

# Investigation of ground water quality in Bungudu and Nahuce towns

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## Abstract:

The aim of this research work is to determine the physical, chemical and heavy metals properties of some selected wells and boreholes in Bungudu and Nahuce towns in Zamfara state Nigeria. Local latrine pits are dug and used for defecation in these towns, most of these pits are found closer or less than 15m to water source as required by World Health Organization. Therefore, there is fear of water contamination, physical, chemical and heavy metals characteristics of borehole and well water of Bungudu Birnin Malan second Juma'a mosque, vartugufa Nasarawa and Nahuce, Sabon Gari, Juma'a mosque, Yarkaita and opposite Hospital Nahuce were investigated and found to be within the acceptable limits set by World Health Organization. All the physical parameters such as colour, odour, turbidity (0.01 to 2.65NTU) and temperature for both boreholes and wells were found to be within acceptable limits. The chemical parameters, i.e., pH (6.9 to 7.7) and nitrite (0.01 to 0.04mg/L) are also within the recommended range. Presence of heavy metals such as Aluminium (0.01 to 0.04mg/L), Zinc (0.01 to 0.09mg/L) and total hardness (71 to 200mg/L) are all within the range of acceptable concentration. Therefore, ground water from the study area can be used for human consumption, domestic used, food processing, fish farming, irrigation and industrial applications.

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## 1. Introduction

Water is a chemical compound that exists in nature by the formation and combination of the molecules of Hydrogen and Oxygen in atmospheric air, it is very important and used in diverse ways [1]. Water is one of the essential needs of mankind, without water life cannot be sustained on the earth. Therefore, great importance must be placed not only on quality but on the quality of this resource. Water is believed to be most essential element for survival of human and environment, it is also needed for satisfaction of basic needs [2]. Therefore, water is essential living and safe water is a human right. Despite the importance of safe drinking water, many people are left with unhealthy water for survival [3]. Drinking unhealthy water results in multiple death and serious illness among children in African countries.

Provision of safe clean water as well as clean environment are basic right of individuals for basic health. For drinking water and other domestic purposes, most of low-income communities in developing countries uses shallow ground water sources [4]. Human activities may have adverse effect on groundwater quality, depending on the nature of the contaminants and mode of discharge. The contamination of ground water may be none or very little due to human activities in some locations. But on the other hand, anthropogenic and natural factors may also affect its nature. Once pollution penetrates into sub surface environment, it remains in there for many years being dispersed over a wide areas of ground water. This in turn renders groundwater

unsuitable for human needs. Therefore, understanding the potential influences of human activity on ground water quality is important for protection and sustainable use of ground water sources [5]. Shallow wells may be found in the valleys where the groundwater table is relatively high, the source of recharge is infiltration of rain and river water [6].

Every human being required access to good quality and clean water for consumption, in this research, ground water quality of Bungudu and Nahuce areas was investigated to ascertain its quality for domestic use. The finding of this research could be used to determine the physical and chemical parameters of ground water from these areas to verify whether they are in conformity with WHO guidelines of drinking water quality. Consumers in these areas will be able to know the level of contamination and purity present in the water they used if there is any, which could be either microbial or organic agent or even due to human activities and environmental condition.

## 2. Methods

To achieve the aim of this research, several tests were conducted to determine physical, chemical and heavy metals characteristics of the water samples collected from study areas.

### 2.1 Sampling

The water samples used for this study were collected from Bungudu and Nahuce areas of Zamfara state in

Nigeria. In each area, four (4) bore hole and four (4) well water samples were collected from different location totalling to sixteen (16) sample for the study. Table 1 presents the locations of the collected samples in Bungudu and Nahuce areas. The volume of water collected for each sample was 1 litre in a much cleaned sample container.

Table 1: Bore hole and well water sample's locations

Town	Area	Borehole Water	Well Water
Bungudu	Nasarawa		Bungudu W1
	Yartugufa		Bungudu W2
	Birni Malan	Bungudu BH1	
	2 <sup>nd</sup> Juma,a	Bungudu BH2	
Nahuce	Yar Gaji		Nahuce W1
	Nahuce Hospital		Nahuce W2
	Sabon Garin Nahuce	Nahuce BH1	
	Juma'a Mosque	Nahuce BH2	

## 2.2 Physical tests

Testing the physical characteristics of a water sample is important to assess its quality and suitability for various purposes. World health organization (WHO) has set standards for a water to be fit for drinking. Therefore, it is important to ascertain the level of its suitability in terms of drinking and other domestic uses.

### 2.2.1 Colour Determination

Water in its pure form is colourless. However, a ground water can acquire colour from colloidal substances and materials in solution. Colour may occur due to the presence of humic acids, metallic ions, suspended matter, Iron and manganese. Colour test was conducted on all water samples collected from the sources. The following is the procedure used for colour determination by direct observation.

Colour of well and borehole was observed usually with the naked eye test procedure.

- A portion of the sample was filtered through a GF/B filter paper.
- Also a test tube was filled up to a volume of 10 ml
- A test tube with demonized water was also filled to 10 ml level and retained for use as the lank tube.
- The photometer reading was taken using the demonized water as blank

### 2.2.2 Temperature

Measuring the temperature of water is essential for various reasons, as it provides valuable information about the physical and chemical characteristics of the water. The temperature of water is a critical parameter that impacts numerous natural and human-related processes. The test was conducted using mercury in glass thermometer.

### 2.2.3 Turbidity Determination

Turbidity is defined as the optical property that will cause light to scattered and observed rather than transmitted in straight lines through a sample. Although turbidity is caused by material in suspension it is difficult to correlate it with the quantitative measurement of suspended solids in a sample, as the shape, size and restructure index

of the particles in suspension affect the light scattering property of a water sample [7].

The turbidity determination was conducted using Turbidity meter, the meter consists of convate (turbidity bottle). The water sample was poured in to a clean convate to the rim level and tight using provided cap. The convate's surface was wiped with a provided clean and soft material to remove water or dirt stains as well as finger prints. Then the convate was inserted in to the turbidity meter cell. A "Read" button was pressed and the result was displayed after about 30 second.

### 2.2.4 Odour Determination

Water in its pure form does not have any odour. Odour in water can be due to natural or manmade causes. Natural causes may include the presence of decaying plants, algae and other organisms in the water body. Decomposition of organic matter liberates gases such as ammonia, methane and hydrogen sulphide [8]. These gases impart odour to water. The Odour of each sample water was perceived by nostrils. A beaker was used to about  $\frac{3}{4}$  of the just collected water and smelled by three different persons.

## 2.3 Chemical tests

Chemical tests on water samples are crucial for assessing water quality and determining its suitability for various purposes, such as drinking, industrial processes, and environmental monitoring.

### 2.3.1 pH Determination

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and waste water treatment e.g., acid-base neutralization, water softening, precipitation, coagulation, disinfection and corrosion control are pH dependent [9]. At a given temperature the intensity of the acidic or basic character of a solution is indicated by pH. At certain pH value, coagulation cannot take place. The test was conducted using pH meter. The test was started by calibration of pH meter using buffer solution of known pH value, the water sample was then poured in to the pH meter bottle and pH electrode was inserted in to the bottle for pH determination. The pH value was the recorded, the procedure was repeated five times using the same water source.

### 2.3.2 Nitrate Determination

Determining nitrate levels in water is important for assessing water quality, especially in the context of environmental monitoring, drinking water safety, and agricultural practices [10]. The test was conducted using photometer.

## 2.4 Heavy Metals

### 2.4.1 Aluminum concentration determination

The concentration of aluminium in water can vary widely based on the water source, geographical location, and human activities in the surrounding area. Aluminium is a naturally occurring element, and its presence in water can

result from weathering of rocks, soil leaching, and anthropogenic activities [11]. High aluminium concentrations can be harmful to human aquatic life, particularly in freshwater ecosystems [12]. Lower aluminium levels help protect fish and other aquatic organisms from adverse effects such as reduced reproduction and impaired growth. This test was conducted on water samples collected from the study areas using Photometer.

### 2.4.2 Zinc concentration determination

This test was conducted on water samples collected from Bungudu and Nahuce areas of Zamfara state. High zinc levels in water can be toxic to human and aquatic life, particularly to fish and invertebrates [13]. Maintaining lower zinc concentrations helps protect aquatic ecosystems and biodiversity [14]. This test was conducted using Photometer.

### 2.4.3 Total hardness determination

Total hardness test was conducted on all water samples collected from the study area. Total hardness in water is a measure of the concentration of minerals, primarily calcium and magnesium ions [15]. It is an important parameter in water quality assessment and has implications for various applications. Total hardness is typically expressed in terms of milligrams per liter (mg/L) or parts per million (ppm) of calcium carbonate ( $\text{CaCO}_3$ ). Total hardness is commonly expressed in degrees of hardness, which can be classified as follows:

- Soft Water: 0 - 60 mg/L  $\text{CaCO}_3$
- Moderately Hard Water: 61 - 120 mg/L  $\text{CaCO}_3$
- Hard Water: 121 - 180 mg/L  $\text{CaCO}_3$
- Very Hard Water: Above: 180 mg/L  $\text{CaCO}_3$

The test was conducted using Photometer.

## 3. Results and Discussions

### 3.1 Colour and Odour

Colour and odour tests were conducted on all water samples collected in this study. Table 2 presents the result of colour and odour tests conducted on water samples collected for the study.

Table 2: Result of Colour and Odour tests

Water Sample	Colour	Odour
Bungudu W1	Colourless	Odourless
Bungudu W2	Colourless	Odourless
Bungudu BH1	Colourless	Odourless
Bungudu BH2	Colourless	Odourless
Nahuce W1	Colourless	Odourless
Nahuce W2	Colourless	Odourless
Nahuce BH1	Colourless	Odourless
Nahuce BH2	Colourless	Odourless

From Table 2, all the water samples tested were found to be colourless and test less. Therefore, based on WHO standard, both borehole and well water are fit for domestic use. Colourless and odourless water is desirable for its purity, acceptability, and versatility in various applications. It provides a positive and reassuring experience for consumers and reduces concerns related to water quality.

Ensuring water is free from colour and odour is a key objective in water treatment and management practices.

### 3.2 Turbidity

Turbidity test was conducted on all water samples collected. The result is presented in Table 3.

Table 3: Turbidity values for various sample analysis from Bungudu and Nahuce

Sample No	Turbidity	Standard Range
Bungudu W1	1.31	5 NTU
Bungudu W2	2.65	5 NTU
Bungudu BH1	1.93	5 NTU
Bungudu BH2	0.69	5 NTU
Nahuce W1	0.01	5 NTU
Nahuce W2	0.02	5 NTU
Nahuce BH1	0.02	5 NTU
Nahuce BH2	0.01	5 NTU

From Table 3, it is noted that the result of colour and odour test are generally consistent with the outcome of turbidity test in the sense that colourless and odourless water should be less turbid. The result also shows a very low turbidity which satisfied the WHO turbidity criteria for drinking water. As the water from the study area is Turbidity-free, the water could be used several applications. A turbidity free water can be used for human consumption, good for health and safety, good for aquatic ecosystem and can be best used for agricultural irrigation.

### 3.3 pH test

The pH test was conducted on all samples from study areas. The result is presented in Table 4.

Table 4: pH values Bungudu and Nahuce areas

Sample No	PH value	Standard Range
Bungudu W1	6.9	6.5 – 8.4
Bungudu W2	7.2	6.5 – 8.4
Bungudu BH1	7.7	6.5 – 8.4
Bungudu BH2	7.5	6.5 – 8.4
Nahuce W1	6.9	6.5 – 8.4
Nahuce W2	7.0	6.5 – 8.4
Nahuce BH1	7.01	6.5 – 8.4
Nahuce BH2	6.9	6.5 – 8.4

From Table 4, the values of all water samples are within the acceptable range provided by WHO for drinking water and other domestic purposes. As the water pH is within the recommended World Health Organization (WHO) standard it is of great benefits, as it contributes to the overall safety, usability, and ecological health of water resources. Extreme pH levels can indicate potential contamination or the presence of harmful substances, affecting human health.

### 3.4 Nitrate concentration

Nitrate test was conducted on all water samples collected from study areas, the result is presented in Table 5.

Table 5: Nitrate Concentration in Bungudu

Sample No	Nitrate level	Standard Range
Bungudu W1	0.040	0-3mg/l
Bungudu W2	0.010	0-3mg/l
Bungudu BH1	0.011	0-3mg/l
Bungudu BH2	0.013	0-3mg/l
Nahuce W1	0.02	0-3mg/l
Nahuce W2	0.04	0-3mg/l
Nahuce BH1	0.01	0-3mg/l
Nahuce BH2	0.03	0-3mg/l

From table 5, the nitrate concentration of water in both Bungudu and Nahuce are very low and within the recommended range by WHO. Lower nitrate concentrations in water offers various benefits for both human health and the environment. Excessive nitrate levels in drinking water, particularly above regulatory standards, can pose health risks. Lower nitrate concentrations ensure the safety of drinking water and reduce the risk of nitrate-related health issues, especially for infants.

### 3.5 Aluminium concentration

This test was conducted on water samples collected from Bungudu and Nahuce areas of Zamfara state. The result is presented in Table 6.

Table 6: Aluminium concentration of Bungudu and Nahuce water samples

Sample No	Aluminium concentration (mg/L)	Standard Range (mg/L)
Bungudu W1	0.02	0 – 0.9
Bungudu W2	0.04	0 – 0.9
Bungudu BH1	0.01	0 – 0.9
Bungudu BH2	0.03	0 – 0.9
Nahuce W1	0.01	0 – 0.9
Nahuce W2	0.02	0 – 0.9
Nahuce BH1	0.02	0 – 0.9
Nahuce BH2	0.01	0 – 0.9

From the result presented in Table 6, the aluminium concentration is within the acceptable range of 0 – 0.9mg/L provided by WHO. High aluminum concentrations in drinking water have been associated with neurotoxic effects. Lower aluminum levels help mitigate the potential health risks related to neurotoxicity. Elevated aluminum concentrations can be harmful to aquatic life, particularly in freshwater ecosystems. Lower aluminum levels help protect fish and other aquatic organisms from adverse effects such as reduced reproduction and impaired growth. Therefore, ground water in the study areas could be used for fish farming.

### 3.6 Zinc concentration

Zinc concentration determination was carried out on all water sample collected. The result is presented in Table 7.

From Table 7, the value of zinc concentration is within the recommended range provided by WHO for suitable water for drinking. High concentrations of zinc in drinking water can lead to adverse health effects. Lower zinc levels help mitigate potential health risks, including gastrointestinal

issues and impaired immune function. Excessive zinc in water can cause nausea and other gastrointestinal distress. Lower zinc concentrations help prevent waterborne diseases and discomfort associated with zinc ingestion.

Table 7: Zinc Concentration in Bungudu.

Sample No	Level of Zinc	Standard Range
Bungudu W1	0.2	0 – 5.0 mg/L
Bungudu W2	0.1	0 – 5.0 mg/L
Bungudu BH1	0.05	0 – 5.0 mg/L
Bungudu BH2	0.07	0 – 5.0 mg/L
Nahuce W1	0.09	0 – 5.0 mg/L
Nahuce W2	0.016	0 – 5.0 mg/L
Nahuce BH1	0.02	0 – 5.0 mg/L
Nahuce BH2	0.01	0 – 5.0 mg/L

### 3.7 Total hardness

Total Hardness test was conducted on water samples collected for this study. The result is presented in Table 8.

Table 8: Total hardness

Sample No	Total hardness (mg/L)	Standard Range (mg/L)
Bungudu W1	200	0 – 300
Bungudu W2	75	0 – 300
Bungudu BH1	80	0 – 300
Bungudu BH2	78	0 – 300
Nahuce W1	92	0 – 300
Nahuce W2	71	0 – 300
Nahuce BH1	96	0 – 300
Nahuce BH2	78	0 – 300

From table 8, the total hardness is within the recommended range provided by WHO for drinking water and domestic use. Lower levels of total hardness in water offers several benefits for various applications, including domestic use, industrial processes, and environmental conservation. Lower total hardness helps minimize the formation of scale in household appliances such as water heaters, dishwashers, and kettles. Scale build-up can reduce appliance efficiency and longevity. Therefore, the ground water in the study area is fit for all domestic use.

## 4. Conclusion

The physical, chemical and heavy metals characteristics of borehole and well water of Bungudu Birnin Malan second Juma'a mosque, vartugufa Nasarawa and Nahuce, Sabon Gari, Juma'a mosque, Yarkaita and opposite Hospital Nahuce are found to be within the acceptable limit set by World Health Organization. All the teste physical parameters for both boreholes and wells were found to be colourless and odourless. The chemical parameters, i.e. pH and nitrite are also within the recommended range. Presence of heavy metals such as Aluminium, Zinc and total hardness are all within the range of acceptable concentration. Therefore, ground water from the study area can be used for human consumption, domestic used, food processing, fish farming, irrigation and industrial application.



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