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Effects Of Solar Radiation, Waterguard And *Moringa Oleifera* Treatment On Bacterial Population Of Some Selected Streams In Benue State Of Nigeria

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Abstract: ***Effects of solar radiation, water guard and Moringa oleifera treatments on bacterial population of some selected streams namely Gbaya, Ujeragbo and Kende in Gwer East, Benue State of Nigeria were conducted to assess their effectiveness as water treatment methods. Bacterial loads on surface water samples were determined before and after treatments using pour plate method. Bacteria were isolated and characterised using standard biochemical methods. Bacteriological analysis showed that Ujeragbo stream had the lowest bacterial population with a mean viable count of*** 1.33×10^3 ***cfu/mL. There was significant*** ($p < 0.05$) ***reduction in the mean viable counts recorded for all the water samples in Gbaya, Ujeragbo and Kende following tratments with different methods. In the daily analyses of bacteria counts, control water samples gave extremes values for all water samples analysed which were not acceptable according to WHO (2011). Bacteria counts were not recorded following combined (solar, water guard and Moringa oleifere) treatments in water samples from Ujeragbo stream on the fifth day. The use of contaminated surface water without treatment could be hazardous to human health. Therefore, effective treatment methods employed in appropriate combinations are recommended in controlling bacterial population in contaminated water sources***

Keywords: Solar radiation, Moringa oleifere, water guard, Gbaya, Ujeragbo and Kende

I. INTRODUCTION

Access to safe and clean drinking water is of major concern throughout the world HENCE Provision of clean, safe, potable water is one of the central objectives of the World Health Organization (UNICEF, 2009).

In order to make these surface water clean and available for as many people as possible, cheap, simple and efficient process methods are necessary. This is because purified water is essential for living a healthy life (PRITCHARD *ET AL.*, 2009). In many communities, the acute shortage of potable freshwater is aggravated by lack of proper management, industrial development, rising population growth, extreme weather condition, increased pollution, corruption and poor implementation of water-related infrastructural projects, which has continued to put a heavy burden on the provision of adequate water resources in terms of distribution, availability, accessibility and quality (Liang *et al*., 2013). This critical shortage of water need to be addressed especially in developing countries (Coleman *et al*., 2013). Waterborne pathogenic organisms such as bacteria, protozoa, and viruses pose one of the leading global human health hazards. Many of these pathogens are not only transmitted through water but also follow other infectious pathways. Since surface water serves as a major source of water in Gwer East Local Government, contaminations of most of these water sources are difficult to avoid due to rigorous and reckless use of these surface water. Drinking and other uses of unsafe water may result in fatal illnesses. Water purification technologies would have to be reviewed in terms of its simplicity, accessibility

(cost) and efficiency. Conventional methods of assuring potable water in developing countries are unsustainable so there is need to consider the application of sustainable technologies using locally available materials in surface water treatment (PRITCHARD *ET AL*., 2009).

II. MATERIALS AND METHODS

COLLECTION OF WATER SAMPLES

Surface water samples were collected from Gbaya, Ujeragbo and Kende in Gwer East Local Government Area of Benue State. The samples were collected where people commonly take water for their domestic activities. Standard sampling methods of APHA (1999) was adopted in the collection of the water samples. Water samples for bacteriological analyses were collected using sterile bottle held at the bottom and inserted into the water with the mouth downward to a depth of at least a foot below the water surface (UNEP/WHO, 2006). Water current was created by dragging the bottle slowly through the water to ensure that the organisms (if any) on the sides of the bottle are washed away and not into the bottle. The bottle was removed from the water as soon as it is full and is immediately stoppered, properly labelled and transported to the laboratory in an ice packed cooler (to maintain the lowest possible temperature) and kept in a freezer until time of analysis (Ademoroti, 1996).

COLLECTION OF PLANT SAMPLES AND AUTHENTICATION OF PLANT SEEDS

Seeds of *Moringa oleifera* were purchased from Railway market, Makurdi, Benue State. The plant part (seeds) was packed in sterile polythene bags and transported to the laboratory, Biological Sciences, University of Agriculture, Makurdi for identification and analyses.

CONVERSION OF *MORINGA OLEIFERA* SEEDS TO POWDERED FORM

Seeds were selected and dried under shade for 10 days. The seeds were de-shelled by hand, crushed and converted to powdered form using a blender and sieved using a strainer with a pore size of 2.5 mm^2 to obtain a fine powder according to Pritchard *et al*. (2009). The powder was stored in a sealed plastic container with cover at room temperature (25^0C) prior to processing and use.

WATER GUARD

Water guard (Water Care) was purchased from a pharmacy store in Makurdi, Benue State. The expiry date was taken into cognisance before use.

SOLAR RADIATION (SODIS)

Solar radiation panel was obtained from Energy Research Centre, University of Nigeria, Nsukka Campus, Nsukka, Enugu State. The solar radiation panel was constructed using a very wide rectangular pan overlaid with a standard reflecting 3 mm glass to concentrate sunlight energy unto the water samples during treatment (EAWAG, 2007).

TREATMENT OF WATER SAMPLES WITH DIFFERENT TREATMENT METHODS

TREATMENT WITH WATER GUARD

The usual recommended concentration of 4 ml/L of water guard which is equivalent to two capfuls of its container for 25 litres of water was used and after shaking vigorously to ensure uniform mixing was allowed to stand for 1hour before use for bacteria analyses (CDCP, 2007). Daily analyses were carried out for 5 days to obtain total viable count for each day.

TREATMENT WITH MORINGA OLEIFERA POWDER

Exactly 2 g of the prepared powder was mixed with a small amount of sterile distilled water to make a 2 % suspension in a small bottle as described by Ali (2010). The bottle was closed and then shaken after 5 minutes to obtain a good water extract, in order to activate the ingredients present in the powder. This milky extract was then filtered through a clean sterile cloth into 2 litres of the water samples to be treated. After the milky white suspension has been added to the water samples it was stirred rapidly for at least 2 minutes and then slowly for 10-15 minutes. The treated water was covered, left to settle for at least an hour and for treatment to take place. The clean water from the solution was then taken after treatment for analyses. Daily analyses were carried out for 5 days to obtain total viable count for each day.

TREATMENT WITH SOLAR RADIATION

Exactly 5 litres of the water samples was measured into clean transparent plastic container of 10 litres capacity and exposed to ultraviolet rays from the sun as reflected from the standard solar panel constructed for a period of 6 hours (EAWAG, 2007). Water samples were taken to the laboratory for daily analyses over a period of 5 days to obtain total viable count for each day.

BACTERIOLOGICAL ANALYSIS OF WATER

PREPARATION OF CULTURE MEDIA

All the media used for this study were prepared according to the manufacturer's specification.

SERIAL DILUTION

Serial dilutions method as described by Nester *et al*. (2007) was used for the water samples by taking 1.0 ml of the original solution with a sterile pipette into the first bottle containing 9 ml of sterile distilled water to make 10^{-1} dilution of the original water samples and the bottle was shaken thoroughly. Exactly 1.0 ml of the prepared 10^{-1} dilution was pipetted into another 9.0 ml of sterile distilled water to obtain 10^{-2} dilution of the original sample. This was diluted further to

give 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6}. The serial dilution was used for total viable count (standard plate count).

For each water sample serially diluted (6-fold), aliquot of 0.1 ml of each dilution was plated out onto nutrient agar, MacConkey agar, Eosin Methylene Blue Agar, SSA and blood agar for bacterial identification (Vandepitte *et al*., 2003).

STANDARD PLATE COUNT (SPC) FOR BACTERIA ENUMERATION

Standard plate count for bacteria enumeration was carried out on the water samples before treatment (control) and daily on the water samples after treatment for 5 days. Pour plate method as described by Nester *et al*. (2007) was used. From the serial dilution prepared from the water samples, 1ml of each dilution was introduced into labelled sterile Petri dishes and 15 ml of plate count agar (kept at 45 ^{o}C in a water bath) was added to each plate. The plates were rotated gently 4-6 times clockwise and anticlockwise, allowed to set and incubated aerobically at 37 ^{o}C for 24 hrs in an inverted position. The series of dilutions and plating were done in triplicate. A concentration of 30 – 300 colony forming units (cfu) per plate was targeted to allow for the most accurate enumeration possible. This procedure was carried out on the water samples before and after treatment.

After 24 hours of incubation, bacterial colonies for each dilution were counted using automatic colony counter. Counts were recorded as colony forming units per mL (cfu/mL) and bacterial loads were determined by multiplying average counts by dilution factor.

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

CHARACTERIZATION AND IDENTIFICATION OF THE ISOLATES

Characterisation and identification of isolates was carried out adopting methods of Vandepitte *et al*. (2003) and Cheesbrough (2008).

DATA ANALYSIS

Data generated were subjected to analysis of variance (ANOVA) as outline by Steel and Torrie (1980) using MINITAB statistical software version 17.0. Analysis of variance was conducted to assess whether significant ($p < 0.05$) differences existed among the treatment methods given so as to assess their effectiveness at 95.0 % confidence level.

III. RESULTS AND DISCUSSION

	Before Treatment (control)	Solar radiation	*Moringa Oleifera*	Water Guard	Combine Treatment	SEM Value	p-value
W1	3.37 x 10^{3a}	1.00 x10^{3b}	0.60 x10^{3c}	0.70 x10^{3c}	0.93 x10^{3b}	0.67	0.00
W2	1.33 x 10^{3a}	1.30 x10^{3a}	1.00 x10^{3b}	1.37 x10^{3a}	0.90 x10^{3b}	0.84	0.00
W3	4.33 x 10^{3a}	1.60 x10^{3b}	0.77 x10^{3d}	1.50 x10^{3b}	1.07 x10^{3c}	1.07	0.00

Key: W1 (Gbaya River), W2 (Ujeragbo stream), and W3 (Kende stream) are sample location identification, SEM – Standard errors of the means. Each of the mean value was a product of three determinations. Means that do not share a letter in a row are significantly different ($p < 0.05$).

Table 1: Bacteria Load (Total Viable Counts) of Water Samples Before and After Treatment with Different Methods

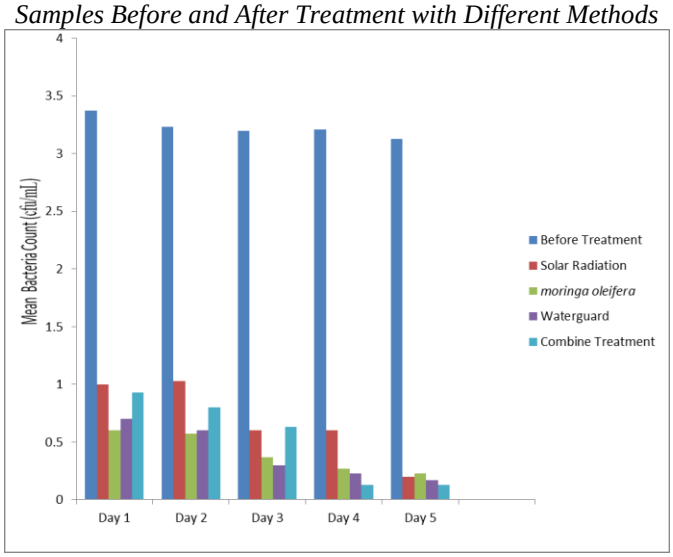

Figure 1: Daily Effect of Treatment on Bacterial Population of Water Samples from Gbaya Stream

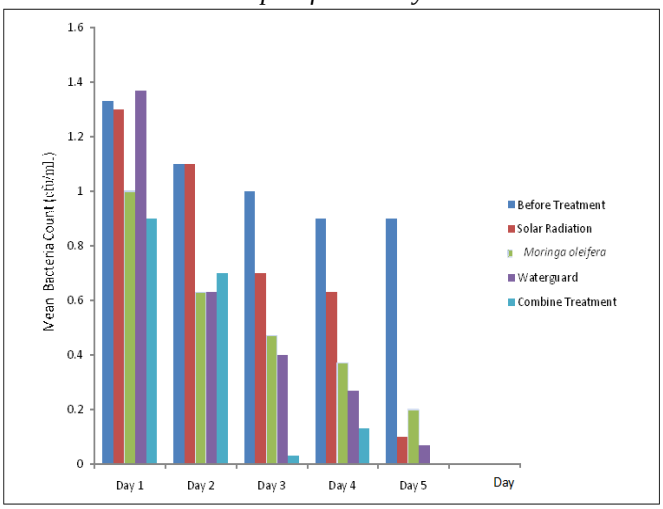

Figure 2: Daily Effect of Treatment on Bacterial Population of Water Samples from Ujeragbo Stream

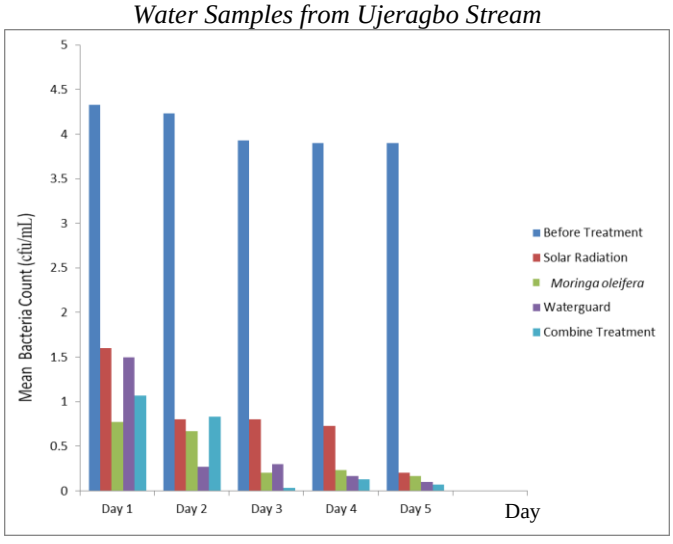

Figure 3: Daily Effect of Treatment on Bacterial Population of Water Samples from Kende Stream

IV. DISCUSSION

Bacteriological analyses of control and treated water samples from the study area showed that Ujeragbo stream gave the lowest bacteria loads (mean viable count). The mean viable counts for the water samples were generally higher exceeding the set standard stated for water meant for drinking purposes. WHO (2011) recommends a zero value of bacteria and total coliform counts in drinking water. The presences of these bacterial species in the water samples possibly suggest that the water bodies in the study area have been contaminated with wastes either of human or animal origin. This means that using this water without treatment could be hazardous to human and animal health. This observation is line with similar studies conducted on surface water in Malawi by Pritchard *et al*. (2009), in Bamenda, Cameroun by Yongabi *et al*. (2011), in Abeokuta, Ogun State by Ojekunle *et al*. (2014) and in Guma Local Government Area, Benue State, Nigeria by Ichor *et al*. (2014). Following treatments, there was drastic reduction in the bacterial counts recorded for water samples collected from Gbaya, and Kende stream. The mean values recorded from these locations after treatment showed significant differences from the mean values recorded for their control water samples ($P < 0.05$). This shows that the treatment methods impacted significantly on the bacteria loads of the water samples. Following treatment with water samples from Gbaya stream, there was no significant difference between solar and combine treatment but they differ significantly from treatment with *Moringa oleifera* and water guard. However, after treatment with water samples from Ujeragbo stream, there was no significant differences in the mean viable count recorded after solar and waterguard treatment ($P > 0.05$), and also between *Moringa oleifera* and combine treatment ($P > 0.05$). It was observed that the treatment methods possess bactericidal activity. This is supported by previous studies of Oluduro and Aderiye (2007), Bukar *et al*. (2010) and Montakhab *et al*. (2010) where treatment with *Moringa oleifera* was confirmed to possessed bactericidal activity. This could be due to fact that the active ingredients in *Moringa oleifera* seeds are mainly amino acids which possess positively charged cations that works like magnets attracting negatively charged particles such as bacteria thus reducing the bacteria loads of the water samples. Similar research by Dejung *et al*. (2007) and Boyle *et al*. (2008) also supported this study that solar treatment possesses bactericidal activity. Bacteria count recorded after treatments indicated that some of the bacteria have survived the treatment processes. This could be attributed to high turbidity recorded in most of the water samples analysed. This is in agreement with earlier stated observation by Gyamfi *et al*. (2012) and Mohammed *et al*. (2015) where they reported that water with high turbidity contain colloidal materials which could shield the microorganisms from destruction during treatment. Bacterial species identified from these water bodies were mostly members of *Enterobacteriaceae* family. These bacterial species includes *Salmonella*, *E. coli*, *Klebsiella*, *Proteus*, *Pseudomonas*, *Enterobacter*. *Citrobacter freundii.* These bacterial species isolated were found to be the same with those that are commonly seen in contaminated water bodies and other aquatic environments and it is in line with the research work of Okonkwo *et al*. (2008) where similar bacterial species were isolated from surface water sample.

V. CONCLUSION

It was established from findings of this study that water bodies in the study area have high counts of pathogenic bacteria. Different treatment methods employed proved to be effective. It is therefore recommended that surface water be treated especially at the village level to reduce bacterial population before use.

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