Original Research Article

An Assessment of the Bacteriological Quality of the Drinking Water Sources and its Health Implications on Residence of Sokoto Metropolis, Sokoto State State, Nigeria.

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Abstract: Portable water is the water that is free from disease producing microorganisms and chemical substance that are dangerous to health the quality of drinking water sources is a powerful environmental determinant of health. This study aimed at assessing the bacteriological quality of the drinking water sources and its Health implications on residence of Sokoto metropolis, Sokoto State, Nigeria. Water samples from well, taps and boreholes were collected with the aid of a sterile 250ml plastic bottles from different location. Bacteria isolation, nutrient agar, Macconkey agar, TCBS, EMB and SSA were used. Macconkey broth powder was used for the MPN test. All media were prepared and sterilized as instructed by manufacturer, bacteriological characteristic were determined using the multiple tube fermentation procedure, the nutrient agar medium (FLUKES) was used to analyse total enumeration of THC, the most probable number method (MPN) was used to analyse total and faecal coliform count . The procedure for total coliform count was also carried out here only that the presumptive tubes were incubated for 48 hours. After assessing the bacteriological properties of drinking water in the study area, faecal coliforms were detected in all samples analyzed, the average value (31.9us/cum) and (74.1us/m) of conductivity of all the water sample collected from wells and borehole as found to be below the standard 9100us/cm) recommended by NAFDAC, The heterotrophic plate count was high in well water at 7.30×10^6 cfu/ml , Inorganic chemicals were found to be contained in the water as a result of human activities around the water sources.The bacteria isolated were Escherichia coli, salmonella sp, Shigella sp., Citrobacter sp., proteus sp., and Vibrio sp. in this study is an indication that if not check an outbreak could occur in the future. It was therefore recommended that water should meet different quality specifications depending on the particular uses. Thus, potable and domestic water should be harmless for the health of man and should have proper bacteriological qualities. Also education of the inhabitants by both government and private bodies on the danger of their act in response to the way water sources are cited.
Keywords: Bacteriological quality, faecal coliform, Total coliform, Total Heterorophic count.

INTRODUCTION

Water is a common chemical entity that is essential for the survival of all known forms of life [1]Water plays an important role in the prevention of diseases; taking eight glasses of water daily minimizes the tendency of colon cancer by 45% and bladder cancer by 50% as well as reducing the risk of other cancers [2].The quality of drinking water is a powerful environmental determinant of health [3], water plays an indispensable role in sustenance of life and it is a key pillar of health determinant since 80% of diseases in developing countries arc due to lack of good 'quality water [4]. Taps, boreholes, streams, wells, rivers and lakes has continued to the important sources of drinking water in most villages in developing countries. The unhygienic surroundings of wells and boreholes is

definitely the prominent source of water contamination while the streams, rivers and lakes which are sources of drinking water arc used as sewage disposal site. The usual sources or drinking water is the streams, rivers, well and boreholes which are mostly untreated and associated with various health risks [5].

Many infectious diseases arc transmitted by water through the fecal-oral route. Unsanitary water has particularly devastating effects on young children in the developing world. Each year >2 million persons, mostly children <5 years of age die of diarrheal disease [5]. According to Shittu [6], water is vital to our existence in life and its importance in our daily life makes it imperative that thorough microbiological and physico-chemical examinations be conducted on water. The

quality of water influence the health status of any populace, hence, analysis of for physical, biological and chemical properties including trace element contents are very important for public health studies [7].

Portable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health [8]. The ingestion of water contaminated with pathogens has manifestated in diseases like typhoid fever, amoebic dysentery and cholera etc which has resulted in deterioration of' health and in some cases death [9]. Shittu [6] also put it that in Nigeria majority of the rural populace do not have access to portable water and therefore depend on wells, boreholes, streams and river water for drinking and domestic use. The bacterial qualities of groundwater, pipe borne water and other natural water supplies in Nigeria have been reported to be unsatisfactory, with coliform counts far exceeding the level recommended by WHO [10].

The quality of drinking water is a powerful environmental determinant of health [3].Water plays an indispensable role in sustenance of life and it is a key pillar of health determinant since 80% of diseases in developing countries are due to lack of good quality water[4]. Drinking water quality management has been a key pillar of primary prevention for over one and half centuries and it continues to be the foundation for the prevention and control of water borne diseases [3]. Contaminated water is a global public health threat placing people at risk of a host of diarrheal and other illness as well as chemical intoxication [5]. The major risk to human health is faecal contamination of water supplies. Serious ill health can be caused by water contaminated from faeces being passed or washed into river, stream, pool or being allowed to seep into well or borehole [4]. There has been a report of wells and borehole water contamination through many domestic waste water and livestock manure especially if there is a puncture in a layer of soil [11]. These waste and sewage when deposited near the boreholes may travel with percolating rain water directly into the boreholes or may travel along the well-wall or surrounding material or the drill-holes [12]. There are several variants of the faecal-oral pathway or water disease transmission. These include contamination of drinking water catchments (example human or animal faeces), water within the distribution system (such as leaky pipe or obsolete infrastructure) or of stored household water as a result of unhygienic handling [3]. Increase in human population pose a great pressure on provision of safe drinking water especially in developing countries [5]. Consequently, water borne diseases such as cholera and typhoid are diseases associated with contaminated water [13, 14],. High prevalence of diarrhea among children and infants can be due to the use of unsafe water and unhygienic practice [15, 16]. Thus, many infectious diseases are transmitted by water through faecal oral contamination. Diseases due to drinking of

contaminated water leads to the death of five million children annually and make 1/6 of the world population sick [6]. Also water may contain toxic inorganic chemicals which may cause either acute or chronic health effect. Acute effects include nausea, lung irritation, skin rash, vomiting and dizziness, sometime death usually occurred. Chronic effect, like cancer, birth defects, organ damage, disorders of the nervous system and damage to the immune system are usually more common [17].

This study therefore assessed the bacteriological quality of drinking water sources and its health implication among residents within Sokoto metropolis, Sokoto state, Nigeria.

MATERIALS AND METHODS
Study Area
Sokoto state is located between longitude 4° to 6° north. It shares borders with Niger republic towards north, Zamfara State to the East and Kebbi State to the South and West, with a population of 3.702.676 [18]. Sokoto State has a land area of about 28,232.37 km^2 [19] with a mean annual rainfall ranging between 500mm to 1,300mm. The mean annual temperature is about 38.3^0c, the maximum daytime temperatures are under 40°C for most months of the year. There are two major ethnic groups namely, Hausa and Fulani. Also there arc Zabarmawa as minority in the border of the Local Government Area [19].

Sample Collection
Water samples from well, taps and boreholes were collected with the aid of a sterile 250 ml plastic bottles from different locations (Runjin Sambo, Arkilla. Rijiya Shehu and Gagi and Dundaye), boreholes from (Mabera, Kanwuri, Kuffa and Runji Sambo, Sama road and Tsohuwar Kasuwa), within Sokoto metropolis, Sokoto State Nigeria. Samples collected were transported to the laboratory after 30 minutes of collection in an icebox.

Bacteriological Analysis
Bacteria Isolation, nutrient agar, MacConkey agar, TCBS, EMB and SSA were used MacConkcy broth powder was used for the MPN test. All media were prepared and sterilized as instructed by the manufacturer, bacteriological characteristics were determined using the multiple tube fermentation procedure [20.21] where nine tube and inverted vials containing lactose broth were incubated at 35^0C for 48 hours for the presumptive test and at the confirmation test. A sterile wire loop was used to transfer a drop of culture from each positive tube to a tube containing brilliant green lactose bile broth to determine gas formation in any vial within 48 hours and at 37°C to be positive test. While a typical colony from an EMB plate was transferred on to a nutrient agar and into a tube with inverted vial containing lactose broth to perform the complete test. The nutrient agar medium (FLUKES)

was used for the enumeration of THC and was prepared to the quantity needed following the manufacturer's instruction. A 0.lml of each of the dilution factors was plated out and spread evenly with a sterilized spread rod. The plates were incubated at 35^0C for 24h and the THC of samples was recorded. The most probable number method (MPN) was used to analyse total and faecal coliform count [22]. The procedure for total coliform was also carried out here only that the presumptive tubes were incubated for 48 hours. Presumptive colonies were confirmed by gram staining and biochemical reactions and each plate was given a positive or negative score, isolates were confirmed by some Conventional biochemical test.

Statistical Analysis:
          Descriptive statistical analyses were used to show relationship and variation among the data.

RESULT ANALYSIS
          The table-1 indicates that water sample from Dambuwa had the minimum heterotrophic count of $2.07x$ 10^6 cfu/m1 while the minimum count was in

Rijiyar Shehu with 1.33 ± 10^6. 1cfu/ml. The highest total coliform count was in Dambuwa which had 3.14 x 10^6cfu/m1 while the lowest count was in Rijiyar Shehu having 1.3 x 10^6 cfu/ml. The highest faecal count was in Darnbuwa 6.0 x 10^6 cfu/ml while the lowest occurred in Runjin Sambo with 2.0 x 10^6 cfu/ml, isolates include *Bacillus mycoides* and *Salmonella* species in Arkilla, *Shigella* and *Salmonella* specie*s* in Rijiyar Shehu, *Staphylococus aureus, S. epidermis* and *Eschericia coli* in Runjin Sambo, and finally *Salmonella* species in Dambuwa. The table above revealed that the total heterotrophic counts of all water at 1.7 x 10^6 cfu/ml in both Sama Road and Gagi. The highest coliform count was recorded with 2.07 x 10^6 cfu/ml and the lowest was in Runjin Sambo with 1.33 x 10^6 count with no coliform recorded in Gagi and Dundaye. High faecal coliform count was recorded in Sama Road with $2.0x10^6$ cfu/ml and the lowest was in Runjin Sambo with $1x10^6$ cfu/ml with no faecal coliform corded in Dundaye and Gagi. Isolates include *B firmus S. Pygenes Citrobacter* species, *S*. aureus, *Bacillus cereus* and *Proteus* species.

Table 1: Bacteriological properties of water sample in Sokoto Metropolis

Sample site	Samples	THC (cfu/ml)	TCC (cfu/m1)	FCC (cfu/ml)	Isolates
Arkilla	WW	$2.00x10^6$	2.19 ± 1.0	3	*Salmonella spp Bacillus mycoides*
Rijiyar shehu	WW	$1.00x10^6$	1.3 ± 0.1	3	*Shigella species, Salmomella species*
Runjin sambo	WW	$7.30x10^5$	2.13 ± 0.2	3	*S. aureaus S epidermin, E. Coli*
Dambuwa	WW	$1.67 x10^6$	3.14 ± 1.10	6	*S.aureus, Salmonella spp*
Sama road	BW	$2.07x10^6$	$3.I4\pm 1.10$	2	*B. Firmus, S. Pyogenes Citrobacter spp and S.aureus*
Runjin sambo	BW	$1.22x10^6$	1.33 ± 1.15	1	*Bacillus cereus*
Gagi	BW	$1.073x10^6$	0.00	0	*Proteusspecies B.cereus and S, aureus*
Dundaye	BW	$1.33x10^5$	0.00	0	*Staphylococcus*
WHO	AW	1/100ml	0.100	0/100ml	
NSDWQ	AW	10/100ml	0.100	0/100ml	

Key:
WHO: World Health Organization   CFU: Colony Forming Unit
NSDWQ: National Standard for Drinking Water Quality   WW: Well water
BW: Borehole water   THC: Total heterotrophic count
TCC: Total coliform count   FCC: Faecal coliform count
BW: Borehole Water   AW: All Water Required

Table-2: Health implication of mineral content in drinking water

Sample Site	Sample	Contaminant	Mcl	Potential Health Effect
Arkilla	WW	Nitrate, Antimony	5ppm 4ppm	Methaemoglobinemia, headache, fatigue and diarrhea
Rijiyar shehu	WW	Flouride	2ppm	Mottling of teeth
Runjin sambo	WW	Thalium	1ppm	Hair loss, gastrointestinal irritation, tissue damage.
Dambuwa	WW	Nitrite	0.8ppm	Methaemoglobinemia
Sama road	BW	Flouride	2ppm	Mottling of teeth
Runjin sambo	BW	Arsenic	5	Dermal, affects the nervous system
Gagi	BW	Antimony	4	Diarrhea
Dundaye	BW	Arsenic	5	Dermal, affects the nervous system

  Key: Ppm: Parts per million, BW: Borehole water , WW: well water

DISCUSSION

After assessing the bacteriological properties of drinking water in the study area, faecal coliforms were detected in all samples analyzed. They pose a great health risk to infants, young children and people with severely compromised immune system. Total coliform count was generally high, with Dambuwa recording the highest count. The presence of coliform in water suggest a possible outbreak of such water-borne diseases as dysentery, cholera and typhoid fever were found to be prevalent in area. Similar study by Xu [23] reported that water mostly used for drinking and other domestic works in most rural area of china contain pathogens associated with acute and chronic gastrointestinal disease. When coliform bacteria present in water supplies are in levels greater than one per 100ml of water. Although coliform bacteria are generally considered a risk to health, infection due to coliform may be fatal for infants, elderly and immune-compromised people [16] also agree that the presence of coliforms indicates that water is contaminated by potentially dangerous faecal matter. Although coliform organisms may not always be directly related to the presence of faecal contamination or pathogen in drinking water. the coliform test is still useful for monitoring the quality and safety of water for human consumption.

The average value (31.9µs/cm) and (74.1µs/cm) of conductivity of all the water sample collected from wells and borehole was found to be below the standard (100µs/cm recommended by [20, 24] and [25]. This lower conductivity may be due to the presence of chlorides, phosphate and nitrite and this was responsible for corrosion in pipes. Similar findings by [26] identified presence' of chloride and nitrite in water samples to be responsible for the low water conductivity.

The heterotrophic plate count was high in well water particularly in Runjin Sambo 7.30x 10^6 cfu/ml it was so because water sources were close to a pit latrine. This could have attributed to high level of contamination. Also faecal coliform recorded was 6.0 cfu/ml for the same sample. This implies that water been contaminated by human or animal waste can cause short term effects such as diarrhoea, cramps, nausea, headache.

Inorganic chemicals were found to be contained in the water as a result of human activities around the water sources however, many of the chemicals noted in the water have occurred naturally; the presence of *Shigella* could be attributed to the problems associated with treatment plant at the Sokoto water works. Findings of [27] where he reported that tap water will only contain *Shigella* if it is untreated and drawn from a contaminated source, *salmonella* presence can be linked to the broken down pipes and improper protection of reservoir and open wells. The study revealed that the numbers or microorganisms differ in different water sources this was evidence in the boreholes and also in high level of coliform counts in well water compare to boreholes.

Thus water sources in Sokoto metropolis can be said to be grossly contaminated resulting from different pollution sources. Similar study by [28] reported that contamination of the water bodies/sources is from either a point sources, which is single identifiable sources pollution or a non-point source, which is the major threat to ground water pollution. According to [29] such contamination brings the threat of infection for people who use the water for drinking bathing and washing of fruits and vegetables.

Most sources or water in Sokoto metropolis were found to be opened exposed shallow wells and area surrounding boreholes were found to be poorly kept and unhygienic. This contributes to the contamination of water gotten from these sources. Auer and Niechaus [28] reported in similar study that surface and ground 'water contamination by faecal pathogens generally occurs through surface run-off, leaching and direct faecal deposition into the water bodies via several livestock production activities like confined animal feed, free range system, abattoir waste and land spreading of manure.

CONCLUSION

The presence of pathogenic and indicator organisms in these water samples render them unfit for human consumption. Drinking water is highly contaminated due to the indiscriminate disposal of faecal wastes, poultries droppings and piggery wastes, and the presence of *Vibrio* sp, *Escherichia coli, Salmonella* sp. *Shigella* sp and other enteric organisms and inorganic chemicals. Water sources within the Sokoto Metropolis are poorly cited. Low level of awareness was noted among residence on the health implications of the presence of harmful chemicals and organism in drinking water and the health risk associated with unsanitary and unhygienic practices.

RECOMMENDATIONS

On the basis of the conclusion drawn, it was therefore recommended that
1. Water should meet different quality specifications depending on the particular uses. Thus portable and domestic water should be harmless for the health of man and should have proper bacteriological qualities.
2. Education of the inhabitants by both government and private bodies on the danger of their act in respect to the way water sources are cited; sewage is disposed and related diseases that accompany the act should be given a top priority.
3. Full cooperation of the local and community to protect water from pollutants and chemical

contamination should be advocated.

4. If and when any coliform bacteria are noticed and found in water sources and supplies. disinfection process should be instituted and the water bodies must he resampled from the same and related site, to confirm original positive finding.

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