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Assessment Of Bacterial Quality Of Some Selected Boreholes Water In Kurnar Asabe Quaters Kano Metropolis

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ABSTRACT

Bacteriological quality assessment of different water samples collected from selected boreholes in Kurnar Asabe quarters, Kano metropolis was carried out for a period of six months. A total of thirty (30) samples were collected from 10 selected boreholes in the study area using systematic random sampling technique and some of the physico-chemical parameters such as temperature, pH, electrical conductivity and turbidity were measured on the spot before transporting to the laboratory for further physico-chemical and bacterial analysis. Membrane filters (MF) method was used for bacteria isolation. The total bacterial count was determined by using dilution method. Bacterial identification was done using standard laboratory methods. The physico-chemical parameters of the water samples were within the normal range of WHO limit. The total bacterial count (TBC) in boreholes water samples in this study ranged from 1.0 x10^2 to 1.1x10^5cfu/ml. Similarly, the total coliform count (TCC) of the borehole waters analyzed ranged from 0 to 11 cfu/100ml. Escherichia coli, Shigella, Staphylococcus aureus, Bacillus cereus, Salmonella typhi, Pseudomonas aeruginosa, Enterobacter sp and Klebsiella pneumoneae were identified. People consuming such water are at risk of several clinical symptoms such as cholera, gastro-intestinal disorders, diarrhea and typhoid fever.

Keywords: *Bacteria, Borehole, Physico-chemical, Kano Metropolis*

INTRODUCTION

Water is one of the most essential natural resources needed by every living thing. Whether it is used for drinking, bathing, food production or recreational purposes, portable and accessible water supply is crucial for public health [1]. Water is the commonest solvent for many substances and it rarely occurs in its pure nature. Water can be obtained from a number of sources, among which are streams, lakes, rivers, ponds, rain, springs and wells (Okonko et al., 2008) [2]. Drinking water has always been a major issue in many countries, especially in developing countries like Nigeria. In many developing countries, availability of water has become a critical and urgent problem and it is a matter of great concern to families and communities depending on non-public water supply system [2]. Increase in human population has exerted an enormous pressure on the provision of safe drinking water especially in developing countries [3]. Unsafe water is a global public health threat, placing persons at risk for a host of diarrheal and other diseases as well as chemical intoxication [4]. Contaminated water sources are vehicles for the transmission of waterborne diseases such as cholera, shigellosis, and Campylobacteriosis [5]. The most frequently implicated microorganisms in waterborne diseases are the enteric bacteria such as *Escherichia coli*, *Shigella* species, *Salmonella* species, among others, which according to WHO/UNICEF [6], have been associated with the estimated 80% diseases affecting developing countries. Unsanitary water particularly has devastating effects on young children in the developing world. The World Health Organization (WHO) estimated that about 1.1 billion people globally drink unsafe water and the vast majority of diarrheal diseases in the world (88%) are attributable to unsafe water, sanitation and hygiene. Approximately 3.1% of annual deaths (1.7 million) and 3.7% of the annual health burden world-wide (54.2 million) are attributable to unsafe water, sanitation and hygiene [7].

Each year, more than 2 million persons, mostly children less than 5 years of age, die of diarrheal disease [8,9]. For children in this age group, diarrheal disease accounted for 17% of all death from 2000 to 2003 ranking third among causes of death, after neonatal causes and acute respiratory infections [10]. Nearly 90% of diarrheal-related deaths have been attributed to unsafe or inadequate water supplies and sanitation conditions affecting a large part of the world's population [4,7]. An estimated 1.1 billion persons (one sixth of the world's population) lack access to clean water and 2.6 billion to adequate sanitation [4,10]. In Nigeria, majority of the rural populace do not have access to potable water and therefore, depend on well, stream and river water for domestic use [11].

During passage through the ground, water dissolves minerals in rocks, collect suspended particulate matter, particularly those of organic sources as well as pathogenic micro-organisms from faecal matters [12]. In some areas, water sources are shared with the animals making the water dirty and contaminated. Therefore, auditing and monitoring of physic-chemical, minerals, and microbial quality of drinking water has fast becoming an essential aspect of water quality studies. In Nigeria, hand dug wells and borehole waters represent the two major sources of drinking water and are becoming polluted due to the increasing growth in human population, industrialization, indiscriminate refuse dumpsites, and climate change [13]. Reports from previous research works showed that majority of hand dug wells and borehole waters in Nigerian communities were microbiologically poor [13,14,15,16,17,18]..

Major factors affecting microbiological quality of surface waters are discharges from sewage works and runoff from informal settlements. Indicator organisms are commonly used to assess the microbiological quality of surface waters and faecal coliforms are the most commonly used bacterial indicator of faecal pollution [18]. They are found in water that is contaminated with faecal wastes of human and animal origin. Total coliforms comprise bacterial species of faecal origin as well as other bacterial groups (e.g. bacteria commonly occurring in soil). The coliforms are indicative of the general hygienic quality of the water and potential risk of infectious diseases from water [18]. The study was aimed to assess the bacterial quality of some selected boreholes water in kurnar asabe quarters in Kano metropolis.

Materials and Methods

Study area

Kurna- Asabe is located in Fagge Local Government within Kano Metropolis in North-Western Nigeria. Kano State is bordered by Katsina State to the North-West, Jigawa State to the North-East, Bauchi State to the South-East and Kaduna State to the South-West. Kano is located on 12° N and 8°30'E. It has a total area of 20,131 km^2. The urban area covers 137km2 and comprises of six LGAs - Kano municipal, Fagge, Dala, Gwale, Tarauni and Nassarawa with population of 2,163,25 as at 2006 [19]. Climate of the study areas have been described as 'AW' type as identified by Koppen's climatic classification [20]. The vegetation is a Savanna type simply described as closed grass or other predominantly herbaceous vegetation with scattered or widely spaced woody plants. Vegetation types in the state are the northern Guinea savanna and Sudan savanna. Northern Guinea Savanna is open woodland with grasses shorter than in the southern guinea where grasses are 1.5 to 3m tall. The Sudan Savanna has scattered trees in open grassland with grasses under 1.2m tall. The vegetation has been largely cleared for cultivation to form cultivated parkland. Parkland has scattered protected trees at some distance apart in open cultivated land [20].

Sample Collection

Water samples were collected from boreholes used by Kurna-Asabe community as a source of water for domestic purposes such as cooking, bathing, drinking, washing and performing ablution. A total of 30 water samples were randomly collected from 10 boreholes selected in the study area using systematic random sampling technique. Samples from the boreholes were collected in triplicate and the water samples were well labeled and transported in black polyethylene bags to Water Laboratory in the Department of Geography Bayero University Kano for physico-chemical analysis and Microbiology Laboratory of Kano University of Science and Technology Wudil for microbial analysis.

Physico-Chemical Analysis

The pH of water samples was analyzed using a pH meter. Thermometer reading in ^{0}C was used in recording the temperature of the water samples and water turbidity was determined sing turbidimeter. The conductivity, nitrate content, total hardness and chloride content of the water samples were determine using the methods of FAO [21].

Microbiological analysis

Membrane filters (MF) method. The method described by Asiya and Ali [22] was followed;

100 ml of each water sample was filtered through sterile membrane which retained the bacteria on its surface. The membrane was removed aseptically and placed on a Nutrient agar (NA) as a basal medium and MacConkey agar as a differential medium to determine enteric bacteria. All the plates were incubated at 37°C for 24 hrs. Coliforms colonies (indicating faecal contamination) growing on the surface of the membrane were counted and recorded as Coliforms density (total Coliforms colonies per 100 ml) or colony forming unit (CFU).

Total bacterial count (TBC)

Total bacterial count was conducted using serial dilution method as describe by Ibe and Okplenye [23]. A dilutions were made from 10^{-1} – 10^{-5}. An aliquot of 0.1ml of each dilution was aseptically plated on Nutrient agar in triplicate. The plates were incubated at 37^{0}C for 24 hours and the colony counting was done manually using colony counter.

Total bacterial count (TBC) = N/D x V; where N = mean colony, D = dilution and V = volume

Identification of Bacterial Isolates

Presumptive colonies were confirmed by gram staining, biochemical (Indole, Methyl-red, Vougues Proskeaur, Citrate utilization Catalase and Oxidase) tests, nitrate reduction, sugar fermentation and motility test. Each plate was graded as positive or negative. Bacteria isolates were characterized according to Bergy's manual of systemic determinative Bacteriology by Holt *et al*. [24].

Data Analysis

Data obtained for physico-chemical and microbial analyses were recorded and analyzed using Statistical Package for Social Science (SPSS) 2010 version. Mean and standard deviations were calculated of the three samples per sampling site. The average results of the water quality were compared with that of World Health Organization drinking water standard for references.

RESULTS

Physico-chemical Analysis

The average physicochemical analysis of the water samples from 10 different boreholes is presented in Table 1. The turbidity of the water samples ranges 'between' 1-3 while Ph of the samples ranges from 6.5 - 6.8. The result of physico-chemical analysis of the 10 boreholes in this study demonstrated that the boreholes waters were within the permissible standard of World Health Organization.

Table1. *Physico-chemical analysis of the water samples*

	Boreholes										
Properties	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**WHO**
Temp. (^{0}C)	24±1.2	23±1.8	25±2.2	25±1.0	23±1.4	26±2.1	24±1.8	23±0.8	25±1.3	26±1.7	-
Turbid. (NTU)	2±0.0	1±0.0	1±0.0	3±0.0	1±0.2	1±0.0	2±0.3	2±0.0	1±0.0	2±0.0	5
Ph	6.6±0.0	6.5±0.0	6.7±0.0	6.5±0.3	6.5±0.3	6.8±0.8	6.5±0.8	6.6±0.5	6.6±1.0	6.8±0.9	6.5-8.5
Cond. (us/cm)	180±4.6	193±1.9	200±3.2	210±2.5	190±3.5	155±1.8	170±1.2	165±3.0	170±2.2	205±1.8	-
Hardn. (mg/l)	100±3.5	75±2.5	90±1.7	120±3.2	80±1.0	85±1.7	95±2.2	105±3.1	90±1.2	110±1.4	500
Chlor. (mg/l)	150±3.5	110±4.7	125±3.2	190±5.5	125±3.6	110±4.	135±3.4	150±2.9	120±3.7	180±2.2	200
Nitrate (mg/l)	24±1.5	22±1.7	23±2.3	27±1.2	18±0.5	21±2.2	24±3.5	26±1.9	20±1.5	25±2.1	50

Total bacterial count (TBC) and Total Coliforms Count (TCC)

The total bacterial count (TBC) and total coliforms count (TCC) in the 10 borehole water samples was presented in table 2. The coliforms are indicator organisms that their present indicates the presence of disease causing organisms.

The results showed the TCC of most of the bore holes were within the permissible standard of WHO except boreholes number 3, 4 and 6 with values greater than 10 cfu/100ml.

Table2. *Total bacterial count (TBC) and Total Coliforms Count (TCC) of the samples*

Boreholes	TBC (cfu/ml)	TCC (cfu/100ml)
1	$1.1x10^5$	3
2	$1.3x10^4$	5
3	$1.0x10^2$	7
4	$2.0X10^2$	0
5	$1.8x10^3$	1.0
6	$1.0x10^3$	11
7	$1.1x10^2$	4
8	$1.7x10^3$	2.6
9	$2.1x10^4$	5
10	$1.6x10^2$	0
WHO	**$1.0x10^2$**	**≤ 10**

Identification of Bacterial Isolates

The biochemical and morphological characteristics of the recovered isolates from the water samples is presented in Table 3. Isolates were subjected to various biochemical tests such as Indole, Methyl-red, Vougues Proskeaur, Citrate utilization Catalase and Oxidase tests, sugar fermentation and motility test.

A total of 8 different isolates were recovered from all the water samples examined.

Table3. *Identification of Bacterial Isolates from the water samples*

Tests	A	B	C	D	E	F	G	H
GS	-	-	-	+	-	-	+	-
SH	Rod	Rod	Rod	Coccus	Rod	Rod	Rod	Rod
IN	+	+	+	-	-	-	+	-
MR	+	+	+	-	+	+	-	-
VP	-	-	-	-	-	-	+	+
CU	-	-	+	-	+	-	+	-
CA	-	+	-	+	+	+	+	-
CO	-	-	-	+	-	-	-	-
OX	-	-	-	-	+	-	+	-
MO	+	-	-	-	+	+	+	+
NR	+	+	+	-	+	+	+	+
MF	+	+	+	+	+	+	+	+
LF	+	-	+	-	-	-	+	+
Organis.	*E. coli*	*Shigella*	*Klebsiella*	*S.aureus*	*P. aeruginosa*	*S. typhi*	*Bacillus*	*Enterobacter*

Key: *GS=Gram staining, SH= Shape, IN =Indole, MR=Methyl-red, VP=Vougues Proskeaur, CU=Citrate Utilization, CA=Catalase, CO=Coagulase, OX=Oxidase, MO=Motility, NR=Nitrate reduction, MF=Mannitol fermentation, LF=Lactose fermentation*

Bacteriological analysis of water

The distribution of bacterial isolates recovered from water samples is presented in Table 4. The result showed that *Escherichia coli, Shigella, Staphylococcus aureus, Bacillus cereus, Salmonella typhi, Pseudomonas aeruginosa, Enterobacter sp and Klebsiella pneumoneae* were identified. *Escherichia coli and Enterobacter sp* were almost present in all the water samples examined.

Table4. *Distribution of bacterial isolates recovered from water samples*

	Boreholes									
Isolates	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Escherichia coli	+	+	+	+	+	+	+	+	+	+
Shigella	+	-	-	+	+	+	-	-	+	-
Staphylococcus aureus	-	-	-	+	-	+	+	+	-	+
Bacillus cereus	+	+	+	+	-	-	+	+	-	+
Salmonella typhi	+	-	+	+	-	+	+	+	+	-
Pseudomonas aeruginosa	-	+	+	+	-	-	+	+	-	+
Enterobacter sp	+	+	+	-	+	+	+	+	+	+
Klebsiella pneumoneae	+	-	-	-	+	+	+	-	+	+

Discussion

The study was aimed to assess the bacterial quality and physico-chemical properties of some selected boreholes water in kurnar asabe quarters in Kano metropolis. Temperature is one of the most important ecological and physical factors which has a profound influence on both the living and non-living components of the environment, thereby affecting organisms and the functioning of an ecosystem. The average temperature of the water samples examined ranged from 23-26^0 C. Although temperature generally influences the overall quality of water (physico-chemical and biological characteristics), there are no guideline values recommended for drinking water. However, this temperature range can be suitable for microbial growth. Turbidity defined the clarity or cloud of water in which the values are attained by measuring the scattering and absorbing effect that suspended particles have on light [25]. In this study, most of the water samples have a turbidity value of 1 or 2 NTU except borehole number 4 with 3 NTU. This indicated that the water samples are clear and within the permissible standard of World Health Organization. Other physico-chemical parameters such as chlorine and nitrate content of the water sample examined in this study indicated that the range and limit is within W.H.O standard.

The recognized bacterial indicators most commonly used for assessing water quality are bacteria of the *Enterobacteriaceae* family. The coliforms bacteria are Gram-negative rods, aerobic or facultative anaerobic, non spore-forming, rapid lactose-fermenting with gas formation within 48 h at 35°C. Some bacteria from this group are indigenous to soil and waters. This necessitates the use of a more precise indicator for fecal contamination in many situations. The fecal coliforms bacteria are members of the coliforms group of bacteria usually found in the feces of warm-blooded animals. The presence of fecal coliform bacteria in water is indicative of contamination by fecal material and is therefore considered indicative of a health risk, because many enteric pathogens are present in feces. Furthermore, the significance of the coliform group density has long been established as an indication of the degree of pollution and thus the microbiological quality of water.

The total bacterial count (TBC) in boreholes water samples in this study ranged from 1.0 x10^2 to 1.1x10^{5}cfu/ml. Similarly, the total coliform count (TCC) of the borehole waters analyzed ranged from 0 to 11 cfu/100ml. this proved that the borehole water used in this study have low coliforms count except borehole number 6 with total coliforms count of 11 cfu/100ml which exceeded the limit set by WHO. Several studies were conducted by different researchers to determine microbial quality of water. Erah *et al.* [26] in a study conducted on the quality of ground water in Benin City, Nigeria found unacceptable levels of aerobic bacteria and fungi present in borehole water of Teboga District of Benin City. In another similar work, Eniola *et al.* [27] obtained a range of 5.0 x102 - 7.0 x 102 cfu/ml for stored borehole water samples.

The result of bacterial identification in this study showed that *Escherichia coli, Shigella, Staphylococcus aureus, Bacillus cereus, Salmonella typhi, Pseudomonas aeruginosa, Enterobacter sp and Klebsiella pneumoneae* were identified. *Escherichia coli and Enterobacter sp* were almost present in all the water samples examined. The most predominant organisms being *Escherichia coli* and *Enterobacter* as they both occurred in almost all the borehole water analyzed.

The presence of *Salmonella typhi*, *Klebsiella* sp., *Escherichia coli* and *Staphylococcus aureus* in most of the borehole water samples is unacceptable from the public health point of view because such organisms could be pathogenic. Several studies conducted on bacteriological quality of borehole water revealed the presence of such bacteria. A study conducted by Bello *et al*., [28] on Bacteriological and Physicochemical Analyses of Borehole and Well Water Sources in Ijebu-Ode, Southwestern Nigeria, the result revealed that eight genera of bacteria which include *Escherichia coli, Klebsiella sp, Salmonella sp, Shigella sp, Enterococcus sp, Proteus sp, Pseudomonas aeruginosa* and *Staphylococcus aureus* were isolated from the water samples. This support the present study

Conclusion

In conclusion, this study aimed to determine the physico-chemical and bacteriological quality of of some selected boreholes water in kurnar-asabe quarters in Kano metropolis. The physicochemical parameters of the water samples collected from 10 selected boreholes in the study area such as the pH, temperature, turbidity, nitrate and chlorine content of the water samples examined were within the range of WHO limit.

Bacteriological analysis of water show the presence of showed that *Escherichia coli, Shigella, Staphylococcus aureus, Bacillus cereus, Salmonella typhi, Pseudomonas aeruginosa, Enterobacter sp and Klebsiella pneumoneae*. People consuming such water are at risk of several clinical symptoms of certain diseases such as gastro-intestinal disorders, diarrhea and typhoid fever

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