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# Comparative Analysis of Raw And Treated Water In Some Selected Areas In Abuja, Nigeria

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## ABSTRACT

**Introduction:** This study presents a comparative analysis of the quality of raw and treated water in selected areas within the Abuja Municipal Area Council of the Federal Capital Territory, Nigeria. With the global challenge of ensuring access to safe drinking water as emphasized by Sustainable Development Goal 6 (SDG 6), this research addresses the significant public health concerns related to waterborne diseases arising from the consumption of untreated or inadequately treated water. The study aimed to determine the effectiveness of local water treatment processes in reducing contaminants and to assess compliance with national and international water quality standards.

**Materials and Methods:** A total of forty samples were collected from four different areas in AMAC namely Garki, Gwarimpa, Kubwa, and Lugbe. These samples underwent physicochemical and microbiological testing to evaluate parameters such as pH, turbidity, alkalinity, conductivity, Nitrate, Nitrate, Hardness and the presence of contaminants including Total bacteria count, Total coliform count, yeast, and mould. Results: The result of the analysis showed that the pH values across the zones had a mean range of 6.47-7.26 for raw water and 6.21-6.89 for treated water. Conductivity was between 156.7-418.6 µS/cm for raw water and between 28.6-117.9 µS/cm for treated water. Other parameters including nitrate, alkalinity, nitrite, chloride, Carbon dioxide, and hardness reduced post-treatment.

**Conclusion:** There was no significant difference between raw and treated water although findings also indicated that untreated water sources exhibited higher levels of contaminants, posing potential health risks, while treated water generally met regulatory standards. However, the effectiveness of treatment varied across different areas. This research underscores the necessity for improved water treatment infrastructure and monitoring practices to safeguard public health in Abuja Municipal Area Councils, Federal Capital Territory. Abuja.

**Keywords:** Borehole water, Water Quality, Treated water, Microrganisms, Ground Water, Physicochemical, Microbiology, Raw water.

## INTRODUCTION

Water is one of the most vital natural resources necessary for the existence of life. Good drinking water is a luxury and one of the most essential requirements of life. Water used for domestic purposes in developing countries is usually sourced from rivers, streams, and wells, which are most likely to be polluted by domestic, agricultural, and industrial wastes. Safe drinking water suitable for domestic purposes must not contain any chemical or biological impurities (1). Diseases like birth defects and cancer are caused by the release of industrial wastes such as heavy metals or agricultural wastes such as pesticide residues. This has been linked to the source of drinking water in many communities (2)

Sustainable Development Goal 6 (SDG 6) on water and sanitation, adopted by United Nations Member States at the 2015 UN Summit as part of the 2030 Agenda for Sustainable Development, provides the blueprint for ensuring the availability and sustainable management of water and sanitation for all. According to the UN, 2.2 billion people lack access to safely managed drinking water which might be dangerous socially and economically and also affect the health of people drastically (3). SDG 6 emphasizes the sources and sustainability of quality and safe drinking water.

According to the World Health Organization, an estimated 2 billion people do not have access to safely managed drinking water services. In most urban cities in most countries of the world, including Nigeria, the government must provide potable water to its citizens. Many infectious diseases in developing countries are associated with contaminated water. Most areas in AMAC, both rural and urban cannot afford or access properly treated water for their daily use and therefore rely on water from untreated borehole sources, wells, and streams which may have significant effects on health. Water and sanitation are at the core of sustainable development.

Ensuring access to safe and uncontaminated drinking water is becoming a growing global challenge due to human activities such as the discharge of industrial waste, and excessive agricultural practices.

While surface water is the primary worldwide source of drinking water, groundwater is gaining popularity due to its natural clarity and the minimal treatment required to reduce turbidity. However, the expanding demands of the agricultural and industrial sector over the years have contributed to groundwater and surface water contamination. Untreated water can carry health risks therefore, it is essential to treat and purify water before consumption. The quality of raw water can be compromised by various factors, including physical, chemical (such as heavy metals and disinfection by-products), and biological contaminants. The “Guidelines for Drinking Water Quality” publication by the World Health Organization identified a minimum of seventeen significant genera of bacteria that can potentially exist in tap water and have the potential to cause severe health issues (4). The percentage of waterborne disease outbreaks linked to failures in the distribution system has been on the rise over time (5).

This project aims to compare the quality of raw and treated water in some selected areas in AMAC, FCT and determine if the result meets the relevant regulatory standards and guidelines for safe drinking water, to determine the effectiveness of the treatment processes in removing contaminants.

There was a comparison between the results of the analysis of raw water with treated water to determine the effectiveness of the treatment processes in removing contaminants. The objective was to assess whether the treated water meets the compare the results of the analysis of raw water with treated water to determine the effectiveness of the treatment processes in removing contaminants, assess whether the treated water meets the relevant regulatory standards and guidelines for safe drinking water, to highlight the physicochemical and microbiological quality of the both raw and treated water and to highlight the physicochemical and microbiological quality of the both raw and treated water.

Federal Capital Territory Abuja, Nigeria has two major water treatment dams, namely, the Gurara and Lower Usuma Dams, and a municipal water treatment agency known as Abuja Water Board, which serves areas under AMAC. A study has revealed that these treated water sources are not enough to cater to the fast-growing population within the metropolis (6) and this is the reason many communities and residents sink boreholes and pump the water to large overhead reservoirs for distribution to homes. This is also the reason for the proliferation of water factories that have commercialized the treatment of water to residents for sale. This study aimed to assess the physicochemical and microbiological quality of borehole water in selected communities within AMAC and compare it with the Nigerian industrial standard drinking water guidelines and also, compare the quality of untreated borehole water to that of treated water.

# MATERIALS AND METHODS

## Water Sample Collection

A total of 40 water samples were collected using the stratified random sampling method from four different locations in AMAC metropolis of FCT, Nigeria, including Garki, Gwarimpa, Kubwa, and Lugbe. Five treated water and five raw water samples were collected from four locations within AMAC. These samples were collected from various water production companies. Sterile universal sampling bottles were used to collect the samples, labeled and transported immediately to the laboratory for analysis in a cooler containing ice packs. Analysis was carried out within 5 hours of collection.

## Physicochemical Analysis

Parameters such as pH, conductivity, and temperature were measured utilizing a calibrated pH/conductivity meter. Total hardness, carbon dioxide, total alkalinity, and chloride concentrations were quantified through titrimetric analysis. Nitrate, nitrite, and iron concentrations were assessed using photometric methods.

## Microbiology Analysis

Microbiological analysis was carried out for each sample using various media including Plate count agar (PCA), Potato dextrose Agar (PDA), and Eosin methylene blue (EMB) using the pour plate method.

## Statistical Analysis

The data generated in this study was analyzed using SPSS version 23.0 to verify if there was significant difference in the water quality of raw and treated water and the Nigerian industrial standard.

# RESULTS AND DISCUSSION

**Table 1: Mean±SD of Chemical Properties of Raw Water Samples**

| Parameters | Gwarimpa | Garki | Kubwa | Lugbe |
|---|---|---|---|---|
| PH | 6.47±0.42 | 6.80±0.26 | 7.26±1.08 | 6.64±0.47 |
| Conductivity | 214.5±88.02 | 156.7±65.89 | 218.24±111.24 | 418.6±199.08 |
| Alkalinity | 23.60±21.78 | 13.80±8.49 | 25.60±22.28 | 14.8±20.5 |
| Hardness | 50.40±17.05 | 52.80±35.51 | 36.0±19.79 | 115.6±54.0 |
| CO2 | 34.40±17.46 | 32.40±29.61 | 22.0±15.6 | 38.0±35.86 |
| Chloride | 4.80±1.79 | 9.60±6.07 | 11.2±7.8 | 25.60±34.9 |
| Nitrate | 11.73±12.81 | 13.72±24.29 | 9.5±12.8 | 12.68±15.76 |
| Nitrite | 0.06±0.07 | 0.01±0.01 | 0.02±0.02 | 0.08±0.08 |
| Turbidity | 2.79±3.39 | 1.35±2.66 | 1.06±0.96 | 1.06±0.96 |
| Iron | 0.03±0.03 | 0.09±0.13 | 0.03±0.02 | 0.08±0.12 |
| TBC | 234.0±352.1 | 706.0±910.37 | 69.6±101.6 | 769.2±1583.0 |
| TCC | 56.40±87.32 | 200.8±446.77 | 0.40±0.89 | 0.00±0.00 |
| Yeast | 72.0±107.33 | 4.80±10.73 | 0.00±0.00 | 10.0±17.32 |

Key: CO2=Carbondioxide

Mean and Standard Deviation of Chemical Constituents of The Raw Water Samples

The Mean and Standard deviation (SD) of the assayed analytes from the water samples obtained from the study location were computed using SPSS 23.0. The Mean±SD of these analytes assayed from raw water samples from the study locations is represented in Table 1.

| Parameters | Gwarimpa | Garki | Kubwa | Lugbe |
|---|---|---|---|---|
| PH | 6.21±0.41 | 6.8±0.68 | 6.73±0.66 | 6.89±0.44 |
| Conductivity | 117.9±92.4 | 184.2±69.81 | 28.6±29.87 | 93.88±131.39 |
| Alkalinity | 28.80±32.64 | 19.60±10.0 | 11.6±11.08 | 15.60±20.41 |
| Hardness | 37.2±31.16 | 47.20±30.54 | 19.6±15.06 | 22.80±38.84 |
| CO2 | 14.8±9.54 | 16.4±15.38 | 6.8±4.1 | 13.6±10.13 |
| Chloride | 8.0±8.1 | 6.0±4.4 | 11.2±3.03 | 16.80±10.35 |
| Nitrate | 3.07±3.78 | 30.7±38.18 | 3.5±4.4 | 2.56±3.7 |
| Nitrite | 0.03±0.02 | 0.02±0.01 | 0.02±0.03 | 0.02±0.04 |
| Turbidity | 1.31±1.96 | 0.79±1.15 | 1.24±1.69 | 0.65±0.98 |
| Iron | 0.04±0.07 | 0.08±0.09 | 0.03±0.02 | 0.05±0.07 |
| TBC | 233.0±352.9 | 442.4±982.5 | 158.2±225.5 | 0.00±0.00 |
| TCC | 0.00±0.00 | 160.0±357.77 | 0.00±0.00 | 0.00±0.00 |
| Yeast | 128.2±184.0 | 0.00±0.00 | 12.0±15.01 | 0.00±0.00 |

**Table 2 Mean±SD of Chemical Properties of Treated Water Samples**

Key: TBC=Total Bacterial Count, TCC=Total Coliform Count

Mean and Standard Deviation of Chemical Constituents of the Treated Water Samples

The mean and standard deviation of the chemical properties of the treated water samples obtained from the study location were calculated. The chemical properties assayed were Conductivity, total alkalinity, PH, Nitrate, Nitrite, etc. Microbiological quality which includes the total bacteria count, total coliform count, and total yeast count of the water samples was also assessed. Table 2 gives the mean and standard deviation of the chemical and microbiological properties assayed.

**Table 3: Comparison of Chemical and Microbiological Constituent of Raw and Treated Water Samples.**

| Parameters | Gwarimpa | | Garki | | Kubwa | | Lugbe | |
|---|---|---|---|---|---|---|---|---|
| | t | p | t | p | t | p | t | p |
| $_{P}H$ | 1.06 | 0.347 | -0.035 | 0.974 | 0.915 | 0.412 | -0.708 | 0.518 |
| Conductivity | 1.95 | 0.124 | -0.696 | 0.525 | 3.313 | **0.030** | 2.62 | 0.059 |
| Alkalinity | -0.322 | 0.764 | -1.21 | 0.292 | 1.17 | 0.309 | 0.054 | 0.959 |
| Hardness | 1.05 | 0.354 | 0.269 | 0.801 | 1.34 | 0.252 | 2.62 | 0.059 |
| $CO^2$ | 1.999 | 0.116 | 1.29 | 0.267 | 2.41 | 0.074 | 1.47 | 0.216 |
| Chloride | -0.814 | 0.461 | | | **0.00** | 1.00 | 0.538 | 0.619 |
| Nitrate | 1.44 | 0.224 | -1.18 | 0.304 | 1.081 | 0.341 | 1.26 | 0.275 |
| Nitrite | 0.916 | 0.412 | -1.50 | 0.208 | -1.00 | 0.374 | 1.60 | 0.184 |
| Turbidity | 1.81 | 0.145 | 0.385 | 0.720 | -0.18 | 0.869 | 0.499 | 0.644 |
| Iron | -0.282 | 0.792 | 0.132 | 0.901 | 0.260 | 0.807 | 0.439 | 0.683 |
| TBC | **0.004** | 0.997 | 0.368 | 0.731 | -0.683 | 0.532 | 1.09 | 0.338 |
| TCC | 1.44 | 0.222 | 1.03 | 0.363 | 1.72 | 0.2229 | 0.582 | 0.793 |
| Yeast | 0.632 | 0.562 | 1.0 | 0.374 | 1.16 | 0.488 | 1.29 | 0.266 |

Key: p=p-value, t=t-value, Co2=Carbondioxide *p-value significant at $p<0.05$

Key: TBC=Total Bacterial Count, TCC=Total Coliform Count

Comparison of Chemical and Microbiological Properties of Raw Water Samples and Treated Water Samples in The Study Location.

The chemical and microbiological properties of raw water samples and treated water samples from the study location were assessed using paired t-test. Table 3 provides detailed results of the analysis.

**Table 4: Comparison between Concentrations of chemical and Microbiological Properties of Treated Water Samples and NIS standard**

| Parameters | Gwarimpa | | Garki | | Kubwa | | Lugbe | |
|---|---|---|---|---|---|---|---|---|
| | t | p | t | p | t | p | t | p |
| PH | -2.94 | **0.043*** | -1.31 | 0.260 | 1.50 | 0.209 | 1.79 | 0.148 |
| Conductivity | -21.4 | **<0.001*** | -26.13 | **<0.001*** | -72.70 | **<0.001*** | -4956.0 | **<0.001*** |
| Alkalinity | -4.90 | **0.008*** | -17.91 | **<0.001*** | -11.94 | **<0.001*** | -0.104 | 0.922 |
| Hardness | -8.09 | **0.001*** | -0.94 | 0.761 | -1.80 | 0.217 | -2.13 | 0.382 |
| CO2 | 3.46 | **0.026*** | 2.38 | 0.076 | 3.67 | **0.021*** | 2.99 | **0.040*** |
| Chloride | -25.32 | **<0.001*** | -47.10 | **<0.001*** | -65.46 | **<0.001*** | -17.97 | **<0.001*** |
| Nitrate | -4.10 | **0.015*** | 1.21 | 0.292 | **-3.27** | **0.031*** | **-4.49** | **0.011*** |
| Nitrite | 0.691 | 0.528 | -1.0 | 0.374 | 0.272 | 0.799 | -1.0 | 0.374 |
| Turbidity | -1.50 | 0.209 | 1.54 | 0.799 | 1.64 | 0.177 | 1.49 | 0.211 |
| Iron | -7.55 | **0.002*** | -0.825 | 0.431 | -0.298 | 0.817 | -1.03 | 0.339 |
| TBC | 0.843 | 0.447 | 0.779 | 0.479 | 0.577 | 0.595 | 0.869 | 0.305 |
| TCC | 1.142 | 0.706 | 1.00 | 0.374 | 1.38 | 0.471 | 1.63 | 0.598 |
| Yeast | 1.558 | 0.194 | 0.820 | 0.471 | 1.77 | 0.417 | 0.125 | 0.858 |

Key: p=p-value, t=t-value, Co2=Carbondioxide *p-value significant at $p<0.05$

Key: TBC=Total Bacterial Count, TCC=Total Coliform Count

Comparison of Concentration of Chemical & Microbiological Properties of Treated Water with NIS Standard Concentration

The obtained concentrations of the chemical and microbiological constituents of the treated water samples were compared with the NIS standard concentration using a paired t-test. Table 4 gives a summary of the findings.

**Table 5: Comparison Between Concentrations of Chemical and Microbiological Properties of Raw Water samples and NIS Standard.**

| Parameters | Gwarimpa | | Garki | | Kubwa | | Lugbe | |
|---|---|---|---|---|---|---|---|---|
| | t | p | t | p | t | p | t | p |
| PH | -2.08 | 1.06 | -2.005 | 0.116 | -0.484 | 0.654 | -2.06 | 0.108 |
| Conductivity | -19.95 | **<0.001*** | -28.619 | **<0.001** | -15.714 | **<0.001*** | -6.507 | **0.003*** |
| Alkalinity | -7.84 | **0.001*** | -22.58 | **<0.001*** | -7.464 | **0.002*** | -9.28 | **0.001** |
| Hardness | 1.50 | 0.229 | 1.01 | 0.317 | 0.894 | 0.477 | 1.29 | 0.563 |
| CO2 | 4.41 | **0.0012*** | 2.447 | 0.071 | 3.149 | **0.035*** | 2.369 | 0.077 |
| Chloride | -119.0 | **<0.00*1** | -33.32 | **<0.001*** | -25.382 | **<0.001*** | -4.765 | **0.009*** |
| Nitrate | 0.302 | 0.778 | 0.342 | 0.749 | -3.268 | **0.031*** | 0.380 | 0.723 |
| Nitrite | 1.24 | 0.282 | -2.236 | 0.089 | -0.167 | 0.876 | 1.655 | 0.173 |
| Turbidity | 1.84 | 0.140 | 1.14 | 0.318 | 2.454 | 0.070 | 2.454 | 0.070 |
| Iron | -17.315 | **<0.001*** | -3.63 | **0.022*** | -20.646 | **<0.001*** | -4.269 | **0.013*** |
| TBC | 0.851 | 0.443 | 1.488 | **<0.001*** | 0.669 | 0.540 | 0.945 | 0.398 |
| TCC | 1.44 | 0.222 | 1.005 | 0.372 | 1.00 | 0.374 | 0.871 | 0.672 |
| Yeast | 1.50 | 0.208 | 1.00 | 0.374 | 1.71 | 0.409 | 1.291 | 0.266 |

Key: p=p-value, t=t-value, TBC=Total Bacterial Count, TCC=Total

Comparison of Concentration of Chemical & Microbiological Properties of Raw Water with NIS Standard Concentration.

The concentrations of chemical & microbiological constituents of raw water samples were compared to the NIS standard concentrations. Table 5 gives a summary of the findings.

# DISCUSSION

The project investigated the chemical and microbiological properties of raw and treated water samples from four locations: Gwarimpa, Garki, Kubwa, and Lugbe. The aim was to compare the quality of raw water and treated water collected from each area and to determine if the water meets the Nigerian industrial standard for drinking water.

The raw water's pH values varied by location, with Kubwa having the highest pH (7.26 ± 1.08), indicating the most neutral water among the samples, while Gwarimpa had the lowest pH (6.47 ± 0.42). These values remained mainly within Nigeria's Industrial Standard (NIS) for drinking water maximum allowable limit (6.5 to 8.5) (7). Wokem and Udonsi (2003) observed in an earlier study conducted at Oso-Edda in Ebonyi State, Nigeria, that the ponds had a pH range of 5.2 to 7.6, with a mean of 6.1. This falls within the acceptable limits set by the WHO, except in the Bob-Manuel compound, where the pH was slightly acidic, with a mean value of 6.2. (8). In studies carried out by Alexander in 2010 on the groundwater quality in Mubi town in Mubi

North Local Government Area of Adamawa State to examine the suitability or otherwise of their use of the groundwater for drinking and domestic purposes, the analysis revealed that the water sample was slightly acidic and alkaline (pH 6.30 + 0.01 to 7.52 + 0.05). (9).

The raw water pH range obtained from the analysis was near neutral, which was conducive to the growth of most bacterial species (7). Post-treatment, pH values were slightly reduced in some areas, with Lugbe having the highest pH (6.89 ± 0.44), Gwarimpa the lowest (6.21±0.41) which indicates effective treatment.

Water conductivity refers to the ability of water to conduct an electrical current. The presence of conductive ions could be attributed to inorganic substances like chlorides, alkalis, carbonate, sulfide compounds, and dissolved salts. A direct correlation exists between conductivity and total dissolved solids because as conductivity rises, the total dissolved solids also increase. (10). The conductivity of raw water varied widely, Lugbe exhibits the highest value (418.6 ± 199.08 µS/cm), suggesting a higher concentration of dissolved ions, whereas Garki has the lowest conductivity (156.7 ± 65.89 µS/cm). Post-treatment, Conductivity values also decrease, Garki showing the highest conductivity (184.2 ± 69.81 µS/cm), and Kubwa having the lowest conductivity (28.6 ± 29.87 µS/cm), suggesting effective removal of ions in most locations. These values were within the maximum permissible limit by the Nigerian Industrial Standard. This is in agreement with a study by Subedi ,Tyata, Khadgi, and Wong in 2012 titled Physicochemical and Microbiological Analysis of drinking water treated by Ozone. Samples were collected from tap water, stone spout, and tube well. They found that the conductivity of the sample collected from the tube well was within the standard value and reduced after treatment by ozone. (11).

Alkalinity is a measure of the substances in water that have acid-neutralizing ability; alkalinity buffers against pH changes and makes underground water less vulnerable to the impact of acid rain. The raw water Alkalinity levels were relatively low, Kubwa shows the highest alkalinity (25.60 ± 22.28 mg/L), while Garki has the lowest (13.80 ± 8.49 mg/L). Although, Alkalinity generally decreases post-treatment with Gwarimpa exhibiting the highest value (28.80 ± 32.64 mg/L), and Kubwa the lowest (11.6 ± 11.08 mg/L). Alkalinity in both raw and treated water were within the NIS standard in most locations.

In terms of Hardness was Lugbe has significantly higher levels (115.6 ± 54.0 mg/L) compared to the other locations, with Kubwa having the lowest hardness (36.0 ± 19.79 mg/L). High levels of hardness in water could impact its palatability and usability. The primary natural contributors to water hardness are dissolved polyvalent metal ions, mainly calcium and magnesium (12). Temporary hardness is caused by the presence of bicarbonates and carbonates of calcium and magnesium. In contrast, permanent hardness results due to the presence of calcium and magnesium sulfates and chlorides (13). Hard water is not known to have any significant adverse effect on health (14). The significant mineral content found in both pipe-borne and borehole alkaline water, as indicated by the analysis, can lead to the buildup of deposits in water pipes and appliances that use water. Post-treatment, Hardness was reduced across all locations, with the largest decrease observed in Lugbe (22.80±38.84mg/l). Hardness was observed to be within the NIS limit.

$CO_2$ levels were also highest in Lugbe (38.0 ± 35.86 mg/L) and lowest in Kubwa (22.0 ± 15.6 mg/L). Post-treatment analysis revealed a significant reduction in $Co_2$ levels across all locations, with Lugbe at (13.6±10.13mg/l) and Gwarimpa demonstrating the most substantial decrease. Treated and raw water $CO_2$ levels remained within the NIS limit.

Lugbe showed the highest chloride concentration (25.60 ± 34.9 mg/L), while Gwarimpa had the lowest (4.80 ± 1.79 mg/L). High levels of chloride in water suggest possible natural mineral presence although were still within the NIS limit of raw water. Post-treatment, Chloride levels also declined, indicating successful treatment processes. In raw and treated water, chloride remained within the NIS limit.

Nitrate levels were generally low with the lowest in Kubwa (9.5±12.8mg/l) and highest in Garki (13.72 ± 24.29 mg/L). Nitrate levels drop markedly post-treatment, particularly in Lugbe (2.56±3.7mg/l). Nitrite levels were low across all locations with the lowest in Garki (0.01±0.010) and highest in Lugbe (0.08 ± 0.08 mg/L). Concentration remained low, with minimal change post-treatment with Gwarimpa showing the highest nitrite concentration (0.03 ± 0.02 mg/L), and Garki having the lowest (0.02 ± 0.01 mg/L). These levels remained within the NIS limit.

Gwarimpa had the highest turbidity (2.79 ± 3.39 NTU), whereas Kubwa and Lugbe have the lowest, both at 1.06 ± 0.96 NTU. Post Treatment, Gwarimpa also had the highest turbidity (1.31 ± 1.96 NTU) and Lugbe the lowest (0.65 ± 0.98 NTU). Garki exhibited the highest iron concentration (0.09 ± 0.13 mg/L), while Gwarimpa and Kubwa had the lowest iron concentrations, both at 0.03 mg/L. Post treatment, Garki exhibited the highest iron concentration (0.08 ± 0.09 mg/L), whereas Kubwa the lowest (0.03 ± 0.02 mg/L).

For Raw water, Total bacterial count (TBC) was highest in Lugbe (769.2±1583.0) and Kubwa the lowest (69.6 ± 101.6 CFU/mL). Post Treatment, Total bacterial count (TBC), was highest in Garki (442.4 ± 982.5 CFU/mL), and least in Lugbe (0.00 ± 0.00 CFU/mL). Garki showed the highest total coliform count (200.8 ± 446.77 CFU/100mL) while Lugbe and Kubwa had the lowest, with Lugbe at 0.00 ± 0.00 CFU/100mL. Post treatment, Garki also has the highest total coliform count (TCC) (160.0 ± 357.77 CFU/100mL), while Gwarimpa, Kubwa, and Lugbe had no detectable TCC (0.00 ± 0.00 CFU/100mL). The Presence of coliforms indicates fecal contamination of the water. Gwarimpa had the highest yeast concentration (72.0 ± 107.33 CFU/mL), whereas Kubwa had the lowest, with no yeast detected (0.00 ± 0.00 CFU/mL), which was within the NIS limit. The results of the microbiological analysis carried out on the raw and treated water samples are presented in Table 1 and 2 respectively. From the Table, it can be observed that the total bacteria count and the total coliform count detected in both raw and treated water were relatively high. This is in agreement with a study by Foka, Yah , and Agbortabot in 2018 where they conducted a study focusing on Physico-Chemical Properties and Microbiological Quality of Borehole Water in Four Crowded Areas of Benin City, Nigeria, During Rainfalls. The total coliform count for treated water was found to be high with a mean of 1.13 × 102 which was above the WHO and NIS limit. (15). Total bacteria count and coliforms were significantly reduced in treated water, with Kubwa and Lugbe showing zero coliform counts, indicating effective microbial treatment in some areas. However, some Microrganisms presence persisted in other areas. This result implies that the samples found to contain total bacteria count are the same ones that contained Coliforms and the presence of coliforms in these water samples typically indicates possible contamination by fecal matter from either human or animal sources. Research indicates that in densely populated commercial regions, the inefficient disposal of sewage, slums, and wastewater, particularly during flood events, can contribute to the distribution of coliforms and other bacteria in borehole water systems. (16).

When compared, there was no statistically significant difference between the raw and the treated water samples which means there is no significant difference between the quality of raw and treated water. The presence of indicator organisms such as Coliforms in both raw water and treated water is a measure of its sanitary quality. (17). This is an indication that raw water might not be suitable for human consumption if it is not treated further.

In 2013, Mustafa, Ibrahim, Harunayi, and Abubakar analyzed the physical and chemical properties of water collected from a borehole used for drinking in Maiduguri Metropolis, Nigeria. Their findings revealed that none of the water samples met the bacteriological standards, as the coliform count ranged between 6x10 and 145x10 MPN/ml. In addition to this, they found that two borehole samples didn't align with the WHO, NAFDAC, and NSWDWQ recommended pH norms. As a result of these discoveries, they recommended that public awareness be raised about the state of the wash boreholes and the need for consumers to treat the water before using it for drinking or other household purposes. (18).

Elinge, Yusuf, Jude, Peni, and Owusu in 2010 conducted a study focusing on the physio-chemical and bacteriological analysis of water samples from four boreholes within the Aliero community in Kebbi State, Nigeria. They found varying concentrations of metal ions in the samples. Some borehole samples had concentrations higher than the World Health Organization's (WHO) desired limit, while others were within acceptable ranges. The bacteriological analysis pointed out that one borehole had the highest bacteria count, registering at 4.0x105 ctu/cm3; Another borehole had a total coliform count of 1320mpn/100ml. Based on this analysis, while some boreholes were deemed safe for drinking, others were not. They also noted that tap water appeared to be safer compared to these borehole water samples due to pre-treatment processes. (19).

# CONCLUSION AND RECOMMENDATION

This study underscores the importance of regular water quality assessments and targeted treatment interventions. The analysis demonstrates that water treatment processes are generally effective in reducing chemical and microbiological contaminants. However, variability in raw water quality across different locations highlights the differences in the quality of water from each area which necessitates tailored treatment approaches. Kubwa's significant conductivity reduction highlights an effective ion removal process.

Despite overall improvements, persistent microbial contamination in the treated water suggests the need for enhanced microbial control measures. Comparing treated water properties to NIS standards indicates that, while most parameters meet acceptable limits, continuous monitoring and optimization are essential to ensure safety and quality. Ongoing evaluation and process adjustments are crucial to maintain compliance with health standards and ensure safe water for all users.
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## ABBREVIATIONS

AMAC: Abuja Municipal Area Council

CO2: Carbondioxide

TBC: Total Bacteria Count

TCC: Total Coliform Count

NIS: Nigerian Industrial Standard

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