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Comparative Relationship between the Water Quality Parameters and Standard for Drinking in Jibia Dam, Katsina State

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ABSTRACT

A study was conducted on the water quality of Jibia Dam to evaluate its suitability for human consumption. The research aimed to compare the water quality parameters of the dam with international drinking water standards. Poor monitoring of water quality could result in pollution and pose significant health risks. Water samples were collected from three locations during the wet and dry seasons of 2019/2020, and 13 parameters were analyzed using standard laboratory methods. These parameters included temperature, pH, electrical conductivity, total dissolved solids, turbidity, total hardness, chloride, nitrate, dissolved oxygen, biological oxygen demand, ammonia, nickel, and lead. The study found that the mean values of the parameters were as follows: temperature (26.81°C), pH (6.99), electrical conductivity (116.95 µS/cm), total dissolved solids (96.52 mg/L), turbidity (30.60 NTU), total hardness (196.83 mg/L), chloride (96.15 mg/L), nitrate (13.41 mg/L), dissolved oxygen (62.04 mg/L), biological oxygen demand (45.93 mg/L), ammonia (11.93 mg/L), nickel (0.24 mg/L), and lead (0.13 mg/L). Among these, total hardness had the highest mean value (196.83 mg/L), while lead had the lowest (0.13 mg/L). The study also revealed that 46.15% of the parameters, including temperature, pH, dissolved oxygen, chloride, turbidity, and nitrate, met international drinking water standards. The findings highlight the need for further research on additional physicochemical parameters, particularly heavy metals, that were not included in this study. This will provide a more comprehensive assessment of the water quality in Jibia Dam.

Key words: Water, Quality, Parameter, Standard, Drinking

INTRODUCTION

The increasing concentrations of environmental heavy metals can be attributed to various anthropogenic and natural activities (Khan & Ara, 2021). This issue is particularly critical in developing countries where environmental regulations and monitoring are often inadequate (Chowdhury et al., 2016). Numerous studies have investigated the sources, distribution, and potential risks of heavy metals in sediments, soil, water, and agricultural products, particularly in rapidly developing regions (Junianto et al., 2017; Mortuza & Al-Musnad, 2017; Mahfuza et al., 2017). Heavy metals are persistent environmental pollutants with long biological half-lives and the capacity to bioaccumulate in food chains, posing serious health risks when consumed in excess (Haware & Pramod, 2011). Bempah et al. (2011) identified several sources of heavy metal toxicity, including industrial discharges, fertilizers, metal-based pesticides, contaminated irrigation water, and post-harvest handling practices such as transportation and storage. These metals primarily affect the brain and kidneys, but they can also lead to conditions such as hypertension from lead exposure, carcinogenic effects from arsenic, and kidney toxicity from cadmium (Gottipolu et al., 2012). Water, as a critical resource for agriculture, industry, and human sustenance, plays a key role in sustainable development. However, rapid urbanization, population growth, and limited financial resources often force people in developing countries to rely on substandard water sources, compromising public health and sustainability. The lack of access to clean water and the contamination of freshwater supplies leave many urban and rural communities without safe drinking water (Yaradua et al., 2022). To mitigate the adverse effects of heavy metals on the environment and human health, consistent monitoring of heavy metal levels in water and other media is essential (Ganeshamurthy, 2008).

Jibia Dam act as for irrigation, fishing and drinking/ domestic use. However, the growing pressure from agricultural runoff, domestic waste, and human activities results serious threats to the water quality. Poor water quality can negatively affect human health which are crucial for drinking. Increase addition of materials or energy to the Dam, makes the water unfavourable for life and leads to chronic or acute illness to the human health. Despite the importance of Jibia Dam comprehensive studies on its water quality remain scarce. Monitoring water quality parameters, such as dissolved oxygen, pH, temperature, turbidity, and contaminant levels, is essential to determine the dam’s ability to sustain human for drinking. Additionally, evaluating the levels of

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pollutants and their sources is necessary to mitigate risks to human biodiversity and public health. The research seeks to compare the relationship between the water quality parameters and standard for drinking in Jibia Dam, Katsina State. It will address how physical, chemical, and biological water quality parameters impact human health. This study were contribute to understanding the environmental challenges facing the dam and provide data for the sustainable management. The result were compared with Food and Agriculture Organisation (FAO) (2006) threshold safe limits, providing stakeholders with the necessary information to take appropriate actions. However, limited research has been conducted on assessing water quality of Jibia Dam on human health. The findings from this study will determine whether the water consumed by residents of Jibia Dam, Katsina state are contaminated.

METHODOLOGY

Study Area: Jibia Dam, constructed between 1987 and 1989, was developed to support irrigation activities in Jibia Local Government Area (LGA) of Katsina State, located in northwestern Nigeria near the Maradi region of the Niger Republic. Jibia Town lies approximately 43 kilometers west of Katsina Town, with coordinates ranging between latitudes 13°04'18"N and 13°10'N, and longitudes 07°15'06"E and 07°30'E (Fig. 1). The study on Jibia Dam was carried out between 2019 and 2020.

Sampling points:Three sampling points were selected within the dam (Fig. 1), representing the upstream, middle, and downstream sections. 35-meter interval was maintained between each sampling station, following the method outlined by Warish et al. (2017).

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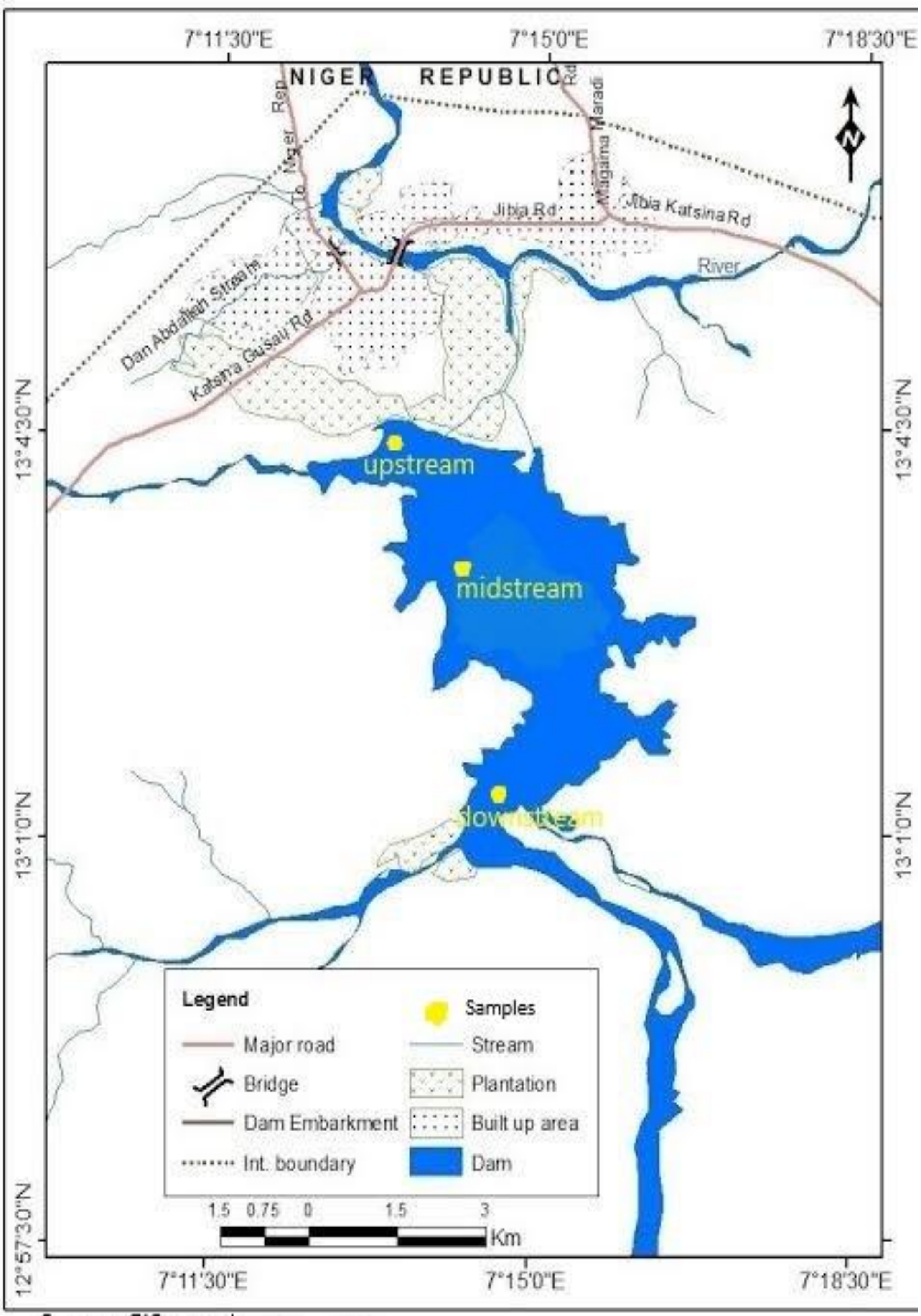

Source: GIS expert

Fig. 1: Map of the study area showing the sampling points

Determination of physiochemical parameters:

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Temperature was measured in situ using a calibrated digital thermometer, the probe was immersed directly into the water at each sampling location, and the reading was recorded immediately APHA (2017). pH was determined using a pH meter, the pH meter was calibrated with standard buffer solutions (pH 4.0, 7.0, and 10.0), the electrode was then rinsed with distilled water, immersed in the water sample, and the pH value recorded APHA (2017). Electrical Conductivity (EC) was measured using a conductivity meter, after calibration, the probe was rinsed with deionized water, submerged in the sample, and the reading was recorded in microsiemens per centimeter (µS/cm) WHO (2017). Total Dissolved Solids (TDS) was measured using a TDS meter or calculated from EC values, the TDS meter was immersed in the sample, and the reading was recorded in milligrams per liter (mg/L), alternatively, TDS was calculated as $TDS = EC \times 0.67$ (for freshwater) APHA (2017).Turbidity was determined using a nephelometer, the sample was placed in a turbidity cell, and the instrument measured turbidity in nephelometric turbidity units (NTU) APHA (2017).Total Hardness was determined using titrimetric method using EDTA (ethylenediaminetetraacetic acid), a known volume of the water sample was titrated with EDTA using Eriochrome Black T indicator until the endpoint (color change) was reached APHA (2017). Chloride was determined using Argentometric titration using silver nitrate, the sample was titrated with silver nitrate using potassium chromate as an indicator until a reddish-brown precipitate formed APHA (2017). Nitrate (NO_3^-) was determined using Spectrophotometric method, A color reagent was added to the water sample, and the absorbance was measured at a specific wavelength using a spectrophotometer. The nitrate concentration was calculated from a calibration curve Hach (2002). Dissolved Oxygen (DO) was determine using Winkler's titration method, Manganese sulfate and alkaline potassium iodide reagents were added to the sample. The formed precipitate was titrated with sodium thiosulfate, and DO concentration was calculated APHA (2017). Biological Oxygen Demand (BOD) using Five-day incubation method, the initial DO was measured. The sample was incubated in the dark at 20°C for five days, and the final DO was measured. The difference between initial and final DO values indicated the BOD APHA (2017). Ammonia (NH_3) was determined using Nesslerization, Nessler's reagent was added to the sample, and the resulting color intensity was measured spectrophotometrically at 425 nm APHA (2017). Nickel (Ni) Atomic Absorption Spectrophotometry (AAS)

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was used the water sample was acid-digested, and the nickel concentration was measured using AAS at its characteristic wavelength APHA (2017). Lead (Pb) using Atomic Absorption Spectrophotometry (AAS), the water sample was acid-digested, and the lead concentration was measured using AAS at its characteristic wavelength APHA (2017) adopted from (Ibrahim, 2022).

FINDINGS

Comparisons of physicochemical Parameters with International Standard

Mean value of Temperature (^{0}C) in Jibia Dam was found to be 26.81^0 C (Table 1). The value is within the international standard which is 25^{0}C-30^{0}C - FAO (2006), (Table 9), due to climatic nature of the environment. The result is substantiated with the work of Abba *et al*., (2018) result shows temperature value was within the accepted range. The pH mean value in Jibia Dam was found to be 6.99 (Table 1). The value is within the international standard which is 6.0-9.0 - FAO (2006) (Table 1) due to balance of carbon dioxide in the Dam and exchangeable ions that result to pH balance. The result is substantiated with the work of Tasiu and Dabo, (2017) result shows pH value was within the accepted range.

Electrical Conductivity (EC) mean value was found to be 116.95µs. the value is below the international standard which is 150µs-200µs. FAO (2006) (Table 1) due to instability of organic salt in the Dam, the EC needs to be increase in order to meet the recommended range. The result is varied with the work of Abba *et al*., (2018) result shows Electrical Conductivity (EC) value was within the accepted range.

The Total Dissolve Solid (TDS) mean value was found to be 96.52mg/l and the value is above the international standard which is not exceed 0.13mg/l (Table 1) due to geology of the area and salt from irrigation contribute to the TDS load. The Total Dissolve Solid (TDS) needs to be decrease to meet the recommended range. The result is varied with the work of Jenyo and Oladele, (2016) which shows the Total Dissolve Solid (TDS) value was within the accepted range.

The Turbidity (Tur.) mean value was found to be 30.60NTU due to attractive bond forces and transportation of turbidity plume. The value is within the international standard which is 30NTU 80NTU FAO., (2006) (Table

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1). The result is varied with the work of Abba *et al.*, (2018) which shows the turbidity of the Dam is high specifically at rainy season.

The Total Hardness mean value was found to be 196.83mg/l. The value is above the international standard which is 75mg/l- 150mg/l. FAO (2006) (Table 1), due to water in the Dam that percolates through deposits of limestone, chalk/gypsum. The Total Hardness (TH) needs to be reduce to meet the recommended range. The result is varied with the work of Jenyo and Oladele, (2016) which shows the Total Hardness is below the international standard.

Chloride (Cl) mean value was found to be 96.15mg/l. The value is within the international standard which is not exceed 250mg/l. FAO (2006) (Table 1), due to atmospheric deposition from precipitation and aerosols, leaching of rocks, dissolution of evaporate sediments and domestic waste. The result is similar with work of Apollos *et al*., (2016) which is also within the acceptable international standard for fish farming.

Nitrate (NO_3) mean value was found to be 13.41mg/l. The value is within the international standard which is 0mg/l- 100mg/l FAO (2006) (Table 1). Result originates from fertilizers and septic systems that is not taken up by plants carried away by surface runoff leaches to the groundwater in the form of nitrate. The result is similar with work of Apollos *et al*., (2016) which is also within the acceptable international standard for fish farming.

Dissolved Oxygen (DO) mean value was found to be 62.04mg/l. The value is within the international standard which is 6mg/l and above Warish *et al*., (2017) (Table 1). This result is due to portable temperature and dissolved gases that control other physical characteristic of the water as well as chemical reactions. The result is similar with work of Agbaire *et al*., (2015) which is also within the acceptable international standard for fish farming.

Biological Oxygen Demand (BOD) mean value was found to be 45.93mg/l. The value is above the international standard which is 3mg/l-20mg/l FAO (2006), Biological Oxygen Demand (BOD) needs to be reduce to meet the recommended range (Table 1) because of leaves, dead plants and animals and animal

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manures in the Dam. The result is differed with work of Agbaire *et al*., (2015) which is within the acceptable international standard for fish farming.

Ammonia (NH_3) mean value was found to be 11.93mg/l. The value is above the international standard which is below 0.02mg/l FAO (2006). The ammonia (NH_3) needs to be reduce to meet the recommended range. (Table 1). Ammonia result because of natural byproduct of fish metabolism. The result is differed with the work of Rilwanu and Dabo (2017) result shows Ammonia (NH_3) value was within the accepted range.

Nickel (Ni) mean value was found to be 0.24mg/l. The value is slightly above the international standard which is ≤0.20 FAO (2006) (Table 1). Due to moderate pentlandite, garnierite and limonite. Nickel (Ni) needs to be reduce to meet the recommended range in the study area. The result is substantiated with the work of Ekrem and Arzu, (2017) result shows Nickel (Ni) value was highly above acceptable range.

Lead (Pb) mean value was found to be 0.13mg/l, the value is slightly above the international standard which is 0.10 and below FAO (2006) (Table 1) due to use fossil fuels and past use of leaded gasoline. Lead (Pb) needs to be reduce to meet the recommended range. The result is substantiated with the work of Ekrem and Arzu, (2017) which shows Lead (Pb) value was highly above acceptable range.

The analysis reveals that (TH) recorded the highest value among all the parameters across the thirteen (13) samples, with an average concentration of 196.8mg/l while Lead (Pb) had the lowest average value at 0.1mg/l (Table 1). Additionally, only 46.15% of the parameters, including (T), pH, (DO), (CL), (TUR.) and (NO_3), met international standards. Consequently, the water is deemed unsuitable for drinking. Therefore, the water is not favourable for drinking

Table 1. Compared the Mean Values with FAO (2006) standard of fishing water quality

Parameters	**Unit**	**Mean Value**	**International standard**
Temperature	^0C	26.81	25-30
Electrical conductivity (EC)	µS	116.95	150-200

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pH	-	6.99	6.0-9.0
Dissolved oxygen (DO)	Mg/L	62.04	6.0 and above
Biological oxygen Demand (BOD)	Mg/L	45.93	3-20
Chloride (CL)	Mg/L	96.15	Not exceed 250
Ammonia (NH_3)	Mg/L	11.93	Below 0.02
Total Dissolved Solid (TDS)	Mg/L	96.52	Not exceed 0.13
Turbidity (TUR.)	NTU	30.60	30- 80
Total hardness (TH)	Mg/L	196.83	75- 150
Nitrate (NO_3)	Mg/L	13.41	0- 100
Nickel (Ni)	Mg/L	0.24	0.2- Below
Lead (Pb)	Mg/L	0.13	0.1- Below

Source FAO., 2006

CONCLUSION

Among all the parameters analyzed the finding shows that Total Hardness (TH) has the highest value in all the thirteen (13) samples with mean value of 196.8mg/l and Lead (Pb) in the study shows the lowest value with mean value of 0.1mg/l (Table 1). The finding also shows that only 46.15% of the parameters were within international standards which is Temperature, pH, Dissolved oxygen (DO), Chloride (CL), Turbidity (TUR.) and Nitrate (NO_3). Therefore, the water is not favourable for drinking

RECOMMENDATIONS

The assessing water quality necessitated the introduction current water status in the Dam which will help stakeholders and fisher men an awareness about its quality and guiding efforts to bring it to acceptable standard based on established criteria. Further research is recommended to investigate additional physicochemical parameters not covered in this study, such as various heavy metals.

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