Scholars Journal of Agriculture and Veterinary Sciences **e-ISSN 2348–1854**
Sch J Agric Vet Sci 2014; 1(4B):279-287 **p-ISSN 2348–8883**

An International Publisher for Academic and Scientific Resources) DOI: 10.36347/sjavs.2014.v01i04.025

Antimicrobial and Coagulant Property of *Moringa Oleifera* Seed in Water Purification

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Abstract: The study was designed to evaluate the activity of *Moringa oleifera* in microbiological water purification. Microbes are injurious to the health of man and animal when consuming contaminated water. The moringa seed were extracted using ethanol as solvent and pure culture of *Escherichia coli, Salmonella* spp., *Pseudomonas aeruginosa, Proteus mirabili, Streptococcus faecalis, Staphylococcus aureus* was used to determine the seed antimicrobial activity which was compared with the antimicrobial property of a standard known drug Ciprofloxacin termed the control. The total mesophilic bacterial count, total mesophilic fungal count, most probable number and physicochemical properties of the water sample which was gotten from Umuariaga Village in Abia State, Nigeria was determined prior to treatement and after treatment with *Moringa oleifera*. Result obtained from this study revealed *Moringa oleifera* possessed strong antibacterial activity and improved physicochemical properties of the water sample as thee seeds possessed flocculation properties. Chemical water treatment agents such as metal salts, synthetic polymers and chlorine formulations are deemed unfavourable on human health while *Moringa oleifera* seeds acts as a natural coagulant, flocculent, absorbent for the treatment of drinking water with no toxic effect on human health.
Keywords: Moringa oleifera, Water, Microorganism, Ciprofloxacin, Coliform, Agar

INTRODUCTION

Water is used for several purposes by humans but the level of purity of the water consumed is very crucial since it has a direct effect on health. Surface and ground water is polluted from agriculture, domestic and industrial activities. The quality and accessibility of drinking water are of permanent importance to human health. Drinking water may contain disease-causing agents and toxic chemicals and to control the risks to public health, systematic water quality monitoring and surveillance are required. When surface water is used for drinking water production, turbidity removal is an essential part of the treatment process. It is generally achieved using coagulation with metal salts followed by aggregation of particles through sedimentation and filtration. The conventional method of water purification using aluminum sulphate (alum) and calcium hypochlorite adds thousands of chemicals in drinking water supplies around the world and are considered potentially hazardous to human health at relatively high concentrations [1].

Most of the chemicals used in water purification and production are imported thereby making it expensive and beyond the reach of most people in the rural areas. Hence, they resort to sources such as clams, dug outs, streams, rivers and lakes. Water from these sources is usually turbid and contaminated with micro-organisms that cause many diseases including guinea worm and bilharzias. Water-borne diseases are one of the main problems in developing countries, about 1.6million people are compelled to use contaminated water and more than a million people (of which two million are children) die from diarrhea each year. Water borne diseases still remain one of the major causes of human morbidity and mortality in developing countries especially in the rural areas, where there is inadequate or no pipe-borne water supply. The possibility of use of plants that are inexpensive and easily available such as *Moringa oleifera* "Zogale" to remove turbidity, colour and reduce the microbial load in raw water, a function played by chemicals such as alum, will provide a cheap source of portable drinking water [2].

Bacterial and fungal infections are wide spread throughout the world. The situation is more critical especially in developing countries were in most cases lack of adequate sanitation and primary health care programs make it difficult and expensive to combat diseases, this has encouraged scientists to screen higher plants for various biological activities including antibacterial and antifungal effects [3-5]. About 40% of pharmaceuticals are derived from natural sources (plant,

animals, bacteria and fungi). Moreover several natural products obtained from medical plants lead to the development of various pharmaceuticals and analogues or derivatives. Recently, focus on plant research has increased and a large body of evidence has been collected to show immense potential medical plants used in various traditional system [6]. *Moringa oleifera* (vernacular name Alruway "the tree for purifying", family (*Moringaceae)* is a topical tree with a capsulated and dehiscent fruit [7]. Report has been made on the finding of the antibiotic principle of *Moringa oleifera* seed through their purification, elucidation and antimicrobial properties and also on its antibiotic substance [8].

Plate 1: Dehuled Moringa Seeds

Plate 2: Moringa Seeds with it Shell

MATERIALS AND METHOD

Plant Material

The seeds of *Moringa oleifera* plant were bought from the market (Wuse Market in Abuja). The seeds were identified and confirmed at the Botany Department of Michael Okpara University of Agriculture, Umudike, by Dr. Omosun Garuba, as *Moringa oleifera* (syn . *M. Pterygosperma* gaertu)

Preparation of Material

The Moringa seeds were de-shelled and air dried at a room temperature (23-25^{o}C) for five days before grinding. The white kernel was grinded into powdered form using mortar and pestle and stored in a sterile bottle.

Plant Extraction

Maceration method was used to get the extract using ethanol as solvents. 50g of powdered seeds separately extracted in 500ml conical flasks with 60ml of ethanol. This was done in duplicate. The conical flasks were covered with foil to avoid contamination and evaporation of the ethanol. The conical flasks was shaken for 30mins and allowed to stand at room temperature for about 3 days with occasional manual agitation of the flask, using a sterile glass rod every 2 hours. The extracts were separately filtered using sterile Whatman No. 9 filter paper. The resulting filtrates concentrated with 100ml of ethanol for evaporation to dryness so as to eliminate the excess solvent in a water bath.

Microorganisms

Pure culture of microorganisms used for the evaluation of the antimicrobial potential of the seeds ethanol extracts includes (*Eschrichia* spp, *Salmonella* spp, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Proteus mirabilis* and *Streptococcuss* spp).

Antimicrobial Activity Assay

Antimicrobial activity of the ethanol extracts of the seeds was assayed using the paper disc diffusion method[9-10]. The concentrated seed extracts were dissolved in 51% dimthyl sulpoxide (DMSO) and sterile discs (6mm, Hi-media, India) were each impregnated with 1000µl of 1000mg/m1 of each extract with different concentration (1000mg of extract 500mg of ciprofloxacin). The disc was carefully and firmly placed on the Muller Hiaton Agar (MHA) plates earlier seeded with standardized bacterial suspensions (approximately 1.5 x 106 cfu/ml). Paper discs impregnated with 500µl of a solution of 500mg/1 of the standard antibiotics; ciprofloxacin was used as control for comparison. Filter paper discs dipped into sterile distilled water and allowed to dry were used as control. The plates were then incubated at 37^{o}C for 2hrs. Anti-bacterial activity was determined by measurement of diameter of zone of inhibition around each paper disc in (mm).

Determination of Minimum Inhibitory Concentration (M1C)

The minimum inhibitory concentration (MIC) of the ethanolic extract of the powdered seed extracts was determined as described by [11]. Two fold serial dilutions of the plant extracts, were prepared, from

which 2mls aliquots was taken and added to 18ml of pre sterilized molten nutrient agar at a temperature of 40^{O}c. the media were then poured into sterile petri dishes and allowed to solidify, the surfaces of the media were allowed to dry before streaking with 18hrs old cultures of the test bacterium. The plates were later incubated in an incubator at 37^{o}C for up to 72h after which they were examined for the presence or absence of growth. The MIC was taken as the lowest concentration that prevented bacterial growth.

Water Purification Activity
Collection of Water Sample

Raw water samples were collected from Umuaraga river in a sterile, screw cap bottles and transported to the laboratory immediately the pH and temperature were taken at collection and then after the experiment.

Preparation of *Moringa oleifera*
Seed Solution and Water Treatment

Different concentrations of Moringa seed solutions were made by dissolving lg, 3g, and 5g of the Moringa seed powder weighed on a triple beam balance into a 100mls of distilled water each contained in a conical flask to obtain 1%, 3% and 5% concentration of the solution respectively. The solution was shaken properly for 1 minute to extract and activate the coagulant and antimicrobial proteins in the seed powder. It is important to know that 5 Moringa dried seeds make up 1g of the seed powder. Each of the concentrations was poured into one liter of the raw water contained in a beaker (2 liter capacity) and the water stirred for 60 seconds and then slowly for 2 minutes. The treated water was then allowed to stand undisturbed for 6 hours. After which 100mls was collected from the top of the water and subjected to post treatment analysis [12-13].

Microbial Analysis of the Water Sample

The microbial analysis of the water sample was performed to determine the microbial quality of the water sample. This analysis was carried out before and after treatment of the water sample with M. *oleifera* seed solution already prepared. The tests include; the total viable count and the estimation of most probable number (MPN) of faecal coliform bacterial. The total viable count includes: the total mesophilic spp. bacterial count and the total mesophilic fungal count.

Total Mesophilic Bacterial Count

A 10 fold serial dilution of water sample was carried out. 9ml of sterile (the diluents) was placed into 5 different test-tubes each arranged in a rack. The water sample was then shaked to mix and 1ml was taking using a sterile 2ml syringe and then added into the first test tube in the rack and shaken properly to mix. 1ml of the water was then taken from the first test tube and mixed. This process was repeated for 5-test tubes. 0.1ml aliquot of the 1 to 3rd dilution was plated in an already solidified nutrient agar. The water sample was spread evenly in the surface of the agar using a sterile hockey stick. The inoculated media was then allowed to dry and then incubated at 37^{o}C for 24 hours. After the incubation period, the number of colony growths on the agar was counted and recorded as colony forming unit per ml

$$(\text{cfu/ml}) = \frac{\text{No of colonies}}{\text{Volume plated}} \times \text{dilution factor}$$

Total Mesophilic Fungal Count

10-fold serial dilution of the water sample was carried out using the method already described above. Them0.1ml aliquot from 1-3 dilutions was plated on different plates containing already solidified sabourand dextrose agar medium. The water was spread evenly on the surface of the plate using a sterile hockey stick and the plate allowed to dry and then incubated at 25^{o}C for 72 hours. The number of colonies on the plate was counted after incubation and recorded as colony forming unit per ml

$$(\text{CFU/ml}) = \frac{\text{No of colonies}}{\text{Volume plated}} \times \text{dilution factor}$$

Most Probable Number (MPN)

The coliform count of the water sample was determined using most probable number technique. The water sample was shaken to mix and 10mls was added to each of the 3 test tubes containing 10mls of marconkey broth each (double strength using a 10ml sterile syringe. 1ml of the water samples was added to 3 test tubes each containing 10ml of marconkey broth (single strength) and 0.1ml of the water sample was added to 3 test tubes each containing 10mls of marconkey broth (single strength). The inoculated broths were then incubated at 44^{o}C for 24 hours with the bottles loosely capped. After incubation the results were read and recorded using Bergey's manual standards.

Physicochemical Analysis of the Water Sample

The water sample physicochemical parameters were determined prior and after treatment with M. *oleifera* seed solution using specific methods. The parameters determined were:

Determination of Turbidity

This was carried out on part of the 100mls collected from the top of the treated water, using HACH DR/200 direct reading spectrophotometer. It was configured to read turbidity at the wave length of 750nm specified for measuring turbidity. Distilled water was first poured into a 25ml cuvette and inserted into the spectrophotometer. The calibration button was pressed and the instrument was then calibrated. Each of the samples to be read was poured into a 25ml cuvette and inserted into the spectrophotometer. The turbidity

of the samples was displayed on the LCD panel of the instrument in Nephelometric turbidity units (NTU). After each reading, the spectrophotometer was calibrated again with the distilled water before being used on the next sample.

Determination pH

The pH of the samples was read using a digital Jenway 3505pH meter, which was calibrated with standard buffer solutions (pH 4 and 10.0). 5mls of the water samples was measured into a clean beaker and the electrode of the instrument inserted into the water and the start button pressed, the reading was taken.

Determination of Total Suspended Solids (TSS)

This was determined by weighing a filter paper on weighing beam balance, the water samples were then filtered using the filter paper. The wet paper was then dried in the hot air oven at 103 to 105^{o}C, after which the filter paper was removed and allowed to cool in a desiccator then reweighed. The increase in weight was read and recorded as the total suspended solids in the water samples.

Determination of Total Dissolved Solid (TDS)

This was determined by weighing a clean beaker on weighing beam balance, the water samples were then filtered using the filter papers. The beaker containing the water samples was placed on a hot plate for evaporation, after which the beaker was removed from the hot plate and allowed to cool, then reweighed. The increase in weight as read and recorded as the total dissolved solids in the water samples.

Determination of Temperature

The temperature of the different water samples were measured by using mercury filled celsius thermometer with an accuracy of 0.1^{o}C

RESULT AND DISCUSSION

The antimicrobial activity of the ethanolic extract of *Moringa olerifera* seeds is presented below. In this study, a standard antibiotics (Ciprofloxacin) was used as the control and its antimicrobial activity was compared with that of *M. oleifera* seed.

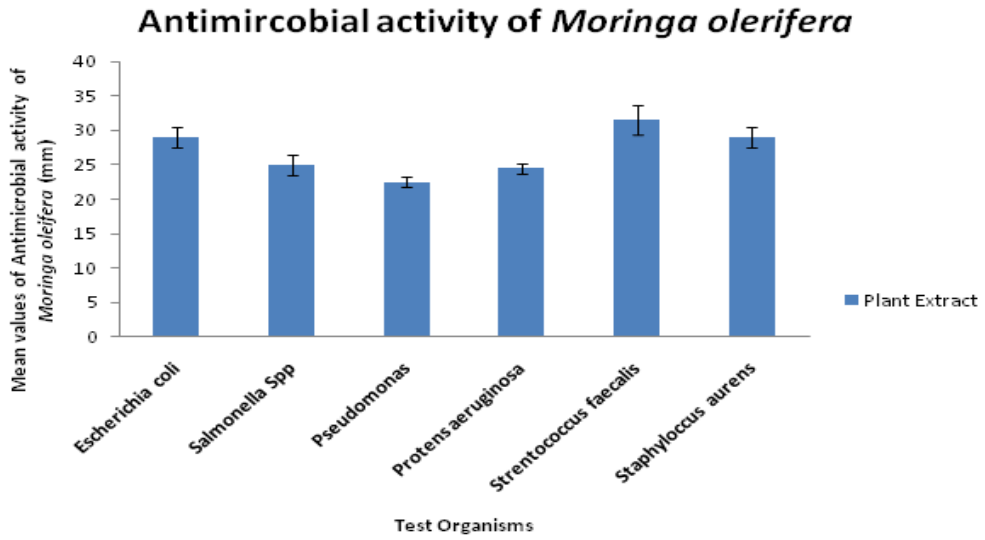

Fig. 1: Bar chart showing the antimicrobial activity of *Moringa oleifera* seeds

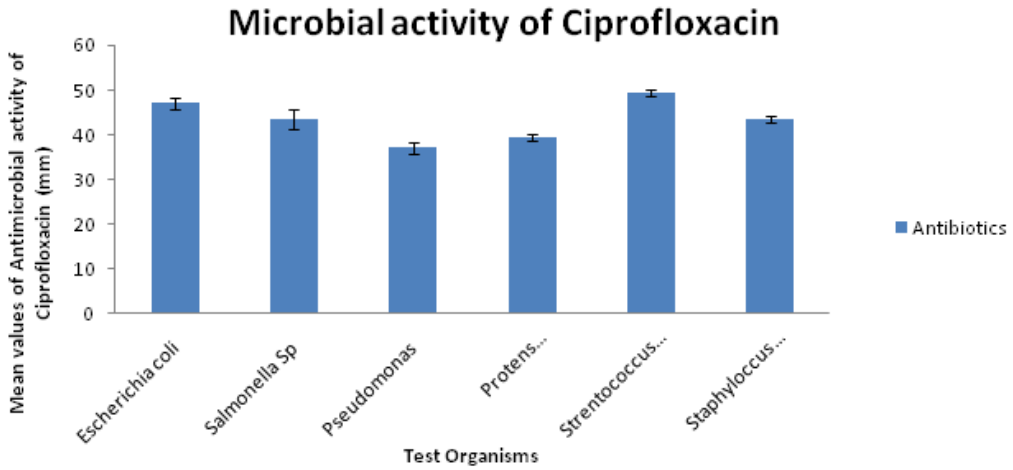

Fig. 2: Bar chart showing the antimicrobial activity of Ciprofloxacin

Table 1: Result of Minimum Inhibitory Concentration (MIC) of Plant Extract

Test Organisms	1000mg	500mg	250mg	125mg	62.25mg	31mg	MIC (mg)
Escherichia coli	29.00±1.414	19.00±1.414	10.50±0.707	4.50±0.707	-	-	125
Salmonella spp.	25.00±1.414	15.50±0.707	6.00±1.414	-	-	-	250
Pseudomonas aeruginosa	22.50±0.707	10.50±0.707	3.50±0.707	-	-	-	250
Proteus mirabilis	24.50±0.707	13.50±0.707	7.50±0.707	2.50±0.707	-	-	125
Streptococcus faecalis	31.50±2.121	15.50±0.707	8.00±1.414	4.50±0.707	2.50±0.707	-	62.25
Staphylococcus aureus	29.00±1.414	16.50±0.707	9.50±0.707	5.50±0.707	3.50±0.707	-	62.25

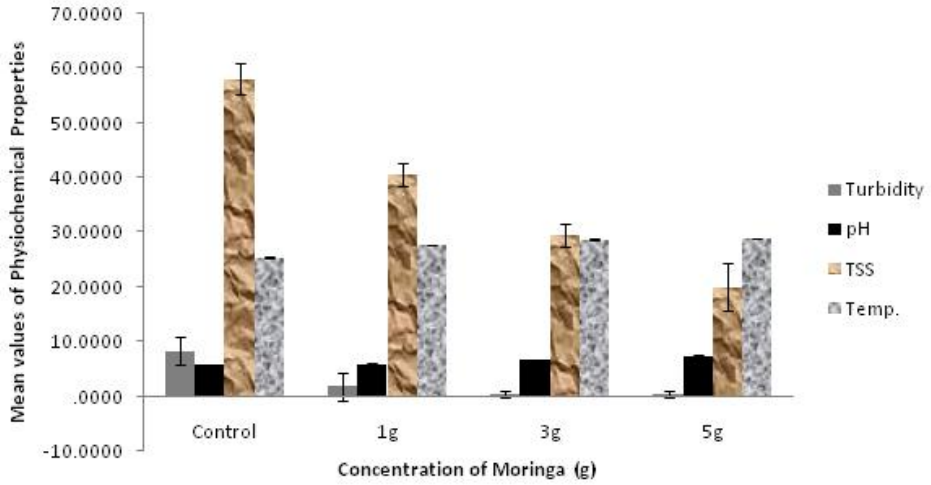

Fig 3: Bar chart representing the concentration of Moringa extract and mean values of physicochemical properties of water sample

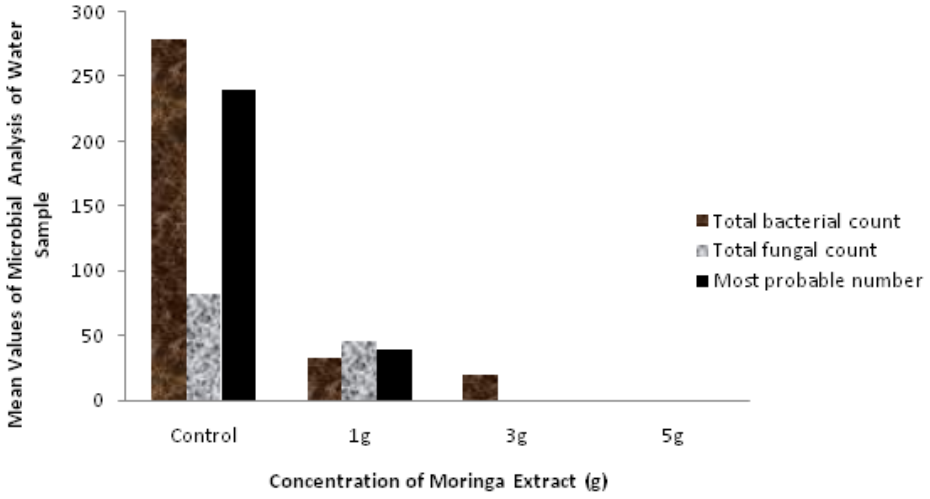

Fig 4: Bar chart representing the concentration of Moringa extract and mean values of microbial analysis of water sample

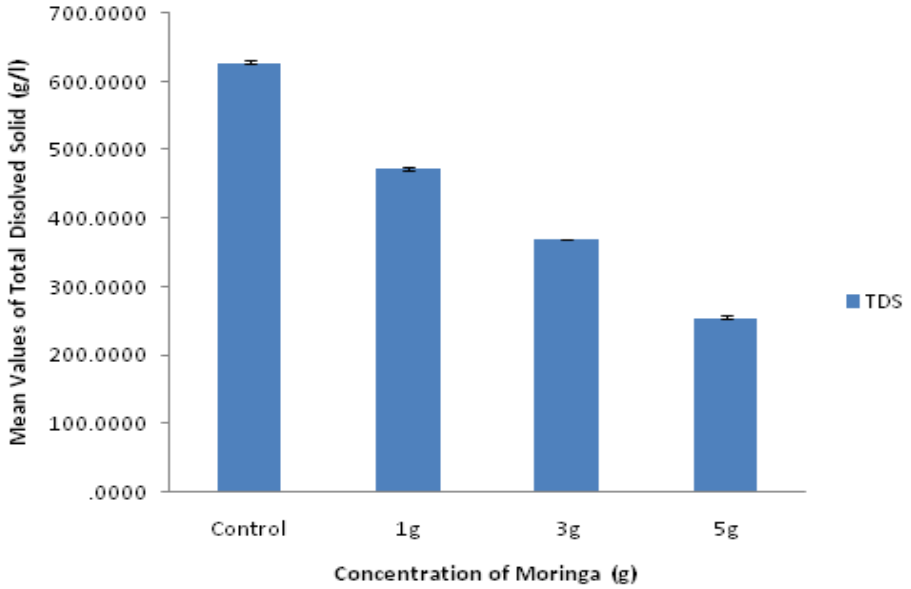

Fig. 5: Bar chart representing the concentration of Moringa extract and mean values of total dissolved solid of water sample

DISCUSSION

The present study was conducted to obtain preliminary information on the comparative study of antibacterial activity of ethanol extract of *Moringa oleifera* seed and ciprofloxacin. The disc diffusion method was applied in this study the comparism of the antimicrobial activity of seed extract and ciprofloxacin on tested bacterial strains were compared.

As such the standard antibiotics (ciprofloxacin) showed stronger antibacterial activity against tested bacterial than ethanol seed extract. Both the antibiotics and the seed extract showed high inhibitory potentials against streptococcus faecalis though that of the antibiotics was higher with the zone of inhibition of 49.50(mm) compared to seed extract 31.50(mm) also from the study, it was observed that both the antibiotics and the seed extract showed low inhibitory potential against pseudomonas aeruginosa with the zone of inhibition of 37.00(mm) for the antibiotics and 22.50(mm) for the seed extracts.

The result obtained from this work indicated that the ethanol extracts of the Moringa seed have antibacterial activity on all the tested organisms but it has little effect on pseudomonas aeruginosa. According to this research work, preparing an extract with ethanol was shown to provide better antibacterial activity. This is because ethanol can extract the active ingredient of the plant more than aqueous extracts. From this study, it can be seen that both the Moringa extract and ciprofloxacin had a high zone of inhibition on gram positive bacteria and the lowest zone of inhibition on gram negative bacteria. This suggests that that the *M. oleifera* seeds used contain bioactive substances. The activity of the plant extract against microorganisms may be indicative of the presence of broad spectrum antibiotic compounds (benzyl isothiocyanate) in that plant. Failure of the extract to exert antibacterial effect on the test organism is not enough to conclude that the extract does not contain substances that can exert antibacterial activity against the test organism because the potency of the extract depends on the method used to obtain the extract [14]. Research has also shown that the difference in antimicrobial properties might be attributable to the age of the plant used, freshness of the plant material, physical factor (temperature, light or water), contamination by field microbes, and incorrect preparation of the plant etc [15-16]. Today, most pathogenic organisms are becoming resistant to antibiotic.

Moringa oleifera seeds have been reported to be a good source of vitamin C (an antioxidant), vitamin E, oleic acids, phenolic and carotenoids [17-18]. To overcome this alarming problem, the discovery of novel active compounds against new targets is a matter of urgency, thus *M. oleifera* seeds could become promising natural anti-microbial agents with potential applications in pharmaceutical industries for controlling the pathogenic bacteria. The microbial assessments of the raw water sample treatment indicated that the water sample contains 2.79×10^4 cfu/ml of mesophilic bacteria, 8.2×10^4 cfu/ml of mesophilic fungi and 2.40×10^4 CFU = colony forming unit and MPN = most probable number.

The result of the microbial analysis indicated that the microbial load in the water sample reduced drastically as the concentration of the Moringa solution increased from 1 to 5% (1g of Moringa seed powder in 100ml, 3g of Moringa seed powder in 100ml, 5g of Moringa seed powder in 100ml). When the water sample was treated with 1g of Moringa seed powder the

microbial load dropped drastically when it was treated with 3g only the bacterial of the growth was observed (1.9×10^4 cfu/ml). With 5g all the Moringa organisms in the water were killed, there was no growth. The findings of this study showed that the active agents in the *Moringa oleifera* seeds solution are water soluble materials s seen from their coagulation and antimicrobial activities. Thus, one can treat water with *Moringa oleifera* seeds these active agents have been reported to posses antimicrobial activities, they include: 4- (4^1- 0- acetyl –α – L - rhamnopyranosyloxy) benzyl isothiocyanate [19-20] 4-(α- L- rhamnopyranosyloxy) benzyl isothiocyanate [21], niazimicin, pterygeospermin and 4-(α- L - rhamnopyranosyloxy) benzyl glucosinolate [20].

The data obtained from this microbial analysis of the raw water before treatment with Moringa seed solution showed that the total mesophilic bacterial total spp bacteria are as high as 2.79×10^4 cfu/ml and 2.40×10^4 mpn/ml respectively, the high total cliform bacterial suggests the presence of pathogens in the raw water and also a high total mesophili fungi 8.2×10^4 (cfu/ml).

These data thus indicate how unsafe the raw water is for human consumption and other domestic uses as it could cause gastro intestinal diseases. The uses of the water for bathing, washing of hands, logs and face could expose one to skin and cutaneous diseases, especially the compromised individuals. The presence of mesophilic fingi in the water makes this possible.

However, treatment of the water with *Moringa oleifera* seed solutions at different concentrations led to drastic reduction in the microbial counts in the water. At 1% (1g/100ml) concentration of Moringa solution, the total mesophilic bacterial counts, total cliform bacterial count and total mesophilic fungal counts were reduced to 3.2×10^4 (cfu/ml, 3.9×10^4 mpn/ml and 45×10^4 (cfu/ml respectively at 3% (3g/100ml) concentration of Moringa solution, the total Mesophilic bacteria counts reduced to 1.9×10^4 (cfu/ml and there was no growth in both mesophilic fungal count and total cliform bacteria count. At 5% concentration, the total mesophilic bacteria count, total cliform bacteria count and total mesophilic fungal count showed no growth. The production of antibiotic metabolic, such as carboxylic acid (Thomasshow and Welter, 1988) and 2,4- diacetyl phyloroglucinol may also be involved in the elimination of fungal pathogens. It can be suggested that these metabolites had an antagonistic activity in these results. The results from these works also showed that the Moringa solution showed anti-microbial efficiency of 85-93% for the coliform bacteria, 93-100% for mesophilic fungal count as the concentration of the Moringa solution increased from 1-5% indicating that the inhibition of the microbial growth by the Moringa solution increased. This means that the extracts worked in dose dependent manner, as the concentration of the extract increased the activity also increased.

Chemical water treatment agents such as metal salts, synthetic polymers and chlorine formulations are deemed unfavourable on human health[22]. The resulting effects being that low water quality is supplied especially, during the rainy season when rivers are highly turbid[23]. Edward confirmed that water containing too many contaminations either by certain microorganisms or chemical compounds is rendered unsafe for its intended use [24]. The turbidity of water depends on the quantity of solid matter present in the suspended state. It is a measure of light emitting properties of water and the test is used to indicate the quality of waste discharge with respect to colloidal matter. The effect of *M. oleifera* seed suspension on water turbidity indicated that the suspension has a clarifying potential, which might be attributed to the inherent bioactive component of the seeds. The mechanism is such that water soluble proteins carrying positive charge released from the *M. oleifera* seeds attached and bind themselves with the impurities in the water samples having predominantly negative charge. According to WHO, the turbidity level of a standard water quality was reported to be less 1(<1), which agrees with our result especially, for the sample treated with 3g/L and 5g/L of *M. oleifera*. It was observed that the initial turbidity was 8.3 NTU in the river water sample which was beyond the limits as per WHO standards in surface water (Figure 3). In the present study it was observed that the use of *Moringa oleifera* seed decreased the turbidity with increased dose from 1,3 and 5g/L respectively. The turbidity of the treated water sample with different concentrations of *Moringa oleifera* seed powder was below 5 NTU. This results showed that the treated water is (the water samples turbidity should not be more than the 5 NTU, but ideally should be below 1 NUT [1].

The test for ph of water was carried out to determine whether it is acidic or alkaline before and after treatment. The initial pH of the water sample (5.8) this means that the water is acidic after treatment with different concentration of Moringa the pH increased at 1g it increased to 6.0, 3g it increased to 6.7 and at 5g it increased to 7.4. The pH of the untreated water was acidic in nature. The recommended acceptable range of pH for drinking water specified by WHO [1] is between 6.5 and 8.5 the results were between this range except the one treated with 1g which was 6.0. The pH increases with increasing concentrations of the Moringa seed powder as a coagulant. It was reported that the action of M. 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 seed powder would accept a proton from water resulting in the protein from water resulting in the release of a hydroxyl group making the solution basic [25]. It is being reported that high basic

or acidic water is not suitable for drinking as the body pH must be maintained at 7.4. this result indicated that the pH increased with *M. oleifera* concentration. The untreated water becomes slightly acidic due to dissolved CO_2 from air. pH is considered as important chemical parameter in river water since most of the aquatic organisms are adapted to an average pH.

The pH is affected not only by the reaction of carbon dioxide but also by organic and inorganic solutes present in water. Any alteration in water pH is accompanied by the change in other physiochemical parameters. pH maintenance (buffering capacity) is one of the most important attributes of an aquatic system since all biochemical activities depend on pH of the surrounding water.

The results obtained for the total dissolved solids (TDS) in the different water samples showed that the effect was concentration and water sources specific. Excess amount of TDS in waters samples indicates poor water quality. It thus implies that any good water treatment agent should be able to reduce this parameter. It reported that increase in value of TDS indicated pollution by extraneous sources [26]. In the present study, it was observed that the initial TDS was in the range of 628 mg/l for the river water sample which is beyond the standard limits of WHO which is 500. After treatment with *M. oleifera* seed powder, the total dissolved solid was reduced. With 1g it reduced to 473 mg/l, with 3g it reduced to 370 mg/l and with 5g it reduced to 255 mg/l and all these are present within the WHO standard limits. *Moringa oleifera* is known to be a natural cationic polyelectrolyte and flocculent with a chemical composition of basic polypeptides with molecular weights ranging from 600 to 16,000 daltons, containing up to six amino acids of mainly glutamic acid, methionine and arginine [27].

Total suspended solid (TDS) is the material in water that affects the transparency or light scattering of the water. It is typically composed of fine clay or silt particles, plankton, organic compounds, inorganic compounds or other microorganisms. These suspended particles size range from 10ηm to 0.1ηm, it can be influenced by changes in pH. Changes in pH will cause some of the solutes to participate or will affect the solubility of the suspended matter. Suspended solids are the run off pollutants which greatly influence the turbidity of the receiving water which in turn affects the light penetration resulting in reduced photosynthesis[28]. The untreated water had a TSS of 58mg/l and when it was treated with different concentration of Moringa seed powder. It reduced as the concentration increased 1g (40.5 mg/l), 3g (929.5 mg/l), 5g (20 mg/l).

Temperature is an important water quality parameter and the temperature of the water affects the rate of coagulation. The higher the temperature, the more effective the coagulation process. According to this study the temperature of the untreated water was 25.4ºC after treatment with different concentrations of Moringa seed powder the temperature increased with 1g it increased to 27.7ºC, 3g it increased to 28.7ºC, 5g it increased to 29ºC, and it is within the range of WHO standard of 27-30ºC.

CONCLUSION AND RECOMMENDATIONS

The result of this work indicated that the seed extracts of this plant possess inhibitory potential against the tested pathogens. The active ingredients of this plant could be enhanced if the component of the plant is purified. This plant therefore holds a promise, a potential source of a new drug for treating infections caused by these clinical pathogens.

Moringa oleifera seeds acts as a natural coagulant, flocculent, absorbent for the treatment of drinking water. It reduces the turbidity, TDS, TSS after the treatment; it also acts as a natural antimicrobial agent active against the microorganisms which is present in the drinking water and decreases the number of bacterial. The MPN test had shown positive which indicates the water samples are feacally contaminated and not safe for drinking, after treatment it reduced. I recommend that 5g of Moringa powder should be used because it killed all the microorganisms, also drinking water should observe the boiling before drinking method.

Moringa oleifera does not have any toxic effect. It is eco-friendly and cheaper method of purification of water and therefore can replace the chemical method of water purification in house hold levels communities and companies at large.

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