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A COMPARATIVE STUDY OF *Moringa oleifera* AND ALUMINUM HYDROXIDE CHLORIDE IN GREYWATER TREATMENT IN ABEOKUTA, OGUN STATE, NIGERIA.

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ABSTRACT

Two methods of treating water using a natural coagulant and a chemical coagulant were assessed. The natural coagulant was *Moringa oleifera* seeds (a forest plant) i.e Treatment 'A' while the chemical used was Aluminum hydroxide chloride i.e Treatment 'B'. The aim of this study was to compare the use of a natural coagulant with a chemical coagulant. Samples were collected at Omida, Ibara, Mama Cass, Mr Bigg's and Sidipon village respectively. The filtrate of *Moringa oleifera* seed extract was dosed into the greywater sample at 10% dosing range and made to run through a greywater treatment plant while Aluminum Hydroxide Chloride was also dosed at 10% dosing range and made to run through the treatment plant respectively. The greywater treatment plant is a self designed treatment plant made to treat both water and wastewater. The raw water was firstly analyzed, after which the treated samples were taken to the laboratory for analysis. Result for the physical, chemical and bacteriological analysis of treatment 'A' before and after treatment were as follows: pH (9.3, 9.7), EC (2995, 1175µs), Temperature (27.7, 27.6^{o}c) , TDS (365, 155ppm), TSS (0.32, 0.30ppm), TS (376, 155ppm), Sulphate (588, 314mg/l), Magnesium (400, 260mg/l), Nitrate (7.5, 6.1mg/l), Phosphate (285, 12mg/l) and total coliform count after treatment is given as (2.8x10^{3} cfu/ml), while that of treatment 'B' before and after treatment were as follows: pH(11, 9.9), EC (3000,630), Temperature (27.7, 27.6^{o}c), TDS (0.47, 0.45ppm), TS (416, 320ppm), Sulphate (571, 246mg/l), Magnesium (820, 860mg/l), Nitrate (4.4, 6.0mg/l), Phosphate(169, 6.1mg/l) the total coliform count after treatment was given as ; (3.0x10^{3}cfu/ml). One-way Anova test was used to determine differences between results obtained using the two coagulants. The result indicated no significant difference at $p=0.05$ between the two treatments. Hence, result was further compared with World Health Organization Standard for Drinking Water. Comparatively, the analysis obtained from water treated with *Moringa oleifera* was found to be more effective than the chemical coagulant, and can be easily made available for the use of the populace.

Keywords*: Moringa oleifera,* Aluminum hydroxide chloride, Greywater, treatment plant.

INTRODUCTION

Water is a key driver for sustainable development, given its multi-dimensional effects. Its wise utilization and management can also improve human health, food and nutrition, energy, biodiversity and ecosystems. The challenges of water availablityare so many but most importantly the challenges to water resources managers include the fact that fresh water exist briefly in nature

(Ayoade, 1988). People are also compelled to use contaminated water which causes the death of about 1.1 billion people globally (Postnote, 2002).

The common methods used for water purification include physical process such as filtration and sedimentation, biological process such as slow sand filter or activated sludge, chemical processes such as flocculation and chlorination and the use of electromagnetic radiation such as ultraviolet light. Increase in global population and lack of structural infrastructures to enhance water supply has also contributed immensely to the deteriorating health of the populace especially the children (WHO/UNICEF, 2012).

The World Health Organization estimates that 94% of diarrhea cases are preventable through modifications to the environment, including access to safe water. Therefore, simple techniques for treating water and make it available for use in the lives of the populace is very essential. (WHO, 2007).

The management of water resources, both at the national and international levels, has grown in complexity due to the unique physical, geographic and political characteristics of water and its impact on the entire spectrum of socio-economic development. Therefore, there is an urgent need to develop, appropriate water management framework, infrastructure and knowledge sharing networks for sound and sustainable cooperation between people whose lives depend upon shared water resources (Hans d'orville, 2011).

In Nigeria, wastewater is generated from bottling companies, for, example, Sona breweries Plc, Nigeria Breweries Plc, Seven up Bottling Company and others. This wastewater undergoes treatment before t is disposed to the drainage channel and this can be achieved through the use of the effluent treatment plant. The effluent treatment plant is designed for the task of wastewater treatment.

A study was carried out by Martins et al., (2001) at the University of Agriculture, Abeokuta. *Moringa oleifera* seeds were used for domestic water purification in three villages, which were selected based on their proximity to Abeokuta. These villages were Kobape village, Olufowora village and Itori Town. Water samples were collected and analyzed for physical, chemical and bacteriological parameters. Coagulant used include *Moringa oleifera and alum.* The alum stock was prepared from ground granules, which was used as a control for the experiment, while *Moringa oleifera* was prepared from the pounded seed as filtrate. Result showed that, *Moringa oleifera* is a good coagulant, which reduces bacteriological load and most probable number (MPN) drastically from the raw water .

A study was also carried out using *Moringa oleifera* seed to determine the histological changes in gill, liver and kidney tissues of nile Tilapia (Oreochromis niloticus), fingerlings and adults when exposed to aqueous extract of *Moringa oleifera* seeds at different sub-lethal concentration and under a standard bioassay procedure.(Reish and Oshida, 1987; Ayotunde *et al*., 2004).

Furthermore, Oguntola (2011) noted that since *Moringa oleifera* has a detoxifying effect, it can also be used to purify water. He stressed further that , as a coagulant *Moringa oleifera* can attach itself to harzardous bacteria and other materials in water and in the process purify the water.

Other researchers that stressed the significance of *Moringa* oleifera as coagulant for

water purification includes Ramachandran et al, 1980. Jenssen (1996); Ndabigengesere et al., (1995); Francis and Amos(2009); Brooker (2001).

Materials and Methods

Materials

This experiment involves the construction of greywater treatment plant and the following materials were used for the construction of the treatment plant:

- 5 plastic containers
- 3/4 P.V.C pipes
- 3/4 Steel pipes
- Cartridge filter
- *Moringa oleifera* seed
- Aluminum hydroxide chloride (General purpose coagulant)
- Conical flask
- Electrode
- Water bath
- Planks
- Tangit gum

Description of the study Area

The study area is located in Abeokuta South Local Government Area, of Ogun State, Nigeria. Five locations were selected based on their lifestyle characteristics, water usage pattern, water resources and age distribution. Locations include Onikolobo, Mr Bigg's , Mama Cass, Omida Market and Sidipon village respectively.

Field work

1. Collection of greywater sample from 5 locations in Abeokuta South Local Government Area.
2. *Moringa oleifera* seeds were collected from *Moringa* tree in the forest plantation, located at the Federal University of Agriculture, Abeokuta.
3. The seeds were processed by removing the seed from its coat and grounded into powder with a mortar and pestle. The grounded powder was mixed with 1litre of water and sieved through a mesh. The filtrate was then collected in a clean glass cup and used as coagulant.
4. The chemical coagulant Aluminum hydroxide chloride (Liquid form) was purchased from the market with 100% purity level.

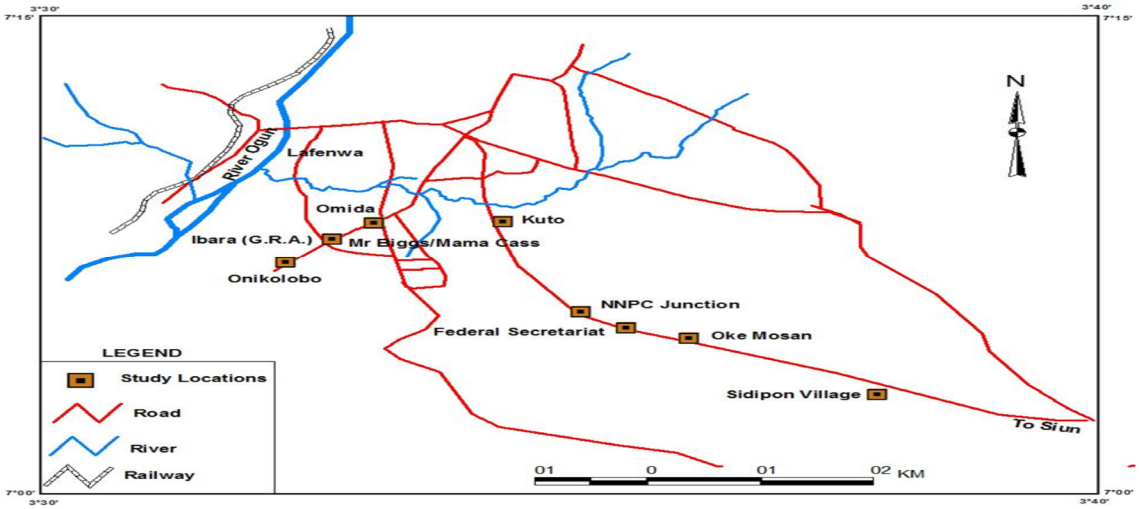

Figure 1: Map of the Study Area showing the samples site
SOURCE: FUNAAB CARTOGRAPHY LABORATORY 2015

Method of Application of *Moringa oleifera* (a natural) coagulant to greywater.
An aqueous extract of *Moringa oleifera* filtrate was added to the greywater samples collected at different locations. The filtrates of *Moringa oleifera* seeds were dosed at 10% dosing range using the dosing pump with its unit in (mg/l), as it passes through the greywater treatment plant.

Method of Application of Aluminum Hydroxide chloride (a chemical coagulant) to greywater
20 mg/L of Aluminum Hydroxide chloride was dissolved in 25 litres container of greywater sample, it was mixed thoroughly and was left for 5 days in the laboratory. On the fifth day, the greywater sample was run through the treatment plant. The treatment plant consists of 5 segments; each of the segments consists of graded sand, aeration/ dosing chamber, white sand activated carbon and cartridge filter respectively. The first container consists of graded sand which ranges from 0.5, to1.0 and 2.0mm. The function of this graded sand is to filter dirt's and suspended solids that are found in water, after which the water is dosed with chemical in the second container at 10% dosing range in order to reduce the microbes that are found in the wastewater. Aeration takes place in the second container, the purpose of aeration is to remove odor from water as the water passes through the polyethylene pipe to the third container. There is a control valve in between the pipes, which regulates the inflow and outflow of water. The third container consists of the white sand; the function of this sand is to remove all the particulates in the water including micro-organisms that are not visible to the eyes. Water passes through the third container to the fourth container, which consist of the activated carbon. The function of the activated carbon is ti remove the color, odor and the taste of the water for clarity and portability, it then passes through the cartridge filter where tiny suspended matter are trapped and water eventually comes out from the tap through the fifth container. These containers are placed on a plank so that water can flow by gravity from one container to the other. As the waste water travels different materials are being trapped from one stage to the other until the desired water quality is attained. The Laboratory set up is shown in Figure 2.

Laboratory Analysis
The following materials were used for laboratory analysis: pH meter, Electrical conductivity meter, Total dissolved solid meter, Standardized ammonium hydroxide, phenol disulphonic acid, Barium chloride, Vanadomolybdo reagent, spectrophotometer, EMB (Eosine methylene blue), flame photometer and total plate count.

Data Analysis; Analysis of variance i.e (One -way Anova) was used to distinguish the variability between the two treatment types.

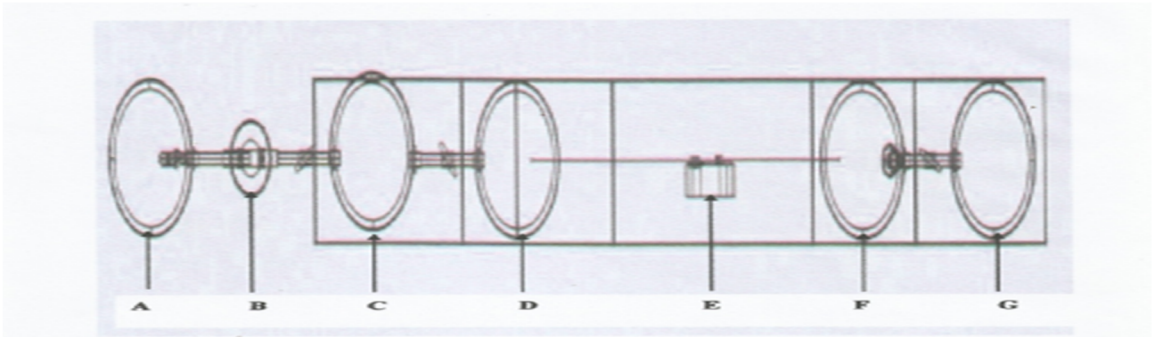

Fig.2: The plan view of the treatment Plant

A - Sedimentation tank
B - Aeration / Dosing chamber
C - White sand chamber
D - Activated carbon chamber
E - Stand
F - Bottle filter
G - Collection tank

RESULTS AND DISCUSSION

Tables 1 and 3 shows the result of the laboratory experiment on the greywater obtained from 5 sources and dosed with several quantities of *Moringa oleifera* and Aluminum hydroxide chloride. These results, which showed values for raw water, treated water and control compared to recognized standard.

The results of greywater treated with *Moringa oleifera* are summarized in Table 1; The physical, chemical and bacteriological analysis of the sample of the greywater before and after treatment using *Moringa oleifera* was shown in Table 1.pH increases due to the presence of polypeptides that are contained in the chemistry of *Moringa oleifera,* but this increase has no health implication as it is within the World Health Organization Standard (WHO, 1993 and 2006) respectively.
The value of electrical conductivity of the water was also reduced. The total dissolved solid, total suspended solids and total solids meets up with the acceptable laboratory standard TS=TSS+TDS and it is also within the permissible limit of (WHO, 1993 and 2006).
The value of Nitrate which causes cyanosis in infant when in excess in drinking water was also reduced. The value of Sulphate and Copper were also reduced drastically. The elevated value of copper causes health problem such as gastrointestinal disorder but when treated with *Moringa oleifera* the value fell within the permissible limit.

Other parameters such as (Phosphate. Iron, Lead, Manganese and Zinc) were also compared with WHO standard (WHO, 1993 and 2006) and they fell within the permissible limit except magnesium. Thus, 'WHO states that hardness in water has no health implication to human life.

Table 2; shows the comparison of the treated value with World Health Organization standard for drinking water using Aluminum hydroxide chloride as coagulant. All the physical and chemical parameters tested fell within the limit except magnesium which has no health implication in human beings.

Table 3; shows the comparison of Physical and Chemical properties of water samples treated with *Moringa oleifera* and Aluminum hydroxide chloride properties. The least value for treatment A and B have the ratio 7:8 after comparing them with each other. Hence the result presented above shows the efficiency of *Moringa oleifera* in water treatment which is a natural coagulant than the chemical coagulant which is Aluminum hydroxide chloride.

Table 1: Physical and Chemical properties of the water samples before and after treatment with *Moringa oleifera*.

Physical and Chemical Properties	Before Treatment	After Treatment	WHO Standard (1993.)	WHO Standard (2006.)
pH	9.30	9.75	-	-
EC(μs/cm)	2995	1175	-	-
Temperature(0C)	27.7	27.6	-	-
TDS(ppm)	376	155	500mg/l	No guideline
TSS(ppm)	0.32	0.30	-	-
TS(ppm)	376	155	-	-
Sulphur (mg/l)	588	314	500mg/l	No guideline
Magnesium (mg/l)	400	260	40mg/l	50mg/l
Nitrate (mg/l)	7.5	6.1	50mg/l	50mg/l
Phosphate (mg/l)	285	12.0	-	-
Iron (mg/l)	0.60	0.62	0.5-50mg/l	No guideline
Lead (mg/l)	0.09	0.10	0.01mg/l	0.01mg/l
Manganese(mg/l)	0.24	0.30	0.4mg/l	0.5mg/l
Zinc (mg/l)	0.07	0.14	3mg/l	Noguideline
Copper (mg/l)	0.15	0.11	2mg/l	2mg/l

Table 2: Physical and Chemical properties of the water samples before and after treatment with Aluminum Hydroxide Chloride.

Physical and Chemical Properties	Differences	Method with lower value
pH	0.2	Moringa oleifera
EC(μs/cm)	545	Aluminum hydroxide chloride.
Temperature(0C)	0	Moringa oleifera
TDS(ppm)	165	Moringa oleifera
TSS(ppm)	0.15	Moringa oleifera
TS(ppm)	164.65	Moringa oleifera
Sulphur (mg/l)	68.64	Aluminum hydroxide chloride.
Magnesium (mg/l)	600	Moringa oleifera
Nitrate (mg/l)	0.195	Moringa oleifera
Phosphate (mg/l)	5.895	Aluminum hydroxide chloride.
Iron (mg/l)	0.005	Aluminum hydroxide chloride.
Lead (mg/l)	0.02	Aluminum hydroxide chloride.
Manganese(mg/l)	0.035	Aluminum hydroxide chloride.
Zinc (mg/l)	0.05	Aluminum hydroxide chloride.
Copper (mg/l)	0.005	Aluminum hydroxide chloride.

Table 3: Comparison of Physical and Chemical properties of water samples treated with *Moringa oleifera* and Aluminum hydroxide chloride properties.

Physical and Chemical Properties	Before Treatment	After treatment	WHO Standard (1993.)	WHO Standard (2006)
pH	11.05	9.95	-	-
EC(μs/cm)	3000	630	-	-
Temperature(0C)	27.7	27.6	-	-
TDS (ppm)	416	320	500mg/l	No guideline
TSS (ppm)	0.47	0.45	-	-
TS (ppm)	416	320	-	-
Sulphur (mg/l)	571	244	500mg/l	No guideline
Magnesium (mg/l)	820	860	40mg/l	50mg/l
Nitrate (mg/l)	4.4	6.0	50mg/l	50mg/l
Phosphate (mg/l)	169	6.1	-	-
Iron (mg/l)	0.65	0.61	0.5-50mg/l	No guideline
Lead (mg/l)	0.09	0.08	0.01mg/l	0.01mg/l
Manganese (mg/l)	0.20	0.27	0.4mg/l	0.5mg/l
Zinc (mg/l)	0.10	0.09	3mg/l	No guideline
Copper (mg/l)	0.08	0.10	2mg/l	2mg/l

CONCLUSION

The seed of *Moringa oleifera* is a good water purifier; it leaves water clear with 90-99% of the micro-organisms removed after passing through the treatment plant.

It can be concluded from this study that, the use of *Moringa oleifera* was more efficient in greywater treatment and the seed of this natural plant does not have any health implication on human health. This is because, the result obtained after treatment with *Moringa oleifera* compared favorably with 1993 and 2006 World Health Organization (WHO) Standard for drinking water. Hence, the use of natural coagulant like *Moringa oleifera* is advocated in line with the present global best practices uses for natural resources, such as using plant extract for treatment as they are considered safer than the synthetic treatments.

The greywater treatment plant serves as a filter for the removal of particles and microorganisms that are contained in the water and thus make the water potable for use.

The result also shows that there is no significant difference between the two treatments types at p=0.05 and the result fell within the permissible limit of World Health Organization (WHO)Standard for drinking water.

Conclusively, the coliform test shows a negative result from the bacteriological analysis, indicating that there is no presence of faecal coliform in the water samples after treatment.

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