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RESEARCH PAPER

Assessment of Bacteria Associated with Household Wells in a Slum Community, Minna, Niger State

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ABSTRACT

Water occupies about 71% of the earth's surface and yet it is one of the scarcest commodities, especially in the developing countries of the world. This study aimed to assess bacteria present in household wells in a slum community in Minna, Niger state. A total of ten (10) water samples were collected from household wells in a slum community (Dutsen Kura Hausa), Minna, Niger State. The samples were analyzed using the membrane filtration technique and pour plate method to assess the bacteriological quality of the water source. The results showed that the total viable counts ranged from 1.9×10^3 to 7.2 10^3 Cfu/ml, total coliform counts ranged from100 Cfu/100ml to 627 Cfu/100ml, faecal coliform counts ranged from 58 Cfu/100ml to 550 Cfu/100ml and *Salmonella Shigella* counts ranged from 0 to 1.1×10^3 Cfu/ml respectively. The coliform counts as well as *Salmonella Shigella* counts were high and exceeded the acceptable maximum limit prescribed by the World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ). The bacteria isolated from the household Wells were *Escherichia coli, Pseudomonas aeruginosa, Salmonella spp., Lactobacillus spp., Staphylococcus aureus, Shigella spp., Bacillus spp.,* and *Enterobacter spp*. *Escherichia coli* and *Pseudomonas aeruginosa* were frequently detected and constituted 17.4%. The results of this study revealed the potential health hazard posed by the pathogens in the water source and therefore, there is a need to provide a portable water supply to the slum dwellers.

Keywords: Assessment, Bacteria, Household wells, Slums.

INTRODUCTION

One of the most important substances for human existence is water, required by life in adequate amounts. In the past, governments were primarily responsible for providing water to most parts of the world. However, some private individuals and groups are being forced to look for alternate ways to provide water for themselves because the government is unable to meet the people's daily needs (Onu, 2024). Water is a vital component of life and the socioeconomic development of any society (Puneeth, 2019). It is utilized in household activities (cooking, drinking, washing, bathing), agricultural operations, and hydroelectric power generation. Water is necessary for human survival and development. Water makes up 60-70% of a person's entire body weight. Without food, a man can go for several days, but without water, he can only last for a few days. As a result, water is required for plant and animal physiological activity (Agwaranze *et al*., 2017). Despite its importance in maintaining life and livelihood, it is the main cause of mortality and sickness.

In developing countries, biological pollution of drinking water is a serious issue for public health officials, and diseases caused by poor drinking water quality, lack of maintenance, and sanitation account for about 5% of all deaths

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(Muhammad *et al*., 2021). Bacteria which can be present in water include *Salmonella* spp., *Shigella* spp., pathogenic *Escherichia coli, Vibrio cholerae, Yersinia entercolitica* and *Campylobacter* species. Various viruses such as Hepatitis A and Rota virus could also be present. Parasites such as *Entamoeba histolytica* and *Giardia* spp. are human pathogens that when present in drinking water cause serious risk of diseases (Muhammad *et al*., 2021).

A household well is a groundwater well used to supply water for the domestic needs of an individual residence. It is also used for livestock or lawns and gardens or family uses. Improper construction of wells, sites where refuse are dumped, and various human activities may lead to contamination of wells. Water generally from these wells is not safe for consumption except if the water is treated (Auta *et al*., 2017).

Slums refer to an area or group of buildings characterized by unsanitary conditions, deterioration, overcrowding or absence of essential or basic facilities such as health facilities, drainage systems, recreational grounds, potable water, schools and post offices (Kumar, 2017).

According to research carried out in 2012 by the UN-Habitat about 33% of the population in developing countries lived in the slums. About 61.7% in Sub-Saharan Africa, 35% in South Asia, 31% in Southeast Asia, 28.2% in East Asia, 24.6% in West Asia, 24.1% in Oceanic, 23.5% in Caribbean and Latin America and 13.3% in North Africa.

World Health Organization (WHO, 2018) estimated that about 750 million people lack access to safe and clean consumable water. As a result of poor quality of water, there is improper sanitation which leads to approximately 700,000 deaths of children every year due to diarrhoea. Thus, access to drinking water remains a major concern, particularly for developing countries, and especially for their populations living in rural areas (Carrard *et al*., 2019; Konkobo *et al*., 2023).

This study aimed to assess bacteria present in household wells in a slum community in Minna, Niger state.

METHODOLOGY

Study Area

The study area was Dutsen Kura Hausa Area of Minna, Niger State. Minna is located between latitude 9^0 36' 27.94" N and longitude 6^0 33' 12.22" E and lies within the physical and cultural zone of transition described as the middle belt of Nigeria. It is situated at elevated meters above sea level and Minna has a total landmark of 74.344km^2 wide. The city of Minna is the administrative capital of Niger State in Nigeria with an estimated population of 286,838 as of 2016 (Maude and Ijah, 2020).

Sample Collection

A total of ten (10) water samples were collected randomly from wells in the Dutsen Kuran Hausa area of Minna, Niger State. The water samples were collected using a bucket tied to a rope, used by the slum dwellers and then filled into a two hundred milliliter (200 ml) sterile screw-top bottle, leaving an inch space for vigorous shaking. The samples were labeled indicating the location, date and time of collection respectively. The samples were kept in an ice pack to maintain the temperature below 10^0C and were transported to the microbiology laboratory of the Federal University of Technology Minna, for analysis (Maude and Ijah, 2020).

Enumeration of Bacteria

The water samples were analyzed for total viable bacteria, total coliform, faecal coliform and *Salmonella shigella* counts.

Total Viable Bacteria

Total viable bacteria in water samples were obtained using pour plate method (Cheesbrough, 2009). Zero-point one milliliter (0.1 ml) of 10^{-3} dilution factor was aseptically dispensed into sterile Petri dishes and twenty milliliter (20ml) of Nutrient Agar (NA) was added. The plate was allowed to solidify, and incubated at 37°C for 24 hours. Discrete colonies appeared on the plate after the incubation and were counted. The

results were expressed as the number of bacteria colony-forming units per milliliter (cfu/ml). Similar colonies formed were further subcultured onto nutrient agar using the streak plate method and incubated at 37°C for 24 hours. Pure cultures obtained were directly transferred to an already prepared nutrient agar slant (Sule *et al*., 2020).

Isolation of *Salmonella shigella Species*

Zero-point one milliliter (0.1 ml) of 10^{-2} dilution factor was aseptically dispensed into sterile Petri dishes and twenty milliliter (20 ml) of *Salmonella shigella* Agar (SSA) was added using the pour plate method as described by Cheesebrough, (2009). The plates were allowed to solidify, and incubated at 37^0C for 24 hours. The plates were examined for blackish or colorless colonies with a diameter of 2.4 mm. Similar colonies formed were further subcultured onto nutrient agar using the streak plate method and incubated at 37°C for 24 hours. Pure cultures obtained were directly transferred to an already prepared nutrient agar slant (Sule *et al.,* 2020).

RESULTS & DISCUSSION

Table 1: shows the total viable bacteria count of well water from the Dutsen Kura Hausa Slum in Minna Niger State. The total viable bacteria count of water samples varied from 1.9×10^3Cfu/ml to 7.2×10^3 Cfu/ml. High counts in total viable Bacteria of the water samples observed in Table 1 may probably be due to the runoff of water into some of the wells and particles from the environment which gain access into the wells may also be responsible for the increase in bacterial population. It could also be due to the exploitation of areas close to the well sampling sites or as a result of suitable conditions such as moisture and temperature. This observation is similar to the research of Maude and Ijah (2020), who recorded high viable Bacteria counts in well water from Kpakungu and Barikin Sale, Minna Niger State. Alarming counts from this finding highlight the unsuitability of most water samples for human consumption (Elijah, 2023).

Feacal Coliform Bacteria

Faecal Coliform Bacteria was obtained using membrane filtration techniques (Maude and Ijah, 2020). An absorbent pad was soaked with membrane lauryl sulphate broth. The water samples were shaken thoroughly and 100 ml of the water samples were filtered simultaneously using a 0.45 µm pore-sized membrane filter with 47 mm diameter. The filters were placed on the soaked pad. The plates were inverted and incubated at 44.5^OC for 24 hours. After incubation, yellow discrete colonies formed were counted and expressed as colony-forming units per 100 ml (Cfu/100 ml) of the water sample.

Characterization of the Isolates

Bacteria isolated were characterized by gram staining and biochemical tests. The biochemical test includes; catalase, coagulase, citrate utilization, oxidase, urease, methyl red, and Starch hydrolysis test (Cheesbrough, 2009).

Table 2: shows the faecal coliform bacteria counts of Well water from Dutsen Kura Hausa Slum in Minna Niger State. Faecal coliform Bacteria counts of Water Samples varied from 58 cfu/100ml to 550 cfu/100ml while Total coliform counts ranged from 100 to 627cfu/100ml.

Table 1: Total viable bacterial counts (Cfu/ml)

Samples	Counts
A	$2.1x10^3$
B	$5.0x10^3$
C	$5.8x10^3$
D	$1.9x10^3$
E	$7.2x10^3$
F	$4.8x10^3$
G	$2.1x10^3$
H	$1.9x10^3$
I	$3.6x10^3$
J	$5.0x10^3$

Table 2: Feacal & total coliform bacterial counts (Cfu/100ml)

Samples	Faecal Coliform Counts	Total coliform Counts
A	135	170
B	120	240
C	500	552
D	308	328
E	400	510
F	200	369
G	058	100
H	111	213
I	482	523
J	550	627

Table 3: *Salmonella Shigella* counts (Cfu/ml)

Samples	Counts (Cfu/ml)
A	0.0
B	7.0×10^2
C	0.0
D	5.0×10^2
E	5.0×10^2
F	1.1×10^3
G	6.0×10^2
H	0.0
I	0.0
J	1.1×10^3

Table 3: Shows the *Salmonella Shigella* counts of Well Water from Dutsen Kura Hausa Slum in Minna Niger State. The *Salmonella Shigella* counts varied from no count to 1.1×10^3Cfu/ml.

Table 4: Shows Morphology and Biochemical Characteristics of Bacteria isolates from Well Water from Dutsen Kura Hausa Slum in Minna Niger State. The organisms isolated were; *Pseudomonas aeruginosa, Klebsiella* spp., *Escherichia coli, Salmonella* Spp., *Lactobacillus* spp., *Staphylococcus aureus*, *Shigella* spp., *Bacillus* spp., *Enterobacter* spp.

Table 4: biochemical test for characterization of bacteria isolates

Gram reaction	Shape	Catalase	Oxidase	Coagulase	Urease	MR	VP	Citrate	Starch util	Suspected organism
-	Rod	+	+	-	-	-	+	+	-	*Pseudomonas aeruginosa*
-	Rod	+	-	-	+	+	-	-	-	*Klebsiella spp.*
-	Rod	+	-	-	-	+	-	-	-	*Escherichia coli*
-	Rod	+	-	-	-	+	-	-	-	*Salmonella spp.*
+	Cocci	+	-	-	-	-	+	-	-	*Lactobacillus spp.*
+	Cocci	+	-	+	+	+	-	+	-	*Staphylococcus aureus*
-	Rod	+	-	-	-	+	-	-	-	*Shigella spp.*
+	Rod	+	+	-	+	+	-	-	+	*Bacillus spp*
+	Rod	+	-	-	+	-	+	+	-	*Enterobacter spp*

Key: positive = +, negative = -, spp = specie, MR = methyl red, starch util = starch utilization. VP= voges proskauer

Table 5: percentage frequency of occurrence of bacterial isolates

Bacteria	Frequency of occurrence	Percentage (%)
Pseudomonas aeruginosa	8	17.4
Klebsiella spp.	7	15.2
Escherichia coli	8	17.4
Salmonella spp.	6	13.0
Lactobacillus spp.	2	4.3
Staphylococcus aureus	6	13.0
Shigella spp.	2	4.3
Bacillus spp.	5	10.9
Enterobacter spp.	2	4.3
Total	**46**	**100**

Table 2 shows faecal coliform Bacteria counts and total coliform bacteria of well water analysed. The faecal coliform counts were high and exceeded the permissible limits of zero faecal coliform per 100ml of water stipulated by NSDWQ (2007) and WHO (2012). The presence of these Bacteria may be a result of untreated sewage that seeps into the Wells, seapage from soak away into Wells located near it and animal droppings. Maude and Ijah (2020) reported that locations of Wells too close to pit latrines, soak away or refuse dumps could pollute groundwater. The total coliform counts were high and found to exceed 10-25 Coliforms per 100ml recommended by NSDWQ (2007) and zero total coliforms per 100ml stipulated by WHO (2012). The findings agree with the earlier report by Maude and Ijah (2020), that coliforms in most well water exceeded 10-20 Coliforms per 100ml due to the fact that most of the Wells had no proper covers/lids, thereby exposing them to contamination with animal droppings, dead animals, seapage, splash sewage and Coliforms carried by winds.

Table 3 shows *Salmonella Shigella* counts of well water analysed. The detection of *Salmonella and Shigella* in well water obtained from wells in Dutsen Kura Hausa slums agrees with the report of Musliu *et al.,* (2011) that isolated *Salmonella and Shigella* from well water in limestone mined area in Sokoto, Nigeria. The presence of *Salmonella* in water has serious public health implications, as this organism is the cause of dreadful zoonotic diseases (Maude and Ijah, 2020). *Salmonella* is one of the most common causes of intestinal illness worldwide and the etiological agent of more serious systemic illnesses like typhoid and paratyphoid fevers. The primary factor driving the load of s*almonella* in surface water was determined to be surface runoff (Wamyil *et al*., 2023).

Table 4 Shows the Biochemical test for Characterization of bacteria. The bacteria isolated were *Escherichia coli, pseudomonas aeruginosa, klebsiella* spp., *Staphylococcus aureus, lactobacillus* spp., *Salmonella* spp., *Shigella* spp., *Bacillus* spp., *and Enterobacter* spp., the presence of *Escherichia coli* indicates recent faecal contamination of well water samples which requires immediate attention (Chandran and Mazumder, 2015). The presence of heterotrophic bacteria generally indicates poor environmental sanitation and recent pollution by sewage. On-site observation of the hand-dug wells showed that a good number of these sources are not protected and lack concrete floors around the hand-dug well, this reflects poor environmental sanitation and higher contamination. The use of buckets which have been left on the ground in collecting water from unprotected water sources might contribute to the increased contamination levels (Onu, 2024).

Table 5 showed that *Escherichia coli* and *pseudomonas aeruginosa,* had the highest frequency of occurrence (17.38%), of the total samples analyzed, and followed by *klebsiella* spp., (15.21%). The present finding agrees with the report of Auta *et al*., (2017) and Maude and

Ijah (2020), which recorded a high occurrence of pathogenic Bacteria in well water in Minna, Nigeria. The presence of *Escherichia coli in* water is a strong indication of recent sewage or animal waste contamination and suggests the presence of disease-causing microorganisms (Chandran and Mazumder, 2015). These gram-negative microorganisms are most times implicated in gastrointestinal abnormalities (Nvene *et al.*, 2023).

The findings have shown a high level of bacterial contamination in all the samples. This water source within the slum community in Niger State is, however, potentially hazardous. Hence, the need for well-maintenance and hygienic practices by households to reduce the risk of disease outbreak from the organisms encountered in this study.

CONCLUSION

The result of this study shows that there is high bacteria contamination in household well water analyzed. Thus, the well water does not meet the standard stipulated for drinking water by regulatory agencies and serves as an effective source of transmission of diseases such as Typhoid fever, Cholera, Schistosomiasis etc. Hence, this can pose a serious threat to Human health.

Recommendations

i. Adequate proper covering of wells is necessary to prevent faeces of man and animals from being carried by wind or surface runoff into the wells.
ii. Water drawing containers and rope should be cleaned to avoid contamination by faeces of man and animals. This can be avoided by hanging on a poll after every use.
iii. The well water should be subjected to heating before consumption.
iv. The dumping of waste in dry wells should be stopped.
v. Epidemiological studies should be carried out in the slums to identify causes and ways of preventing diseases prevalent in slums.

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