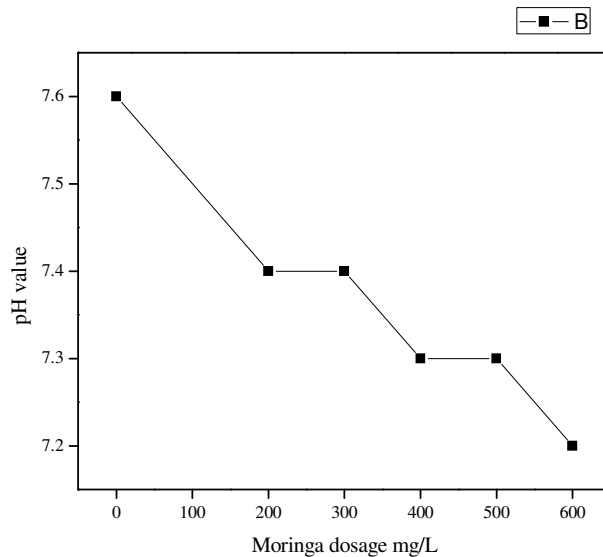


Figure-4
 Effect of various dosages of Moringa extract on the final Ph

Conclusion

The present study demonstrated the effectiveness of combined use of Moringa seeds extract with PAC in the turbidity removal from drinking water. The study proved that TOC increases with Moringa dosages increase which might hinder moringa use in large scale, while the combined use with PAC decreased the negative effect of TOC on water. Purification of active protein of moringa is recommended to avoid the adverse impact of moringa in water quality.

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