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Efficacy of Water Guard Disinfectant as a Domestic Stored Water Treatment Method in Makurdi Metropolis

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ABSTRACT

The study of the effect of water guard on microorganisms isolated from domestic water collected and stored for use in various homes in Makurdi metropolis was carried out. A total of 80 samples of water were randomly collected from locations in Makurdi which include; high-level, North bank, Wurukum and Wadata and analyzed for bacteria contamination. Microorganisms isolated from the water before treatment include: *Escherichia coli* (31.92%), *Klebsiella* spp (11.39%), *Diphtheroid* spp (13.94%), *Staphylococcus aureus* (17.89%), *Salmonella typhi* (9.42%), *Enterobacter aerogenes* (8.00%) and *Streptococcus faecalis* (7.44%). The microorganisms isolated after treatment of water with water guard include: *Escherichia coli* (49.27%), *Klebsiella* spp (16.79%), *Diphtheroid* spp (6.57%), *Staphylococcus aureus* (27.37%). The most prevalent organism in water after treatment was *Escherichia coli due* to its presence in almost all the locations after treatment. The result shows significant differences in the occurrence of microorganisms present in untreated and treated water samples at $p<0.05$. Some of the bacteria isolated before treatment of water with water guard were not seen after treatment. Monitoring of the effect of exposure time of the microbes to water guard is advocated.

Key words: Water guard, bacteria, water treatment and contamination

INTRODUCTION

Water is known to serve as a route for transmission of water borne diseases world-wide most especially in the developing countries, among the poorer urban and rural households when contaminated. WHO estimates that up to 80% of ill-health in developing countries is water and sanitation related. Only 61% of people in developing countries are estimated to have access to a water supply, greater in rural than urban areas and 36% to sanitation facilities, greater in urban than rural areas (WHO., 1998, 2003, 2007). Most of the mortality and morbidity associated with water-related diseases in developing countries is due directly or indirectly to infectious agents (Cheesbrough, 2000).

Though water appears to be the most abundant liquid substance on earth, there appears to be non for human utilization. In Makurdi, inadequate portable water has compelled residents to resort to point of use means of water treatment/purification to avoid contracting pathogenic microorganisms. Despite the efforts of the Benue State government to solve this problem by embarking on greater Makurdi water works, which is yet to be operational, the residents of the metropolis have resorted to different methods of water treatment and purification in order to obtain safe water for drinking and other domestic uses.

Sodium hypochlorite, NaOCl, with the product name "Water guard" is being used today as an alternative means of making water safe for human use. It is a greenish yellow liquid that is prepared by reacting dilute caustic soda solution with liquid or gaseous chlorine accompanied by cooling and is used as a disinfectant in water and waste water treatment, swimming pool and sanitary equipment among other uses. Depending on the strength of NaOCl, severity can range from mild irritation to severe burns (Powell Fabrication and manufacturing inc.). It has been found to be highly effective for bacteria, somewhat effective for viruses, most protozoa, helminths and not effective for Cryptosporidium oocysts, toxoplasma oocysts, turbidity, chemicals, taste, odour and color (CDCP., 2007). Du *et al*. (2011) showed that a chlorine dose of 2.0 mg L^{-1} and contact for 1 h could achieve a great deal of indicator bacteria reduction in MBR effluent samples. Hypochlorite solution for household water treatment is produced in four ways in order of decreasing quality control:

- Chlorine gas injection in to a stream of water
- Dilution of higher concentration of NaOCl solution
- Dilution of hypochlorite powder
- Electrolytic generation of NaOCl from salt, water and electricity (Lantagne *et al*., 2008; Luby *et al*., 2001).

There is a popular view among the Makurdi residents from our oral interview that water treated with water guard is free from microbes which is what this study seeks to prove.

The study therefore aims to:

- Determine the level of microbial contamination of water available for domestic use
- Identify these microorganisms and characterize them
- Determine the efficacy of the chemical 'water guard' presumed to be bactericidal in water treatment

The result obtained in this study will help the populace to determine the hygienic quality of water available in their homes for use and a scientific justification of the efficacy of the use of water guard for water treatment which underscores the relevance of this study.

MATERIALS AND METHODS

Sampling sites/sample size: A total of 80 samples of water were obtained from homes and the sources from which the water was obtained taking note of respectively from High level, North bank, Wadata and Wurukum areas of Makurdi metropolis. Twenty samples from each location were randomly collected from twenty different homes using sterile bottles under aseptic conditions and transported to the Advanced Biology Laboratory, Biological sciences Department, University of Agriculture, Makurdi for analysis within one hour of sample collection; collection of samples were done in such a way that each container was filled with water sample and ensured that there was no air bubble inside the container and then covered with the cap. In homes where water is usually fetched from wells for consumption/drinking directly, the collection was done by tying the sample bottle on weighted length or rope. The bottle cap was removed aseptically and was lowered into the well at appropriate depth until the sampling bottle was filled with water. The container was gently pulled out of the well and the cap was replaced when no air bubble was seen inside. It was ensured that there was no touch of the sampling bottle's mouth in order to prevent any cross-contamination.

Sample analysis: Total plate count was determined by carrying out serial dilution as described by Benson (1990). A four folds serial dilution was carried out by taking 1 mL of the original water sample using a sterile 1.0 mL pipette into a tube containing 9.0 mL of distilled water to give 1:10 dilutions. The tube was thoroughly swirled to ensure uniform mixing. With another sterile 1 mL pipette, 1 mL of this dilution was transferred into the next tube containing another 9 mL of distilled water to give 1.100 dilutions. This was diluted further to give 1.1000 and 1.10,000, respectively. With the use of sterile 1 mL pipette, 1.0 mL was transferred from each of the dilution into individual sterile Petri-dishes. The Petri-dishes were labeled according to the dilution factors. The molten nutrients agar medium which was allowed to cool down to a temperature of about 45°C was poured into each of the petri dishes containing 1.0 mL of the diluents and swirled for proper mixing. They were allowed to set before incubation at a temperature of 37°C for 24 h with the media plates placed in an inverted position

Identification of microorganisms: After sub culturing, the microorganisms were identified based on their biochemical and cultural characteristics as described by Cheesbrough (2008).

Treatment of water samples with water guard: The recommended concentration of 4 mL L^{-1} of water guard equivalent to two capfuls of its container for 25 L of water was used and after vigorous shaking to ensure uniform mixing allowed to stay for 30 min before use for bacteria analysis.

Statistical analysis: Chi square and correlation analysis to determine significant differences and simple percentage was employed for data analysis.

RESULTS

Table 1 shows the results of microorganisms isolated and identified from untreated water samples across High-level, Northbank, Wadata and Wurukum areas of Makurdi metropolis of Benue State. Across the areas, it was found that *Escherichia coli* (31.92%) occurred most frequently followed by *Klebsiella* spp (11.39%), *Staphylococcus aureus* (17.89%), *Diphtheroid* spp (13.94%) and *Salmonella* typhi (9.42%), with least occurring ones to include *Enterobacter aerogenes* (8.00%) and *Streptococcus faecalis* (7.44%).

Among the microorganisms present in the water samples from the areas, it was found that Escherichia coli occurred more and appeared more in Wadata area compared with other areas while North bank area had the highest number of different microorganisms and microbial load appeared to be least in High level area followed by Wurukum area with Wadata having the highest microbial loads (31.90 CFU mL^{-1}) followed by North bank.

Results of the isolates from untreated water samples across the sections exhibited correlations and significant differences with the isolates from the treated water samples.

Table 2 shows the results of microorganisms isolated and identified from treated water samples across High-level, North Bank, Wadata and Wurukum area of Makurdi Metropolis of Benue State. Of the microorganisms isolated, *Escherichia coli* exhibited a greater resistance to water guard, followed by *Staphylococcus aureus*, *Klebsiella* spp and *Diphtheroid* spp while *Salmonella typhi*, *Enterobacter aerogenes* and *Streptococcus faecalis* are found to be highly sensitive to water guard treatment.

Table 1: Microorganisms isolated from untreated water samples across the markets

Location and isolates	Viable count (CFU mL^{-1}) $n\times10^4$
High level	
Salmonella typhi	2.0
Staphylococcus aureus	7.3
Escherichia coli	6.8
Klebsiella spp	2.7
Enterobacter aerogenes	1.5
North bank	
Escherichia coli	7.8
Salmonella typhi	5.0
Diphtheroid spp	5.4
Enterobacter aerogenes	3.4
Klebsiella spp	2.5
Staphylococcus aureus	6.7
Wadata	
Escherichia coli	13.8
Staphylococcus aureus	5.0
Diphtheroid spp	6.5
Klebsiella spp	4.1
Enterobacter aerogenes	3.5
Wurukum	
Escherichia coli	5.5
Salmonella typhi	3.0
Diphtheroid spp	3.9
Klebsiella spp	2.8
Streptococcus faecalis	7.9

Table 2: Microorganisms isolated from treated water samples across the markets

Location and isolates	Viable count (CFU mL^{-1}) $n\times10^4$
High level	
Escherichia coli	3.9
Staphylococcus aureus	4.3
Klebsiella spp	2.7
North bank	
Escherichia coli	1.9
Diphtheroid spp	0.2
Staphylococcus aureus	2.2
Wadata	
Diphtheroid spp	1.6
Klebsiella spp	0.9
Escherichia coli	7.1
Staphylococcus aureus	1.0
Wurukum	
Escherichia coli	0.6
Klebsiella spp	1.0

Table 3: T-tests, correlations and significant differences of both untreated and treated water samples across the markets

Locations	T-test	Correlation	Significant difference
High level	8.510	0.660	0.541(0.014)
North Bank	3.826	-0.351	0.410(0.031)
Wadata	0.076	-0.910	0.090(0.944)
Wurukum	0.296	-0.587	0.298(0.782)

T: Test, T_{cal} T_{table}, High level: 8.510>5.841, North bank: 3.826<4.604, Wadata: 0.076<4.604, Wurukum: 0.296<4.032

The results of T-test and correlation analysis were employed to determine different levels of significance. The occurrence of bacteria in untreated and treated water samples varied across the areas studied Table 3.

DISCUSSION

The treatment of water using water guard was carried out. Prior to treatment the following bacterial were isolated; *Salmonella typhi*, *Escherichia coli*, *Diphtheroid* spp, *Klebsiella* spp, *Streptococcus* spp, *Enterobacter aerogenes* and *Staphylococcus aureus*. This finding corroborates the findings of previous studies that untreated water is a potential route for diseases transmission since pathogenic microbes can be contracted during use (Gavini *et al*., 1985; Tortora *et al*., 1995). The presence of *E. coli* in domestic water is an indication of faecal contamination which by implication shows the possibility of the existence of other pathogenic organisms and if consumed without any proper and appropriate treatment may result into varying degrees of infections (Uraih, 2004; WHO., 1993; Ellis *et al*., 1993). Some of the isolated organisms like *S. aureus* and *Klebsiella* spp are reported to be opportunistic pathogens in water which presence portends health risks to people especially those with impaired general or local defense mechanism such as the elderly, young, patients with wounds, burns and those undergoing immunosuppressive therapy etc. (Bergdoll, 1990; WHO., 1993; Tortora *et al*., 1995; Kerry-Williams and Noble, 1986).

The organisms that were eliminated upon treatment with water guard include; *Salmonella typhi*, *Enterobacter aerogenes* and *Streptococcus faecalis*.

This implies that *Salmonella typhi* which has water as one of its routes of transmission cannot be contracted when the water is treated with water guard at the recommended concentration by the manufacturer. Other organisms such as *Enterobacter aerogenes* said to be responsible for urinary tract infections and nosocomial infections and *Streptococcus faecalis* responsible for scarlet fever and sore throat will not be contracted by humans when the water is treated with water guard at recommended concentration.

Water guard is being used today as an alternative means of making water safe for human use. There is a popular view by most Makurdi residents from our personal interactions especially with those seen to be less socioeconomically privileged that water treated with water guard is portable and free from microbes. Our result however found this view not completely true due to the presence of some microorganisms after treating the water with water guard at the recommended concentration by the manufacturer. This could be as a result of inadequate concentration of the chemical based on manufacture's recommendations to cure the water of such microorganisms or due to natural non sensitiveness of these organisms to water guard or the limited time to which the water samples were subjected to treatment. The microorganisms isolated after treatment were: *Escherichia coli* (49.2%), *Staphylococcus aureus* (27.37%), *Klebsiella* spp (16.79%), *Diphtheroid* spp (6.57%).

The occurrence of these microorganisms at various locations under study was significant before and after treatment since some were not present at all the locations and even though present, the population measured in viable counts varied.

Our finding has clearly demonstrated that water guard is not absolutely effective in water treatment as some microorganisms survived after treatment thus implying that treated water using water guard could still be unsafe, non-portable for domestic consumption. To reduce the risk of water borne infections in homes, we recommend better conventional methods of water treatment, improved water sanitation and supply and speedy completion of ongoing water projects embarked upon by government in order to make portable water available to the teaming population in Makurdi metropolis. We recommend further studies on the effect of different concentrations and exposure time of water samples to water guard to determine its effect on microorganisms found in water.

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