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BACTERIOLOGICAL AND PHYSICOCHEMICAL ANALYSIS OF WATER AND AIR QUALITY IN GARKI POLICE BARRACKS, ABUJA, NIGERIA

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Physicochemical and Bacteriological analysis were carried out on water and air samples from selected locations within Garki Area 1 police barracks Abuja, Nigeria. A total of 50 samples of water and air were collected from five different locations (Block 13C, Block 14A, Block Block 3C, Block 15C, and Block 12C) and analyzed using standard methods. The physicochemical parameters monitored included pH, temperature, electric conductivity, turbidity, dissolved oxygen, appearance, odour, taste, hardness, chemical oxygen demand, biological oxygen demand. Preliminary, cultural, morphological, biochemical characteristics of the isolates revealed the following isolates; *Escherichia coli*, *Klebsiella* sp, *Pseudomonas* sp, *Salmonella* sp, and *Bacillus* sp. The total Coliform Count from the water of these blocks ranged between $2.5-3.8 \times 10^8$ cfu/ml, while the total Coliform Count of the air. Samples of these blocks ranged between $1.9-3.1 \times 10^8$ cfu/m³. Isolated bacteria of water with percentage of occurrence were *Klebsiella* sp. (80%), *Salmonella* sp (56%), *Enterobacter* sp (48%), *Escherichia coli* (48%) and *Pseudomonas aeruginosa* (44%). While the isolated bacteria of air with percentage of occurrence were *Pseudomonas aeruginosa* (60%), *Klebsiella* sp (52%), *Bacillus* sp (52%) and *Escherichia coli* (44%). Findings from this study indicates the presence of pathogenic bacteria with health risk to human in both water and air environment. Therefore there is need for improved sanitation hygiene and water quality as well and regular hygiene education in the study area.

ABSTRACT

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INTRODUCTION

Water is considered a vehicle for the propagation and dissemination of human associated bacteria. Safe drinking water is a fundamental human right and if contaminated with opportunistic, pathogenic or environmental, bacteria, it may have health implications for consumers. Human health should therefore be protected by preventing microbial contamination of water and air that is intended for consumption or inhaled. In rural communities, untreated surface water from rivers, dams, and streams is directly used for drinking and other domestic purposes. These unprotected water sources can be contaminated with microbes through rainfall runoff and agricultural inputs, mixing with sewage effluents and faeces from wild life, which render them unacceptable for human consumption. Faecal coliforms, *Aeromonas* and *Pseudomonas*, are used as indicators of faecal contamination in water and the presence of these pathogens may have severe health implications on consumers especially those that are immune compromised. (Mulamattathil *et al.*, 2014).

The environment of freshwater has been confirmed to be altered in varied forms; via some amplified processes such as subversive impurity leakages, bio-turbation, surface water and sediment flood and humans activities (Olatunji and Anani 2020)

The consequences of waterborne bacteria and virus infection; polio, hepatitis, cholera, typhoid, diarrhea, stomach cramps, etc, have been well established but nitrate contamination is just as deadly. Consequent to the realization of the potential health hazards that may result from contaminated drinking water, contamination of drinking water from any source is therefore of primary importance because of the danger and risk of water borne diseases (Okonko *et al.*, 2008) and (Edema *et al.*, 2001; Fapetu, 2000).

The original source of some drinking water is rich in aquatic microbes, some of which could be dangerous if they enter the human body. Accordingly, the treatment of water for drinking involves stages where microbes are removed or destroyed before the water gets into homes. After purification the water is subjected to tests by bacteriologists to ensure the safety for human consumption. A long series of dilutions is not necessary by some sample because most water

supplied are fatty low in bacteria content, while others require long series of dilutions (Okonko *et al.*, 2008) and (Fawole and Oso, 2001).

Air serves as a mode of transport for the dispersal of bioaerosols (particles of biological origin e.g. bacteria, fungi, pollen, viruses that are important constituents of the atmosphere and could possess the potential to cause a variety of diseases in humans and animals). The composition and concentration of the microorganisms comprising the bioaerosols vary with source and their dispersal in air. In the indoor air environment for instance, most of the air pollution comes from sources inside the building itself, hair spray, perfume, room deodorizer, paints, thinners, home appliances, photo copiers, printers, computers, and air purifiers. The use of disinfectants (linear alkyl benzene sulfonates) and fatty acid salts (soap) in cleaning agents (rug shampoo) can cause enhanced eye and airway irritation. Obiekezie *et al.*, (2019) and Guo (2011).

The survival of microorganisms in air varies, though generally, fungal spores, enteric viruses and amoebic cysts are somewhat resistant to environmental stresses encountered during transport through air. Bacteria and algae are more susceptible, although bacterial endospores for example spores of *Bacillus* spp. are quite resistant. In recent years, outdoor air quality has become an important issue, because of industrialization. Microorganisms present in the air originate from soil, plants, water and dispersed by dust. However, spore-forming bacteria and fungi are able to survive in bioaerosols and stay viable for a long time in the air Obiekezie *et al.*, (2019) and (Fowoyo and Igbokwe 2014).

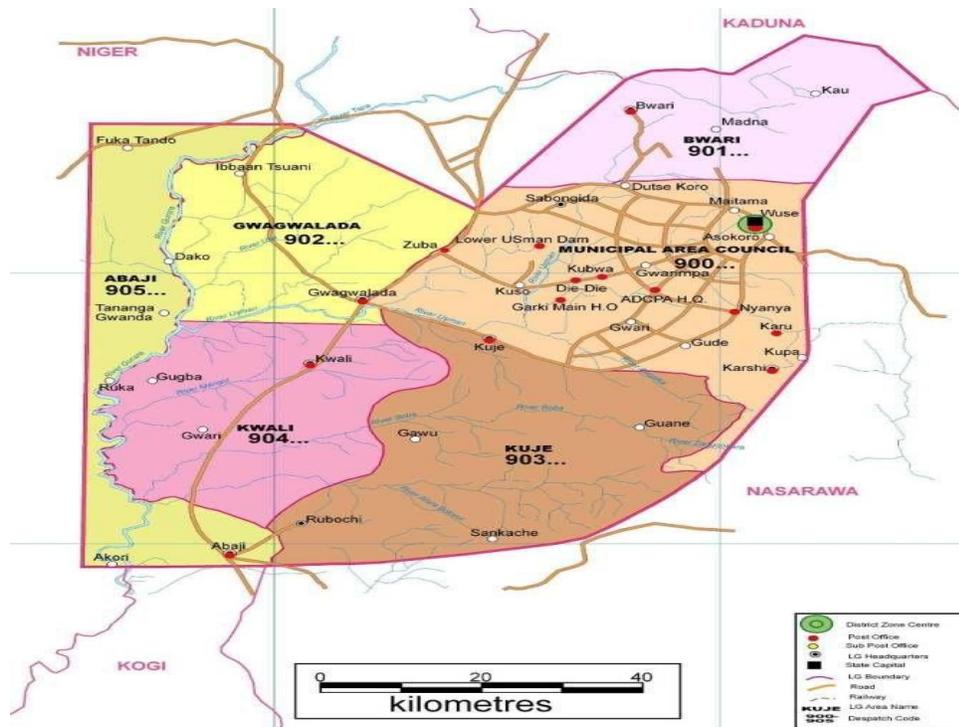
A good knowledge of the chemical qualities of raw water and air is necessary so as to guide its suitability for use. Thus, regular physico-chemical analysis of water at source must be carried out to determine or check the effectiveness of treatment process. Considering the fact that the public health condition may be related to the quality of treated water supplied and that public health can be protected by reducing the pathogenic microorganisms in drinking water and air, the present study was design to determine the bacteriological and

physicochemical quality of water and air in Garki Police barracks, Abuja, Nigeria.

MATERIALS AND METHODS

Study Area

This work was carried out in Garki Police Barracks. Garki barracks is located at Nsukka Street, Along Apo Bridge Expressway, Garki, Abuja, Nigeria. Its zip code is 900110.



Map of Abuja showing the six area councils

Sample Collection

A total of Fifty (50) samples of both water and air was gotten from borehole and outdoor air at different locations of Garki barracks. Twenty five (25) water samples were collected using a sterile bottle (2.5 L) with the bottle cap sterilized using ethanol and cotton wool and properly corked. The bottle were not filled to the top to allow air bubbles escape. The water samples were transported to the laboratory in a cooler with ice packs within few hours of collection. Samples that were not analyzed immediately was stored in refrigerator at 4°C (Cheesbrough, 2000).

A total of Twenty five (25) air samples was collected from five (5) different locations in Garki barracks, Abuja using a plate sedimentation methods. Petri dishes containing culture media suitable for bacteria was used as sampling surfaces. Obiekezie *et al.*, (2019) and Makut (2014).

The plates were set up at a height representative of the normal human breathing zone, five feet, 150cm and 180cm above ground level. Thereafter, plates containing culture medium were exposed to air for at least 30 minutes in order to allow air microorganisms to settle gravitationally directly on the media surfaces of the plate and transported immediately to the laboratory for incubation analyses Obiekezie *et al.*, (2019) and Udo-Ibiam *et al.*, (2016)

Isolation of Total Heterotrophic Bacteria and Coliform Count

A Tenfold serial dilution was done using the water sample. 9 ml of distilled water was measured into Ten McCartney bottles and 1ml of the water sample were diluted in the first bottle labeled 10^{-1} the sample was transferred into the second bottle labeled 10^{-2} this method were repeated till 10^{-10} . Pour plate were done using different media for the total heterotrophic bacteria and Coliform counts and the 10^8 dilution used. It was incubated at 37°C for 24 hours. The

stock was also plated and incubated at the same temperature for 24 hours. Results were taken after 24 hours and the distinct colonies isolated and stored at 4°C for further uses (Avishai and Davidson, 2014).

Nutrient agar (NA) were used to determine the total aerobic heterotrophic bacteria (TAHB), Eosin methylene blue (EMB) agar was used to determined faecal coliform, MacConkey agar was used to determined total coliform and *Salmonella-Shigella* species agar (SSA) was used to determine the *Salmonella* and *Shigella* species respectively. All plates were incubated at 35-37°C for 24h with exception of EMB plates meant for the isolation of faecal coliforms, which will be incubated at 44.5°C for 24h Obiekezie *et al.*, (2014) and (Abu and Egenonu, 2008).

Gram Staining

This staining technique introduced by Christian Gram in 1884, is very important in bacteriology. It distinguishes nearly all bacteria as Gram positive or Gram negative according to their resistance to decolorization of crystal violet or iodine complex.

A thin smear of the bacterial culture was made on a clean grease free glass slide. The film was air dried by waving it around a flame for a while, and then the smear was fixed by heat by waving over Bunsen flame. The slide was placed on a rack over a sink and the smear was covered with crystal violet reagent for one minute. The slide was rinsed with Gram's iodine for 30 seconds. The slide was rinsed slowly in water, after which 70% acetone was applied on the slide until no more dye ran off from the smear. The smear was rinsed again and then covered with safranin for 30 seconds and then rinsed under slow running tap water. The slide was allowed to dry and observed using the oil immersion lens (100×).

Biochemical Tests

This included; Catalase, Indole, Coagulase, Motility, Citrate utilization, Spore staining, Methyl red and Voges-Proskauer tests and Sugar fermentation tests (Clarke and Cowan, 1952).

Indole Test

The indole test for the suspected organism was carried out as described by Tankeshwar, 2012. A colony of the pure culture was inoculated into previously sterile test tube containing 5mL of tryptone broth and incubated at 37°C for 24

hours in ambient air. After incubation, 0.5 mL Kovac's reagent was added to the broth culture and shaken. A positive reaction was indicated by the appearance of pink colored ring in the reagent layer above the broth.

Methyl Red

Two test tubes containing MR-VP broth were inoculated with a pure culture of the test organism and incubated at 35°C for 4 days. 5 drops of methyl red indicator was added to the first tube (for Voges-proskauer test) while Barrit's reagent was added to the other tube. Formation of red colour indicated positive reaction for methyl red (Tankeshwar, 2014).

Citrate Utilization Test

Citrate utilization test for the suspected organism was carried out as described by Tankeshwar, 2013. A test tube containing Simmon's citrate agar (slant surfaced) was inoculated with lightly as a single streak with pure culture of the test organism. It was incubated at 37°C for 24 hours. Blue coloration of the medium denoted alkanization and was interpreted as positive while if the medium remained green, it was interpreted as negative.

Coagulase Test

Three drops of 0.85% sterile normal saline was placed on a clean glass slide and 0.2ml of plasma was added to the normal saline after which a colony of suspected organism was emulsified on the slide containing normal saline and plasma. Coagulation of plasma indicates positive coagulase. Obiekezie *et al.*, (2014).

Catalase Test

A small amount of the pure colony of the test organism incubated at 37°C for 24 hours was transferred aseptically to the surface of a clean, dry glass slide using an inoculation loop. A drop of 3% Hydrogen peroxide was placed on the slide and mixed gently. Rapid evolution of oxygen (bubbling gas) within 5-10 seconds showed a positive result while absence of bubbles or only few scattered bubbles showed negative result. (Tankeshwar, 2013).

Determination of Physicochemical Parameters of Water Samples

After collection of samples, physicochemical analyses were conducted on the water sample. This physicochemical analysis included; p^H, electric conductivity, chloride, nitrate, sodium, potassium, total dissolved solid, biochemical

oxygen demand, sulphate, dissolved oxygen, chemical oxygen demand, calcium, magnesium, phosphate and turbidity were determined using standard methods adopted from Enerijiofi *et al.*, (2018).

RESULTS

In this present study, a total of fifty (50) samples were collected, 25 samples each for both water and air for the period of five weeks from five different locations in Garki police barracks, Abuja, namely; Block 13C, Block 14A, Block 3C, Block 15C, Block, and Block 12C. These samples were analyzed and the following organisms were isolated from both samples; *Salmonella* sp, *Klebsiella* sp, *Escherichia coli*, *Enterobacter* sp, *Pseudomonas* sp, and *Bacillus* sp.

Table 1 And 2 Coliform Bacteria from some selected borehole water and air in Garki Police Barracks, Abuja

The cultural, morphological and biochemical characteristics of bacterial isolates from borehole water and air in Garki police barracks are as given in Table 1 and 2. Bacteria that grows greenish on EMB, pink on MAC, rods shape, 1mm size, gram negative, Methylene blue positive, Indole positive, catalase positive, citrate negative, coagulase negative was recorded as *Escherichia* sp. Mucoid pink to purple on EMB, Mucoid to red on MAC, rods shape, 3mm size, gram negative, methylene blue negative, indole negative, catalase positive, citrate positive and coagulase negative was recorded as *Klebsiella* sp. Whitish on NA, rods shape, 2mm size, gram positive, methylene blue negative, indole negative, catalase positive, citrate positive, and coagulase positive was recorded as *Bacillus* sp.

Table 3 and 4 Total bacteria count of some selected borehole water and air in Garki police barracks, Abuja.

The total bacteria count of some selected borehole water and air are as given in Table 3 and 4. Mean total Heterotrophic bacteria count of water and air in Block 13C, 14A, 3C, 15C, and 12C ranges from 2.5×10^8 - 4.0×10^8 cfu/ml and 1.8×10^8 - 3.0×10^8 cfu/m³ respectively. The mean total Coliform count of water and air in Block 13C, 14A, 3C, 15C, and 12C ranges from 2.5×10^8 - 3.8×10^8 cfu/ml and 1.9×10^8 - 3.1×10^8 cfu/m³ respectively. The mean total Fecal Coliform count of water and air in Block 13C,

14A, 3C, 15C, and 12C ranges from 1.5×10^8 - 3.6×10^8 cfu/ml and 1.8×10^8 - 2.9×10^8 cfu/m³ respectively.

Table 5 and 6 Isolation rates of bacterial isolates from some selected borehole water and air samples in Garki police barracks, Abuja.

The isolation rates of Bacterial isolates from some selected borehole water and air samples are given as table 5 and 6. The isolation rates of the bacterial isolates from water sampled indicates that *Klebsiella* sp. had the highest percentage of occurrence of (80%), *Salmonella* spp. happened to be the second most commonest bacterial isolate with isolation rates of (56%), followed closely by *Escherichia coli* and *Enterobacter* sp. with an isolation rates of (48%) each, while the least occurring bacterial isolates is *Pseudomonas* sp (44%). The isolation rates of the bacterial isolates (%) from air sampled indicates that *Pseudomonas* sp. had the highest isolation rates of (60%), followed by *Klebsiella* and *Bacillus* sp. with an isolation rate of (52%) each, while the least occurring bacterial isolate is *Escherichia coli* with (44%).

Table 7 and 8 Antibiotic susceptibility patterns

The antibiotic susceptibility pattern of bacteria isolated from some selected borehole water and air sampled in Garki barracks, Abuja are given in Table 7 and 8 *Salmonella* spp, *Klebsiella* sp, *Escherichia coli*, *Enterobacter* sp, *Pseudomonas* sp, and *Bacillus* sp from borehole water and air sampled were both more susceptible to; Peflaxacin, Gentamycin, Ciproflaxacin, and Streptomycin but more resistance to; Ceftazidime, Ceporex, Ofloxacin, Cefuroxime, Streptomycin, and Augmentin.

Table 9 and 10 physicochemical parameters of some selected borehole water samples in Garki police barracks and WHO drinking water standards

The physicochemical parameters of some selected borehole water sampled are given in Table 9. The concentration pH in some selected borehole water ranged from 6.289 - 6.892. The temperature ranged from 22.4 - 23.1°C. The Electric conductivity (EC) ranged from 112.2 - 140.9(μS). The turbidity ranged from 0.16 - 0.55(NTU). Dissolve oxygen ranged from 4.13 - 4.82(mg/l). Appearance of the borehole water

samples were both Colourless. The taste was tasteless. The Hardness was both 53.4(mg/l). The chemical oxygen demand (COD) ranged from 9.81 - 16.51(mg/l). The Biochemical oxygen demand (BOD) ranged from 4.30 - 6.20(mg/l).

DISCUSSION OF FINDINGS

The characterization and identification of bacteria in water and air sampled from Garki barracks showed that Block 13C, Block 14A, Block 3C, Block 12C, and Block 15C were both contaminated with different bacteria ranging from coliforms, faecal coliforms, and *Salmonella* spp. The bacterial species identified were member of the *Enterobacteriaceae* family. The bacterial organisms were mainly Gram negative, non - spore forming and are pathogenic. Water and air should be free from disease causing organisms or large number of pathogenic organisms. In this present study, the sources location of drinking water available to the Garki police barrack are contaminated as against the WHO standard. Accordingly, WHO (1984), provides that there should be no coliform in 100ml of water in distribution for human drinking. This contamination may be due to the proximity of the boreholes and exposure of the environment near to sewage/faeces conveyor belt as distance less than 30 meter as recommended by WHO (1984, 1987, and 1996). Similarly Microorganisms present in the air originate from land used patterns, human activities/scavengers, soil, plants, water and dispersed by dust. Dueker *et al.*, (2018).

This study revealed that total bacteria count of water sampled ($\times 10^8$) ranged from $2.5-4.0 \times 10^8$, $2.5-3.8 \times 10^8$, and $1.5-3.6 \times 10^8$ cfu/ml, for total heterotrophic bacteria count, total coliform count and total faecal count respectively. Our findings were similar to the values reported by Yahaya *et al.*, (2016). This study also revealed that total bacteria of air sampled ($\times 10^8$) ranged from $1.8-3.0 \times 10^8$, $1.9-3.1 \times 10^8$, and $1.8-2.9 \times 10^8$ cfu/m³ for total heterotrophic bacteria count, total coliform count, and total faecal count respectively. Our findings were similar to the value reported by Obiekezie *et al.*, (2019).

The isolation rates of the bacterial isolates (%) from water samples indicates that *Klebsiella* sp. had the highest percentage of occurrence of (80%), *Salmonella* sp happened to be the second

commonest bacterial isolate with isolation rates of (56%), followed closely by *Escherichiacoli* and *Enterobacter* sp. with an isolation rate of (48%) each, while the least occurring bacterial isolates is *Pseudomonas aeruginosa* (44%). Our findings are above values reported by Olatunji and Anani (2020). This study also revealed that isolation rates of the bacterial isolates (%) from air samples indicates that *Pseudomonas* sp. had the highest isolation rates of (60%), followed by *Klebsiella* and *Bacillus* sp. with an isolation rate of (52%) each, while the least occurring bacterial isolate is *Escherichia coli* with (44%). This is similar to the findings reported by Salisu *et al.*, (2025) and Obiekezie *et al.*, (2019).

The antibiotic susceptibility pattern of the bacterial isolates against conventional antibiotics displayed varying degree of susceptibility. The bacterial contaminants were both highly susceptible to the following broad-spectrum antibiotics; Peflacine, Gentamycin, Ciproflaxacin, and Streptomycin. Their high susceptibility perhaps could be due to the fact these drugs mostly are administered via the parental routes which will limit their misuse and or abuse which had been reported to account for the upsurge in the incidence amongst antibiotics. This conforms to the report of other workers such as Ngwai *et al.*, (2010) and Makut *et al.*, (2014).

Physicochemical properties of the borehole water samples and their comparison with World Health Organization (WHO). All the samples appear to be colourless, tasteless, and odorless. The temperature of the water samples ranged from 22.4-23.1°C. It should be noted that high water temperature enhances the growth of microorganisms and may increase taste, odor, and color but for the present research the temperature of all samples were within the Recommended WHO (2006).

This study shows the pH range of 6.29-6.89 for the water samples. The pH values of all the samples were within the pH range assign by WHO (2006).

The Electrical Conductivity (EC) range was 112.2-140.9us/cm for the water samples which fall within acceptable WHO (2006) limit.

Dissolve Oxygen (DO) reflects the physical and biological processes prevailing in the water. The DO in this study ranges from 4.12-4.82mg/l. All

the samples were within the limit of WHO for drinking water.

Biochemical Oxygen Demand measure the amount of Oxygen used by microorganisms, in this study BOD ranges from 4.30-6.20 which is within the stipulated limit given by WHO (2006).

Turbidity of water depends on the quality of solid matter present in the suspended state. The greater the turbidity the higher the risk of gastrointestinal diseases Ezeribe *et al.*, (2012). This study recorded turbidity value ranging from 0.08-0.55NTU which is within the limit of WHO (2006).

CONCLUSION

It was obvious that the quality of water in Garki barracks had been compromised. This is because the water did not meet most of the standard limit of WHO. The total heterotrophic count, total coliform counts and total faecal count exceeded the WHO standard for safe drinking water.

Similarly, Health risk assessment indicates the presence of pathogenic bacteria isolated from air environment with serious health risk to people living in Garki police barracks due to the possibility of cross - contamination of foods sold in open.

Table 1: Cultural, morphological and biochemical characteristics of bacterial isolates from borehole water in Garki police barracks, Abuja and their probable identity

Shape	Size	Pigmentation	Gram.S	M.R	IN	CAT	CT	COA	Probable isolates
rods	1mm	Greenish on EMB pink on MAC	-	+	+	+	-	-	<i>Escherichia coli</i>
rods	3mm	Mucoid Pink to Purple on EMB, Mucoid pink to red on MAC	-	-	-	+	+	-	<i>Klebsiella spp</i>
rods	0.3	Opaque yellow with Black centers	-	-	-	+	+	-	<i>Pseudomonas aeruginosa</i>
Rods	2mm	Pink to dark blue on EMB	-	-	-	+	+	-	<i>Enterobacter spp</i>
rods	3mm	Opaque Yellow with black centers	-	+	-	+	+	-	<i>Salmonella spp</i>

Key: M.R Methyl red, IN = Indole, CAT + Catalase, CT = Citrate utilization Test, COA = Coagulase Test, Gram.S = Gram Staining, + = Positive, - = Negative.

EMB = Eosine Methyleme Blue Agar, MAC = MacConkey agar,

Table 2: Cultural morphological and biochemical characteristics of bacterial Isolates from air in Garki police barracks, Abuja and their Probable Identity

Shape	Size	Pigmentation	Gram.S	M.R	IN	CAT	CT	COA	Probableisolates
Rods	3mm	Mucoid pink to purple on EMB, mucoid pink to red on MAC	-	-	-	+	+	-	<i>Klebsiella</i> spp
rods	1mm	Greenish on EMB, pink on MAC	-	+	+	+	-	-	<i>Escherichia coli</i>
rods	2mm	Whitish on NA	+	-	-	+	+	+	<i>Bacillus</i> spp
rods	0.3mm	Whitish on NA colourless on MAC	-	-	-	+	+	-	<i>Pseudomonas aeruginosa</i>

Key: M.R = Methyl red, IN = Index, CAT = Catalase, CT = Citrate Utilization Test
 COA = Coagulase Test, Gram.S = Gram Staining, + = Positive, - = Negative,
 EMB = Eosine Methylene Blue Agar, MAC = MacConkey agar,
 NA = Nutrient Agar

Table 3: Total bacteria count of borehole water in Garki police barracks, Abuja $\times 10^8$ (cfu/ml)

Sample (cfu/ml)	THBC ($\times 10^8$)	TCC ($\times 10^8$)	TFC ($\times 10^8$)
Block 13 C	2.5	3.8	2.3
Block 14 A	3.0	2.7	3.6
Block 3 C	3.5	3.3	1.5
Block 15 C	3.7	2.5	2.8
Block 12 C	4.0	2.9	3.0

Key: THBC = Total Heterotrophic Bacteria Count
 TCC = Total Coliform Count
 TFC = Total Faecal Coliform Count

Table 4: Total bacterial count of air in Garki police barracks, Abuja $\times 10^8$ (cfu/m³)

Sample (Cfu/ml)	THBC ($\times 10^8$)	TCC ($\times 10^8$)	TFC ($\times 10^8$)
Block 13 C	1.8	2.5	1.9
Block 14 A	2.6	3.0	2.8
Block 3 C	3.0	1.9	2.9
Block 15 C	2.5	2.5	1.8
Block 12 C	2.3	3.1	2.0

Key: THBC = Total Heterotrophic Bacteria Count
 TCC = Total Coliform Count
 TFC = Total Faecal Count

Table 5: Isolation rates of the bacterial isolates from different sources of water in Garki police barracks, Abuja.

Location (n)	<i>Salmonella</i> sp	<i>Klebsiella</i> sp	<i>Escherichiacoli</i> (%)	<i>Enterobacter</i> sp (%)	<i>Pseudomonasaeruginosa</i>
B 13 C (5)	3(21.43)	5 (25.00)	4(33.33)	3(25.00)	2(18.18)
B 14 A (5)	2 (14.29)	5 (25.00)	3 (25.00)	2 (16.66)	1 (9.09)
B 3 C (5)	4 (28.57)	3 (15.00)	2(16.66)	2 (16.66)	4 (36.36)
B 15 C (5)	3 (21.43)	4 (20.00)	2 (16.66)	3 (25.00)	2 (18.18)
B 12 C (5)	2(14.29)	3 (15.00)	1(8.33)	2 (16.66)	2 (18.18)
Total (25)	14 (56.00)	20(80)	12(48)	12(48)	11(44)

Key: B 13 C = Block 13 C
 B 14 A = Block 14 A
 B 3 C = Block 3 C
 B 15 C = Block 15 C
 B 12 C = Block 12 C

Table 6: Isolation rate of the bacterial isolates from air in Garki police barracks, Abuja

Location (n)	<i>Klebsiella</i> sp(%)	<i>Escherichia coli</i> (%)	<i>Bacillus</i> sp (%)	<i>Pseudomonas aeruginosa</i> (%)
B 13C (5)	4(30.77)	1(9.09)	3(23.08)	4 (26.67)
B 14 A (5)	2(15.38)	3(27.27)	2(15.38)	3 (20.00)
B 3 C (5)	1 (7.69)	2 (18 – 18)	4 (30.77)	3(20.00)
B 15 C (5)	3 (23.08)	3 (27.27)	3 (23.08)	2 (13.33)
B 12 C (5)	3 (23.08)	2 (18.08)	1 (7.69)	3 (20.00)
Total (25)	13 (52)	11(44)	13(52)	15 (60)

Key: B 13 C = Block 13C B12C = Block 12C
 B 14 A = Block 14 A
 B 3 C = Block 3C
 B 15 C = Block 15 C

Table 7: Antimicrobial susceptibility patterns of the different bacterial isolates of water in Garki police barracks, Abuja.

Isolates	OFX	AU	PEF	CTZ	CN	CPX	CEP	TRX	S	CEF
<i>Salmonella</i> sp	R(16)	S(19)	R(14)	R(8)	S(20)	S(30)	S(19)	S(22)	S(26)	S(18)
<i>Klebsiella</i> sp	S(20)	S(20)	S(28)	S(20)	R(18)	S(24)	S(19)	S(20)	S(20)	S(20)
<i>Escherichia coli</i>	S(22)	R(14)	S(24)	R(10)	S(20)	S(20)	R(12)	R(8)	S(20)	S(20)
<i>Enterobacter</i> sp	S(19)	R(18)	S(22)	R(8)	R(16)	S(20)	S(20)	S(19)	S(24)	S(19)
<i>Pseudomonas aeruginosa</i>	R(16)	S(20)	R(16)	S(19)	R(14)	S(24)	R(18)	S(20)	R(18)	R(8)

Key: OFX = Ofloxacin (10MCG); AU = Augmentin (30MCG); CEP = Ceporex (10MCG); TRX = Ceftriaxone (30MCG); PEF = Peflaxine (10MCG); CN = Gentamycin (10MCG); S = Streptomycin (30MCG); CEF = Cefuroxime (30MCG); CTZ = Ceftazidime (30MCG); CPX = Ciproflaxacin (10MCG);

Table 8: Antimicrobial susceptibility patterns of the different bacterial isolates of air in Garki police barracks, Abuja against some commonly used antibiotics.

Isolates	OFX	AU	PEF	CTZ	CN	CPX	CEP	TRX	S	CEF
<i>Klebsiella</i> sp	S(20)	S(22)	S(28)	S(20)	S(20)	S(22)	S(22)	R(6)	R(18)	R(14)
<i>Escherichia coli</i>	R(14)	R(12)	S(22)	R(12)	S(24)	S(22)	S(20)	S(19)	R(18)	S(20)
<i>Bacillus</i> sp	S(20)	R(16)	S(20)	R(18)	S(20)	S(22)	R(14)	S(20)	S(24)	R(16)
<i>Pseudomonas aeruginosa</i>	S(20)	R(12)	S(20)	S(20)	S(20)	S(22)	R(12)	S(19)	R(18)	R(12)

Key: OFX = Ofloxacin 10mcg; CPX = Ciproflaxacin 10mcg;
 AU = Augentin 30cmg; CEP = Cefprozil 10mcg;
 PEF = Peflaxine 10mcg; TRX = Ceftriaxone 30mcg,
 CTZ = Ceftazidime 3030mcg; S = Streptomycin 30mcg;
 CN = Gentamycin 10mcg; CEF = Cefuroxime 30mcg

Table 9: Physicochemical qualities of borehole water samples in Garki police barracks. Abuja

Parameters	Block 13C	Block 14 A	Block 3C	Block 15 C	Block 12 C	Limits (WHO/FMEN)
pH	6.892	6.289	6.313	6.556	6.829	6 – 9
Temp. (°C)	22.6	23.1	22.8	22.8	22.4	< 40
EC (µS)	136.4	136.5	130.9	140.9	112.2	300
Turb. (NTU)	0.55	0.36	0.08	0.16	0.40	1.5
Do (mg/l)	4.82	4.32	4.27	4.13	4.22	5.0
Appearance	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless
Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Not offensive
Taste	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless
Bicarbonate	6.00	10.00	8.00	5.00	3.00	0.0-100
Hardness (mg/l)	53.4	53.4	53.4	53.4	53.4	200
Nitrate	1.00	0.56	2.00	0.90	1.05	0.0-50
COD (mg/l)	9.81	10.12	14.30	11.35	16.51	30
Calcium	2.00	1.00	3.05	5.00	3.10	0.0-22
TDS (mg/l)	1.02	2.10	4.00	3.12	5.10	0.0-500
BOD (mg/l)	4.30	6.20	4.96	4.61	5.11	7.

Table 10: WHO drinking water Standards

Isolates	WHO/FMENv Recommended limits	WHO Permissible Limits
<i>Escherichia coli</i>	0 cfu/100mL	0 cfu/100mL
<i>Shigella dysenteriae</i>	0 cfu/100mL	10 cfu/100mL
<i>Salmonella typhi</i>	0 cfu/100mL	10 cfu/100mL

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