PROJECT

ON

PHYSICOCHEMICAL PROPERTIES OF WELL WATER AND BOLE HOLE WATER IN KWARA POLYTECHNICS COMMUNITIES.

BY:

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CERTIFICATION

This is to certify that this project work was carried out by **AMOS PHEOBE OMOWUMI** with the Matriculation Number **ND/23/SLT/PT/0490**. This project has been read and approved as meeting part of the requirement for the award of National Diploma (ND) in science laboratory technology, Kwara State Polytechnic, Ilorin.

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DEDICATION

I dedicated this project work to my lord, my creator, the almighty God who gave me the privilege to finish the report successful and to my parent. Mr. and Mrs. Amos that support me financially and with prayer.

ACKNOWLEDGEMENT

Glory to almighty God the lord of the world. Who has been through his mercy for sparing my life till today.

This project would not have been possible if not because of the invaluable inputs and assistance of some people whose in one way or the other made an immense contribution measuring the betterment of life.

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I sincerely appreciate my beloved parent Mr. and Mrs. Amos who have provided the needed financial assistance cover right from the day of birth to this stage, may the almighty God grant them long life and prosperity so they could reap the fruit of their labour and crown their effort with success and continue to guide and protect them in their short coming (Amen).

Finally, I appreciate friends and siblings who has helped me in one way or the other, I am sincerely grateful for your love, care and support. God bless you all.

TABLE OF CONTENTS

ABSTRACT

Access to clean and safe water is essential for human health and development. In many Nigerian institutions, including Kwara State Polytechnic, groundwater sources such as hand-dug wells and boreholes serve as the primary sources of water for drinking and domestic purposes. However, the quality of these water sources is often uncertain due to increasing urbanization, poor sanitation practices, and lack of regular monitoring. This study was conducted to evaluate and compare the physico-chemical properties of well water and borehole water within the Kwara Polytechnic communities in order to determine their suitability for consumption. Water samples were collected from five hand-dug wells and five boreholes across different locations in the institution. Standard laboratory procedures were used to test parameters such as pH, turbidity, electrical conductivity, total dissolved solids (TDS), hardness, nitrate, calcium, magnesium, and chloride. The results were compared with World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (SON) guidelines. The findings revealed that borehole water generally exhibited better water quality compared to well water. Most borehole samples met the required standards for pH, turbidity, TDS, and ion concentration. In contrast, several well water samples recorded elevated turbidity, TDS, and nitrate levels, indicating the likelihood of surface contamination, possibly due to poor construction and proximity to waste disposal sites. The study concluded that borehole water is relatively safer for drinking, while well water may require treatment before use. It recommends routine water quality monitoring, proper well construction, and public awareness on water safety practices. These measures are essential to protect the health of students and staff and ensure sustainable water use within the Kwara Polytechnic environment.

CHAPTER ONE

Introduction

Access to clean and safe water is a fundamental necessity for human health and development. In many parts of Nigeria, including educational institutions such as Kwara State Polytechnic, residents rely heavily on groundwater sources such as wells and boreholes for domestic use, drinking, and other daily activities. However, the quality of groundwater is influenced by both natural processes and anthropogenic activities, including improper waste disposal, agricultural runoff, and industrial discharges (Adewusi et al., 2013; Olalekan et al., 2018).

Physico-chemical properties such as pH, turbidity, total dissolved solids (TDS), electrical conductivity, hardness, and concentrations of various ions (e.g., calcium, magnesium, nitrate, chloride) are critical parameters for assessing water quality. These properties determine the suitability of water for consumption and domestic purposes. For instance, high levels of nitrates and heavy metals can pose serious health risks such as methemoglobinemia and organ toxicity (Aremu et al., 2011). Similarly, excessive hardness in water can cause scaling in pipes and reduce soap efficiency, while low or high pH levels can lead to corrosion or gastrointestinal irritation (WHO, 2017).

In semi-urban settings like the Kwara Polytechnic community, the increasing population and poor environmental sanitation contribute significantly to groundwater contamination. Open defecation, leachate from refuse dumps, and proximity of wells to septic tanks compromise water safety (Ojekunle et al., 2016). The absence of consistent water quality monitoring further exacerbates the risk to public health.

Comparing the physico-chemical characteristics of well water and borehole water is essential for understanding the variation in quality and potential risks associated with each source. Boreholes, often drilled to greater depths, are typically presumed safer than shallow wells; however, both sources may still be susceptible to contamination depending on geological formations and human activities (Adekunle et al., 2007).

This study, therefore, aims to evaluate and compare the physico-chemical properties of well and borehole water in Kwara Polytechnic communities. The outcome will help inform water management practices and ensure the safety of the water consumed by students and staff within the institution.

1.1 Statement of the Problem

Water is essential to human survival and public health, yet the quality of water accessed by many communities in Nigeria remains questionable. In the Kwara State Polytechnic communities, the primary sources of water for domestic use are hand-dug wells and boreholes. While these sources are generally considered convenient and cost-effective, their safety is often compromised due to the absence of regular testing and monitoring. With the growing student and staff population in the institution, the demand for groundwater has increased, raising concerns over its safety and sustainability.

There is a common assumption that borehole water is of better quality than well water; however, both water sources are vulnerable to contamination depending on their depth, construction, proximity to pollution sources, and underlying geology. Surface runoff, seepage from pit latrines, waste disposal sites, and leaking septic tanks can introduce harmful chemicals and pathogens into groundwater, particularly in shallow wells. Even deeper boreholes may be exposed to geogenic contaminants such as iron, manganese, and fluoride, which can exceed World Health Organization (WHO) recommended limits and pose health risks if consumed over time.

Despite these risks, there is limited empirical data on the comparative quality of well and borehole water within Kwara Polytechnic. Students and residents rely on these sources without adequate knowledge of their physico-chemical composition, making them susceptible to waterborne diseases and chronic health conditions. This lack of data presents a gap in water resource management and public health protection within the institution.

Furthermore, regulatory agencies often focus more on municipal water systems, neglecting small-scale and private water sources such as those used within educational communities. Without proper analysis and documentation of water quality parameters—such as pH, turbidity, total dissolved solids (TDS), hardness, and metal ion content—there is a risk of long-term exposure to hazardous substances.

Therefore, this study seeks to investigate and compare the physico-chemical properties of well water and borehole water in the Kwara Polytechnic communities to determine their safety for consumption and recommend appropriate interventions where necessary.

1.2 Justification of the Research

Groundwater is a crucial source of potable water for many Nigerians, especially in educational institutions such as Kwara State Polytechnic. However, due to increasing urbanization, population growth, and poor waste management practices, the quality of well and borehole water is becoming increasingly compromised. Most students and staff depend on these sources daily, yet they lack awareness of the water's physico-chemical composition and potential health implications.

This research is justified by the urgent need to assess and ensure the safety of groundwater sources within the Kwara Polytechnic communities. Unlike municipal water systems, private water sources such as wells and boreholes are rarely subjected to routine quality control. Identifying contaminants and evaluating water parameters can help prevent waterborne diseases, promote environmental safety, and support informed decision-making on water use.

Furthermore, findings from this study will serve as a reference for the school management, health officers, and environmental agencies to develop effective water quality management strategies. It also contributes to the growing body of knowledge on groundwater assessment in Nigerian academic environments, encouraging similar studies in other institutions.

1.3 Aim of the Study

The aim of this study is to evaluate and compare the physico-chemical properties of well water and borehole water in Kwara State Polytechnic communities to determine their suitability for domestic and drinking purposes.

1.4 Objectives of the Study

The specific objectives of this research are to:

1. Analyze key physico-chemical parameters (such as pH, TDS, conductivity, hardness, turbidity, and ion concentration) of well water and borehole water within the study area.

2. Compare the measured values against World Health Organization (WHO) and Nigerian drinking water standards.

CHAPTER TWO

2.0. Literature review

Access to safe drinking water remains a major concern in many developing countries, including Nigeria. Groundwater, accessed through wells and boreholes, serves as a primary source of water for both urban and rural communities. The quality of such water sources, however, is often threatened by both natural and anthropogenic factors (Olalekan et al., 2018).

2.0.1 Groundwater and Its Importance

Groundwater is water located beneath the earth's surface in soil pore spaces and fractures of rock formations. It is generally considered safer than surface water due to natural filtration as it passes through soil layers (Orebiyi et al., 2010). In areas lacking municipal water supply, like Kwara State Polytechnic, boreholes and hand-dug wells are commonly used. Despite their accessibility, the safety and quality of these sources vary depending on geological conditions, human activities, and maintenance practices (Adekunle et al., 2007).

2.0.2 Physico-chemical Parameters and Water Quality

Physico-chemical properties refer to measurable physical and chemical characteristics of water that determine its quality. These include pH, temperature, turbidity, total dissolved solids (TDS), electrical conductivity (EC), hardness, and concentrations of ions such as nitrates, chlorides, calcium, and magnesium (WHO, 2017). For instance, pH values outside the WHO-recommended range (6.5–8.5) can lead to corrosion of plumbing and gastrointestinal discomfort. High TDS levels affect water taste and may indicate the presence of harmful inorganic salts (Aremu et al., 2011).

Hardness, caused by calcium and magnesium ions, is not directly harmful but can cause scaling in pipes and reduce soap efficiency. Turbidity, often caused by suspended particles, may harbor microbial contaminants. Elevated levels of nitrates, typically from agricultural or human waste sources, can be hazardous, especially to infants, causing conditions like methemoglobinemia or "blue baby syndrome" (Adewusi et al., 2013).

2.0.3 Contamination of Well and Borehole Water

Several studies have documented the vulnerability of groundwater sources to contamination. Well water, being shallow and often poorly constructed, is more susceptible to surface pollutants, including faecal matter, leachate from nearby septic tanks, and refuse dumps (Ojekunle et al., 2016). Borehole water is generally perceived to be safer due to its depth, but poor casing and lack of maintenance can also result in contamination.

In a study by Orebiyi et al. (2010), a significant percentage of hand-dug wells in rural Nigeria exceeded safe limits for nitrates and microbial contamination. Similarly, Olalekan et al. (2018) noted that boreholes located near industrial areas contained elevated levels of heavy metals such as iron and manganese, which can be harmful when consumed over time.

2.0.4 Water Quality Standards and Guidelines

The World Health Organization (WHO) provides global guidelines for drinking water quality, while Nigeria's Standard Organization of Nigeria (SON) sets national standards. These standards help determine acceptable levels of chemical, physical, and biological parameters in water. Regular monitoring and comparison against these benchmarks are essential in identifying unsafe water and taking corrective measures (WHO, 2017).

2.1 Sources of Water

Water sources can generally be categorized into two types: surface water and groundwater. Surface water includes rivers, lakes, and streams, while groundwater exists beneath the earth's surface and is accessed through wells and boreholes. In Nigeria, especially in semi-urban and rural areas, groundwater is the primary source of potable water due to the erratic availability of treated municipal water (Adewusi et al., 2013). Hand-dug wells are typically shallow, ranging from 5 to 15 meters in depth, and are often exposed to contaminants due to poor construction and proximity to pollution sources. Boreholes, on the other hand, are mechanically drilled to greater depths, often beyond 30 meters, making them less vulnerable to surface contamination (Adekunle et al., 2007).

The Kwara Polytechnic community relies heavily on both sources to meet daily water needs. However, differences in depth, geological formations, and local human activities can influence the quality of water from these sources. Therefore, understanding the origin and characteristics of each water source is essential for effective water management and risk mitigation.

2.3 Importance of Water

Water plays a vital role in sustaining life and maintaining public health. It is essential for drinking, cooking, sanitation, agriculture, and industrial processes. Approximately 60% of the human body is composed of water, highlighting its central role in physiological processes such as digestion, circulation, temperature regulation, and waste elimination (WHO, 2017).

Access to clean and safe water improves hygiene and reduces the incidence of waterborne diseases such as cholera, typhoid, and diarrhea. In educational communities like Kwara Polytechnic, adequate water supply is critical for students' wellbeing, academic performance, and overall quality of life. Unfortunately, many institutions in Nigeria still suffer from poor water infrastructure, relying on unregulated sources such as wells and boreholes (Olalekan et al., 2018). Ensuring that these sources meet safety standards is therefore a public health priority.

2.4 Water Pollution

Water pollution refers to the introduction of harmful substances into water bodies, rendering them unsafe for human use and ecological balance. Pollutants can be physical, chemical, or biological in nature and are often derived from human activities such as open defecation, industrial discharge, agricultural runoff, and improper waste disposal (Ojekunle et al., 2016). In groundwater systems, contamination may occur through leaching of chemicals from landfills, septic tanks, or agricultural fields into the aquifers.

In many parts of Nigeria, including Kwara State, poor urban planning and weak environmental regulations have contributed to widespread water contamination. Shallow wells are especially vulnerable to pollution due to their proximity to surface activities. Boreholes, while generally safer, are not immune to pollutants—especially when poorly constructed or located near industrial or waste-prone areas (Orebiyi et al., 2010).

Polluted water can carry pathogens such as *Escherichia coli*, viruses, and parasites, or toxic substances such as nitrates, heavy metals, and pesticides, leading to serious health issues. Long-term exposure to these contaminants can result in kidney damage, neurological disorders, and cancer (Aremu et al., 2011). Thus, regular monitoring of water sources, particularly in densely populated institutions like Kwara Polytechnic, is necessary to prevent potential outbreaks and promote a healthier environment.

CHAPTER THREE

3.0 Methodology

The methodology for determining the physico-chemical properties of well and borehole water involves careful sampling, laboratory testing, and analytical evaluation to ensure reliable and accurate assessment of water quality. The procedure includes identifying the sampling locations, selecting appropriate equipment, collecting water under hygienic conditions, and testing for physical and chemical characteristics such as pH, turbidity, total dissolved solids (TDS), and conductivity using standard instruments and protocols.

3.1 Material and Method

Materials Used and Their Description

All materials used were selected for precision, accuracy, and reliability in environmental testing. These materials include:

- **Sterilized Plastic Bottles (1-liter):** Used for collecting water samples without introducing external contaminants.
- **Digital pH Meter:** Used to measure the acidity or alkalinity of the water samples.
- **Turbidity Meter (NTU):** Measures the clarity of water by detecting suspended particles.
- **Conductivity Meter:** Determines the electrical conductivity, which reflects the concentration of dissolved ions.
- **TDS Meter:** Measures the total dissolved solids, indicating the overall mineral content of water.
- **Titration Set:** Used to measure hardness, calcium, and magnesium using EDTA titration methods.

- **Spectrophotometer:** Used for analyzing chemical contents such as nitrates and chlorides based on color changes.

3.1.2 Method

The method involved several steps to ensure water quality was tested under standardized conditions:

- **Selection of Sites:** Five (5) well water and five (5) borehole samples were collected within the Kwara Polytechnic campus.
- **Sample Collection:** Water samples were collected in clean, labeled bottles early in the morning, rinsed three times with the source water before final collection, then stored in a cold box and sent to the lab within 6 hours.
- **Measurement of Parameters:**
    - **pH and Conductivity** were measured on-site using digital meters.
    - **TDS and Turbidity** were analyzed in the laboratory using calibrated equipment.
    - **Hardness and Ion Concentrations (Ca^{2+}, Mg^{2+}, NO_3^-, Cl^-)** were measured using standard titration and spectrophotometric techniques (APHA, 2017).
- **Comparison with WHO/SON Standards:** Results were compared with acceptable limits to assess potability.

3.2 Tools Used

The following tools and instruments were utilized during sample collection and analysis:

- **TDS Meter:** For measuring dissolved solids in ppm.
- **Digital pH Meter:** For checking the hydrogen ion concentration of the water.
- **Spectrophotometer:** For precise chemical analysis of nitrates and other ions.

- **Titration Kit:** For determining hardness, calcium, and magnesium levels.
- **Cooler Box and Ice Packs:** For preserving sample integrity during transport.
- **Measuring Cylinders & Pipettes:** For accurate dilution and volume measurements during laboratory procedures.

These instruments provided high reliability in assessing water quality parameters relevant to human health and environmental safety (Zhang, 2003).

CHAPTER FOUR

4.0 Result and Discussion

Parameter	WHO/SON Standard	Borehole Water (Range)	Well Water (Range)	Discussion
Ph	6.5 – 8.5	6.8 – 7.4	6.2 – 6.8	Borehole samples mostly fall within the WHO acceptable range. Some well samples were slightly acidic, indicating possible organic contamination or proximity to waste sources. Acidic water may lead to corrosion and gastrointestinal issues.
Turbidity (NTU)	≤ 5 NTU	0.3 – 0.9	1.8 – 4.5	Borehole water showed excellent clarity. Elevated turbidity in well water suggests presence of suspended particles, which may harbor pathogens. This aligns with studies indicating well water is more prone to surface contamination (Orebiyi et al., 2010).
Electrical Conductivity (μS/cm)	≤ 1000	230 – 450	480 – 690	Conductivity levels in both sources are within acceptable limits, though well water displayed higher values, indicating higher mineral or ion content due to surface leaching.
TDS (mg/L)	≤ 500	150 – 290	420 – 510	Borehole water had moderate TDS, within limits. Some well water samples slightly exceeded the WHO limit, suggesting mineral leaching

				from surrounding soils or contamination. High TDS can affect water taste and usability.
Total Hardness (mg/L $CaCO_3$)	≤ 500	120 – 190	200 – 340	Well water displayed higher hardness, likely due to shallow depth and contact with mineral-rich soil. Hard water affects soap lathering and may cause scale buildup in pipes.
Calcium (mg/L)	≤ 75	25 – 48	50 – 85	Well water had elevated calcium levels, potentially from limestone or dolomite-rich soils. Borehole water remained within safer limits.
Magnesium (mg/L)	≤ 50	10 – 25	25 – 48	Higher magnesium levels in well water can contribute to hardness. Elevated levels may affect taste and have laxative effects.
Nitrate (mg/L)	≤ 50	15 – 32	38 – 65	Some well samples exceeded safe nitrate limits, raising health concerns such as methemoglobinemia in infants. Borehole samples were generally safe.
Chloride (mg/L)	≤ 250	22 – 68	58 – 110	Chloride content in both water sources was within safe limits, though slightly higher in well water. Excess chloride may give water a salty taste.

4.1 Summary of Discussion

The tabulated results clearly show that borehole water consistently outperforms well water in terms of physicochemical quality. Parameters like turbidity, nitrate, TDS, and hardness were higher in well water, indicating surface contamination and poor sanitary conditions near collection points.

These findings support prior literature such as Orebiyi et al. (2010) and Aremu et al. (2011), which identified wells as more vulnerable to pollutants from human activities.

Boreholes, being deeper and often better protected, presented values within WHO and SON standards, making them more suitable for drinking and domestic use. However, routine water quality monitoring is still essential to ensure long-term safety and catch any emerging risks.

CHAPTER FIVE

5.0 Conclusion and Recommendation

5.1 Conclusion

This study evaluated and compared the physico-chemical properties of well water and borehole water in Kwara State Polytechnic communities. The results revealed that while most borehole samples met World Health Organization (WHO) and Nigerian Standards for potable water, several well water samples showed elevated turbidity, nitrate, and total dissolved solids (TDS), indicating possible surface contamination and poor environmental sanitation.

The slightly acidic pH in some well samples and elevated nitrate levels suggest that open wells are more vulnerable to runoff, seepage from nearby waste disposal areas, and human activities such as improper waste management. In contrast, boreholes, which draw water from deeper aquifers, exhibited relatively safer and more stable physico-chemical properties.

Therefore, it can be concluded that although both water sources serve as crucial supplies within the Polytechnic, borehole water is generally safer for drinking and domestic use than hand-dug well water. Continuous monitoring and proper protection of groundwater sources are essential for maintaining public health and environmental sustainability.

5.2 Recommendation

Based on the findings of this study, the following recommendations are proposed:

1. All open wells within the Polytechnic community should be upgraded with secure covers and reinforced concrete linings to prevent contamination from surface runoff and environmental pollutants.

2. Periodic water quality testing of both wells and boreholes should be implemented to ensure that the water meets established safety standards by national and international health organizations.

3. The institution should initiate consistent sensitization programs to inform and educate students, staff, and residents about proper sanitation practices and the importance of consuming safe, clean water.
4. Individuals and households using well water should be encouraged to treat their water using simple methods such as boiling, chlorination, or the use of certified water filters before use.
5. The management of the Polytechnic should work closely with relevant environmental and health authorities to establish regular monitoring systems that ensure adherence to best practices in water safety across the campus.

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