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RESEARCH ARTICLE

WEAKNESSES OF *Moringa oleifera* USE IN WATER TREATMENT

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ABSTRACT

Moringa oleifera is the most common natural water coagulant that concerned by many researchers. In this study coagulation-flocculation apparatus was employed, low turbidity water 32 NTU and Moringaseed extract were used to investigate the optimum dosage for turbidity removal, settling time, total organic carbon (TOC) and pathogen removal. Different concentrations 0, 200, 300, 400, 500 and 600 ml/L were applied. The results showed that, the removal efficiency increased with the concentration of the dosage, and the permissible limit according to WHO was achieved at 300ml/L. The optimum time for the settlement was 1 hour for different turbidity levels 29.6, 236 and 543 NTU. Total organic carbon increased steadily with the increase of the dosage and the final concentrations in the treated water were 12.43,17.51, 23.36, 27.05 and 34.78 ml/Lrespectively. A considerable amount of pathogens was removed.

INTRODUCTION

Water is the most vital resource to support all forms of life on earth. It will remain essential for mankind's survival and the future development of the world. Access to safe and clean drinking water free of contaminants is one of the main problems facing rural people in developing countries. Water treatment before use is another challenge, as the use of chemical coagulants requires exorbitant amounts of money, in addition to the health side effects associated with the use of these chemical materials. The use of organic materials such as Moringa oleifera [1], Bentonite clay [2], Rajma [3] and other materials locally available in many developing countries are becoming preferred alternative solution for the treatment of drinking water. Moringa is among organic materials that is being used for water purification by several communities in many developing countries. Moringa has been proven as an efficient natural coagulant for water treatment physically, chemically and biologically [4] and it could be a viable alternative to the chemical coagulants [5]. However, there are many limitations facing the use of Moringa in large scale such as release of organic matter, application of high dosage, lacking of completely pathogen removal and long time needed for settling after the coagulation-flocculation process. In this research, experiments have been carried out to confirm these limitations to have a better understanding regarding Moringa use in water purification.

MATERIALS AND METHODS

Preparation of synthetic turbid water

Synthetic turbid water for coagulation tests was prepared according to [2]. Different levels of turbidity were prepared by diluting the suspension of the stock solution using tap water just before the coagulation test.

Coagulant Preparation

The dry *Moringa oleifera* seeds were obtained from Sudan. The seed wings and coat were removed manually, good quality seeds were then selected, and the kernel was ground into a fine powder.1 gm of seed 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 a glass fiber filter. Fresh stock solution was prepared every day for the experimental run in order to avoid ageing effects.

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Experimental procedure

A conventional jar test apparatus was employed in the tests, with six 1.5-L square plexiglass jars. All tests were carried out with 1 L samples in 1.5-L beakers. These beakers were filled with 1000 ml of the synthetic turbid water with identical turbidity level, and placed in each slot in a jar tester. A Moringa stock solution which was prepared previously was added into each beaker at various dosages and agitated at 150 rpm for 1 min. The mixing speed was reduced to 40 rpm for 7.5 min and 20 rpm for 7.5 min. The coagulation pH was kept at 7.0-7.5 by adding 0.1 HCl and 0.1 M NaOH in all coagulation tests. After sedimentation for 30 min, an aliquot of 10 ml was sampled from the mid depth of the beaker and residual turbidity was determined.

Analytical Methods

Turbidity Measurement

Turbidity measurements were conducted using a turbidity meter (Model-2100 P, HACH, USA). After the sedimentation phase, samples for turbidity measurement were collected from upper depth. 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

Shuimadzu 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).

Microbial test

Sterilization

Petri dishes, reagent bottles and beakers were sterilized at 160oC for an hour in a hot oven box. Glass wares like bottles, test tubes and conical flasks were sterilized in the autoclave at 121oC for 15 minutes. Inoculating loops were sterilized by heating to red hot in a gas flame and cooled before use. Workbenches were sprayed with 70% ethyl alcohol and dried before use. All culture media were sterilized at recommended temperatures by autoclaving before use.

Preparation of solid isolation media

30 g of EMB was dissolved in 1L distilled water, swirled and sterilized by autoclaving for 15 minutes at 121oC. The prepared media were allowed to cool to about 45oC and 20 ml volumes of the liquid medium was poured aseptically into sterilized petri dishes and allowed to cool before inoculation.

Pour Plate Procedure

Serial dilutions of treated water using distilled and sterilized water were prepared . 0.1ml of each dilution was introduced into labeled sterile petri dishes. The plates were rotated gently many times clockwise and anticlockwise, allowed to set and incubated at 37oC for 24 hrs.

Counting

After 24 hours of incubation, bacterial colonies for each dilution were counted using an automatic colony counter. Counts were recorded as colony forming units (CFU/ml) and bacterial loads were determined by multiplying average counts by the dilution factor.

RESULTS AND DISCUSSION

Optimization of Moringa dosage

Low turbid water of 32 NTU was used for determining the optimum dosage. Five concentrations of Moringa extract were applied 200, 300, 400, 500, and 600 ml/L, the removal efficiencies obtained were 77.2, 85.6, 87.2, 89.4, and 90 % to attain final turbidity of 7.3, 4.6, 4.1, 3.4, and 3.2 NTU respectively Fig (1). Determination of the required dosage needed, depends on the water source, raw water quality, and types of suspended materials in the water. However, application of high Moringa seeds extract dosage has negative consequences, because minute particles of Moringa seeds pass through the filter and therefore increase the organic load in the treated water.

Table 1. characteristics of synthetic turbid water

Parameter	Value
Turbidity	32 NTU
pH	7.3
Temperature	28.7°C
E.C	367 µ Scm^{-1}
TOC	4.143 $mg.L^{-1}$

Time settling

It was observed that after 30 minutes of the sedimentation time, the treated water still had high amounts of suspended flocs which indicated that flocs formed were either too small or not dense enough to settle within the 30 minutes chosen for sedimentation. Therefore, extension time for sedimentation to achieve a turbidity level within the permissible limit of WHO (<5NTU) was investigated and shown on Figure (2). The values of turbidity for low, medium and high turbid water after an initial settling time of 1 hour were 13.3, 13.8, and 12.9 NTU from an initial raw water values of 29.6, 236, and 543 NTU respectively. These values of residual turbidity represent turbidity reduction efficiency of 53.4, 94.1, and 97.6 % for low, medium and high turbid water respectively. It is observed that moringa is more efficient in high turbid water than the low one. When the time was extended to five hours the residual turbidity values were decreased to 10.6, 9.6 and 8.7 NTU for low medium and high turbid water respectively.

Total organic carbon (TOC)

Moringa dosages applied for examining its effect on TOC as it is shown in Fig (3) are 200, 300, 400, 500, and 600 ml/L. The initial concentration of TOC in the water was 4.143 mg/L, the results obtained are 12.43, 17.51, 23.36, 27.05, and 34.78 respectively. This steady increase of TOC according to dosage increases, proves that; after the coagulation process, some of the organic matter and very minute particles of Moringa Seeds remained in the treated water as dispersion colloidal particles thus increased its TOC. The presence of this organic matter can cause a problem of colour, taste, odor and facilitates the development of the microorganisms. This study is in line with [6, 7, 8]

Microbial test

The result showed that extract seeds of *Moringa oleifera* demonstrated significant growth inhibition on a Total Coliform (TC). More than 80 % of Coliform were removed. Other bacterial growths which were not identified to which bacterial group it's belong were also observed on the media of TC. Moringa seed extract produced a better microbes reduction and it is efficient in microbial disinfection, however there was still some bacterial colonies remaining in the treated water, which will cause a secondary bacterial increase if the water stored for one day or more. This result is in line with [9, 10]

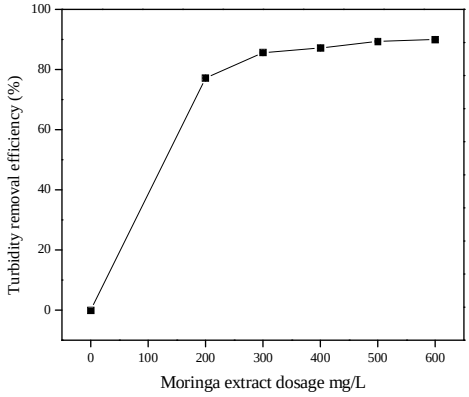

Fig.1. Determination of optimum Moringa dosage on turbidity removal

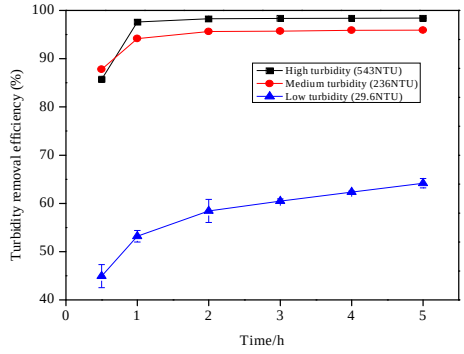

Fig.2. Determination of time settlement for different turbidity levels

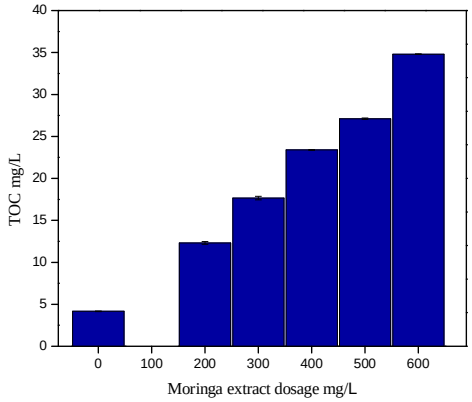

Fig.3. Effect of different Moringa dosages on total organic carbon (TOC)

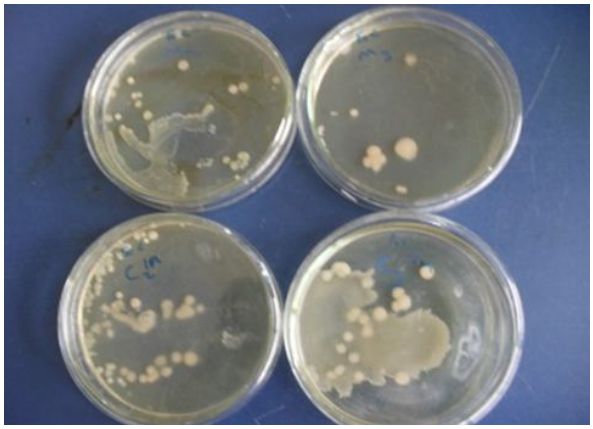

Fig.4. Effect of Moringa on pathogen removal (the above two dishes show the pathogen colonies after treatment)

Conclusion

Many research studies have evidenced the effectiveness of *Moringa oleifera* on water treatment. However, this study proved that Moringa has some weaknesses which could hinder the use of Moringa in large scale, these weaknesses include: application of high dosage which results in the increase of the concentration of total organic carbon (TOC) in the water. Sedimentation time is relatively long comparing to chemical coagulants and as a consequence the water production rate will be decreased. Bacterial removal efficiency is not complete, therefore, a risk of secondary bacterial growth is possible to happen if water kept for long time.

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