Plant Archives Vol. 21, Supplement 1, 2021 pp. 318-323 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
doi link : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.S1.050

COMPARISON BETWEEN TREATMENT OF RIVER NILE WATER WITH ALUMINUM SULPHATE AND AQUEOUS *MORINGA OLEIFERA* SEED EXTRACT

Doaa El-Sayed Mohammed[1], Hanan Sayed Mahmoud[2], Hamada Mohammed Mahmoud[2,3], Osama Mohammed Ahmed[4], Hanaa Ibrahim Fahim[4*] and Heba Younes Ahmed[5]

[1]Potable Water and Sanitation Company, Beni-Suef, Egypt
[2] Zoology Department, Faculty of Science, Beni-Suef University, Beni-Suef, Egypt
[3]Biology Department, School of Sciences and Engineering, American University, Cairo, Egypt
[4]Physiology Division, Zoology Department, Faculty of Science, Beni-Suef University, Beni-Suef, Egypt
[5]Rodents Division, Department of Harmful Animals, Plant Protection Research Institute, Agriculture Research Center, Egypt
Corresponding author: Hanaa Ibrahim Fahim
E-mail address: hanaa_fahim@yahoo.com

ABSTRACT

Aluminum sulphate (alum) is widely used water coagulant. The conventional methods used in water purification raises a lot of concerns over its environmental safety. So, this study aims to embrace new approaches for drinking water treatment. The use of environmental coagulants of plant origin is a conservational, significant potential and low cost method for water treatment. The competence of *Moringa oleifera* seed extract as a coagulant for conjugal water purification was investigated using the Jar Test and compared with alum as a control. Assessment of physicochemical and biological parameters was done for both raw and treated water. Consensuses of this study render that concentration of ammonia increased in the most purified water treated with *Moringa* extract. Turbidity, chlorides, iron, manganese, total algae count and total coliform were decreased in most concentrations. These findings suggested that *Moringa* can be used as a biocoagulant for water treatment. While, it is favorable instead of using the seed powders for water clarification; one could use only the driven water soluble proteins that extracted from the *Moringa* seeds. These proteins are more resourceful in ammonia and nitrates exclusion which increased in the water samples treated with *Moringa* seeds.

***Keywords*:** Water purification, Aluminum sulphate, Traditional coagulant, *Moringa* seeds, Biocoagulant.

Introduction

Today, saving vigorous and highly purified drinking water is a main demanding concern around the world. Traditional methods such as chemical coagulation, flocculation, sedimentation, filtration and disinfection are presently used to increase water excellence. Recently, a lot of concerns raised around the danger of chemicals utilization in water treatment.

Aluminum sulphate (alum) is the most common used water coagulant; its overdosed usage in a water treatment process may lead to an increased concentration of aluminum in drinking water. The residual aluminum increases the water turbidity and may have some negative health impacts on consumers (WHO, 2008). Several researches showed that the possibility of an association between aluminum and neuropathological diseases including pre-senile dementia and Alzheimer's disease (Magaji *et al*., 2015). In addition to other effects, it generates acidic water which is unsafe for pregnant women and causes predementia in some people (Yongabi *et al*., 2012).

Chlorine based disinfectants have been reported to have the potential of forming carcinogenic and mutagenic disinfectant byproducts such as tetrachloromethane which produces hormonal analogue that interferes with male fertility. Disinfectant byproducts have also been reported to be associated with cardiovascular disease, cancer and birth defects (Bichi *et al*., 2012).

Also, the emergence of chlorine resistant strains of organisms such as *Cryptosporidium* oocysts, *Salmonella* species, *Entamoeba* cysts, *Mycobacterium* species, *Escherichia coli* and *Helicobacter pylori* have also been reported (Yongabi *et al*., 2011).

The previous restrictions make it necessary to introduce safe drinking water purification methods. Treatment with environmental coagulants of plant origin was used for years in developing countries; it is effortless, effective and money-spinning method (Ida, 2013).

The use of extracts from plant type is processing both coagulating and antimicrobial properties (Dalen *et al*., 2009). The seeds of *Moringa oleifera* (*M. oleifera)* (drumstick plant) have been establish to be one of the most effective tools for water purification. The seeds proceed as a flocculent that magnetize and aggregate particles detained in water suspension, which then precipitate out of the water flakes, leaving clearing water. *M. Oleifera* seeds also have the potentials to remove a wide range of gram-positive and gram-negative bacteria, algae, organic pollutants and pesticides from tainted water and may produce less sludge than chemical coagulants (Akhtar *et al*., 2007; Suarez *et al*., 2005).

So this study is designed to evaluate the efficiency of seeds extract of *M. oleifera* for water treatment. Proximate analysis and jar test were carried out, to evaluate the characteristics of the seeds and its coagulant activity in promotion of selected water quality parameters (physicochemical, major anions and cations, metals, and biological parameters) in comparison of alum.

Material and Methods

Preparation of *Moringa oleifera* seed solutions

Dried seeds of *M. oleifera* were brought from Agriculture Research Center in Beni-suef. The shell surrounding the seed kernels was removed manually and the kernels were crushed using mortar and pestle into a fine powder (Kardam *et al*., 2010). 1 gm of seed powder was mixed with 100 ml tap water for 3 minutes. The solution was then stirred for 10 minutes, settled for 48 hours and finally filtered with Whatman No.1 filter paper. Concentration of resulting stock solution was approximate 1000 mg/l (1%). Stock solutions with concentration of 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9% and 10% were prepared by following the previous step. The aluminum sulphate (alum) stock solution was prepared by mixing 10 gm alum powder with 100 ml tap water. Fresh stock solutions were prepared every day for the experimental run in order to avoid ageing effects.

Determination of optimum dosage using jar test machine

Water sample (raw water) was fetched from River Nile and dispensed into 5 beakers labeled A, B, C, D and E. The volume of each sample was 1000 ml. A series of doses (2, 4, 6, 8 and 10 ml) were taken from 10% alum stock prepared previously and injected into the raw water.

The jar test was used to determine the optimum dose. The solutions were flash mixed for 0.5 minute at a speed of 300 rpm, followed slow mixing at 35 rpm for 20 minutes. The suspensions were subdivided into two groups, the first one was left to stand without disturbance for 20 minutes and the other was left without disturbance for 1 hour. The transparent medium from each group of the most optimally purified water was filtered by Whatman number1 filter paper, and then transferred into a polyethylene container for further analysis. The same procedures were carried out to different *M. oleifera* seed stocks.

Determination of water quality Parameters:

- **Physicochemical Parameters :** A number of physicochemical parameters of the stream water samples were determined before and after treatment with *M. oleifera* seed solution and alum solution. The parameters included turbidity, temperature, pH, electric conductivity, total dissolved solids, total alkalinity, total hardness, calcium hardness, magnesium hardness, chlorides, sulphate, ammonia, nitrate, nitrite, calcium, magnesium, iron, mangenese, floride, sodium, and botassium. Turbidity was determined by Nephelometric method using HACH 2100P turbidimeter; pH was detected by pH meter (Orion model 420A); temperature, electric conductivityand total dissolved solids were determined using conductivity meter Jenway model 4320. Alkalinity, total hardness, calcium hardness, magnesium hardness, and chlorides were measured using potentiometric titration. Sulphate, ammonia, nitrate, nitrite, calcium, magnesium, iron, mangenese, floride, sodium, and botassium were measured using spectrophotometer. All analyses were in accordance with World Health Organization (American Public Health Association, 2005).
- **Biological parameter :** The most probable number of coliforms which present in each of the untreated and treated water samples was determined by using American Public Health Association standard method and 10200-Fstandard method for algal count.

Results

Physicochemical parameters

Figure 1 shows that, treatment with different concentrations of *Moringa Oleifera* seed extracts (MOSE) declared a positive effect on turbidity, pH, total alkalinity, and calcium hardness; MOSE with 7% concentration was the most effective. Meanwhile MOSE shows a negative effect on temperature, Electric conductivity, total dissolved solids and total hardness and magnesium hardness.

Treatments with different MOSE (1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9% and 10%) as well as treatment with 10% alum solution as control show reduction in turbidity. The percent of removal for samples treated with MOSE ranged between 89.54% and 95.94%.The maximum removal percentage is recorded for 7% (95.94%) MOSE and 10 % (89.54%) is the worst. While that treated with10% alum is 95.06%, (Fig. 1a).

Temperature decrease is noticed for samples treated with both different stocks of MOSE and alum. The percent removal values for MOSE fluctuate between 1.61% and 15.9%. The maximum value is recorded for alum (30.08%) while the minimum one recorded for 10% MOSE (1.61%). The alkalinity of samples treated with MOSE increased until 5% stock by average (2.88%), while decreased at higher stocks by average (8.66%); but it reduced after the treatment with alum by (7.25%).

The values of the calcium hardness after treatment with MOSE decreased by (9.3%) at the 1%, 2% and 3% stocks, while it is increased by average (3%) at the rest stocks. Moreover, the addition of alum to the raw water slightly increases the calcium hardness by (8%).There is not remarkable change in pH values for both MOSE as well as alum (Fig.1b, f& h).

Electric conductivity, total dissolved solids and total hardness show slight increase for both MOSE and alum. The average percentage for MOSE are (3.8%), (3.9%) and (5%) respectively, while the alum recorded (23%), (23%) and (22%) respectively. Magnesium hardness also increased by (64%) for alum followed by 1% Moringa stock solution (44%) Fig.1 d, e & i.

Major anions and cations parameters

It is clearly seen that high concentrations of MOSE are more efficient in chlorides removal when compared to alum. Treatment with both MOSE and alum increase sulphate, Calcium, magnesium, sodium, potassium and floride levels. That increase is more affected by most of MOSE concentrations in sulphate, magnesium, potassium and floride than alum. Moreover, it is observed that high concentrations of MOSE add disadvantage of rising ammonia levels, it gives a higher level at 8%.

Figure 2 shows increase in the sulphate level of raw water samples treated with MOSE by average of 72.46%, maximum level of sulphate increase is recorded at 5% stock solution by 258.5%.While that treated with10% alum stock solution is recorded an increase by 63.62%. Calcium, magnesium, sodium, potassium and floride showed an increase for both samples treated with MOSE as well as samples treated with alum. The average percentages for samples treated with MOSE are with an average 15%, 19%, 18%, 25% and 37% respectively. While the percentages are 90.08%, 12.42%, 135.64%, 21.58% and 29% for samples treated with alum respectively. It must be mentioned here that the nitrate/nitrite and the ammonia levels of the water samples treated with seed extract show an increase by average 56%, 32% and 596% respectively compared to the levels in the original water samples. Meanwhile, the percentage of removal for alum is 100%. Both treatments with alum and seed extract reduce the chlorides levels. However, moringa seeds showed higher percentage of chlorides removal at high concentrations compared to the alum. Removal percentage for alum is 72.5% and the average for seed extract is 66.3%, the maximum at 7% (86.92%).

Metals parameters

Treatment with different concentrations of MOSE shows higher efficiency on Fe removal when compared to alum, 5% is the most effective stock. Seed extract reduce Fe by an average percentage of 91%, while alum increases Fe by percentage 36%. On the opposite, alum is more effective than MOSE in manganese removal. The average percentage of removal of manganese by moringa is 83% with a maximum level at 1%, while the removal percentage for alum was 99.78% Figure 3.

Bacteriological characters and suspended algae

Figure4 shows that the percent of removal bacteria in case of treatment with moringa equals 98.4%,while alum induces a high percent of removal at 97.08%; moringa more efficient than alum. Also, total algae count is reduced by average 98.68% in case of treatment with MOSE and 98.46% in case of treatment with alum.

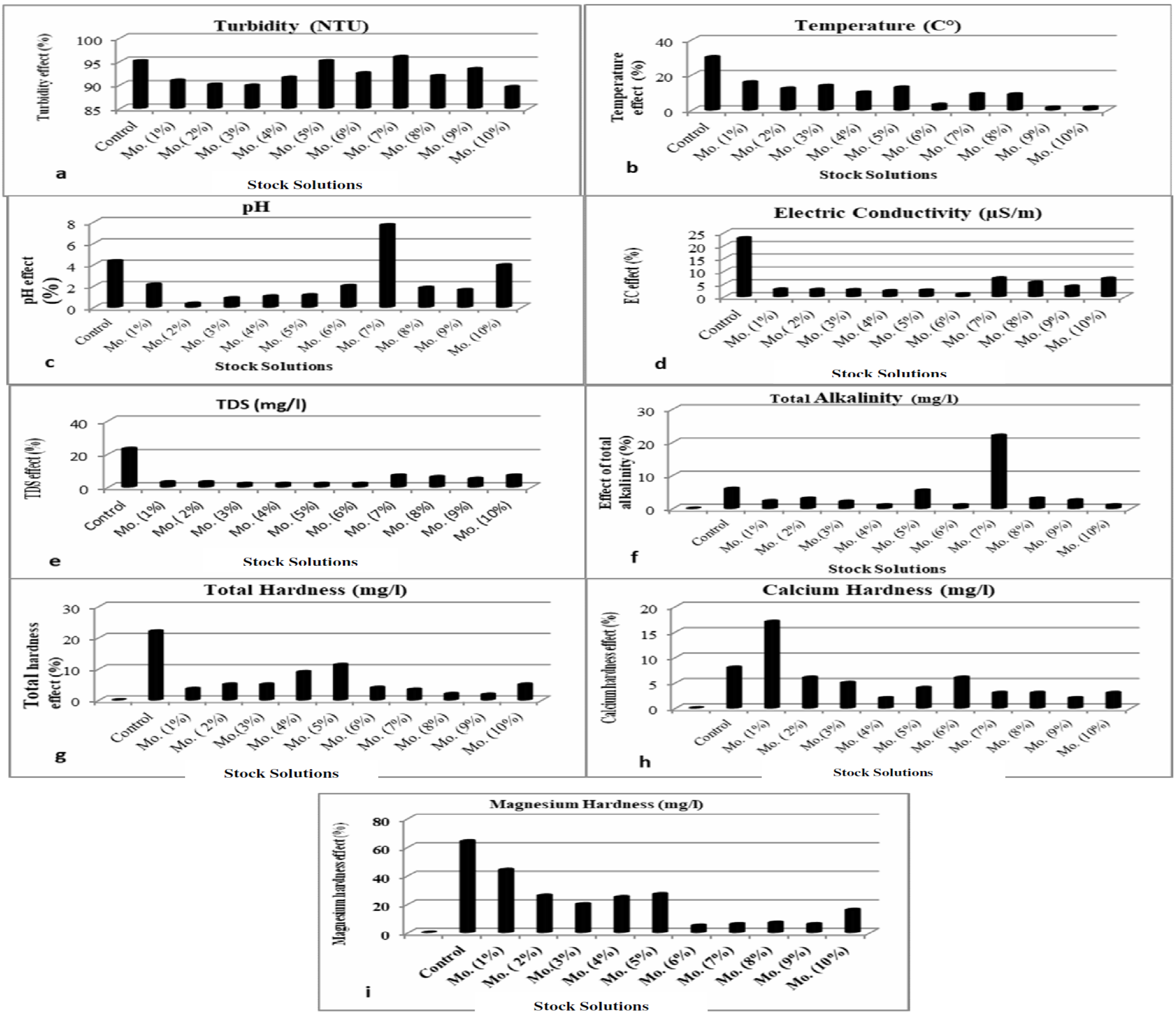

Fig. 1 : Comparison between effect of alum as control and effect of different ***Moringa oleifera*** concentration stocks on physicochemical parameters with percentage.

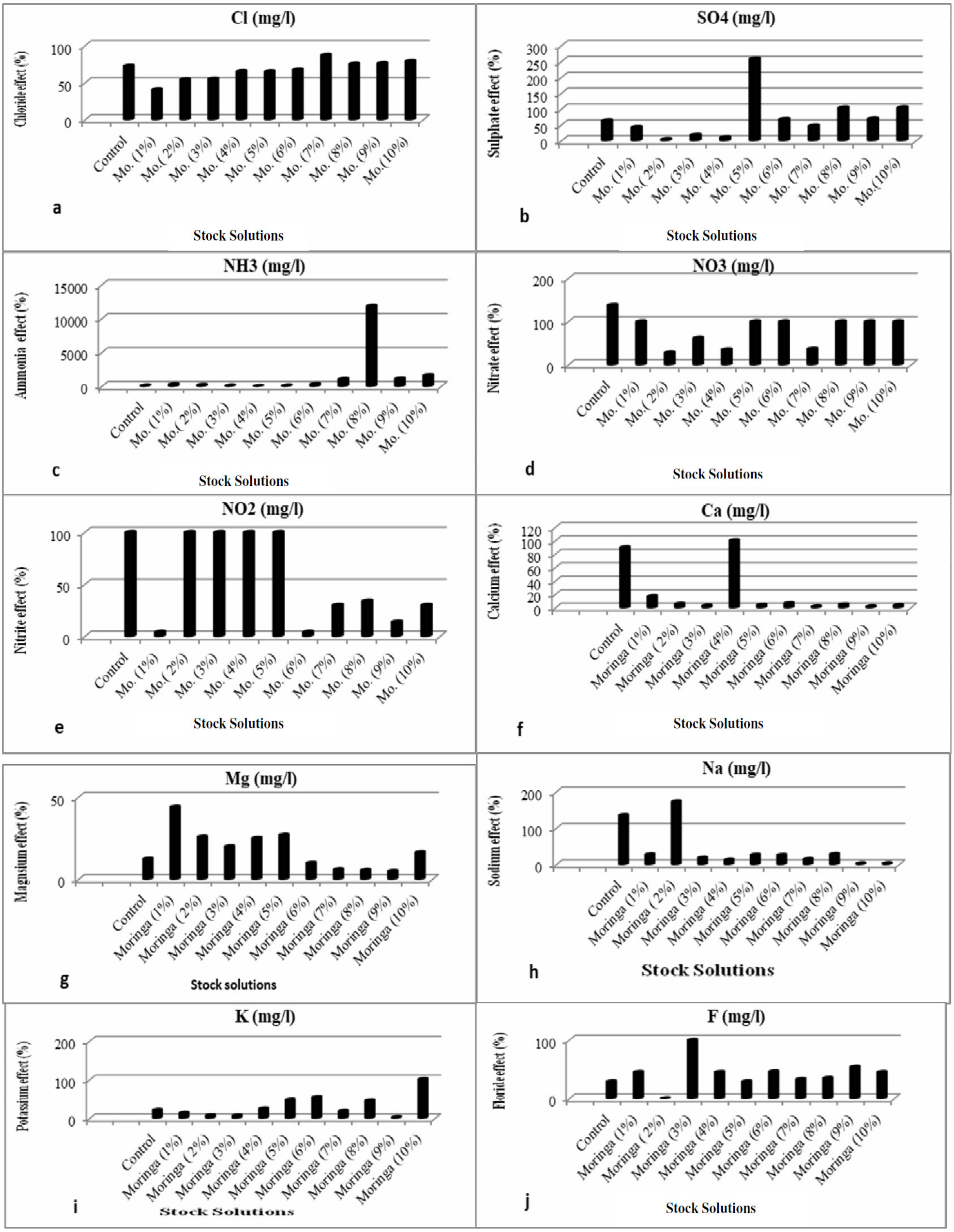

Fig. 2 : Comparison between effect of alum as control and effect of different ***Moringa oleifera*** concentration stocks on major anions and cations parameters with percentage

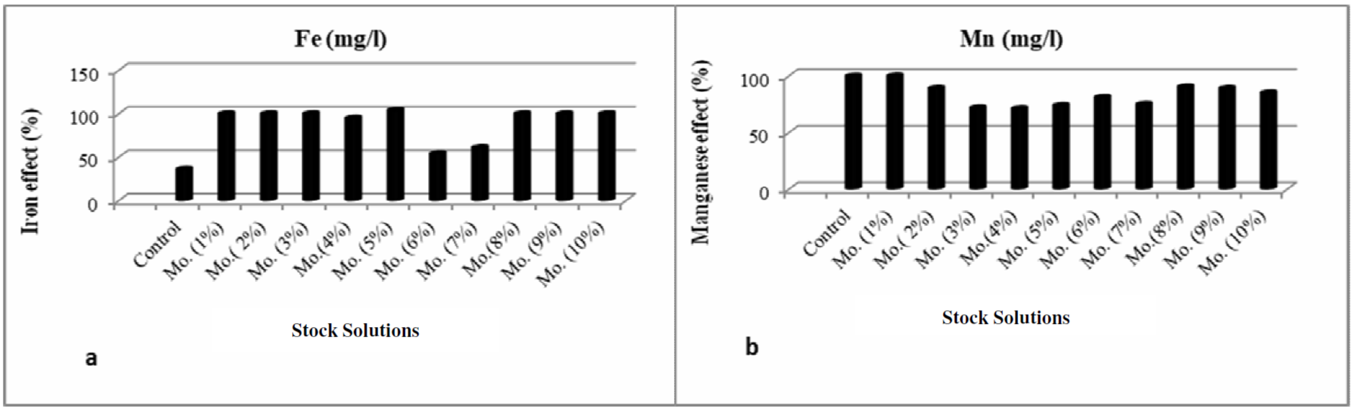

Fig. 3 : Comparison between effect of alum as control and effect of different *Moringa oleifera* concentration stocks on metals with percentage.

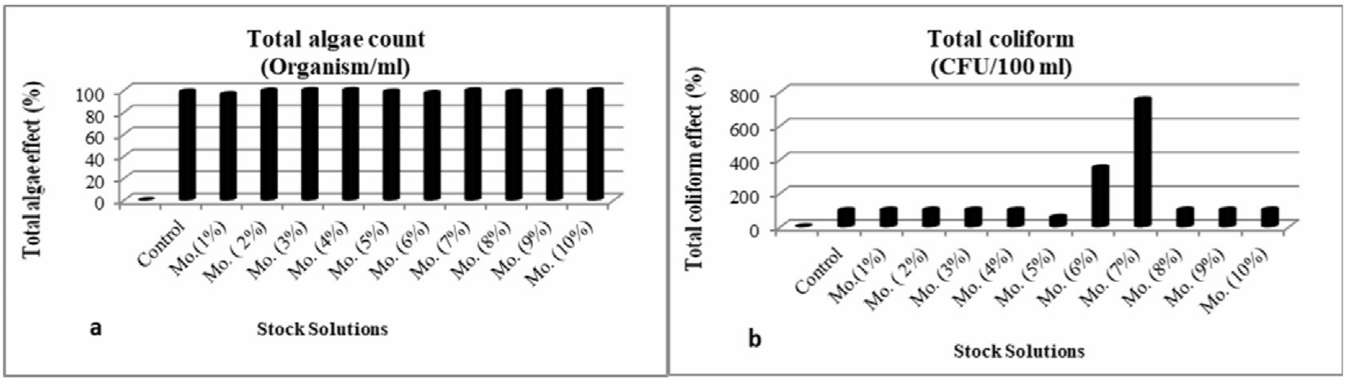

Fig. 4 : Comparison between effect of alum as control and effect of different *Moringa oleifera* concentration stocks on bacteriological characters and suspended algae with percentage.

Discussion

In this study, the effect of alum and MOSE showed a lot of potential in terms of water treatment especially with respect to bacteriological and physico–chemical quality. Turbidity reduction is one of the major noticeable features in this research work (Babu and Chaudhuri, 2005). The decrease in turbidity in samples treated with *M. oleifera* might be correlated to the deed of *M. oleifera* as a coagulant. The mechanism of coagulation with the seeds of *M. oleifera* consists of adsorption and neutralization of the colloidal positive charges that attract the negatively charged impurities in water. At pH below 10, the *Moringa* seed proteins are positively charged and thus the seeds when added to water samples bind to the negatively charged particles (if any) in the samples (Ndabigengesere and Narasiah, 1998a).

Treatment with MOSE did not show improvement in pH, conductivity, total dissolved solids, alkalinity and hardness with the addition of seed concentrate (Schwarz, 2000). Chlorides initially were from 15-19 mg/l in the river water sample, but often treatment with *Moringa* seed reduced it three fold. It is because cations from *Moringa s*eed attract the negatively charged chloride ions present in water and neutralize the chlorides. The nitrate/nitrite and the ammonia levels in the water samples collected from the three regions were comparatively low and well underneath the World Health Organization permitted levels and thus did not pose any threat to the drinking water tested. It must be mentioned here that these nutrients of the treated water samples showed an increase when compared to the levels in the original water samples. This is not surprising considering the fact that the treatment of water samples by the addition of seeds would inevitably add the seeds' natural ammonia and nitrate/nitrite to the water samples as leachates. Consistent with the literature, orthophosphate levels in water, during treatment increase with the *Moringa* dose and also slight increases were noted in the total nitrates and nitrites after treatment-using *Moringa* extracts (Ndabigengesere and Narasiah, 1998b)

Total coliform and algae counts were drastically decreased with the addition of *World Health Organization*. The coagulant properties of the seed are due to a series of low molecular weight cationic proteins (Tauscher, 1994). The seed kernels of *M. oleifera* contain significant quantities of low molecular weight (water soluble) proteins which carry a positive change when the crushed seeds are added to raw water. The proteins produce positive changes acting as magnets and attracting the predominantly negatively charged particles (such as clay, silk, bacteria, algae and other toxic particles in water).The flocculation process occurs when the proteins bind the negative change forming flocks through the aggregation of particles which are present in water. These flocks are easy to remove by settling or filtration. This could be responsible for the considerable reduction in bacterial concentration with the addition of seed suspension. As observed, bacterial diminution in this study could also be associated to utilize of *M. oleifera* seed powder as primary coagulant for water treatment. *M. oleifera* seed contains antibacterial agent, 4 – (alpha – L – rhamnosyloxy) benzyl isothiocynate, aglycosidic mustard oil (Eilert *et al*., 1981). This antibacterial agent could be responsible for the elimination of some of the bacteria found in the raw water for this study. *Moringa* seeds removed the heavy metals tested (iron and manganese); the adsorption of metals using

Moringa seeds is considered to be due to the surface charge on the sorbents.

Conclusion

The paper tested the effectiveness of *M. oleifera* seeds in purifying drinking water, and comparing these results with those obtained by using the alum. *M. oleifera* seeds acts as a natural coagulant, it would be possible to develop an economical and an environmentally safe method of water purification. It also acts as a natural antimicrobial active against the micro-organisms which is present in the drinking water and decrease the number of bacteria. *Moringa* seeds show a higher efficiency than alum in chlorides and iron removal. It increases sulphate, calcium, magnesium, sodium, potassium and floride levels, and shows similar results with alum in temperature, pH, electric conductivity, total dissolved solids, total alkalinity, total hardness, calcium and magnesium hardness. The nitrate/nitrite and ammonia levels in the water samples collected from the River Nile was relatively low and well below the World Health Organization permitted levels and thus did not pose any threat to the drinking water tested. It must be mentioned here that the nitrate/nitrite and ammonia levels of the water samples tested showed a slight increase in the levels of these nutrients compared to the levels in the original water samples. This is not surprising considering the fact that the treatment of water samples by the addition of seeds would inevitably add the seeds' natural ammonia and nitrate/nitrite to the water samples as leachates. The use of local *Moringa* seeds as primary coagulants for clarification of turbidwaters is useful. More research work needs to be done to improve removal efficiency of ammonia and nitrates.

Acknowledgement

The authors are grateful to the University of Beni-Suef, Zoology department, for providing instruments and support.

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