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# COMPARISON BETWEEN TRADITIONAL METHOD AND *MORINGA OLEIFERA* SEEDS IN DRINKING WATER TREATMENT TECHNOLOGY

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## ABSTRACT

Water can be considered as the most important natural resource that can be utilized by man to develop his prosperity as well as his essential needs. Raw water contains different types of impurities that have harmful effects on human health. Water is subjected to some forms of treatment before its use. The main goal of water treatment is to produce potable or acceptable water to use which is biologically and chemically safe for human uses and meet certain water quality standard. The principal target of this study was to investigate *Moringa oleifera* capability of water treatment against the traditional methods of purification using chlorine and Aluminum sulphate (Alum) in turbidity, algae and bacteria removal. *Moringa oleifera* was proved to be efficient when used in specific dose (50 mg/l) with settling time 120 min make 90% removal of turbidity 91.7, 84.8, 87, 91.4% for Diatoms, green algae, blue green algae and total algal count respectively. While the removal of bacterial groups were 88.4, 90, 94.3, 100% for total bacterial count, total coliform, fecal coliform and Fecal streptococcus. Then studied doses of *Moringa oleifera with* alum alone, different doses of *Moringa oleifera* with chlorine, then different doses of *Moringa oleifera* with the traditional method (alum and chlorine).the study showed that the best result in algae and bacteria removal was 50% of *Moringa oleifera* and 50% of (alum with chlorine). It also helped to reduce the cost of chlorination and Alum usage and maintain human health.

**Keywords:** Water quality, Chlorination, Aluminum sulphate, Turbidity, *Moringa oleifera*

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

## 1. INTRODUCTION

Water is an essential ingredient of living beings in the universe. All biological reactions occur in water, and it is the integrated system of biological reactions in an aqueous solution that is essential for the maintenance of live **(Shrivastava et al., 2014).** Water pollution is the contamination of natural water bodies by chemical, physical, radioactive or pathogenic microbial substances. Adverse alteration of water quality presently produces large scale illness and deaths, accounting for approximately 50 million deaths per year worldwide, most of these deaths occurring in Africa and Asia. Although agricultural, industrial and human needs essentially depend on the availability of freshwater, yet the present networks allow eventual mixing up of almost all agricultural and agrochemical drains as well as industrial and domestic wastes. Actually, the burden is too heavy to be tackled by the present water treatment plants. Accordingly, the agricultural network, irrigation and river systems do heavily suffer from excessive water wastes along their passage up to the northern lakes and seacoast. This problem imposes hazardous effects on the health of the rural people beside its vigorous impacts on the national economic **(Griffith, 2013)**.

Concerning algae they are found in almost all aquatic ecosystems, including creeks, rivers, lakes and wetlands. Individual cells are very small, so blue-green algae can be present in a water body without being visible. As environmental conditions become more favorable, algae numbers start to increase rapidly and blooms, or scum, become easily visible on the water surface. Blooms range in color from dark green to yellowish–brown. Algae can play an important role in determination of water quality in lacks, reservoirs and rivers. They are the primary products of organic matter and oxygen in the aquatic environment. Various groups of algae especially diatoms have been used as test organisms for stream biological monitoring **(Del Giorgio et al., 1991).**

The bacterial population in semi enclosed bays is comparatively higher than that in the open sea. Since the coastal human habitation depends more on these former water bodies for fishing and navigation purpose. They also release their domestic wastes directly into the bay, which ultimately degrades the quality of water and increase the bacterial concentration (Dunn et al., 2012). Currently, coliforms and E. coli are of great importance among bacterial indicators used in water quality definition and health risk **(Giannoulis et al., 2005)**

The treatment of water intend for human consumption is a very old practice, the city of paisley, Scotland, is generally credited with being the first city with a treated water supply the system was consisted of settling operations followed by filtration and was put in service in 1804 and then the practice spread all of the world **(Baker 1949)**. Water may require treatment for a number of reasons in necessity of removing the germs of disease, it must be free from unpleasant

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

tastes and odors and elimination of gases and colors. The character and degree of treatment required will depend upon the nature of water and its source. The water treatment is composed of four steps: coagulation – flocculation – sedimentation – filtration. **(Waleed, 2000)** and **(Geriesh et al., 2004).** Coagulation is the addition of chemicals to enlarge the suspended solids particles size by creation of flocs which helps the success of the next step, the most important factor for coagulation is a proper dosage of coagulant with or without a coagulant aid **(heiggazi, 1996)**. Coagulation and flocculation are occurring with the addition of an agent that causes small particles becoming attracted together to form larger and heavier particles which enhance the settling process **(Michael, 2006).** Coagulation is optimized for the removal of dissolved natural organic matter **(Kebreab and Bengt. (2004)** and **(Kemira, 2008).**

Aluminum sulfate (Alum) is the most common chemical used for the coagulation of particles. This substance is suitable since it is not so expensive. Alum has some negative impacts of its usage in water treatment during coagulation process, aluminum precipitates out of water it takes other substances with it **(Edzwald and Van Benschoten, 1990).** If conditions are good, the coagulated material (flock) forms large heavy particles that quickly settle out of the water column. Some residual aluminum is always left in solution which makes health problems as Alzheimer's disease **(Ravikumar et al., 2013)**

Chlorine is a highly efficient disinfectant, and it is added to public water supplies to kill disease-causing bacteria and maintain the quality of water in the distribution system **(Abdullah et al., 2011). Ozonoff, 2006** reported that chlorine is an effective bactericide given appropriate contact time for a given concentration. Chlorine is very effective and inexpensive. Chlorine is one of the most reactive elements found in nature; it readily dissolves in water where it combines with molecules of oxygen and hydrogen to form hypochlorous acid and hypochlorite ion. Chlorination of water is achieved by adding the chemicals calcium hypochlorite or sodium chlorite, both of which are known as "free available chlorine

In recent years, the chlorination process has been found to bring about the Formation of disinfection by-products (DBPs) that may cause long-term health hazards to consumers, thus, leading to a quest for safer disinfectants. DBPs are considered potentially carcinogenic **(Alshraa et al., 2016).**

*Moringa oleifera* as natural coagulant: *Moringa oleifera*, known as *Moringa*, is native to north India but is now found throughout the tropics. *Moringa* is also known as horseradish tree, drumstick tree and mother's best friend. It grows fast and reaches up to 12m. The bark is grey and thick and looks like cork, peeling in patches **(Mishra et al., 2011)** it loses its leaves from December to January and new growth starts in February to March. *M. olefera* produces cream colored flowers when it is 8 months old and the flowering season begins in January and

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

continues through to March. The fruit ripens from April to June and the pods are triangular in cross section, 30 to 50cm long and contain oily, black, winged seeds. Among all the plant material that have been tasted over the years, the seeds of *Moringa oleifeira* which have been shown to be one of the most effective primary coagulant for low-cost water purification. Since 1970's a number of studies have been carried out to determine the effectiveness of seeds of *M. Oleifera* for the treatment of surface water **(Jahn, 1988; Okuda et al., 2001; Kebreab, 2007; Bichi et al., 2012). Folkard and sutherland. (2005)** investigated pilot plant and full scale plant demonstrated that the seeds could be used effectively on continuous flow systems producing treated water. The produced water has quality similar to that of aluminum sulphate. **Miquel** and **Wedney. (2010**) reported that optimizing of water treatment parameters using processed *Morina oleifera* as a natural coagulant for low turbidity water. **Lilliehook, 2005** investigated that when the *M. oleifera* was mixed with aluminum solution, it was possible to get better purification almost as good as with only aluminum solution. Mixing *M. olrifera* with aluminum solution makes it possible to decrease the dosage of aluminum solution by up to 60% without reduced efficiency. Also **Elhefny, 2008** stated that *M. oleifera* gives high removal efficiency in both algae and bacteria.

Effect of *Moringa oleifera* on algae and bacteria: Laboratory tests *Microcystis aeroginosa* population exhibited good growth in controls and treatment with 4-8 mg crushed Moringa seeds per liter. While, in exposure of 20-160 mg crushed *Moringa* seeds $L^{-1}$ caused growth inhibition, in higher doses the cyanobacteria were also showed growth inhibition due to a rapid drop in photosystem II efficiency **(Miquel and Wendy, 2010).** While **(Beltran et al., 2009)** showed that *Moringa oleifera* can decrease the bacteria in surface water by 90-99%.it is clear that *M. oleifera* pronounced hygienic effect which is caused by strong antibacterial potential against Gram-negative and gram positive bacteria **(Suarez et al., 2003, 2005). (Shahata et al., 2009)** stated that *Moringa olefeira* seeds present a viable alternative natural coagulant for efficient removal of the algal groups up to 97%. New research shows that the tree's seeds could provide a low-cost means of water purification and reduce water borne diseases in the developing world and can produce 90-99% reduction in bacteria and algae **(Nieuwenhuijsen et al., 2010*)*** *Moringa oleifera* is recommended to be an alternative coagulant to aluminum sulphate for water treatment not only in Malaysia (where the plant considered indigenous) but, worldwide. the use of moringa seed powder as a natural coagulant and flocculent to clarify turbid water and copper as an antibacterial agent to destroy pathogens like *E. coli* to produce clean drinking water **(Alakaparampil, 2020)**.

## 2. AIM OF THE STUDY

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

The main objectives of this study are to assess the possibility of using *Moringa oleifera* as an alternative to the currently used coagulant (alum) and disinfectant (chlorine) in drinking water treatment plant. Secondly to evaluate the optimum dosage of *Moringa oleifera* and removal efficiency of turbidity, algae and bacterial groups from raw water in comparison of currently used chemical materials.

## 3. MATERIALS AND METHODS

Sampling: Samples of raw water were collected from Mityazid main branch of the River Nile. The samples were collected in clean sterile bottles and transported to the laboratory inside ice box for physicochemical, bacterial and algal analysis within 24 hours of collection

Physicochemical analysis: Temperature (Temp), pH, Turbidity, electric conductivity (EC) and total dissolved solid ((TDS) of the collected samples were measure in the investigated water samples of Mityazid branch. According to SMWW, 2017. Also the samples were analyzed for chloride, phosphate, nitrate, nitrite, and ammonia

Bacteriological Examination: Samples were collected in sterile 250 ml glass bottles. The samples were subjected to bacteriological analysis within two hours.

1. Total bacteriological count (TBC) : Pour plate method was applied according to **SMWW 2017, EPA 2005**. One ml of samples or its decimal dilution was poured into plate count agar (tryptone glucose yeast agar). Duplicate plates were applied for each incubation temperature at 35ºC respectively.

2. Total coliform (TC): Total coliform was determined by membrane filtrations technique. Under aseptic conditions, 100 ml of water was filtered through a girded sterile cellulose nitrate membrane filter (0.45 µm pore size, 47 mm diameter, Sartorius type filters) under partial vacuum. The membrane filters were placed on m-Endo agar for total coliform bacteria detection after 24h at 35 ºC **(APHA, 2011**).

3. Fecal coliform (FC): fecal coliform was determined by Membrane filtrations technique according to standard method for water and waste water (SMWW) by using m-fc agar media filtration, 100 ml from sample was filtered into membrane (0.45 µm pore size) then transferred the membrane into Petri dish contains solidified media , then Petri dishes were incubated at 44 ºC for 24 h.

4. Fecal streptococcus (SC) : Fecal streptococci were detected by membrane filtrations technique by using m-enterococcus solidified media, then the Petri dishes incubated at 35 ºC for 24 h.

Phytoplankton enumeration and taxonomic identification:

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

1. Taxonomic Identification: Nile water algae were identified up to the species level according to the key of freshwater algae **(Prescott, 1969**).

2. Fixation and counting: One liter of each sample was preserved with the lugol's solution (iodine with potassium iodide) (**Ultermohle, 1936**) for the qualitative and quantitative investigation of algae and counting of algal population was carried out using Sedgwick-Rafter counting chamber **(Ingram and Palmer, 1952**)

Coagulants: Coagulation and flocculation was conducted via the "Jar test" procedure. The apparatus used (Fig.1) consists of multiple stirrer fitted with 6 paddles for stirring the contents of 6 jars each of 1.500L capacity. This multiple stirrer is equipped with a speed regulator. The jar test procedure devised by **Cohen (1957)** and **Bulusu & Sharma (1967**) was employed.

Jar test: one liter sample of raw water were placed into jars and test coagulant added in rising dosages. While stirrer set to flash mixing at a stirring speed 40 r.p.m. for 1minute after which, the speed was further reduced in stepwise order down to 20 r.p.m. for another 15-minutes. Then the Jars were left 30 minutes to allow settling the formed flocs. This was followed by sample siphoning from the supernatant solution into clean containers. Characterization of water following coagulation was carried out for turbidity determination and residual phytoplankton counts.

**Fig. 1: Jar test apparatus**

**Chemical Coagulants:**

A. Aluminum sulphate solution: 1 % aluminum sulphate solution in distilled water was prepared using reagent grade aluminum sulphate (Analar) with a chemical formula $Al_2 (SO_4)_3.16H_2O$. Residual alum was determined according to Eriochrome Cyanine R method (SMWW, 2017).

B. Chlorine: A saturated chlorine water solution was used. The power of the available chlorine (concentration) was determined idiomatically before running each experiment

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

C. *Moringa oleifera*: used in this study were obtained from research Institute of aromatic and medicinal plants of the Institute of Horticultural Research, Kanater El-Khairya. The plant is dried and cleaned from kerb then grinded and ready to use

*Moringa oleifera* preparation: After careful removal of seed coats and seed wings the quality of the kernels was inspected. The seeds weighed and then thoroughly pounded and squeezed in a mortar. The powder was transferred to a flask and distilled water was added to the powder to make 3% suspension. The suspension was vigorously shaken for about 5 minutes to promote water extraction of the flocculants then filtered through white cotton cloth. Suspensions can be refrigerated up to two weeks without suffering reduction in efficiency.

Statistical analysis: Collected data were analyzed using analysis of variance (ANOVA) in a complete randomized design **(Gomez, 1984)**.

## 4. RESULTS AND DISCUSSION

### 4.1. Physicochemical analysis:

Changes in the physicochemical analysis of collected water samples from Mityazid main branch canal in response to seasonal variation on various physical parameters indicated that: temperature affects the distribution ,health and survival of aquatic organisms while temperature changes can cause mortality PH seems to be constant in all investigated water samples of mityazid all the pH values were alkaline the relatively lower pH values may reflect the decreased productivity of the mityazid as a result of the polluted water discharged into the mityazid branch .the highest EC was recorded during winter while the lowest one was detected in summer .the lower value in summer might be due to the dilution with the Nile flood season .the increase in EC may be due to the disposal of domestic and industrial effluents in the water . Turbidity values are flocculated between 22.4 and 14.5NTU the maximum TDS was observed during the winter season rather than in summer as a large amount of sediment load was transported from the watershed during the rainy season as showed in table (1).

A noticeable variation in chloride was detected with the lowest content in summer .the lowest content of chloride could be due to the decomposition of chemical compounds.

The data obtained in the present study revealed that the content of Ammonia was high during winter and low during summer this is probably due to the utilization of ammonia by phytoplankton and sewage disposal **(Khalil, 2014)**. The nitrite content revealed a higher value in spring due to the effect of low amounts of drainage water discharged. The highest nitrate was recorded during spring .while the lowest one was detected in winter (table 1).

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

**Table 1: Seasonal variation of physicochemical parameters of Mityazid canal (raw water)**

| Parameters | Spring | Summer | Autumn | Winter |
|---|---|---|---|---|
| **Temperature (ºC)** | 23.5 | 28 | 24.5 | 14.5 |
| **Ph** | 7.8 | 7.66 | 7.64 | 7.82 |
| **Turbidity (NTU)** | 22.2 | 19.2 | 15.8 | 14.5 |
| **Conductivity (ms/cm)** | 444 | 403 | 412 | 541 |
| **TDS (mg/L)** | 280 | 282 | 273 | 369 |
| **Total alkalinity (mg/L)** | 172 | 152 | 160 | 218 |
| **Total hardness (mg/L)** | 130 | 136 | 132 | 220 |
| **Chloride (mg/L)** | 28 | 25 | 34 | 64 |
| **Ammonia (mg/L)** | 0.086 | 0.12 | 0.13 | 0.45 |
| **Nitrite (mg/L)** | 0.232 | 0.08 | 0.008 | 0.12 |

### 4.2. Prechlorination Method

Different doses of chlorine 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6 , 6.5 mg/L were prepared. It was found that, break point chlorination experiment during the period of investigation was 3.5 mg/L which is suitable for turbidity removal from raw water.

### 4.2.1. Coagulant by Aluminum sulphte

The dosage of aluminum sulphate (35mg/L) led to a considerable decrease in raw water turbidity and total algal count during the period of study by jar test technique.

### 4.2.2. Using *Moringa oleifera* seeds (*M. Oleifera*) in water treatment

#### 4.2.2.1. Optimal dose of *M. Oleifera* used in the experiment

Different doses of *M. oleifera* seeds (10, 20, 30, 40, 50, 60 mg/l) were applied on raw water of mityazid canal with turbidity level 22 NTU and total algal numbers 2930 org/ml. At 50 mg/l of *M. oleifera* the turbidity was reduced to 2.23 NTU (turbidity decreased by 90%) as shown in Fig. 2. The count of total algae decreased to 250 org/ml corresponding to 91.4% removal of total algal counts followed by 60 mg/l dose which reduced the number of the different three algal

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

groups to 91.3% (the removal were 91.7,84.8,87% for Diatoms, Green algae, Blue green algae respectively (Fig.3)

Concerning the effect of different doses of *M. oleifera* seeds on bacterial count of raw water, it is clear that a reduction on different groups of bacteria was detected at 50 mg/l of *M. oleifera* as shown in fig.4. The results show that removal of TBC was 88.4%, 90%

Removal of TC, 94.3% removal of FC and 100% removal of SC in response to treatment with 50 mg/l dose of *M. oleifera*.

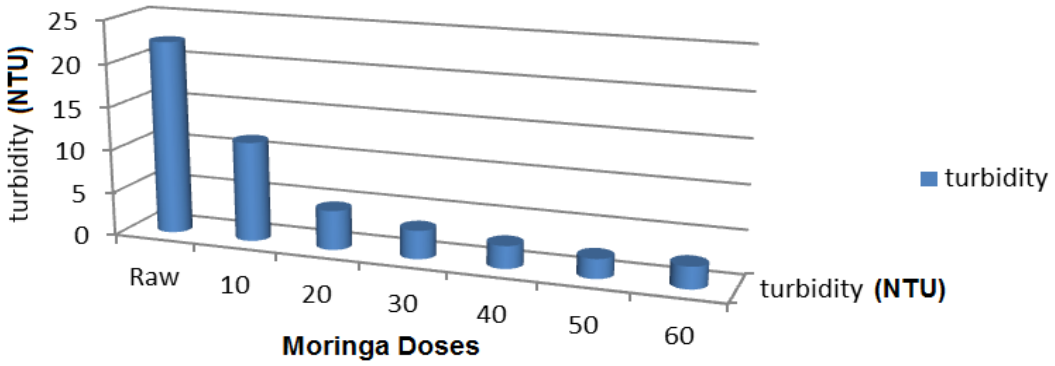


**Fig. 2: Effect of different doses of *Moringa oleifera* on Turbidity**

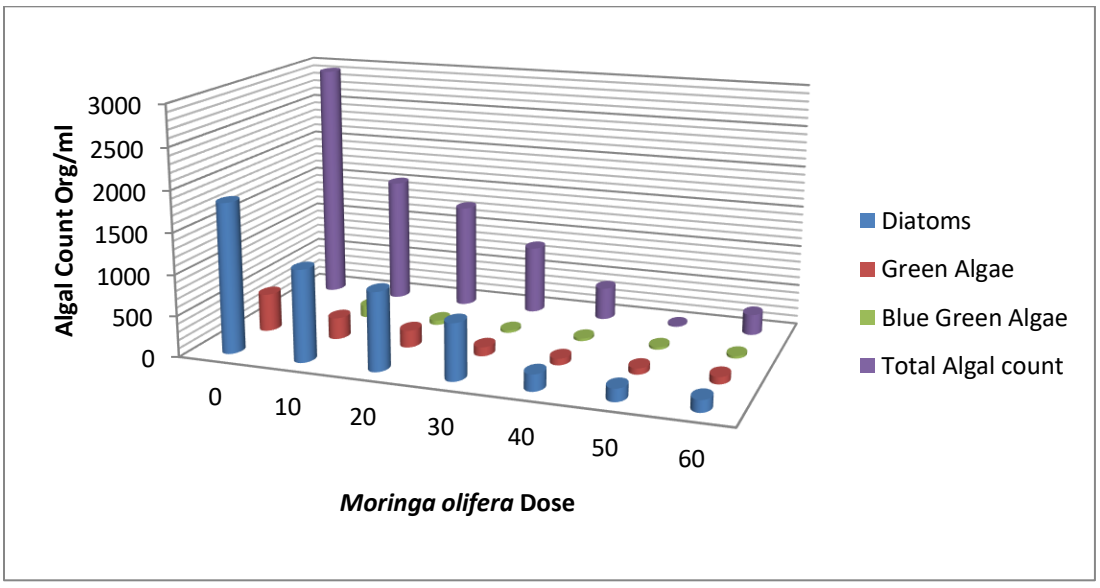


**Fig. 3: Determination of effective *M. oleifera* dose for algal removal**

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

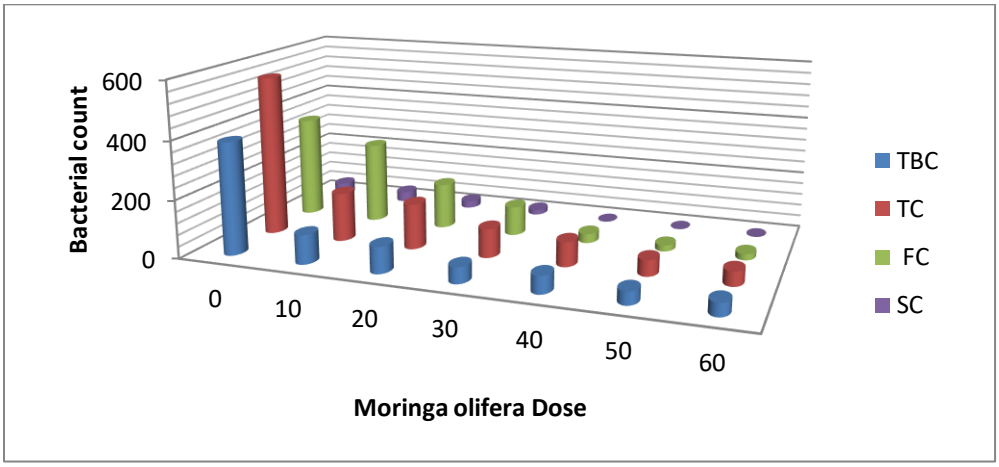


**Fig. 4: Determination of effective *M. oleifera* dose for bacterial removal**

#### 4.2.2.2. The settling time

For successful high efficiency of turbidity removal, jar test was carried out by using different settling time used 30 min, 60min, 90 min, 120 min and 150 min for using 50 mg/l dose of *M. oleifera.* High reduction in algal counts was obtained after 120 in settling time as shown in fig. 5.

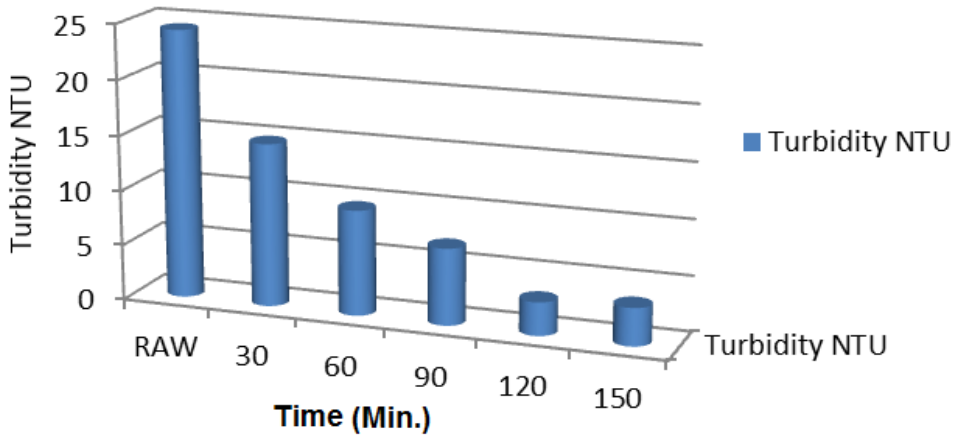


**Fig. 5: Determination of optimal settling time of *M. olifera* with regard to turbidity**

### 4.3 Application of *Moringa oleifera* seeds for water treatment

#### 4.3.1. Application of *Moringa oleifera* as coagulant aid with aluminum sulphate

This experiment was carried out on the water of Mityazid canal to select suitable dose of alum and *M. oleifera* which reduced algal and bacterial count. As mentioned before, the optimum concentration dose of *M. oleifera* is 50 mg/l. The traditional dose of alum for raw water

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

treatment from Mityazid is 35 mg/l. Different concentrations from the optimal *M. oleifera* seeds were prepared as (100, 75, 50 and 25%) which equal 50, 35.5,25 and 12.5 mg/l respectively, and different concentrations of optimal dose of alum were also prepared as (100, 75, 50 and 25% which equal (35, 26.5, 17.5 and 8.75mg/l) respectively.

The results show that the best concentration for algal removal was 25% (8.75 mg/l) of Alum + 75% (35.5mg/l) of *M. oleifera*. By these results 75% of aluminum sulphate in water treatment can be get rid and using *M. oleifera* as coagulant aid for coagulation improvement.

Total algal removal was 81.2, 85.2, 87.2, 92.4, 88 % with 100, 75, 50, 25 and 0 of alum with 0, 25, 50, 75, 100 of *M. oleifera* as shown in Fig. 6. this mean the best concentrations for algal removal is 75% of *M. oleifera* with 25% of alum followed by 100% *M. oleifera* then 50 *M. oleifera* with 50 alum then,25% *M. oleifera* with 75 % alum ,Finally 100% alum only.

Also, the results show that the optimum mixture for bacterial removal was 50% *M. oleifera* and 50% of alum followed by 25% *M. oleifera* with 75 % alum then75% of *M. oleifera* with 25%of alum, 100% *M. oleifera* and 100% alum only. The bacterial group's removal was 80.6,99,97 and 99% for total bacterial count, total coliform, fecal coliform and streptococcus respectively as shown in fig.7.

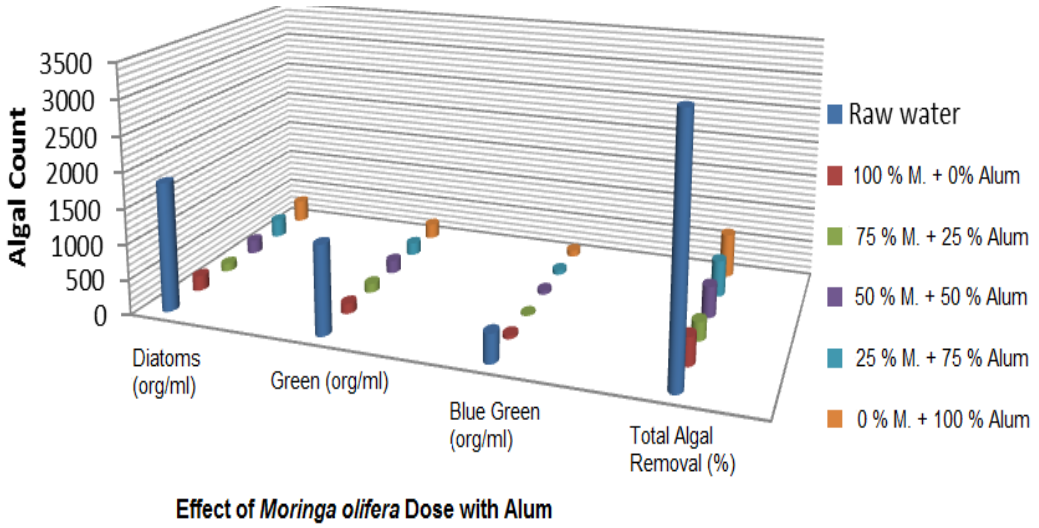


**Fig. 6: Algal count with different concentrations of *Moringa oleifera* combined with aluminum sulphate**

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

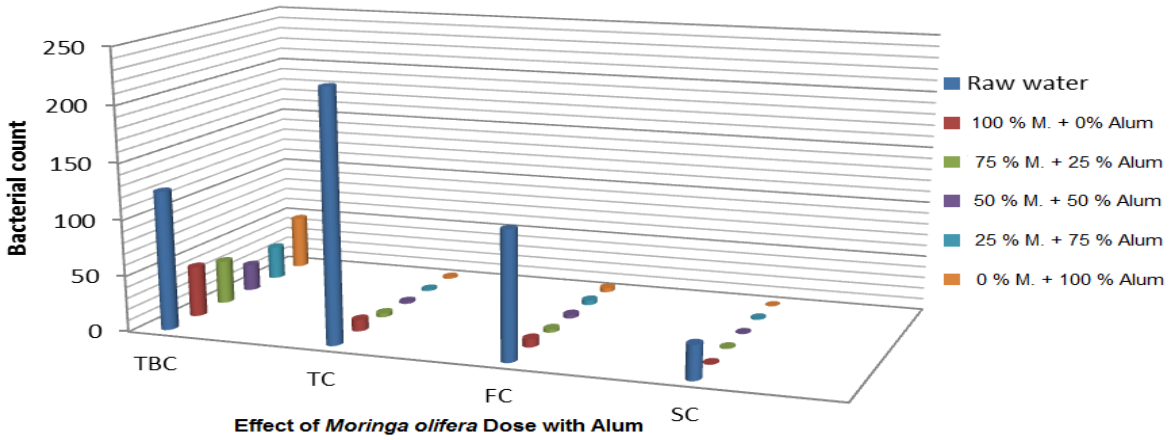


**Fig. 7: Bacterial count with different concentrations of *Moringa oleifera* combined with aluminum sulphate**

### 4.3.2. Application of *Moringa oleifera* as coagulant and prechloration aid with traditional method

In this experiment, different doses of *M. oleifera* with suitable doses of chlorine and alum were applied on Mityazid raw water.

The results show that, the suitable concentration which caused the highest algal removal was 75 % of *M. oleifera* and 25% (chlorine +Alum). Followed by 50% *M.o leifera* and 50% (Alum + chlorine) then 25 of *M. oleifera* and 75% (Alum + chlorine), then 100 % (Alum + chlorine), then 100% of alum and finally 100% of *M. oleifera* as shown in Fig.8. On the other hand, the highest bacterial removal found to be at 50% *M. oleifera* and 50% (Alum + chlorine) followed by75% *M. oleifera* and 25% of (Alum + chlorine) then 25 of *M. oleifera* and 75% (Alum + chlorine), then 100 % (Alum + chlorine), then 100% of alum and finally 100% of *M. oleifera* as shown in Fig. 9.

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

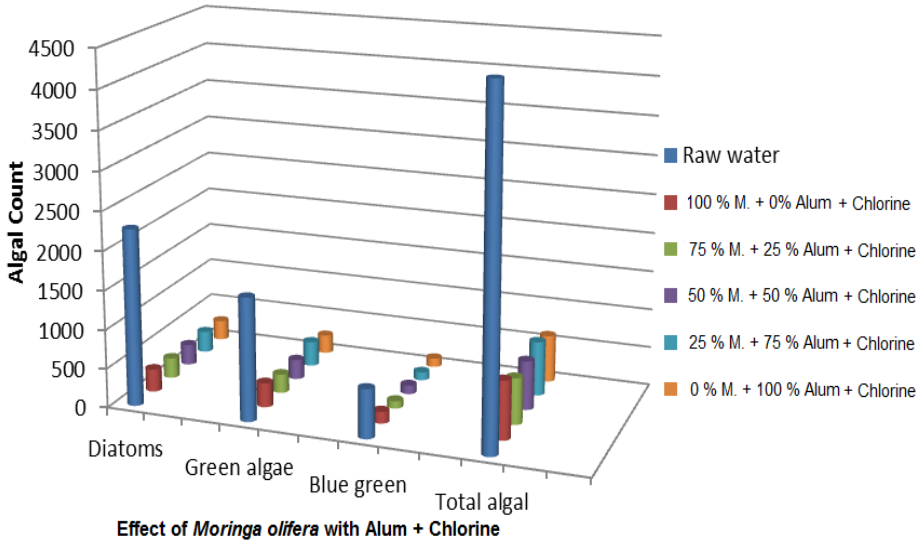


**Fig. 8: Algal count of water samples by different doses of *Moringa oleifera* as coagulant and preclorination**

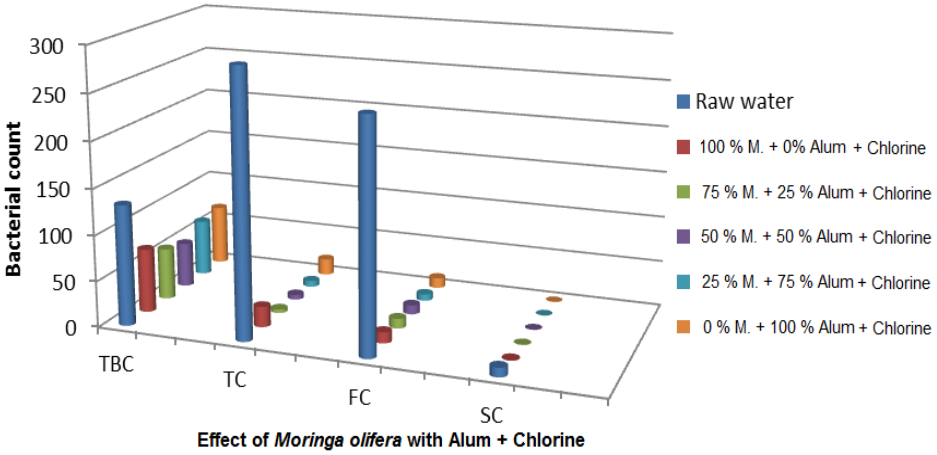


**Fig. 9: Bacterial analysis of raw water with using different doses of *M. oleifera* as coagulant and preclorination**

### 4.3.3. Prechlorination Application of *M. oleifera* with different chlorine concentrations

In this step the optimum dose of *M. oleifera* was applied with different concentrations of chlorine dose (3.5mg/l), the results show that by increasing chlorine dose the removal of algae increase. In addition, the three algal groups easily settled during the period of 2 hrs. The removal of total algal count were 56%, 66.5%, 70.3%, 70.1%, and 69.9% for the following doses 100% of *M.*

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

*oleifera*, 75% *M. oleifera+25%* chlorine, 50% of *M. oleifera +50%* chlorine, 25 *M. oleifera+75%* chlorine and 100% of chlorine doses (Fig 10). The results show that using 50% of *M. oleifera* dose + 50 % of chlorine dose showed the optimum combination for removal different bacterial groups as shown in Fig.11

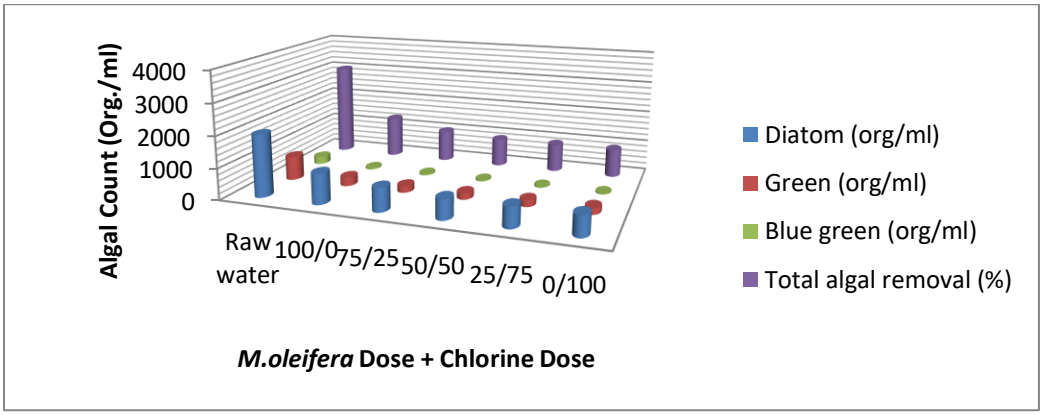


**Fig. 10: Algal count in raw water with different doses of *Moringa oleifera* seeds extract and chlorine**

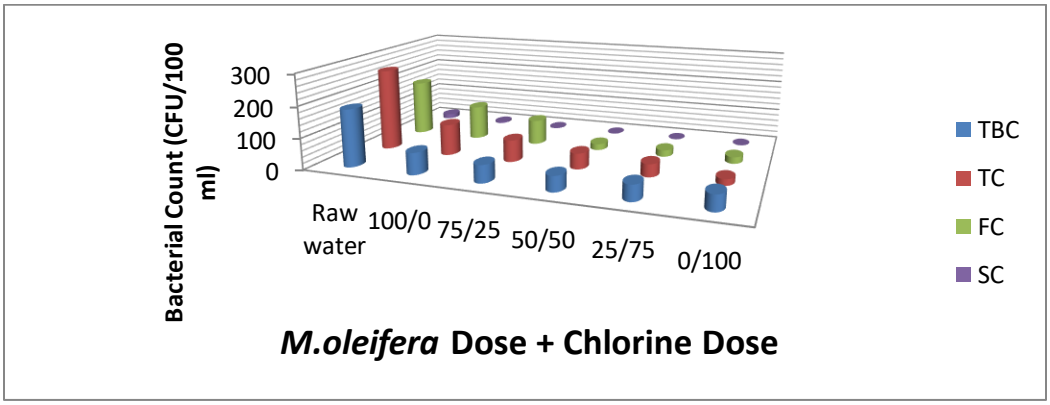


**Fig. 11: Bacterial count in raw water with different doses of *Moringa oleifera* seeds extract and chlorine**

## 5. DISCUSSION

### Application of *Moringa olefeira* in water samples in removing turbidity

The previously listed results showed that, the optimum dose of *M. oleifera* is 50 mg/L which caused turbidity removal by 90% (Fig.7). This is agree with Ali, 2010 who stated that using *Moringa oleifera* gave turbidity removal of 94.82%, 98.5% and 99.3% for the treatment of river water with low, medium and high turbidity, respectively. Also, **EL-hefny, 2008** stated that using

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

of *Moringa oleifera* as a coagulant showed a removal efficiency of turbidity 60%. **Muyibi** and **Alfugara (2003**) documented that optimum dosage of about 100 and 50 mg/l of *M. oleifera* for moderate to high turbidities (50-550 NTU), While The results showed that the optimum flocs settling time of water treated by seed extract of *M. oleifera* was two hours and this agree with findings of **Marobhe et al. (2007)** which reported that optimum dose of floc settling ranged between two and two and half hours. Also, **Sinai, 1990** reported a 92.99% reduction in turbidity within 2 hours settling period for initial turbidities ranging 200-980 NTU using *M. oleifera* dosage of 40- 400 mg/l depending on initial turbidities. Gaikwad and **Munavalli ( 2019)** reported that *M. leifera* have potential for turbidity. This may due to the *M. oleifera* seeds contain soluble protein which serves as a clarifying agent and destabilizes the particles in the water .

**Effect of different dose of *Moringa oleifera* on algal and bacterial count**

When *M. leifera* (50 mg/l) was applied after 120 min settling time. The removal percentage of algae was 95.8.97.5, 99.5 and 97.9 % for diatoms, green algae, blue green algae and total algal count.

By using 50 mg/L dose of *M. oleifera* and 120 min settling time in bacterial load removal, it was found that the removal percent of total bacterial count, total coliform, fecal coliform and fecal *Streptococcus* were 89%, 90%, 93% and 100%, respectively .This showed great reduction in bacterial load in water. These results agree with (**Agrawal et al., 2007**) who reported that the antimicrobial activity of the isolated large molecular mass protein fraction from the seeds of *Moringa oleifera* and **Suarez et al., 2005** approved the efficiency of the polypeptide from *Moringa oleifera* for killing bacteria species. While (**Delegan et al., 2018)** identified the presence of an active antimicrobial agent in *Moringa oleifera* seeds to be capable to kill the bacterial cells. While (**Vunain et al., 2019**) proved that *M. oleifera* have antimicrobial properties for water treatment

The efficiency of *M. oleifera* to reduce algae and bacteria is due to *M. oleifera* contain active polyelectrolyte that neutralize the negative charged colloid in the dirty water this protein makes sedimentation of mineral particles and organics in purification of drinking water **(Bina et al., 2010, Mangale et al., 2012)**

**Application of *Moringa oleifera* as coagulant with Alum**

Coagulation is the most widely used process to remove the substances producing turbidity in water. These substances normally consists largely of clay minerals and microscopic organisms and occur in widely varying sizes ranging from those large enough to settle readily to those small enough to remain in suspension for a very long time

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

Many researchers as (**zaid et al., 2019**) have reported the potential use of *M. oleifera* seed extracts as a primary natural coagulant (instead of aluminum sulphate). Most works on the use of *M. oleifera* in coagulation employ the parameters used in conventional jar tests to evaluate the coagulating efficiency of the seed extract **(Camacho et al., 2017**). While **Mohammed, 2019** stated the application of *M. oleifera* as coagulant aid with alum in water treatment.

The current study, different concentration 0,25,50,75,100% of *M. oleifera* with different concentration of alum (100,75,50,25,0%) were applied. The results show that the best concentration in algal removal is using 75% of *M. oleifera* + 25% of Alum dose, which caused total algal count reduction by 94% while 93% with 100% *Moringa oleifera* dose, 88% with (50% *M.oleifera* + 50% Alum) and 82% with full dose of alum only.

The flocs formed by *M. oleifera* seeds were dense and settled faster than with alum. Also the results show that the best concentration of the reduction of bacterial groups were with 50% of alum with 50% *M. oleifera*. These results agreed with **Folkard and Sutherland (2001)** who reported that dramatic improvements in floc characteristics and significant saving in imported alum usage of the order of 50% to 80%. He also evaluated the performance of *Moringa oleifera* in flocculation of turbid water with alum. They found that *Moringa oleifera* gave equivalent performance to alum in the clarification of highly turbid water. (**Egbuikwem et al., 2013)** confirmed that *M. oleifera* is comparable to alum.( **Paul et al., 2017**) found that *moringa*–aluminate provide a good economical and sustainable alternative raw material and can be used simultaneously with alum to find solution to the use of aluminum sulphate which excess residue on treated water cause deadly diseases.

- **Application of *Moringa oleifera* as coagulant aid with (chlorine +Alum)**

Different doses of *M. oleifera* with different doses of (alum and chlorine) were applied. The results showed that 50% of *M. oleifera* with 50% of (alum with chlorine) caused the highest bacteria and algae removal. The removal of total bacterial count was 65.3% within in range of WHO standards and removal of total coliform was 98.5% while removal of fecal coliform and streptococcus were 100%.

On the other hand the number of diatoms are reduced from 2263 into 260 org/l, number of green algae are reduced from 1576 to 240 org/l, the blue green algae are reduced from 626 to 95 org/l. the removal of total algal count was 85.1% while the removal of algae with normal dose by alum with chlorine was 86.5%. This means the half cost of alum and half cost of chlorine can be saved and keep the health from hazard these results agree with (**Milind et al., 2012)** who compared the cost of *M. oleifera* seeds with that of alum

  

ISSN: 2455-6939

Volume: 07, Issue: 02 "March-April 2021"

The health hazards can be reduced by reducing the amount of alum and chlorine to the half and (**Alsharaa et al., 2016)** proved that *M. oleifera* seed *u*sed as a bio sorbent for the removal of different groups of disinfection by-products (DPBs) as haloethers, trihalomethanes and haloketones (94.9, 90.3 and 86%) respectively from water samples

In general, the results of this study indicate a wide disparity in the efficiency of algal removal among the several processes studied. The using of *Moringa oleifera* as disinfectant may be due to the presence of active ingredients as mentioned by **(Bichi et al., 2012).** The mode of action is attacking the *M. oleifera* seeds extract on the cell wall explained as by rupturing the cell and damaging the intercellular components, when water dips into the cell which causes it to swell more and burst leading to death. The results of some treatment modification were very satisfactory for improving the removal of algal and bacteria raw water

- **Application of Moringa oleifera as disinfectant with chlorine**

The results of using *M. oleifera* with chlorine and reducing its concentration to the half is a great concern, this is due to the presence of an active antimicrobial agent as states by **(Thilza et al., 2010)**, who reported that *M. oleifera* had mild activities against E. coli a and *Enterobacter aerogenes* and Nonfodji et al., 2020 who reported that *M. oleifera* has inhibitory effects on the growth antibiotic resistant bacteria which mean it act as disinfectant. Moreover, **(Suarez et al., 2003)** who stated that Moringa seeds protein may be viable alternative to chemicals commonly used as food preservatives or for water disinfection .While, **(Bichi et al., 2012)** has shown its highest disinfection action was achieved with the used of seed cake.so the high efficiency of M. oleifera in waste water treatment **(Villasenor et al.,2018)**

## 6. CONCLUSION AND RECOMMENDATION

The carried investigation to evaluate the efficiency of *Moringa oleifera* in our community as an alternative to the chemicals used in water treatment steps proved its efficiency in removing turbidity as traditional method by alum and chlorine. *Moringa oleifera can* used as coagulant or as prechlorination aid this mean that the usage of chemical can be reduced by using effective natural coagulant. *M. oleifera* as coagulant or coagulant aid is effective and using *M. oleifera* as water disinfection instead of primary chlorine is effective and gives good results in bacteria and algae reduction. The best results occur in using half dose of *M. oleifera* and half dose of (chlorine with alum combination) by this method half of chemicals cost can be saved and prevent the hazard concern of chlorine and alum.

  

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