Sudan University of Science and Technology

College of Water Resources and Environmental Engineering

Department of Environmental Engineering

Nile Purification Effect of Moringa oleifera seed extract on physicochemical and microbiological quality of water from River

A dissertation submitted to the Sudan University of Science and Technology in partial fulfillment for the degree of Bask(Honors) in Environmental Engineering

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الآية

بسم الله الرحمن الرحيم

{وَمَا خَلَقْنَا السَّمَاوَاتِ وَالْأَرْضَ وَمَا بَيْنَهُمَا لَاعِبِينَ,

مَا خَلَقْنَاهُمَا إِلَّا بِالْحَقِّ وَلَكِنَّ أَكْثَرَهُمْ لَا يَعْلَمُونَ}

صدق الله العظيم

سورة الدخان الآية (38-39)

Dedication

We dedicate this study with our love to our parents who would like to see us in continues success and happy live.

To our brothers and sisters and relatives who always encouraging and supporting us.

To our best friends for their patience, reassurance and encouragement and whose love and trust towards us never fail.

Acknowledgment

first of all, thanks to god for giving us the strength and commitment to finish this research after all obstacles that we went. Also we would like to thank D. Barka Mohammed kabeer for his great efforts of supervising and leading us to accomplish this research.

We would also like to thank the Collage of Water Resources and Environmental Engineering staff for their patience, guidance and encouragement throughout the whole five years .

Especial thanks extended to laboratory teachers for their kind response , patience and kind cooperation .

Finally , we thank each and every person who contributed to this humble project particularly our parents , brothers , and sisters , for everything they gave to enlighten our bath way .

Abstract

This study was carried out to explore the effect of Moringa seeds extract on quality of water sample from River Nile. 20 g moringa seed powder was soaked in a total volume of 100 ml distilled for hour at room temperature, filtered within filter paper to obtain the seed extract. 10ml, 20ml and 30ml extracts were added to 90 ml, 80 ml, and 70 ml River Nile water, respectively. The mixes were incubated at room temperature for 24 hour and then samples were collected for analysis.

The results obtained indicated that the extract obviously affected physical, chemical, and microbiological properties of water. There are decreases in pH and turbidity of water treated with different level of Moringa seeds extracts as compared with raw water; while there is increase in EC. The treatment with the extract also increased Total Hardness (TH) , TH as Ca , TH as Mg because Moringa seeds are good source of minerals.

There are decreases in total count of bacteria and total coliform by treatment with the extract as compared with raw water from river Nile.

The highest decrease in total bacteria count and total coliform in sample treated with 30% Moringa seeds extract. Therefore, it is possible to use different concentrations of Moringa seeds extract to treat turbidity and microbial load in water samples from River Nile.

ملخص البحث

أجريت هذه الدراسة على مياه النيل بهدف معرفة تأثير مستخلص بذور المورنقا على الخواص الكيميائية والفيزيائية والبيولوجية لمياه النيل وتم اختيار موقع لأخذ عينة من مياه النيل عشوائية

تم غمر 20جرام من بدرة بذور المورينقا في حجم كلي مقداره 100ملم وحضن في درجة حرارة الغرفة لمدة ساعة واحده وتمت فلتره المزيج باستخدام ورق الترشيح للحصول علي المستخلص وتمت إضافة 10 ملم و 20 ملم و 30 ملم من المستخلص ل 90 ملم و 80 ملم و 70 ملم من عينة نهر النيل علي التوالي و تم تحضين المزيج في درجة حرارة الغرفة لمده 24 ساعة ثُم أُخذت العينات للتحاليل .

النتائج التي تم الحصول عليها أشارت إلي وجود تأثير واضح علي الخواص الفيزيائية والكيميائية والبيولوجية علي عينة مياه نهر النيل وهنالك انخفاض في الرقم الهيدروجيني والعكورة لعينات الماء الخام بينما هناك زيارة في التوصيل الكهربائي .

المعالجة باستخدام المستخلص أدت إلي زيادة العسر الكلي للكالسيوم والعسر الكلي للمغنيسيوم لان بذور المورنقا مصدر جيد للمعادن وأدت إلي انخفاض في العدد الكلي للبكتيريا وبكتيريا الكوليفورم في العينات التي تمت معالجتها بالمستخلص مقارنة بالعينة الخام واعلي انخفاض في العدد الكلي للبكتيريا وبكتيريا الكوليفورم كانت في العينات التي كانت نسبة المستخلص فيها 30% .

لذلك يمكن استخدام تراكيز مختلفة من المستخلص لمعالجة العكورة والحمل الميكروبي لعينات الماء من نهر النيل .

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CHAPTER ONE

1.Introduction

Water is a transparent fluid which forms the world's streams, lakes, oceans and rain, and is the major constituent of the fluids of living things. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but is often co-exists on Earth with its solid state, ice; and gaseous state, steam (water vapor) (Biswas,1997).

Safe drinking water is essential to humans and other life forms even though it provides no calories or organic nutrients. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation. There is a clear correlation between access to safe water and gross domestic product per capita. However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability (Wikipedia , 2015)

natural water bodies are contaminated by chemical, physical, radioactive or pathogenic microbial substances means.

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. (master , 2007)

Waterborne diseases are pathogenic micro-organisms which are directly transmitted when contaminated drinking water is consumed. Contaminated drinking water used in the preparation of food can be the source of food borne disease through consumption of the same micro-organisms. According to the World Health Organization, diarrheal disease accounts for an estimated 4.1 % of the total daily global burden of disease and is responsible for the deaths of 1.8 million people every year. It was estimated that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene and is mostly concentrated on children in developing countries (masters , 2007).

However recent studies have pointed out several serious drawbacks of using chemical salts in water purification and disinfection.

Therefore, where cheaper alternatives can be found, to replace the conventional treatment chemicals. the use of moringa seeds extract would be a such benefit for people in less developed countries. as a coagulant for water and wastewater treatment.

1.1 Main objectives :

To explore the effect of Moringa oleifera seed extract on physicochemical and microbiological quality of Nile water.

1.2 Specific objectives :

- 1.To evaluate the effect of Moringa seed extract on microbiological quality of Nile water.
- 2.To determine the effect of seed extract on physical properties of Nile water.
- To determine the effect of seed extract on chemical properties of water.
- To determine the effect Moringa on ph.

2.Search Problem

Problems related to chemical salt in water purification

However recent studies have pointed out several serious drawbacks of using chemical salts in water purification and disinfection.

- The cost of procuring these chemicals is increasing rapidly and most developing countries are finding it difficult to cope.
- Alzheimer's disease and similar health related
- problems associated with residual aluminum in
- treated water.
- It produces large sludge volumes.
- It require pH Alkalinity adjustment.
- Low efficiency in coagulation of cold water.

*Then the solve purification water from natural material

CHAPTER TWO

3.Literature review

3.1 definition of water:

Water is a transparent fluid which forms the world's streams, lakes, oceans and rain, and is the major constituent of the fluids of living things. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but is often co-exists on Earth with its solid state, ice; and gaseous state, steam (water vapor) (Biswas,1997).

Water is in three states liquid, solid (ice), and gas (invisible water vapor in the air). While clouds are accumulations of water droplets, condensed from vapor-saturated air (master , 2007).

Water covers 71% of the Earth's surface It is vital for all kind of life. On Earth, 96.5% of the planet's water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor, ```````clouds (formed of solid and liquid water particles suspended in air), and precipitation. Only 2.5% of the Earth's water is freshwater, and 98.8% of that water is in ice and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products. Water on

Earth moves continually through the water cycle of evaporation and transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea. Evaporation and transpiration contribute to the precipitation over land. Water used in the production of a good or service is known as virtual water (Biswas,1997).

Safe drinking water is essential to humans and other life forms even though it provides no calories or organic nutrients. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation. There is a clear correlation between access to safe water and gross domestic product per capita. However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability. A report, issued in November 2009, suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50%.Water plays an important role in the world economy, as it functions as a solvent for a wide variety of chemical substances and facilitates industrial cooling and transportation. Approximately 70% of the fresh water used by humans goes to agriculture (master , 2007).

3.2 Source of water:

The important requirement for human life to exist is water. it is the nature’s free gift to the human race. It is available in various forms such as rivers, lakes, streams, etc. (Biswas,1997).

The importance of water in human life :

The development of any city in the world has practically to be taken place near some source of water supply. It may also further be noted that the water is available in solid, liquid and gas forms. The occurrence of water in all these three forms is basically important for human beings for comfort luxury and various other necessities of life. The used of water by human, plants and animally is universal. As a matter of fact, every living soul requires water for its survival. It is essential for life, health and sanitation. It is the principle raw material for food production and for many other uses outside the home and on farm . (Biswas,1997).

3.3 Pollution of water resources :

Water pollution is the contamination of natural water bodies by chemical, physical, radioactive or pathogenic microbial substances means. 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. In China, for example, about 75 percent of the population (or 1.1 billion people) are without access to unpolluted drinking water, according to China's own standards (Biswas,1997).

Widespread consequences of water pollution upon ecosystems include species mortality, biodiversity reduction and loss of ecosystem services. Some consider that water pollution may occur from natural causes such as sedimentation from severe rainfall events. However , natural causes, including volcanic eruptions and algae blooms from natural causes constitute a minute amount of the instances of world water pollution. The most problematic of water pollutants are microbes that induce disease, since their sources may be construed as natural, but a preponderance of these instances result from human intervention in the environment or human overpopulation phenomena. (www.eoearth.org,2015).

Water pollutant sources can be grouped into two super categories: (a) point sources which can be attributed to discrete discharge from a factory or sewage outfall and (b) non-point sources that include agricultural runoff, urban storm water runoff and other area wide sources. (www.eoearth.org,2015).

Many of the common inorganic chemical water pollutants are produced by non-point sources, chiefly relating to intensive agriculture and high-density urban areas. Specific inorganic chemicals and their major sources are: monopotassium phosphate, ammonium nitrate and a host of related phosphate and nitrogen compounds used in agricultural fertilizers; heavy metals (present in urban runoff and mine tailings area runoff). However, some inorganic such as chlorine and related derivatives are produced chiefly from point sources, ironically employed in water treatment facilities. Moreover, some of the large dischargers of heavy metals to aquatic media are fixed point industrial plants (www.eoearth.org,2015).

Improper storage and use of automotive fluids produce common organic chemicals causing water pollution are: methanol and ethanol (present in wiper fluid); gasoline and oil compounds such as octane, nonane (overfilling of gasoline tanks) ; most of these foregoing discharges are considered non-point sources since their pathway to watercourses is mainly overland flow. However, leaking underground and above ground storage tanks can be considered point sources for some of these same chemicals, and even more toxic organics such as perchloroethylene. Grease and fats (higher chain length carbon molecules such as present in auto lubrication and restaurant effluent can be either point or non-point sources depending upon whether the restaurant releases grease into the wastewater collection system (point source) or disposes of such organics on the exterior ground surface or transports to large landfills, both of which last two cases lead to non-point release to water systems (www.eoearth.org,2015).

The most significant physical pollutant is excess sediment in runoff from agricultural plots, clear-cut forests, improperly graded slopes, urban streets and other poorly managed lands, especially when steep slopes or lands near streams are involved. Other physical pollutants include a variety of plastic refuse products such as packaging materials; the most pernicious of these items are ring shaped objects that can trap or strangle fish and other aquatic fauna. Other common physical objects are timber slash debris, waste paper and cardboard. Finally power plants and other industrial facilities that use natural water bodies for cooling are the main sources of thermal pollution (www.eoearth.org,2015).

3.4 Water transmitted diseases :

Common pathogenic microbes, in addition to G. lamella, are: species of the genus Salmonella (which variously cause typhoid fever and food-borne illnesses); species in the genus Cryptosporidium, which are fecal-oral route parasites often transmitted as water pollutants and are associated with inadequate sanitation; parasitic worms that live inside faunal digestive systems for part of their life cycle (This widespread syndrome is spread partially as water pollutants, with an estimated three billion people currently affected). Hepatitis A is a viral disease, one of whose pathways of transmission is water-borne (Alley , 2000).

Waterborne diseases are pathogenic micro-organisms which are directly transmitted when contaminated drinking water is consumed. Contaminated drinking water used in the preparation of food can be the source of food borne disease through consumption of the same micro-organisms. According to the World Health Organization, diarrheal disease accounts for an estimated 4.1 % of the total daily global burden of disease and is responsible for the deaths of 1.8 million people every year. It was estimated that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene and is mostly concentrated on children in developing countries. (Alley , 2000).

Waterborne disease can be caused by protozoa, viruses, bacteria, and intestinal parasites. Bacterial infections of water include: Cholera – Vibrio cholera bacteria – gastro-intestinal often waterborne, Botulism – Clostridium botulinum bacteria – gastrointestinal food/water borne; can grow in food, Typhoid – Salmonella typhi bacteria – gastro-intestinal water/food borne, Dysentery –Shigella / Salmonella bacteria – gastrointestinal food/water. Viral Infections include: Hepatitis A – Hepatitis A virus – astrointestinal water/food borne, Polio – polioviruses – gastro-intestinal exposure (Alley,2000).

4.Treatment

4.1 re-treatment

1. Pumping and containment – The majority of water must be pumped from its source or directed into pipes or holding tanks. To avoid adding contaminants to the water, this physical infrastructure must be made from appropriate materials and constructed so that accidental contamination does not occur.
2. Screening (*see also* *screen filter*) – The first step in purifying surface water is to remove large debris such as sticks, leave ,rubbish and other large particles which may interfere with subsequent purification step Most deep groundwater does not need screening before other purification steps.
3. Storage – Water from rivers may also be stored in bankside reservoirs for periods between few day and many months to allow natural biological purification to take place. This is especially important if treatment is by slow sand filters. Storage reservoirs also provide a buffer against short periods of drought or to allow water supply to be maintained during transitory pollution incidents in the source river.

Pre-chlorination – In many plants the incoming water was chlorinated to minimize the growth of fouling organisms on the pipe-work and tanks. Because of the potential adverse quality effects (see chlorine below), this has largely been discontinued.

4.2 Unit processes in water treatment

4.2.1 pH adjustment

Pure water has a pH close to 7 (neither alkaline nor acidic). Sea water can have pH values that range from 7.5 to 8.4 (moderately alkaline). Fresh water can have widely ranging pH values depending on the geology of th drainage basin or aquifer and the influence of contaminant inputs (acid rain). If the water is acidic (lower than 7), lime, soda ash, or sodium hydroxide can be added to raise the pH during water purification processes.

Lime addition increases the calcium ion concentration, thus raising the water hardness. For highly acidi waters, forced draft degasifies can be an effective way to raise the pH, by stripping dissolved carbon dioxide from the water.

- Making the water alkaline helps coagulation and flocculation processes work effectively and also helps to minimize the risk of lead being dissolved from lead pipes and from lead solder in pipe fittings. Sufficient alkalinity also reduces the corrosiveness of water to iron pipes Acid (carbonic acid, hydrochloric acid or sulfuric acid) may be added to alkaline waters in some circumstances to lower the pH Alkaline water (above pH 7.0) does not necessarily mean that lead or copper from the plumbing system will not be dissolved into the water. The ability of water to precipitate calcium carbonate to protect metal surfaces and reduce the likelihood of toxic metals being dissolved in water is a function of pH, mineral content, temperature, alkalinity and calcium concentration

4.2.2 Coagulation and flocculation

See also: particle aggregation

One of the first steps in a conventional water purification process is the addition of chemicals to assist in the removal of particles suspended in water. Particles can be inorganic such as clay and silt or organic such as algae, bacteria, viruses, protozoa and natural organic matter Inorganic and organic particles contribute to the turbidity and color of water.

The addition of inorganic coagulants such as aluminum sulfate (or alum) or iron (III) salts such as iron(III) chloride cause several simultaneous chemical and physical interactions on and among the particles. Within seconds, negative charges on the particles are neutralized by inorganic coagulants. Also within seconds, metal hydroxide precipitates of the aluminum and iron (III) ions begin to form. These precipitates combine into larger particles under natural processes such as Brownian motion and through induced mixing which is sometimes referred to as flocculation. The term most often used for the amorphous metal hydroxides is "floc." Large, amorphous aluminum and iron (III) hydroxides adsorb and enmesh particles in suspension and facilitate the removal of particles by subsequent processes of sedimentation and filtration.

Aluminum hydroxides are formed within a fairly narrow pH range, typically : 5.5 to about 7.7. Iron (III) hydroxides can form over a larger pH range including pH levels lower than are effective for alum, typically: 5.0 to 8.5.

In the literature, there is much debate and confusion over the usage of the terms coagulation and flocculation—where does coagulation end and flocculation begin? In water purification plants, there is usually a high energy, rapid mix unit process (detention time in seconds) where the coagulant chemicals are added followed by flocculation basins (detention times range from 15 to 45 minutes) where low energy inputs turn large paddles or other gentle mixing devices to enhance the formation of floc. In fact, coagulation and flocculation processes are ongoing once the metal salt coagulants are added.

Organic polymers were developed in the 1960s as aids to coagulants and, in some cases, as replacements for the inorganic metal salt coagulants. Synthetic organic polymers are high molecular weight compounds that carry negative, positive or neutral charges. When organic polymers are added to water with particulates, the high molecular weight compounds adsorb onto particle surfaces and through interparticle bridging coalesce with other particles to form floc. PolyDADMAC is a popular cationic (positively charged) organic polymer used in water purification plants.

4.2.3 Sedimentation

Waters exiting the flocculation basin may enter the sedimentation basin, also called a clarifier or settling basin. It is a large tank with low water velocities, allowing floc to settle to the bottom.

The sedimentation basin is best located close to the flocculation basin so the transit between the two processes does not permit settlement or floc break up. Sedimentation basins may be rectangular, where water flows from end to end, or circular where flow is from the centre outward. Sedimentation basin outflow is typically over a weir so only a thin top layer of water—that furthest from the sludge—exits.

In 1904, Allen Hazen showed that the efficiency of a sedimentation process was a function of the particle settling velocity, the flow through the tank and the surface area of tank. Sedimentation tanks are typically designed within a range of overflow rates of 0.5 to 1.0 gallons per minute per square foot (or 1.25 to 2.5 meters per hour). In general, sedimentation basin efficiency is not a function of detention time or depth of the basin. Although, basin depth must be sufficient so that water currents do not disturb the sludge and settled particle interactions are promoted. As particle concentrations in the settled water increase near the sludge surface on the bottom of the tank, settling velocities can increase due to collisions and agglomeration of particles. Typical detention times for sedimentation vary from 1.5 to 4 hours and basin depths vary from 10 to 15 feet (3 to 4.5 meters).

Inclined flat plates or tubes can be added to traditional sedimentation basins to improve particle removal performance. Inclined plates and tubes drastically increase the surface area available for particles to be removed in concert with Hazen's original theory. The amount of ground surface area occupied by a sedimentation basin with inclined plates or tubes can be far smaller than a conventional sedimentation basin.

4.2.4 Sludge storage and removal

As particles settle to the bottom of a sedimentation basin, a layer of sludge is formed on the floor of the tank which must be removed and treated. The amount of sludge generated is significant, often 3 to 5 percent of the total volume of water to be treated. The cost of treating and disposing of the sludge can impact the operating cost of a water treatment plant. The sedimentation basin may be equipped with mechanical cleaning devices that continually clean its bottom, or the basin can be periodically taken out of service and cleaned manually.

4.2.5 Floc blanket clarifiers

A subcategory of sedimentation is the removal of particulates by entrapment in a layer of suspended floc as the water is forced upward. The major advantage of floc blanket clarifiers is that they occupy a smaller footprint than conventional sedimentation. Disadvantages are that particle removal efficiency can be highly variable depending on changes in influent water quality and influent water flow rate.

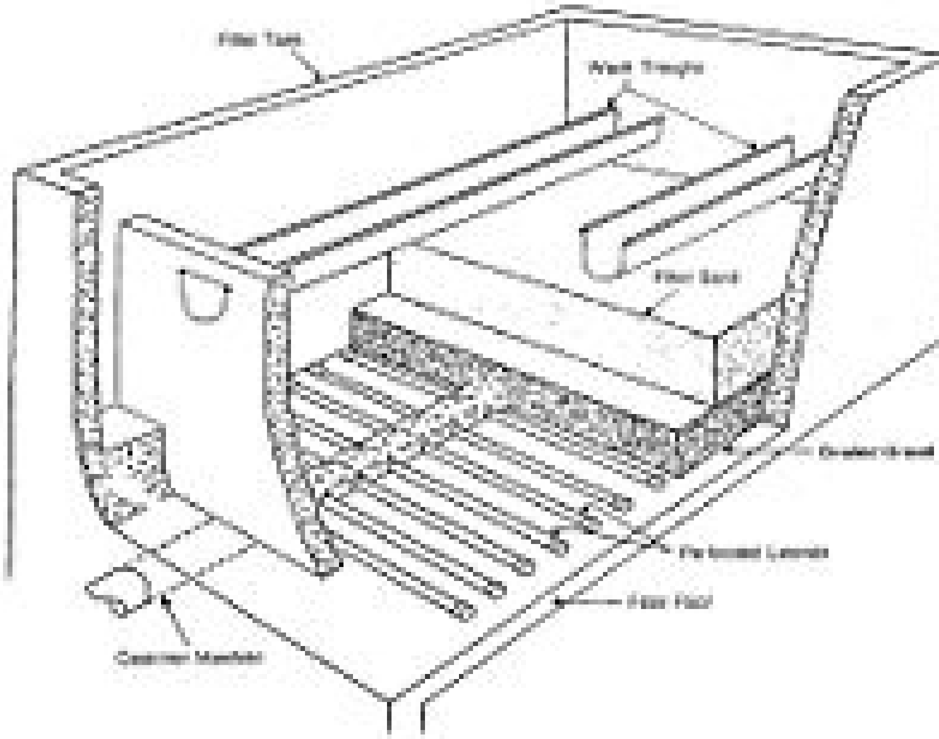
4.2.6 Dissolved air flotation

When particles to be removed do not settle out of solution easily, dissolved air flotation (DAF) is often used. Water supplies that are particularly vulnerable to unicellular algae blooms and supplies with low turbidity and high color often employ DAF. After coagulation and flocculation processes, water flows to DAF tanks where air diffusers on the tank bottom create fine bubbles that attach to floc resulting in a floating mass of concentrated floc. The floating floc blanket is removed from the surface and clarified water is withdrawn from the bottom of the DAF tank.

4.2.7 Filtration

After separating most floc, the water is filtered as the final step to remove remaining suspended particles and unsettled floc.

4.2.7.1 Rapid sand filters



Cutaway view of a typical rapid sand filter

The most common type of filter is a rapid sand filter. Water moves vertically through sand which often has a layer of activated carbon or anthracite coal above the sand. The top layer removes organic compounds, which contribute to taste and odour. The space between sand particles is larger than the smallest suspended particles, so simple filtration is not enough. Most particles pass through surface layers but are trapped in pore spaces or adhere to sand particles. Effective filtration extends into the depth of the filter. This property of the filter is key to its operation: if the top layer of sand were to block all the particles, the filter would quickly clog.

To clean the filter, water is passed quickly upward through the filter, opposite the normal direction (called *back flushing* or *backwashing*) to remove embedded particles. Prior to this step, compressed air may be blown up through the bottom of the filter to break up the compacted filter media to aid the backwashing process; this is known as *air scouring*. This contaminated water can be disposed of, along with the sludge from the sedimentation basin, or it can be recycled by mixing with the raw water entering the plant although this is often considered poor practice since it re-introduces an elevated concentration of bacteria into the raw water.

Some water treatment plants employ pressure filters. These work on the same principle as rapid gravity filters, differing in that the filter medium is enclosed in a steel vessel and the water is forced through it under pressure.

Advantages:

- Filters out much smaller particles than paper and sand filters can.
- Filters out virtually all particles larger than their specified pore sizes.
- They are quite thin and so liquids flow through them fairly rapidly.
- They are reasonably strong and so can withstand pressure differences across them of typically 2–5 atmospheres.
- They can be cleaned (back flushed) and reused.

4.2.7.2 Slow sand filters

Slow "artificial" filtration (a variation of bank filtration) to the ground, Water purification plant Káraný, Czech Republic

A profile of layers of gravel, sand and fine sand used in a slow sand filter plant.

Slow sand filters may be used where there is sufficient land and space, as the water must be passed very slowly through the filters. These filters rely on biological treatment processes for their action rather than physical filtration. The filters are carefully constructed using graded layers of sand, with the coarsest sand, along with some gravel, at the bottom and finest sand at the top. Drains at the base convey treated water away for disinfection. Filtration depends on the development of a thin biological layer, called the zoogleal layer or Schmutzdecke, on the surface of the filter. An effective slow sand filter may remain in service for many weeks or even months if the pre-treatment is well designed and produces water with a very low available nutrient level which physical methods of treatment rarely achieve. Very low nutrient levels allow water to be safely sent through distribution systems with very low disinfectant levels, thereby reducing consumer irritation over offensive levels of chlorine and chlorine by-products. Slow sand filters are not backwashed; they are maintained by having the top layer of sand scraped off when flow is eventually obstructed by biological growth.[*citation needed*]

A specific "large-scale" form of slow sand filter is the process of bank filtration, in which natural sediments in a riverbank are used to provide a first stage of contaminant filtration. While typically not clean enough to be used directly for drinking water, the water gained from the associated extraction wells is much less problematic than river water taken directly from the major streams where bank filtration is often used.[*citation needed*]

4.2.7.3 Membrane filtration

Membrane filters are widely used for filtering both drinking water and sewage. For drinking water, membrane filters can remove virtually all particles larger than 0.2 um—including *giardia* and *cryptosporidium*. Membrane filters are an effective form of tertiary treatment when it is desired to reuse the water for industry, for limited domestic purposes, or before discharging the water into a river that is used by towns further downstream. They are widely used in industry, particularly for beverage preparation (including bottled water). However no filtration can remove substances that are actually dissolved in the water such as phosphorus, nitrates and heavy metal ions.

4.2.8 Removal of ions and other dissolved substances

Ultra filtration membranes use polymer membranes with chemically formed microscopic pores that can be used to filter out dissolved substances avoiding the use of coagulants. The type of membrane media determines how much pressure is needed to drive the water through and what sizes of micro-organisms can be filtered out.

Ion exchange: Ion exchange systems use ion exchange resin- or zeolite-packed columns to replace unwanted ions. The most common case is water softening consisting of removal of Ca^{2+} and Mg^{2+} ions replacing them with benign (soap friendly) Na^{+} or K^{+} ions. Ion exchange resins are also used to remove toxic ions such as nitrite, lead, mercury, arsenic and many others.

Precipitative softening: Water rich in hardness (calcium and magnesium ions) is treated with lime (calcium oxide) and/or soda-ash (sodium carbonate) to precipitate calcium carbonate out of solution utilizing the common-ion effect.

Electrode ionization: Water is passed between a positive electrode and a negative electrode. Ion exchange membranes allow only positive ions to migrate from the treated water toward the negative electrode and only negative ions toward the positive electrode. High purity deionizer water is produced continuously, similar to ion exchange treatment. Complete removal of ions from water is possible of the right conditions are met. The water is normally pre-treated with a reverse osmosis unit to remove non-ionic organic contaminants, and with gas transfer membranes to remove carbon dioxide. A water recovery of 99% is possible if the concentrate stream is fed to the RO inlet.

4.2.9 Disinfection

Pumps used to add required amount of chemicals to the clear water at the water purification plant before the distribution. From left to right: sodium hypochlorite for disinfection, zinc orthophosphate as a corrosion inhibitor, sodium hydroxide for pH adjustment, and fluoride for tooth decay prevention.

Disinfection is accomplished both by filtering out harmful micro-organisms and also by adding disinfectant chemicals. Water is disinfected to kill any pathogens which pass through the filters and to provide a residual dose of disinfectant to kill or inactivate potentially harmful micro-organisms in the storage and distribution systems. Possible pathogens include viruses, bacteria, including *Salmonella*, *Cholera*, *Campylobacter* and *Shigella*, and protozoa, including *Giardia lamella* and other *cryptosporidium*. Following the introduction of any chemical disinfecting agent, the water is usually held in temporary storage – often called a contact tank or clear well to allow the disinfecting action to complete.

4.2.9.1 Chlorine disinfection

Main article: Water chlorination

the most common disinfection method involves some form of chlorine or its compounds such as chloramines or chlorine dioxide. Chlorine is a strong oxidant that rapidly kills many harmful micro-organisms. Because chlorine is a toxic gas, there is a danger of a release associated with its use. This problem is avoided by the use of sodium hypochlorite, which is a relatively inexpensive solution that releases free chlorine when dissolved in water. Chlorine solutions can be generated on site by electrolyzing common salt solutions. A solid form, calcium hypochlorite, releases chlorine on contact with water. Handling the solid, however, requires greater routine human contact through opening bags and pouring than the use of gas cylinders or bleach which are more easily automated. The generation of liquid sodium hypochlorite is both inexpensive and safer than the use of gas or solid chlorine.

All forms of chlorine are widely used, despite their respective drawbacks. One drawback is that chlorine from any source reacts with natural organic compounds in the water to form potentially harmful chemical by-products. These by-products, trihalomethanes (THMs) and halo acetic acids (HAAs), are both carcinogenic in large quantities and are regulated by the United States Environmental Protection Agency (EPA) and the Drinking Water Inspectorate in the UK. The formation of THMs and haloacetic acids may be minimized by effective removal of as many organics from the water as possible prior to chlorine addition. Although chlorine is effective in killing bacteria, it has limited effectiveness against protozoa that form cysts in water (Guardia and *Cryptosporidium*, both of which are pathogenic).

4.2.9.2 Chlorine dioxide disinfection

Chlorine dioxide is a faster-acting disinfectant than elemental chlorine. It is relatively rarely used, because in some circumstances it may create excessive amounts of chlorite, which is a by-product regulated to low allowable levels in the United States. Chlorine dioxide can be supplied as an aqueous solution and added to water to avoid gas handling problems; chlorine dioxide gas accumulations may spontaneously detonate.

4.2.9.3 Chloramines disinfection

The use of chloramines is becoming more common as a disinfectant. Although chloramines is not as strong an oxidant, it does provide a longer-lasting residual than free chlorine and it will not readily form THMs or halo acetic acids. It is possible to convert chlorine to chloramines by adding ammonia to the water after addition of chlorine. The chlorine and ammonia react to form chloramines. Water distribution systems disinfected with chloramines may experience nitrification, as ammonia is a nutrient for bacterial growth, with nitrates being generated as a by-product.

4.2.9.4 Ozone disinfection

Ozone is an unstable molecule which readily gives up one atom of oxygen providing a powerful oxidizing agent which is toxic to most waterborne organisms. It is a very strong, broad spectrum disinfectant that is widely used in Europe. It is an effective method to inactivate harmful protozoa that form cysts. It also works well against almost all other pathogens. Ozone is made by passing oxygen through ultraviolet light or a "cold" electrical discharge. To use ozone as a disinfectant, it must be created on-site and added to the water by bubble contact. Some of the advantages of ozone include the production of fewer dangerous by-products and the absence of taste and odor problems (in comparison to chlorination) . Another advantage of ozone is that it leaves no residual disinfectant in the water. Ozone has been used in drinking water plants since 1906 where the first industrial ozonation plant was built in Nice, France. The U.S. Food and Drug Administration has accepted ozone as being safe; and it is applied as an anti-microbiological agent for the treatment, storage, and processing of foods. However, although fewer by-products are formed by ozonation, it has been discovered that ozone reacts with bromide ions in water to produce concentrations of the suspected carcinogen bromated. Bromide can be found in fresh water supplies in sufficient concentrations to produce (after ozonation) more than 10 parts per billion (ppb) of bromated — the maximum contaminant level established by the USEPA.

4.2.9.5 Ultraviolet disinfection

Ultraviolet light (UV) is very effective at inactivating cysts, in low turbidity water. UV light's disinfection effectiveness decreases as turbidity increases, a result of the absorption, scattering, and shadowing caused by the suspended solids. The main disadvantage to the use of UV radiation is that, like ozone treatment, it leaves no residual disinfectant in the water; therefore, it is sometimes necessary to add a residual disinfectant after the primary disinfection process. This is often done through the addition of chloramines, discussed above as a primary disinfectant. When used in this manner, chloramines provide an effective residual disinfectant with very few of the negative effects of chlorination.

4.3 Portable water purification

Main article: Portable water purification

Portable water purification devices and methods are available for disinfection and treatment in emergencies or in remote locations. Disinfection is the primary goal, since aesthetic considerations such as taste, odor, appearance, and trace chemical contamination do not affect the short-term safety of drinking water.

4.4 Additional treatment options

1. Water fluoridation: in many areas fluoride is added to water with the goal of preventing tooth decay.[14] Fluoride is usually added after the disinfection process. In the U.S., fluoridation is usually accomplished by the addition of hexafluorosilicic acid,[15] which decomposes in water, yielding fluoride ions.[16]
2. Water conditioning: This is a method of reducing the effects of hard water. In water systems subject to heating hardness salts can be deposited as the decomposition of bicarbonate ions creates carbonate ions that precipitate out of solution. Water with high concentrations of hardness salts can be treated with soda ash (sodium carbonate) which precipitates out the excess salts, through the common-ion effect, producing calcium carbonate of very high purity. The precipitated calcium carbonate is traditionally sold to the manufacturers of toothpaste. Several other methods of industrial and residential water treatment are claimed

(without general scientific acceptance) to include the use of magnetic and/or electrical fields reducing the effects of hard water.[citation needed]

3. Plumb solvency reduction: In areas with naturally acidic waters of low conductivity (i.e. surface rainfall in upland mountains of igneous rocks), the water may be capable of dissolving lead from any lead pipes that it is carried in. The addition of small quantities of phosphate ion and increasing the pH slightly both assist in greatly reducing plumb-solvency by creating insoluble lead salts on the inner surfaces of the pipes.
4. Radium Removal: Some groundwater sources contain radium, a radioactive chemical element. Typical sources include many groundwater sources north of the Illinois River in Illinois. Radium can be removed by ion exchange, or by water conditioning. The back flush or sludge that is produced is, however, a low-level radioactive waste.
5. Fluoride Removal: Although fluoride is added to water in many areas, some areas of the world have excessive levels of natural fluoride in the source water. Excessive levels can be toxic or cause undesirable cosmetic effects such as staining of teeth. Methods of reducing fluoride levels is through treatment with activated alumina and bone char filter media.

Problems related to chemical salt in water purification

However recent studies have pointed out several serious drawbacks of using chemical salts in water purification and disinfection.

- The cost of procuring these chemicals is increasing rapidly and most developing countries are finding it difficult to cope.
- Alzheimer’s disease and similar health related
- problems associated with residual aluminum in
- treated water.
- It produces large sludge volumes.
- It require pH Alkalinity adjustment.
- Low efficiency in coagulation of cold water.

Alternatives to chemicals

Therefore, where cheaper alternatives can be found, to replace or supplement the conventional treatment chemicals, their use would be a welcome benefit for the poorer less developed countries.

Coagulation-flocculation followed by sedimentation, filtration and disinfection, often by chlorine, is used worldwide in the water treatment industry before the distribution of treated water to consumers.

However recent studies have pointed out several serious drawbacks of using Aluminum salts.(Hammer , 2004)

5.Moringa oleifera:

It tropical plant belonging to the family Moringaceae .Seeds are brown, and the kernels are white Crushed whole seed or press cake remaining after oil extraction as a coagulant for water and wastewater treatment.(Majithiya H.M,2001)

Moringa oleifera is the most widely cultivated species of the genus Moringa, which is the only genus in the family Moringaceae. English common names include: Moringa, drumstick tree (from the appearance of the long, slender, triangular seed-pods), horseradish tree (from the taste of the roots, which resembles horseradish), Ben oil tree, or benzoic tree (from the oil which is derived from the seeds). It is a fast-growing, drought-resistant tree, native to the southern foothills of the Himalayas in northwestern India, and widely cultivated in tropical and subtropical areas where its young seed pods and leaves are used as vegetables. It can also be used for water purification and hand washing, and is sometimes used in herbal medicine.

M. oleifera is a fast-growing, deciduous tree. It can reach a height of 10–12 m (32-40 ft) and the trunk can reach a diameter of 45 cm (1.5 ft). The bark has a whitish-grey color and is surrounded by thick cork. Young shoots have purplish or greenish-white, hairy bark. The tree has an open crown of drooping, fragile branches and the leaves build up a feathery foliage of trip innate leaves.

The flowers are fragrant and bisexual, surrounded by five unequal, thinly veined, yellowish-white petals. The flowers are about 1.0-1.5 cm (1/2")long and 2.0 cm (3/4")broad. They grow on slender, hairy stalks in spreading or drooping later flower clusters which have a length of 10–25 cm.

Flowering begins within the first six months after planting. In seasonally cool regions, flowering only occurs once a year between April and June. In more constant seasonal temperatures and with constant rainfall, flowering can happen twice or even all year-round.

The fruit is a hanging, three-sided brown capsule of 20–45 cm size which holds dark brown, globular seeds with a diameter around 1 cm. The seeds have three whitish papery wings and are dispersed by wind and water.

In cultivation, it is often cut back annually to 1–2 m (3-6 ft) and allowed to regrow so the pods and leaves remain within arm's reach.

Leaves:

Average yields of 6 tons/ha/year in fresh matter are can be achieved. The harvest differs strongly between the rainy and dry seasons, with 1120 kg/ha per harvest and 690 kg/ha per harvest, respectively. The leaves and stems can be harvested from the young plants 60 days after seeding and then another seven times in the year. At every harvest, the plants are cut back to within 60 cm of the ground. In some production systems, the leaves are harvested every 2 weeks.

The cultivation of M. oleifera can also be done intensively with irrigation and fertilization with suitable varieties. Trials in Nicaragua with 1 million plants per hectare and 9 cuttings/year over 4 years gave an average fresh matter production of 580 metric tons/ha/year, equivalent to about 174 metric tons of fresh leaves.

Oil :

One estimate for yield of oil from kernels is 250 l/ha.[15] The oil can be used as a food supplement, as a base for cosmetics, and for hair and the skin.

Pests and diseases :

The Moringa tree is not affected by any serious diseases in its native or introduced ranges. In India, several insect pests are seen, including various caterpillars such as the bark-eating caterpillar, the hairy caterpillar or the green leaf caterpillar. The budworms Noctuidae are known to cause serious defoliation. Damaging agents can also be aphids, stem borers, and fruit flies. In some regions, termites can also cause minor damage. If termites are numerous in soils, insects management costs are not bearable.

The Moringa tree is a host to Leveillula taurica, a powdery mildew which causes damage in papaya crops in south India. Cultivation management should therefore be checked. (wikipidia, 2015)

Advantage of Moringa oleifera coagulant over chemicals:

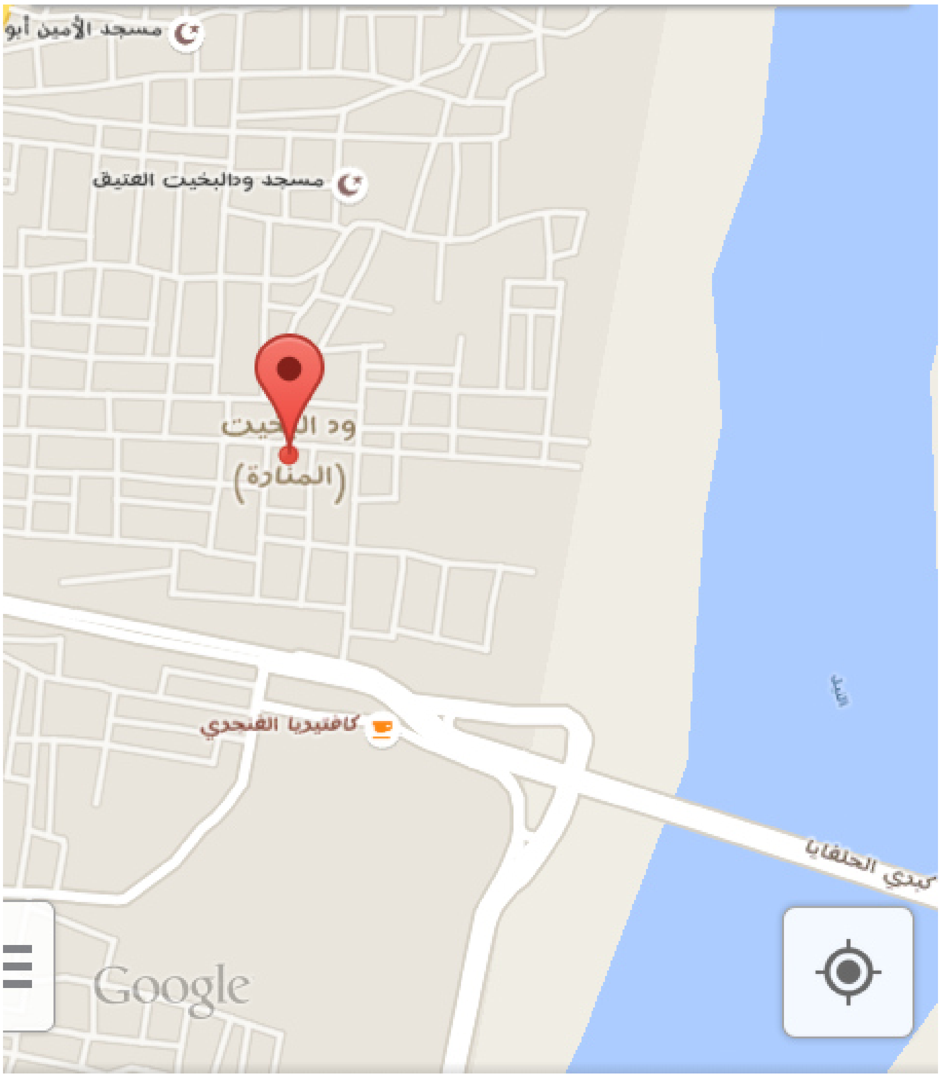
- It is natural, completely non-toxic.
- The M. Oleifera seed extract appears to have.
- natural buffering capacity so, no pH alkalinity.
- Adjustments are required.

- Beside level of turbidity it reduces the level of microorganism in water.

CHAPTER THREE

6.Area of the study

Omdurman Manara water treatment plant



7. Materials and methods

7.1 Materials :

Water samples were collected from River Nile. Moringa seeds (Plate 1) were obtained from a local market in Khartoum North (Khartoum state). Different chemical for analysis were obtained from Water Quality Laboratory- Department of Environmental Engineering (College of Water Resources and Environmental Engineering, Sudan University of Science and Technology).

Preparation of Moringa seed extract:

Moringa oleifera seeds were bought, descended, and the seeds ground into fine powder. 20 gram was weighed in a sensitive balance, and soaked in a total volume of 100 ml distilled water in 250 ml baker. After one hour incubation at room temperature, filtered within filter paper to obtain the seed extract.

Plate1: filtration of Moringa seeds extract

Plate2: Moringa seeds extract

7.2 Treatment of water :

10ml, 20ml -30ml extracts were added to three different bakers containing 90 ml, 80 ml, and 70 ml River Nile water, respectively. The bakers were incubated at room temperature for 24 hour (Plate 3)and then samples were collected for physicochemical and microbiological analysis.

Plate3 : water samples treated with different levels of Moringa seeds extract

Plate 4: treated water

7.3 Analysis :

7.3.1 Microbiological analysis :

7.3.1.1. Total Bacterial Count :

The plate count technique is relies on visible bacterial colonies on agar medium. Samples were collected from treated water and serially diluted and plated on nutrient agar plate. The colonies formed were counted as Colony Forming Unit (CFU).

7.3.1.2. Total Coli form (TC) Enumeration :

MPN method (Multiple Tubes Test) for TC counts a series of five fermentation tubes of lauryl sulphate broth (LSB) (Merck) were inoculated with appropriate volumes of 10-fold dilutions of water samples, and incubated at 37°C for 48h. All gas positive LSB tubes were sub-cultured to tubes of brilliant green lactose bile broth (BGLB) (Merck) and incubated at 37°C for 48h. Gas-positive BGLB tubes were considered positive for the presence of TCs.

7.3.2 Physical analysis :

7.3.2.1 pH :

Samples were collected and their pH was directly measured by calibrated pH meter at room temperature.

7.3.2.2 Turbidity :

Turbidity of collected samples was directly measured by turbidly meter. The bottle of the instrument was washed well with distil water and filled to the sign with collected water samples then putted in the turbidity meter and the result was directly recorded.

7.3.2.3 TDS & EC :

TDS & EC of collected samples were directly measured by EC meter. The bottle of the instrument was washed well with distil water and filled to the sign with collected water samples then putted in the EC meter and the result was directly recorded.

7.3.3 Chemical analysis :

7.3.3.1 Total hardness :

Total hardness tools was washed well with distil water then burette was fill with (EDTA) 5ml was taken from treated water sample and added to 2ml buffer and tittered with eirochrom till color changed to pink then further the mixer was tittered till the color changed to blue.

Ca^{++}:

Tools was washed well with distil water then burette was fill with EDTA. 5ml of treated water sample was measured and added to 2ml NaOH and tittered with myriad till color changed to pink, then the mixer was further tittered till color changed to violet.

T.H = (V*M*W*100)/ (ml water sample)

V: Burette volume

M: EDTA molarities (0.01)

W: Molecular weigh

CHAPTER FOUR

8. Results and discussion

8.1 Effect of treatment with different level of Moringa seeds extract on physical properties of samples from River Nile water

As shown in Table 1, treatment with Moringa seeds extract affected physical properties of River Nile water.

8.1.1 pH:

There is decrease in pH of water treated with different levels of Moringa seeds extracts as compared with raw water (Table 1). Despite the reduction, the levels of pH were within the standard range of water quality.

8.1.2 Turbidity:

There is an observable decrease in turbidity of water treated with different level of Moringa seeds extracts as compared with raw water (table1).the level of turbidity in different treated water was within the stander range of drinking water stander which was (5-100 NTU)

8.1.3 EC:

There is increase in EC of water treated with Moringa seeds extract (table1) , but the increase still within normal range of the water quality stander which was (5-2500 MS). this increase because Moringa seeds extract is good source of minerals.

8.1.4 TDS:

There is increase in (TDS) value of water treated with Moringa seeds extract (table1). But the increase still within range of water quality stander which was (1-1000 MK). that is because Moringa seeds extract have a lot of minerals.

Table 1: Physical properties of River Nile water treated with Moringa seeds extract :

	Raw water	**10% Moringa seeds extract**	**20%**	**30%**	**Water treated with Bac**	**Stander quality range of drinking water**
pH	8.327	7.27	7.52	8.03	8.18	6.5 - 8.5
Turbidity(NTU)	56.2	23.3	21.7	20.9	5	5 – 100
EC(MS)	216.5	219.45	223.9	232.3	216.9	0-2500
TDS(MK)	119.08	163.18	172.28	177.28	119.18	0-1000

8.2 Effect of treatment with different levels of Moringa seeds extract on chemicals properties of water samples from River Nile

8.2.1 Hardness

As shown in Table 2, treatment with Moringa seeds extract affected hardness of River Nile water. Although the levels of different hardness in raw water was within the stander range of drinking water.

At the high doses of Moringa oleifera seeds extract there is decrease in (mg) and hardness value and increase in ca value. Because Moringa oleifera seed is a good source of calcium.

Table 2: Hardness of River Nile water treated with Moringa seeds extract :

	T.H as(caco$_3$)	**T.H as ca(mg/l)**	**T.H as mg(mg/l)**
Stander range	0-500	0-500	0-500
Raw	45	15.05	28.9
10%	112.43	19	92.50
20%	100	23.07	78
30%	44	23.8	68.6

Total hardness and total hardness as(mg) water treated with different Moringa seeds extract levels is shown in table 2 . The highs increase at the lowest doses of the extract while ca level in raw water increase by increase doses of the extract.

8.3 Effect of treatment with Moringa seeds extract on microbiological quality of water samples from River Nile

As shown in Table 3, treatment with Moringa seeds extract affected microbiological quality of water.
There is slight decrease in total count of bacteria (Table 3). As compared with raw water from river Nile. The highs decrease was in the sample treated with 30% Moringa seeds extract.

Table 3: Microbiological quality of water treated with Moringa seeds extract

Water sample	Total count	Total coli form (MPN)
Reference		0.0
Raw	$68*10^7$	210
10%	$56*10^7$	210
20%	$53*10^7$	75
30%	$52*10^7$	38

Total coli form was decrease by increase in levels of Moringa seeds extract. The highs decrease was in the sample treated with 30% Moringa seeds extract.

<u>CHAPTER FIVE</u>

9. Conclusion and recommendations

9.1 Conclusion :

Moringa oleifera seed extract could be use in water treatment in ruler areas which have no water treatment services; since the seeds are cheap and available.

Different doses from Moringa oleifera seeds extracts gave an observed effect but the higher doses was the most.

Moringa oleifera seeds extracts has a small effect in microbiological characters of Nile water that required more studies to take the benefit from this tree.

Using Moringa seeds extract leads to increase in pH,EC and TDS values and decrease in turbidity, total count and total coli form .

This increasing and decreasing which happened effect of water ca and mg content of the treated water as compared with the raw water.

9.2 Recommendation :

- Encourage planting Moringa oleifera trees in every home to get its benefits.
- Encourage Using of Moringa oleifera seeds extract effects on chemicals ,physicals and microbiological characteristics of Nile river water .
- further studies is needed to explore the effect of high doses of Moringa seeds extract on quality of river Nile water.

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