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Microbial quality assessment of selected wells water samples in Bali Metropolis, Taraba State

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Abstract
This study accessed and compared the microbial quality of well water in Bali Metropolis, water samples were collected from sixty (60) selected wells in Ten (10) different geographical zones used for drinking and domestics purpose. Microbial analysis was carried out using Most Probable Number technique for the enumeration of both total coliform and total differential E. coli. The result obtained was then compared with the World health organization (WHO) and Nigerian standard for drinking water quality (NSDWQ) standards for drinking water. All the mean values for the total coliform and E. coli coliform count of all the water samples analyzed were generally high they exceeded the W.H.O. and NSDWQ standard requirement as the value ranges between 12.8cfu/100ml to 92.22cfu/100ml for Total coliforms count and 9.17cfu/100ml to 89.21cfu/100ml for Total Differential E. coli count. This study recorded high number of coliform counts in water samples analyzed, thus making it unsafe for drinking and may pose a serious health threat to consumers and therefore, there is need for treatment of these wells water by the consumers and by simple treatment methods such as boiling, filtration before drinking and agitation by the consumers.

Keywords: Total coliforms count, *E. coli* coliform count, WHO (World Health Organization), NSDWQ (Nigerian Standard for Drinking Water Quality)

Introduction

Well water is used primarily as a source of drinking water by the vast majority (94%) of the rural population in Bali metropolis. A well is an excavation or structure formed in the ground by digging, driving, or by drilling to access water. It is the oldest and most common kind of well is water well to access groundwater in underground aquifers. Water quality refers to the, chemical, physical, and biological characteristics of water centered on the standards of its usage. The most common standards used to monitor and assess water quality carry the health of ecosystems, safety of human contact, and condition of drinking water. Water quality has a major impact on water supply and oftentimes defines supply options (Bartram and Balance, 1996; Alley, 2000; Ahuja, 2009; Boyd, 2015) [1, 3, 2, 4]. According to (UNEP, 2004) 40% of the total population will live in water scarce area by the year 2025. WHO (2014) stated that there was no assurance that people who get water from an improved source will get it free of contamination. One of the studies also showed that about 1.8 billion people get water from a source that is already faecally contaminated, which can cause cholera, enteric fever, and many other acute and chronic diseases (Bain, *et al*., 2014; Jessoe, 2013; Sobsey, *et al*., 2008; Szabo and Minamyer, 2014) [7]. The escalation of human population and expansion in metropolitan land use are some of the major causes that are liable for increased demand for water and as a response to these escalated demand as witnessed in the study area. The main theme of this research is to assess the physical, chemical and microbial characteristics of well water within Bali metropolis. Bali is a semi urban town, as such it has a significantly large and growing population, and a mixture of urban and typical rural land use, these factors together with the local geology considerably affects the pattern of water demand and its quality.

Research Questions
1. What is the Microbial quality of well water samples in Bali metropolis?
2. What is comparison of the samples with the acceptable limits set by World Health Organization Standard (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) for drinking water?

Materials and Methods
Study Area and Sample site
Bali local government area (LGA) is one of the 16 local government areas in Taraba State, Nigeria. it covers a total land area of about 9,146km^2 and ranges between latitude 7^{0}30''00'' to 8^{0}10'00'' North of the equator and 5^{0}45'00'' to 6^{0}15'00'' East of the Greenwich meridian (Taraba State Government 2005). The area is generally positioned on the banks of the upper course of Taraba River at some 150km from Jalingo, by virtue of its location in the water shed area of the river Benue and it proximity to Taraba River a major arm of river Benue at an altitude of 450m above seller. The temperature region is warm to hot throughout the year with a slight cool period between November February, temperature ranges between 23 – 40^{0}C. There is a gradual increase in temperature from January to April which also increases the demand of water for domestic uses in the area. The water supply situation in the area is mainly characterized by scarcity especially in the dry season, most of the households do not have access to pipe borne water as such they rely on wells. In this study, ten (10) geographical zones were randomly selected, these include Anguwan Bayan tasha, Anguwan Idi, Anguwan TIV, Anguwan Chamba, Aguwan Adamu, Anguwan mission, Anguwan Musa, Sabon-Layi, Aguwan Kundi, Dania A and Dania B respectively. Water samples were collected from sixty (60) different wells and used for microbial quality.

Nature of Data
The study assessed the microbial well water quality in ten (10) geographical zones of Bali Metropolis. The study is experimental; it involved collection of water samples and laboratory analysis. The generated data included information on the characteristics of well water in the study area, quality of water from the well consumed by residents, the relative distance of well to the source of contamination and the nature of water contamination related diseases and infections.

Sources of Data
The data used in the study are fundamentally from the main sources, which were produced through laboratory analysis of water samples. Consequently, data used involved the values from the laboratory tests. These include values of parameters measured in the water quality analysis which were given in coliform count/100ml of sample; type and frequency of waterborne diseases/illnesses reported in households. Data from documentary sources were also used. These are mandatory standard limit values of water quality constituents of WHO Water Quality Guidelines 2008 and that of NSDWQ, 2007; Equally, the secondary sources of data were also used which included journals, publications, review of some literatures and the internet.

Sample collection
The study involved sampling water from wells. Water samples were collected from the Ten (10) different zones, taking into cognizance location of residential density and other periphery. Water samples were collected from 60 different wells, for the analysis. Taking the water samples and analysis procedure were guided by the standard method for water analysis (APHA, 1989), and were done with the help of two assistances. They were trained and pre-brief before the actual sampling, thus they were acquainted with the technicalities of water sampling procedure, handling and conveyance of samples. The necessary resources for smooth sampling exercise were also mobilized at that point. All water samples were collected using plastic bottles, which were washed with the samples water in addition to the earlier sterilization. All samples were appropriately labeled with the respective zones. Sampling protocols described by APHA (2005) were strictly adhered to during sample collection. Each sample for analysis was collected in sterilized 500ml plastic bottle with screw caps; care was taken not to allow bubbles into the bottles during the collection. Sample collected was kept in an ice chest, and transported immediately to the laboratory for the analysis.

Table 1: Sampling Area Description

Sampling Number	Sampling Zone/Description
Sample A	Anguwan Bayan Tasha
Sample B	Anguwan Idi
Sample C	Anguwan chamba
Sample D	Anguwan TIV
Sample E	Anguwan Adamu
Sample F	Anguwan mission
Sample G	Sabon layi
Sample H	Anguwan musa
Sample I	Anguwan kundi
Sample J	Dania A
Sample K	Dania B

Sample processing and storage
The water samples collected were labeled as per the sampling station and since the analysis was to commence within three hours no preservatives were used to stop microbial activity. The samples were packed in an icebox and transported to laboratory for analysis.

Laboratory Analysis
The analysis covered the interpretation of the laboratory analysis of the obtained samples from well water. The equipment used for the analysis of water samples included the Inductively Coupled Plasma – Optical Emission Spectrometer ICP–OES, Monochromator, UV/V Spectrometer, evaporating dish and spectrophotometer, MacConkey agar plate and a 10-15X microscope. The statistical tools used are essentially descriptive, where means, percentages as well as tabulations were applied in the presentation of results.

Microbial Analysis
Total Coliforms: The standard bacterial water examination was acted in the research facility utilizing aseptic method to examine the coliform include in samples and was communicated in most likely number per 100ml. Hypothetical, confirmatory and completed tests were performed. In presumptive test, a series of lactose stock tubes were inoculated with water test for three sequential tube dilutions. All tubes were brooded at 37^0 C for 48 hours. Gas creation in tubes demonstrated positive outcome for the

presence of coliforms (Taruna and Alankarita, 2013) [12]. In the confirmatory test, the sample from positive possible cylinders was streaked on Eosin Methylene Blue (EMB) agar plates. The plates were upset and brooded at 37^0 C for 48 hours. Small colonies with dark center and green metallic sheen showed a positive affirmed test for the presence of E. coli. In completed test, the brilliant green bile broth tubes were inoculated with materials from EMB plates and hatched at 37^0 C for 48 hours. Gas creation in broth tubes showed positive outcome (APHA, 2010).

Total differential E. coli count: The most probable number (MPN) of fecal coliforms in 100 ml water sample was assessed by the quantity of positive tubes utilizing the MPN Table (APHA, 2005). Most likely number examination is a factual strategy dependent on the random dispersion of microorganisms per volume in a given example, in this technique estimated volumes of water are added to a progression of cylinder containing a fluid indicator development medium (APHA, 2010). MPN test is completed in three stages: presumptive test which is a subjective investigation that permits recognizing or affirming, the presence of coliforms in an example. Estimated aliquots of the water to be tried are added to a lactose fermentation broth containing an upset gas vial. Tubes of this lactose medium are immunized with 10ml, 1ml and 0.1ml aliquots of the water test. The arrangement comprises of in any event three gatherings, each made out of five Tubes of the predetermined medium (Taruna and Alankarita, 2013) [16]. The tubes in every group are then immunized with the assigned volume of the water test. Development of gas in any of the cylinders is presumptive proof of the presence of coliform microscopic organisms in the example. The presumptive test additionally empowers the microbiologist to get some thought of the quantity of coliform living beings present by methods for MPN (APHA, 2010).

Results and Discursions

Table 2: Mean Values of all the water samples analyzed

Sampling Number.	Total Coliform Count cfu/100ml	Total Diffrential E. coli Count cfu/100ml
Sample A	37.20	21.00
Sample B	27.81	9.17
Sample C	19.50	17.14
Sample D	49.10	35.33
Sample E	90.50	67.00
Sample F	12.80	56.70
Sample G	22.71	37.23
Sample H	92.22	89.21
Sample I	67.34	44.32
Sample J	44.00	35.20
Sample K	23.43	31.10
Range	*12.8 – 92.22*	*9.17 – 89.21*
WHO	***0***	***0***
NSDWQ	***10***	***0***

Sources: *Laboratory Analysis (September - October 2023).*
Note: Bold value indicate the standard recommended value set by WHO and NSDWQ.

From Table 2, all the water sample analyzed from ten (10) different zones showed that the mean Total coliform values ranged between 12.8cfu/ml – 92.22cfu/ml. the results showed that the lowest total count of 12.8cfu/100ml was observed from sample F, the highest count of 92.22cfu/100ml was observed from sample H. the results also shows that the mean total coliform of sample A, B, C, D, and E, recorded 37.3cfu/100ml, 27.81cfu/100ml, 19.5cfu/100ml 49.1cfu/100ml, and 90.5cfu/100ml. Sample G recorded 22.71cfu/100ml, 67.34cfu/100ml was recorded in sample I, and sample J and K record 44.0cfu/100ml and 23.43cfu/100ml respectively. The water sample from sample H had the highest mean total coliform count of 92.22cfu/100ml, these findings is not surprising considering the high population and close ranged of the wells to pit latrines, contaminants from pit latrines could seep slowly into underground water, thereby polluting it. This results agrees with the findings of Mustapha *e tal*, (2013) [18] who conducted a research in Maiduguri Borno state, Nigeria. The research recorded high counts of total coliform of 145 $x10^3$cfu/100ml in Gwange ward and 65 $x10^3$cfu/100ml in bulunkutu ward water samples in Maiduguri.

Total Differential *E. coli* were detected in all the water sample analyzed as the total mean value ranges between 9.17cfu/100ml to 89.21cfu/100ml. the highest mean *E. coli* count were detected in sample H while the lowest in sample B, sample A 21.0cfu/100ml was recorded, while 17.4cfu/100ml, 35.33cfu/100ml, 67.0cfu/100ml, 56.7cfu/100ml, and 44.32cfu/100ml respectively. Sample J detect 35.2cfu/100ml, also 31.1cfu/100ml recorded in sample K. None of the samples are within standard value recommends by WHO and NSDWQ. The presence of total coliforms and total differential *e. coli* count, are indicator organism of other pathogenic bacteria. The total coliform counts of all the water samples analyzed were generally high and exceeded the standard requirement of 0cfu/100ml set by WHO and 10cfu/100ml set by NSDWQ. The detection of e. coli in the water sample indicates that there was a recent feacal contamination. The contamination could be as a result of contamination from pit latrines close to the well water sited close to refuse disposal site. This result agrees with the findings of Uzoigwe and Anwa (2012) [19] who detected *E. coli* in most of the tube wells water samples in port Harcourt, Nigeria. Adeyemi, *et al.* (2017) [20] conducted a research and detected E. coli in wash boreholes in SW, Nigeria. In another similar work by Adetunje and glover (2011) [21] done in selected secondary schools within Navarngo, Kassena-Nankana district in upper-caste region of Ghana, recorded higher value of total differential e. coli count in all the samples, unlike the result from Ahmad *et al*, (2013) [22], who conducted a water quality analysis of wash boreholes water in Gombe Metropolis, Gombe state.

Conclusions

It can be there concluded that, all the well water sample analyzed in the study area were feacally contaminated as the values recorded were above the recommended values set by WHO and NSDWQ. All the parameters analyzed were higher than the recommended limits. It is revealed that the sources of water were under some attack by anthropogenic sources. As such the water sources must therefore be protected from activities such as poor waste management, over use of fertilizers and chemicals which pollute surface and underground water sources. It is paramount that wells are protected from severe runoffs from polluted sites, intensive agricultural communities and waste disposal sites. Therefore, there is a need for awareness to be created about the present water quality of these wells, to make clear to the people on the need for further treatment before consumption.

Recommendations

1. Authorities in charge of water quality assessment must constantly or regularly monitor the water sources to ensure good water quality standards in Bali municipal at least once in every two years to ensure that incidences of contamination are noticed earlier for remedial action to be taken.
2. Most importantly, government must establish and supply water treatment corporations with state-of-the-art equipment within the municipality.
3. Government must also provide adequate funding for research with the aim to routinely monitor the microbiological quality indicators in the metropolis, the state and the country at large, in other to reduce the rate of water related disease.
4. The communities should be educated on the dangers associated with sighting of wells (water source) near pollution points.

If such measures are taken, it will increase public confidence in the quality of their water sources.

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