PURIFICATION OF WATER USING MORINGA *OLEIFERA* SEEDS

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ABSTRACT

Water borne diseases are one of the main problems in developing countries. In many communities of the developing countries water clarification methods like flocculation, coagulation and sedimentation are often inappropriate because of high cost and low availability of chemical coagulants. Therefore this study was undertaken to evaluate the suitability and efficacy of natural coagulant from Moringa oleifera seeds in treating surface water. The water samples were collected from Rivers Landzun and Mussa at three different points each. The surface water was sampled by collection from each point in the river with one litre white plastic bottles. Cation concentrations were determined using Atomic Absorption Spectrophotometer while turbidity, PH and colour were determined using turbidity meter, PH meter and colour comparative disc respectively. PH of the water before and after treatment was not influenced by the moringa oleifera, while turbidity of the water was reduced after treatment. Furthermore the colour level was significantly affected by the treatment values ranges between 5-10 hazen for both rivers. There was an increase in potassium and magnesium values after treatment while a decrease was noticed in sodium concentration. The coliform bacteria count reduced drastically after treatment to 5 counts at Point C of river Landzun. The results suggest that in application of plant coagulant such as moringa oleifera is highly recommended for domestic water purification in developing countries such as Nigeria, where people are used to drinking contaminated turbid water especially in rainy season.

Keywords: Water, Purification, Coagulant, Moringa, Seeds

1.0 INTRODUCTION

Water being universal solvent and free gift of nature contains various impurities in different proportion by mass which may make it unsuitable and unfit for drinking and consumption, as a result of this, it is important and paramount to carry out water treatment about one million people lack safe drinking water and more than six million people (of which two million are children) die from diarrhoea every year (Postnote, 2002). The situation persists and it will continue to cause substantial loss of human lives unless it is seriously dealt with at all levels.

According to Gate (2000), water borne disease are one of the main problems in developing countries about 1 — 6 million people are compelled to use contaminated water, however, in many communities of these countries water clarification methods like flocculation, coagulation and sedimentation are often inappropriate because of high cost and low availability of chemical coagulants. In order to alleviate the prevailing difficulties, approaches should focus on sustainable water treatment systems that are low cost, robust and require minimal maintenance and operator skills. Locally available materials can be exploited towards achieving substantial safe portable water supply.

Moringa Oleifera Lam also known as horse radish tree or drumstick is a medium tree which could be about 10m high. It belongs to the Moringacae family, the Moringacae is a single genius family with fourteen (14) known species of which Moringa Oleifera *(M. Ptrygosperma Gaertn)* is most widely known species and is planted in the whole tropical belt (Jahn, 1988). The tree is indigenous to northern India and Pakistan (Verdcourt, 1985). It is commonly known as the horse — radish tree, arising from the use of root by Europeans in India as a substitute for horse — radish is Cochlearia Armoracia *(Synonym Armoracia Rasticana)* like C. Armoracia, the roots of Moringa are pungent and were commonly used as a condiment or when garnished it has been shown to contain 0.0105% alkaloids, especially Moringinine and a bactericide, spiro chine both of which can proof fatal following ingestion (Oliver-Bever 1986).

1.2 **Description and properties of Moringa Oleifera**

Moringa Oleifera is one of the fast growing tree crops in Agricultural production. It is known to be adapted to an arid sandy condition and thrives very well in subtropical and tropical climates. The crop is short slender, deciduous, perennial tree to about 10m tall with dropping branches that are brittle together with the stermithe bark is corky and the leaves are Feathery. The species is characterize by its long, drum stick (about 30 — 60cm long and 2 — 3 cm wide) shape pods that contain seeds that are enclosed in a brown triangular softened coats and wings which split length side into three parts when dry. The roots are thick and deeply launched in the soil.

Previous studies by Palada and Chang (2003), on the crop revealed that virtually every part of the tree is beneficial where people have a dependable on tree crops and animals for their livelihood. Moringa can be grown in a nursery before it is transplanted. It can be cultivated through the dry tropical and the moist zones. It could grow under an annual precipitation of 4.8 to 40.3dm, annual temperature of 18.7 to 2.8.5°C and Pn of 4.5 to 8, its excellent performance on sandy soil makes it to be drought resistant. It also tolerates bacteria, fungi, literate and sand; this makes flowering and fruiting to be freely and continuously produced. The plant is propagated by planting limb cuttings 1 — 2cm long and it starts bearing pods 6 — 8 months after planting meanwhile constant and regular bearing of seeds commercial after the second year and bears the pod for several years.

1.3 **Benefits of Moringa Oleifer**

The benefits of Moringa Oleifera are almost too numerous to mention, however, it is believed to be the most important and useful in extreme situations like drought conditions in arid regions or areas in the wet tropical experiencing rapid rates of deforestation. Moringa is known to have solved many problems in some African

countries which include Kinzania, Nicaragua, Malawi, Niger and Senegal, hence the problems solved include provision of food during the dry season, provision of forage for animals, provide substitute for firewood, improved nutrition and purifying drinking water to name a few. (Folkard & Sutherland, 1996).

Water treatment describes those processes used to make water more acceptable for a desired end — use. These can include use as drinking water, industrial processes medical and many other uses. The goal of all water treatment process is to remove existing contaminants in the water, reduce the concentration of such contaminants so the water becomes fit for is desired end — use. One such use is returning water that has been used back into the natural environment without adverse ecological impact: the processes involved in treating water for drinking purpose may be solids separation using physical processes such as settling and filtration and chemical processes such as disinfection and coagulation,. Biological processes also employed in the treatment of waste water and these processes may include for example; aerated lagoons, activated sludge or slow sand.

Water purification is the removal of contaminants from untreated water to produce drinking water that is pure enough for the most critical of its intended uses, usually for human consumption. Substance that are removal during the process of drinking water treatment include suspended solids, bacteria, algae, viruses, fungi, minerals such as iron, manganese and sulphur, and other chemical pollutants such as fertilizers. Measures taken to ensure water quality not only relate to the treatment of eh water, but its conveyance and distribution after treatment as well. It is therefore common practice to have residual disinfectants in the treat water in order to kill any bacteriological contamination during distribution (Wikipedia, 2011).

1.4 Objectives

1. Determination of some physical, chemical and biological properties of the treated water.

2.Evaluation of the suitability and efficiency of natural coagulant from MoringaOleifera seeds in treating surface water.

3. Quality evaluation of the treated, water

1.5 Scope and Limitation

1.5.1 Scope of Study

The research work concentrate on the evaluation of surface water treated by coagulation using Moringa Oleifera seeds, and expected to cover the following areas; water sampling, determination of some physical, chemical and biological properties of the treated water and lastly the quality evaluation of the treated water. The samples are collected from two different rivers (Rivers Landzun and Mussa) in Bida, Niger State.

1.5.2 Limitation

Water from varying sources will need different amount or quality of Moringa powder because the impurities present will not be the same, secondly Moringa Oleifera is not an effective coagulant for low turbidity (< 50 NTU) therefore, water with greater turbidity have to be taken as sample and lastly Moringa paste for treating water have to be prepared freshly each time water is to be purified that is, the paste cannot be stored.

1.6 Justification

The practice of using Moringa seed for water purification has not been given much attention in Nigeria. However, the flocculating value of the plant has recently attracted the attention of non-governmental organizations and research centres in some developing countries. Further research into its efficiency in water purification is desirable so that it may be employed in providing easy and safer means of portable water for rural population, since modern technology for portable water is limited, very expensive and unavailable in those areas. This study will also allow for easy transfer of laboratory experience to village needs.

2.0 LITERATURE REVIEW

Water is a chemical substance with the chemical formula H20, it is the most abundant compound on Earth's surface, covering about 70 percent of the planet in nature, and it exists in liquid, solid and gaseous states. It is in dynamic equilibrium between the liquid and gas states at standard temperature and pressure at room temperature, it is a tasteless and odorless liquid with a hint of blue. Many substances dissolve in water and it is commonly referred to as the universal solvent, because of this, water in nature and in use is rarely pure and some of its properties may vary slightly from those of the pure substances. However, there are also many compounds that are essentially, if not completely insoluble in water, water is the only common substances found naturally in all three (3) common states of matter and it is essential for all life on earth (UNO, 2005). Water usually makes up 55 percent to 78 percent of the human body (Jeffrey, 2011).

2.1 Sources of water

There are two basic sources of water the surface water and sub-surface water, surface water includes streams, river, lake, ponds and oceans while sub surface are borehole water, infiltration, well, infiltration galleries, well and tube wells.

2.2 Importance of water

The major importance of water is enormous but few of them will be highlighted water is used for domestic purposes mainly for daily activities. It is used for agricultural processing of crops as well as for irrigation purposes, it is also used for cleansing of harvested products for consumption purposes, it is used for industrial purposes mainly as raw materials in producing water is crucial to the health, it makes up an average percent of the body weight, every system in the body depends on water lack of portable drinking water can lead to dehydration, a condition that occur when there is no enough water in the body system to carry on normal function (Wikipedia, 2012).

2.3 Effect of water pollution

Water pollution is a major global problem which requires on going evaluation and revision of water resources policy at all levels (international down to individual aquifers and wells). Pink (2006) and West (2006) discovered that water pollution is one of the worldwide causes of deaths and diseases and it accounts for the deaths of more than 14,000 people daily. An estimated 700 million Indians have no access to a proper toilet and 1,000 Indian children die of diarrhea sickness every day some 90% of China's cities suffer from some degree of water pollution and nearly 500million people lack access to safe drinking water (New York Times, 2006). In addition to the acute problems of water pollution in developing countries, developed countries continue to struggle with pollution problems as well. In the most recent report of water quality in the United States, 45 percent of assessed streams miles, 47 percent of assessed lake acres and 32 percent of assessed bay and estuarine square miles were classified as polluted (EPA, 2007).

Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, such as drinking water and/ or undergoes a marked shift in its ability to support its consistent biotic communities such as fish. Natural phenomena such as volcanoes, algae blooms, storms and earthquakes also cause major changes in water quality and the ecological status of water (Wikipedia, 2011).

2.3 Water treatment

A safe and convenient water supply is of paramount importance to human health and the well-being of any society. There exist numerous high technology systems to purify water. But for a huge proportion of population in the developing world that lives in the rural areas, such systems would be in appropriates or too expensive. These rural populations of developing countries adopt some techniques with low level of mechanization to suit their own situation. The special features involved in such

traditional treatment methods are worth considering for dissemination, before general technological solutions based on wider experience are proposed for these communities.

The traditional water treatment techniques can be found either serving a small rural community as a whole or individual household. Water purification is the process of removing undesirable chemical, biological contaminants, suspended solids and gases from contaminated water (Wikipedia, 2012). The goal is to produce water fit for a specific purpose most water is purified for human consumption (drinking water), but water purification may also be designed for a variety of other purposes including meeting the requirements of medical, pharmacology, chemical and industrial applications. In general the methods used includes physical processes such as filtration and sedimentation, biological processes such as slow sand filters or activated sludge, chemical processes such as flocculation and chlorination and the use of electromagnetic radiation such as ultra-toilet light (Wikipedia, 2012). The purification process of water may reduce the concentration of particulate matter including suspended particles, parasites, bacteria, algae, viruses, fungi and a range of dissolved and particulate materials derived from the surface that water may have made contact with after rain. According to WHO (2007), 1.1 billion people lack access to an improved drinking water supply, 88% of the 4bil lion annual cases of diarrhea diseases are attributed to unsafe water and in adequate sanitation and hygiene and 1.8million people die from diarrhea diseases each year . The world health Organization (WHO) estimates that 94% of these diarrhea cases are preventabte through modifications to the environment, including access to safe water. Simple techniques for treating water at homes, such as chlorination, filters and disinfection and storing it in safe containers can save a huge number of lives each year, reducing deaths from water borne disease.

Methods of water treatment

The following methods of water treatment are detailed by EPA (1999);

Flocculation/Sedimentation: refers to water treatment processes that combine or coagulate small particles into larger particles settle out of the water as sediment. Alum and iron salts or synthetic organic polymers are generally used to promote coagulation settling or sedimentation occurs naturally as flocculation particles settle out of the water.

Filtration: Many water treatment facilities uses filtration to remove all particles form the water. Those particles include clays and silts, natural organic matter, precipitate from other treatment processes in the facility, iron and manganese and microorganisms, filtration clarifies water and enhances the effectiveness of disinfection.

Ion exchanges: Ion exchanges processes are used to remove inorganic contaminants if they cannot be removed adequately by filtration or sedimentation. Ion exchange can be used to treat hard water. It can also be used to remove arsenic, chromium, excess fluoride, nitrate, radium and uranium.

Adsorption: Organic contaminants, unwanted coloring and taste colour causing compounds can stick to the surface of granular or powder activated carbon and are thus removed from the drinking water.

Disinfection (Chlorination/ Ozonation): Chlorination is the process of adding the element of chlorine to water as a method of water purification to make it fit for human consumption as drinking water. Water which has been treated with chlorine is effective in preventing the spread of water borne diseases; the use of chlorine has greatly reduced the prevalence of water borne diseases as it is effective against almost all bacteria and viruses. The most common objection to it is the flavour

though there have been some suggestions that it is unreliable in killing *Giardia Cysts* in the commonly used concentrations (Wikipedia, 2012).

Natural materials have been used in water treatment since ancient times, but lack of knowledge on the exact nature and mechanism by which they work has impacted their wide spread application and they have been unable to compete with the commonly chemicals. In recent years there has been a resurface of interest to use natural materials due to cost of synthetic organic polymers and inorganic chemicals by using natural coagulate. Considerable savings in chemicals and sludge handling cost may be achieved. Al-Sanawi & Shocrata (1996) reported that 50-90% of alum requirement could be saved when okra was used as a primary coagulant or coagulant aid natural coagulant produce readily biodegradable and less voluminous sludge. Water borne diseases is a persistent health problem throughout the world. The use of natural materials to clarify water has been practiced for centuries. Extracts of seeds from the M. Oleifera tree have been found to be one of the most effective clarifiers (Ghebremichael, 2004).

Studies to test its effectiveness for treating water have been conducted since the early 1970's these early investigations established its effectiveness as a coagulant for treatment of water with high levels of turbidity (Sarpong and Richardson, 2010). Toxiological assessments indicates that use of M. Oleifera as a primary coagulant does not pose a human health threats surface run off taken for house hold use caries silt particles solid, bacteria and other microorganism (some of which are pathogenic). It is therefore necessary to remove all these impurities before this water is used for drinking purpose.

Generally, coagulants are used for physical and chemical purification of turbidly raw waters. At high turbidity the water can no longer be adequately treated using filters, coagulants have to be applied to transform water constituents into forms that can be separated out physically studies by Schwarz (2000), showed that Moringa seed powder

can be used as a quick sample method for cleaning dirty river water. This simple method of filtering not only diminishes water pollution but also harmful bacteria. The moringa powder joins with the solid in the water and sinks to the bottom, this treat 90-99% of bacteria in water. The seed kernels of Moringa Oleifera contain significant quantities of low molecular-weight, water soluble protein which carry a positive change. When the crushed seeds are added to raw water, the proteins produce positive charges acting like magnets and attracting the predominantly negative charged particles (such as clay, silt, bacteria and other toxic particles in water).

Further research by Folkarid & Sutherland, (2001) indicates that Moringa Oleifera seeds coagulate 80.0% to 99.5% turbidity (surrogate for suspended particles) and color(surrogate for natural organicmaterials). Efficiently leading to aesthetically clear supernatural as a safer indicator this was concurrently accompanied by a 90.00% to 99.9% bacteria load reduction (Feacal coliforms) with bacteria concentrated in the sedirnented sludge.

3.0 MATERIALS AND METHODS

3.1 Fabrication Considerations

The following factors were considered in the construction of the mini water treatment plant; ease of operation, safety in handling and operation, availability of the materials and the reliability of the material based on the strength and durability of the equipment.

3.1.1 Materials Selection

The materials used for the construction were 12.5mm diametal galvanized pipes, 18.75mm elbow joints, stop cork and 9 litre and 13 litre plastic tank is which will serve as the reservoir. The materials were selected based on their resistance to corrosion, durability, availability, availability and cost of the materials.

3.1.2 **Constructional Features and Operation of the Mini Water Treatment Plant.**

It is simple water treatment plant developed to clarify and purify water for drinking purpose. The system was set as shown in Plate 1. An outlet from the base of the flocculation unit leads into the sedimentation unit through an elbow joint with a value fitted to control the flow of water. The filtration unit comprises of different sizes of gravel, river bed sand and activated charcoal to filter the water.The PVC pipe connecting the filtration unit and the storage tank is fitted with a piece of muslin cloth to prevent sand particles from morning into the storage tank. A value was also fitted to control flow of water at the discharge point.

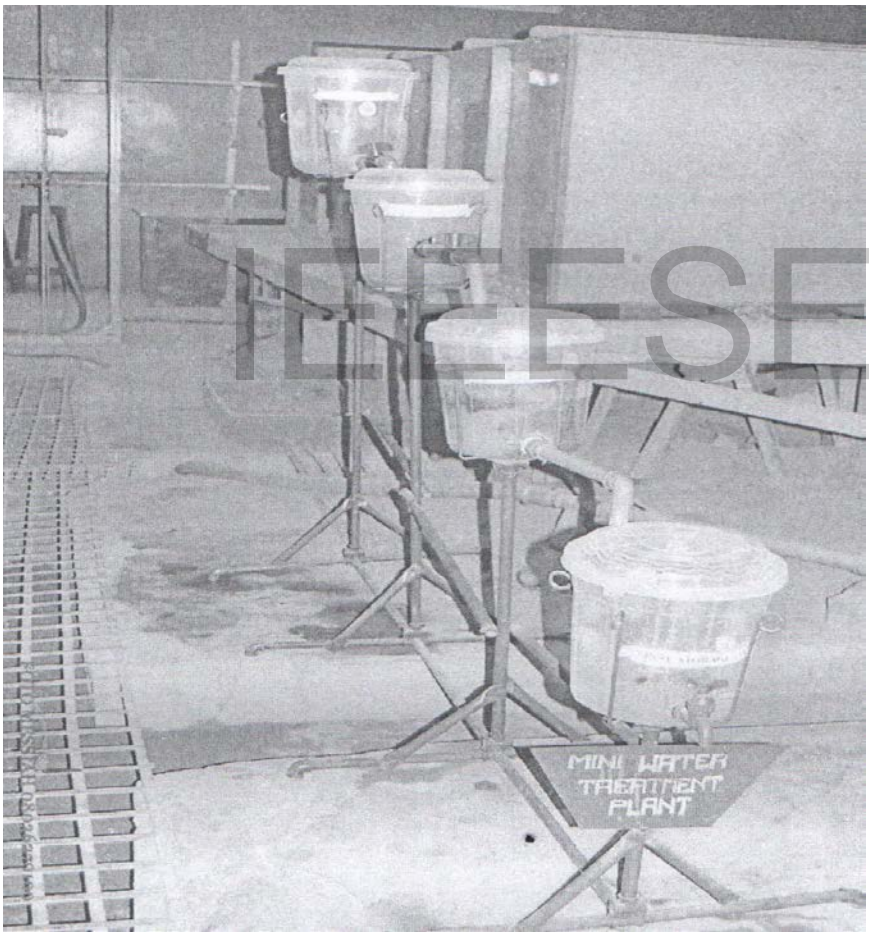

Plate 1. Mini Water Treatment Plant

3.1.3 **The Components Part of the Mini Water Treatment Plant.**

1. **Frame:** it is a structural system that supports other components. It is made of galvanized pipe of 125mm diameter. The system has an overall length of 1050mm
2. **Stand:** An angle iron of 10mm diameter was used to construct the tank to support the plastic tanks.
3. **Plastic tanks:** two types of cylindrical plastic tanks were used. 9 litres plastics tank were used for sedimentation, filtration and final storage tank; while the 13 litres was used as the flocculation unit.
4. **Elbow joint:** This is made of PVC pipes and was used in connecting 18.75mm diameter flow pipes.
5. **Valve:** It is made of plastic, located at the base of the final storage tank to serve as the control of flow of water.

3.1.4 Construction of Mini Water Treatment Plant.

The frame was made with galvanized pipe welded to the stand. The plastic tanks were drilled at different points using electrode and smoothing to the required size with a circular file to construct the tank outlet. The flow pipe was then connected to each tank using a socket and an elbow joint. The frame was supported by galvanized pipe using screws, while each tank was supported with two short pipes. A piece of cloth was used as a sieve in filtration tank to prevent the flow of soil particles from the filtration tank to the storage tank.

3.2. **Water Sampling**

Water samples were obtained in clean transparent one liter plastic bottles with caps. The samples were collected from two rivers at three different points namely point A, B and C in Bida local government area. Sampling was done by collecting from surface water plastic were rinsed with the water which it present, the bottles were securely cooked**,** labeled and transferred to the laboratory.

3.3. **Preparation of Coagulant Solution**

The Moringa oleifera seeds were obtained from government Reserved Area (GRA) Bida, Niger state. The seeds kernel were removed from the pods shelled, crushed and sieve through 0.8mm sieve mesh (Plate 2). **The** seed powder was then **mixed** with a small amount of clean water to form a paste the paste was then diluted with clean water and shake for two minutes to activate the coagulant properties insoluble materials were filtered out using 0.8mm mesh sieve.

3.4. **Treatment of Raw Water**

10 liters of raw water was measured into the flocculation unit and the milky white solution obtained in 3.3 above was added and stirred quickly for 60 seconds, thereafter the water was slowly and regularly stirred for 5 minutes using a stirrer (Plate 3). The stirred water was allowed to flow into the sedimentation unit immediately where it was allowed to remain and settled for one hour. Thereafter, the control valve was opened to aid the flow of water to the filtration unit where it dropped in drip into the final storage tank for collection.

Plate 2. Crushed Moringa seeds for preparation of coagulant

3.5 **Water Analysis**

The surface water samples were analyzed at the Science Laboratory Technology Department, Federal Polytechnic Bida, Niger State. The cations were determined using atomic absorption spectrophotometer (AAS), model (210 VGP) colour and turbidity was determined using turbidity meter and comparator colour disc respectively.

3.5.1 **Determination of pH**

A pH meter (model 30020) was used in the determination of water pH. The instrument was initialized for fifteen minutes; the electrode was rinsed with distilled water after which it was inserted into the water sample and the readings obtained were recorded.

3.5.2. **Determination of Turbidity**

The turbidity meter was powered and then standardized. The meter was set to 0.02 which is the standard for the turbidity test, the standard solution was removed and the samples to be tested was inserted into the same space where the standard solution was taken off and the reading were taken for different samples tested.

3.5.3. Determination of Colour

Two test tubes were rinsed with the water sample. Thereafter, 10m1 of the sample to be tested was measured using a measuring cylinder into one test tube and lOrn1 of distilled water was also measured into the other test tube, both test tubes were covered the test tube containing distilled water was inserted at the left side of a comparator while the other test tube containing the samples was placed at the right side. The colour disc was inserted into the comparator and rotated under the influence of sunlight until the two colours of the samples matched.

3.5.4. Determination of Total Viable Colifrom Bacteria Count

The test involved the use of Nutrient Agar (NA). 28g of nutrient Agar (NA) was measured into 500 ml of distilled water and stored properly. The solution was heated for one hour for the nutrient to dissolve which formed a clean solution and a yellow colour was noticed. From each samples lml was taken into sterile water to make 1:10 dilution. 0.1m1 of this solution was then transferred into disposable petril dish containing the nutrient Agar solution prepared earlier. The entire peril dish was incubated at 37° C for 24 hours. After incubation period, the number of colony forming unit (CFU) in each inorcualated plate were counted and recorded.

3.5.5 Determination of Cations

The cations were determined using an atomic Absorption spectrophotometer (AAS). The machine was switched oil and allowed to boot for 20 minutes. The specific hitach hollow cathode lamp was then selected accordingly since each metal has a characteristic wavelength that will be absorbed. 20ml.of water sample was placed in a separate corvette and the atomizers were positioned inside them in turn, Regulated air and acetylene gas were passed into the chamber and **ignited.** The corresponding hitach hollow cathode of the metal under investigation was set in place with its corresponding wavelength indicated on the instrument. The sample under test was atomized and introduced into a non luminous acetylene flame, burning under carefully controlled condition, the flame became coloured. The degree of colour being proportional to the amount of the particular element present the sample was recorded. Finally, from the calibration curve of each sample under investigation their concentrations were reread and recorded.

4.0 RESULTS AND DISCUSSION

4.1 Surface Water pH

The pH obtained from samples analyzed in the six points showed range of values between 6.5 to 7.0 Ph levels (table 1). These pH values indicate slightly acidic level of the water. The WHO guidelines for drinking water (1993) do not give any guidelines on pH however the standard organization of Nigeria SON, (2007) recommended pH to be 7.0 — 8.0. Therefore the pH of water sampled is favourable for drinking. It is important to note here that based on analysis Moringa Oleifera seeds does not increase or reduce the pH of water (Table 1).

4.2 Turbidity

The turbidity of samples before treatment shows the range 0.97 — 22.4 NTU while after treating with m-oleifera is between 0.48 to 3.46 NTU (tables 1 and 2). WHO guideline on water turbidity is not available. Hence, from the result obtained, it can be observed that moringa Oleifera seed clarify and decolorizes water with high turbidity.

4.3 Colour

The colour obtained from water sample analyzed before and after treatment for both streams showed the range of values between 15-60 hazen and 5-10 hazen respectively (Tables 1 and 2). World Health Organization is silent about the colour (Tables 3 and 4). However, values obtained after treatments are within the maximum permissible level recommend by SON (Tables 3 and 4).

4.4 Iron

Tables1 and2 present the result of iron concentration in the untreated water of river Landzun and Mussa, with point **B** recording the highest value; while the River Mussa shows the 0.05 — 0.07 ppm concentration but after treatment with Moringa oleifera seeds the range was between 0- 0.05ppm. These values are within the SON standards of permissive levels (Tables 3 and 4)

4.4.1 **Copper**

There is no trace of copper element in River Landzu before treatment but the upper stream of River Mussa shows that it has 1.80ppm concentration before treatment and 0.5 ppm after treatment, (Tables 1 and 2). The values indicated that concentration of copper before treatment is within the permissive level recommended by WHO (Table 5). This showed that the surface sampled water is free of copper hazard.

4.4.3 **Lead**

River Muss shows no trace of lead element before and after treatment but river landzun showed a trace of 0.1 and 0.13ppm concentration in the untreated sample of upper and middle stream. However, the treated samples showed no sign of the element but the recommended value is 0.01ppm.

4.4.4 **Potassium**

From the result of the analyzed samples for potassium, it showed that there is high content of potassium in the water before purification but after treatment the potassium level increase through there is no guideline given by WHO for the level of concentration of potassium in water. The value before treatment is between the range of 6.5 ppm while the treated sample is between the range of 4.52 to 10.32 ppm concentration (Tables 3 and 4)

4.4.5 **Chromium**

Health based guideline by the World Health Organization for chromium is 0.05ppm,(Tables 3 and 4) but river Landzun does not show any trace of the element whereas the upper and middle streams of river Mussa gave 0.1 and 0.11ppm(tablesland 2) respectively before treatment and after treatment it reduced to zero.

4.4.7 **Calcium**

Calcium is responsible for strong bone in the body. The values obtained from the analysis of untreated samples shows range of values between 0.1-0.4 ppm (Table 1) in

River Landzun while that of River Mussa showed a constant value of 0.1 ppm (Table 2)But after treatment the values obtained is between 0.125 to 0.38 ppm concentration. World Health Organization is silent about the required concentration.

4.4.8 **Magnesium**

The magnesium level found in the untreated sample of River Landzun was higher than River Mussa. The values range between 4.2 — 7.5 ppm and 1.1 -2.5 ppm respectively (Tables 1 and 2). After treatment, it was discovered that the magnesium levels increased to 4.0- 11.26 ppm (Table 3) and 4.06 — 16.34 ppm (Table 4) concentration for Rivers Landzun and Mussa.

4.5 **Total Viable Coliform Bacteria Count**

Viable coliform Bacteria count analyzed in the surface water revealed that the coliform bacteria is numerous in both rivers but after treating with moringa the bacteria reduced tremendously to an average of 5 count and 48 count for river Landzun and Mussa respectively.

Table 1: Physical and Chemical Properties of Untreated Water from River Landzu.

Parameter	**Point A**	**Point B**	**Point C**	**SON (2007)**	**WHO (1993)**
pH	6.8	6.5	7.0	6.5-8.5	-
Turbidity (NTU)	14.89	10.32	0.97	5	-
Colour (Hazen)	15	20	15	15	-
Na^+ (ppm)	0.98	1.75	2.12	200	200
Ca^{2+} (ppm)	0.1	0.2	0.4	-	-
K^+ (ppm)	4.75	3.5	3.6	-	-
Mg^{2+} (ppm)	4.2	6.0	7.5	0.20	-
Fe^{3+} (ppm)	0.06	0.05	0.07	0.30	-
Cu (ppm)	1.80	0	0	1.0	2.0
Pb (ppm)	0	0	0	0.01	0.01
Cr (ppm)	0	0	0	0.05	0.05

Table 2: Physical and Chemical Properties of Untreated Water from River Mussa

Parameter	Point A	Point B	Point C	SON (2007)	WHO (1993)
pH	6.7	6.6	6.5	6.5-8.5	-
Turbidity (NTU)	6.44	8.61	22.4	5	-
Colour (Hazen)	30	40	60	15	-
Na^{+} (ppm)	0.22	0.59	0.45	200	200
Ca^{2+} (ppm)	0.1	0.1	0.1	-	-
K^{+} (ppm)	0.23	1.1	2.5	-	-
Mg^{2+} (ppm)	0.51	1.20	0.5	0.20	-
Fe^{3+} (ppm)	0	0	0	0.30	-
Cu (ppm)	0	0	0	1.0	2.0
Pb (ppm)	0.1	1.13	0	0.01	0.01
Cr (ppm)	0.1	0.11	0	0.05	0.05

Table 3: Physical and Chemical Properties of Treated Water from River Landzun

Parameter	Point A	Point B	Point C	SON (2007)	WHO (1993)
pH	6.8	6.5	7.0	6.5-8.5	-
Turbidity (NTU)	1.99	0.48	1.74	5	-
Colour (Hazen)	5	5	5	15	-
Na^{+} (ppm)	1.92	0.63	0.93	200	200
Ca^{2+} (ppm)	0.37	0.35	0.20	-	-
K^{+} (ppm)	8.33	8.65	9.42	-	-
Mg^{2+} (ppm)	4.0	7.83	11.26	0.20	-
Fe^{3+} (ppm)	0	0	0.05	0.30	-
Cu (ppm)	0.5	0	0	1.0	2.0
Pb (ppm)	0	0	0	0.01	0.01
Cr (ppm)	0	0	0	0.05	0.05

Table 4: Physical and Chemical Properties of Treated Water from River Mussa

Parameter	Point A	Point B	Point C	SON (2007)	WHO (1993)
pH	6.7	6.6	6.5	6.5-8.5	-
Turbidity (NTU)	1.92	1.74	3.40	5	-
Colour (Hazen)	5	10	10	15	-
Na^{+} (ppm)	0.65	0.48	0.98	200	200
Ca^{2+} (ppm)	0.375	0.130	0.125	-	-
K^{+} (ppm)	10.32	4.52	7.0	-	-
Mg^{2+} (ppm)	16.34	11.41	4.06	0.20	-
Fe^{3+} (ppm)	0	0	0	0.30	-
Cu (ppm)	0	0	0	1.0	2.0
Pb (ppm)	0	0.42	0	0.01	0.01
Cr (ppm)	0	0	0	0.05	0.05

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Results showed that the colour levels of the surface water before treatment make generally high which does not conform with the recommended standard of World Health Organization that water should the colourless; though there is no guidelines for the turbidity but it is expected that water for consumptive use must be free from cloudiness and other suspended materials. The PH value recommended by standard health Organization is between 7.0 - 8.0 only. The down stream of river Landzun was within the permissive level but others are slightly acidic which can still be used for drinking. The study further showed that Moringa Oleifera does not influence the P^{H} of the water treated some of the chemical parameter analysed that is chromium, lead, copper) before treated are above the permissible levels recommended by WHO but after treatment there is reduction in the values which fall within the permissible guidelines recommended by WHO. However, values of some element (mgg Pita & Calcini) increased after treatment could of be attributed to the fact that moringa Oleifera is rich in these elements.

The total bacteria count before treating the water is too high for consumption. This is could be a result of human and animal faeces passed in the stream. The values dropped significantly after treatment. M oringa Oleifera coagulant protein was not only an active coagulant, also, showed antimicrobial effects on a number of grain positive and geam negative bacteria some of which are antibiotic resistant.

5.2 Recommendations

Application of plant flocculants such as Moringa Oleifera is highly recommended for domestic water purification in developing countries such as Nigeria, where people are used to drink contaminated turbid water especially in rainy season. The effects on clay suspension and micro organisms suggest moringa Oleifera may be used for simultaneous coagulation and disinfection in water treatment system.

However, moringa does not guarantee that the raw water ends up completely (100%) free of pathogenic germs. It is clean and drinkable but not completely purified. Consequently this method might reduce water born diseases in developing countries considerably.

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