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Physico-Chemical Assessment On The Quality And Suitability Of Ajiwa And Zobe Dams Water For Consumption And Agricultural Purposes

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ABSTRACT
This study assesses the physico-chemical parameters of Ajiwa and Zobe dam's water with the aid of determining their quality and suitability for consumption and agricultural uses. Water samples were collected for the period of six weeks, starting from the first week of May in the year, 2023. A total of nine (9) samples were collected from each dam, three samples each from three different points of the dams which were analyzed for some physico-chemical parameters (Temperature, pH, Total dissolved solids, Dissolved oxygen, Biochemical oxygen demand, nitrates, phosphates, calcium, magnesium and chlorides) using Standard Methods. The pH was recorded for Ajiwa dam as 6.933 ± 0.11 while at Zobe dam it was 6.97 ± 0.61. The TDS was 735.83 ± 42.69 mg/L and 708.17 ± 87.70 mg/L, DO (mg/L): 8.71± 1.65 and 7.19 ± 0.82, BOD (mg/L): 22.1 ± 3.65 and 23.65 ± 5.80, NO-3 (mg/L): 13.22 ± 6.95 and 11.58 ± 5.07, PO4 (mg/L): 2.40 ± 0.81 and 3.24 ± 0.67, Ca (mg/L): 109 ± 15.86 and 105 ± 17.78, Mg (mg/L): 47.67 ± 25.10 and 72.33 ± 17.25:, Cl- (mg/L): 65.67 ± 8.82 and 61.17 ± 24.02 for Ajiwa and Zobe dams respectively. Each parameter was compared with the standard desirable limit for drinking water as prescribed by World Health Organization (WHO) and required limits for irrigation water as prescribed by Food and Agricultural Organization (FAO). Based on the analysis conducted, most parameters analyzed were above the desirable limit and therefore the water from the two dams are unsafe for drinking, domestic purposes and agricultural practices without some forms of physical and chemical treatments.

Keywords: Water, Physicochemical analysis, Ajiwa dam, Zobe dam, BOD

INTRODUCTION
Water is pivotal to both natural ecosystems and human development. It is important to all living organisms, most ecological systems, human health, food production and economic development (Gebreyohannes *et al.,* 2010). Water is essential for various activities such as drinking, cooking, industrial, agricultural and recreational purposes. In the human body, it is also used in transporting nutrients, dissolving organic matter and replenishing nutrients while carrying away waste materials as such the public health significance of water quality cannot be over emphasized (Jayalakshmi *et al*., 2011).
Dams are manmade water bodies, primarily constructed for the supply of portable water, farming and irrigation practices. Human activities and settlement hinge on the availability of water. Owing to increasing industrialization and exploding population, the demand of water supply have been increasing tremendously (Mastoi *et al.,* 2014). In most developing countries, the water supplied to households, commerce and industry does not meet drinking water standards, even though only a very small proportion is actually consumed or used in food preparation. More than 3.4 million people die each year from water, sanitation, and hygiene-related causes. Nearly all deaths, 99 percent, occur in the developing world (Udoessien, 1997). UNDP also reported that the water and sanitation crisis claims more lives through

disease than any war claims through guns (WHO, 2008). Thus the quality as well as quantity of clean water supply is of vital significance for the welfare of mankind (Gebreyohannes *et al.*, 2010).

Apart from the use of surface water such as dams, lakes and rivers for drinking purposes, use of surface water for agricultural purpose without any treatment is common practice in our country. Some crops, and especially the vegetables, grown on such type of water may contain toxic chemicals. The consumption of such type of vegetables grown on untreated water, are very harmful for consumers due to high quantity of toxic substance accumulated in their tissues. Contaminated water harbor the growth of harmful enteric microorganisms that causes diseases such as diarrhea, cholera and typhoid fever (FAO, 1997).

The deterioration of water quality has led to the destruction of ecosystem balance, contamination and pollution of ground and surface water resources. Water quality degradation world-wide is due to many anthropogenic activities which release pollutants into the environment thereby having an adverse effect upon aquatic ecosystems (Gebreyohannes *et al.*, 2010). Quality of water can be regarded as a network of variables such as pH, oxygen concentration, temperature, etc, and any changes in these physical and chemical variables can affect aquatic biota and human populations that rely on it in a variety of ways (Kolawole *et al*., 2011). Since the quality water is directly related to health, it is therefore very essential to test the quality of the water before it is used for drinking, domestic, agricultural or industrial purposes.

Ajiwa dam and Zobe dam were constructed primarily for the supply of portable water to Katsina and Dutsinma towns and their environs respectively. Apart from that, the two water bodies are employed for the purpose of farming, irrigation and fishing. Therefore, there is a need for continuous monitoring of the pollutants load in the two water bodies so as to safeguard public health threats from using their water. Thus, the present paper tries to focus on the physicochemical quality of Ajiwa and Zobe dam in Katsina State of Nigeria.

Study Area

Ajiwa dam is in Katsina State, Nigeria. It was constructed in the year 1973, primarily for portable water supply to Katsina and surrounding villages. The dam is a large reservoir with great aquaculture potentials. The Ajiwa dam lies between latitude (12° 54'N to 13° 00'N and longitude 07° 43'E to 07° 47'E).

Zobe dam is in Dutsin-ma Local Government Area of Katsina State. It is an earth-fill dam with a height of 19m and a total length of 2,750m. The dam has a storage capacity of 179mca and irrigation potential of 8,000 hectares. Zobe dam was conceived in the late 1970s and was planned to supply 50% of drinking water for Katsina State while also supporting irrigation farming in the Dutsinma area (Muyideen, 2010).

Sample Collection

Water sample was collected for the period of six weeks starting from the first week of May in the year 2023 from the two dams. On each sampling day, a total of nine (9) water samples were collected, three samples each from three different points of the dams. At each point, a composite mixture was made from the three samples collected. Pre-cleaned 2 liter plastic sampling bottles were used. At each sampling point, the bottles were rinsed three (3) times with the water before collection (APHA, 2005). All the samples were taken to laboratory and the analysis was carried out within 21 days (Majiya *et al.*, 2015).

Water Quality Analysis

The water quality parameters were analyzed using standard analytical methods (APHA, 2005). The temperature of each sample was measured in-situ using mercury in glass thermometer calibrated in degree celsius. pH was determined using digital pH meter standardized with buffer solutions pH 4 and 9. TDS was measured using TDScan (Waterproof Series) meter, Dissolved oxygen was determined using Hach Multimeter (Hach Lange, NV). Biological oxygen demand (BOD) was measured based on oxygen consumed in a 5-d test period (5-d BOD or BOD_5) (APHA, 2005). Nitrates and phosphates were obtained using Model (Jenway 720 visible spectrophotometer). Standard laboratory methods as described by the APHA (2005) for the examination of water samples were employed for the analysis of calcium, magnesium and chlorides. All measurements were completed in triplicate and the mean values recorded (Gebreyohannes *et al.,* 2010).

Statistical Analysis

Mean concentrations and standard deviations were calculated for each of the parameters. Comparison of statistical differences between the studied parameters of the two dams was achieved using 2-sample T-test. All the analyses were conducted using SPSS 20 Statistical Software. The means of the parameters were compared with relevant International and National standards and appropriate deductions were made (FAO, 1997; WHO, 2008)

RESULTS AND DISCUSSION

Table 1: Physicochemical Analysis of Ajiwa Dam for the period of six weeks

Period	Temp (°C)	pH	TDS (mg/L)	DO (mg/L)	BOD (mg/L)	NO_3 (mg/L)	PO_4 (mg/L)	Ca (mg/L)	Mg (mg/L)	Cl (mg/L)
Week 1	21.2	7.05	691	5.92	23.2	5.7	1.87	131	29	76
Week 2	23	6.78	723	8.96	21.2	8.3	1.92	123	19	59
Week 3	24.52	7.02	731	8.61	25.9	21	1.34	102	53	72
Week 4	24.3	7	698	10.93	26	18.4	3.42	91	42	72
Week 5	19.3	6.83	801	9.53	19.5	19	2.83	112	94	54
Week 6	18.93	6.92	771	8.32	16.8	6.9	3	95	49	61
Mean	21.88	6.933	735.83	8.71	22.1	13.22	2.40	109	47.67	65.67

Table 2: Physicochemical Analysis of Zobe Dam for the period of six weeks

Period	Temp. (°C)	pH	TDS (mg/L)	DO (mg/L)	BOD (mg/L)	NO_3 (mg/L)	PO_4 (mg/L)	Ca (mg/L)	Mg (mg/L)	Cl (mg/L)
Week 1	20	7.36	750	7.55	23	7.2	2.54	101	67	48
Week 2	19.51	7.09	801	6.98	30	21.2	3.1	121	82	78
Week 3	20.91	6.01	795	5.87	31.2	8.3	2.78	98	71	56
Week 4	22.6	7.8	687	7.5	17.3	12.4	4.1	132	65	58
Week 5	18.45	6.84	612	8.32	18.4	11.1	4.04	86	49	98
Week 6	24.56	6.72	604	6.91	22	9.3	2.87	92	100	29
Mean	21.01	6.97	708.17	7.19	23.65	11.58	3.24	105	72.33	61.17

Table 3: Comparison of Physicochemical Parameters of Zobe and Ajiwa Dams with WHO and FAO Standards

Sn	Parameter	Ajiwa Dam	Zobe Dam	WHO Standard	FAO Standard
1	Temp (°C)	21.88 ± 2.46	21.01 ± 2.23	31.2 - 32.0	-------
2	pH	6.933 ± 0.11	6.97 ± 0.61	6.5 - 7.0	6.0-8.5
3	TDS (mg/L)	735.83 ± 42.69	708.17 ± 87.70	500	2000
4	DO (mg/L)	8.71± 1.65	7.19 ± 0.82	5.0-7.0	>4.0
5	BOD (mg/L)	22.1 ± 3.65	23.65 ± 5.80	2.0-5.0	8
6	NO_3 (mg/L)	13.22 ± 6.95	11.58 ± 5.07	0.30 - 4.60	50
7	PO_4 (mg/L)	2.40 ± 0.81	3.24 ± 0.67	0.1	2
8	Ca (mg/L)	109 ± 15.86	105 ± 17.78	100	800
9	Mg (mg/L)	47.67 ± 25.10	72.33 ± 17.25	120	120
10	Cl (mg/L)	65.67 ± 8.82	61.17 ± 24.02	250	400

DISCUSSION

Temperature: The mean of the temperature of the water sample from Ajiwa Dam was recorded as 21.88 ± 2.46°C while that of Zobe dam was recorded to be 21.01 ± 2.23°C. The temperature values fall within the acceptable temperature limit for drinking water set by WHO (31.2-32°C). The findings also indicated that at 95% confidence level, there is significant difference between the calculated temperatures of the two dams. Similar result was reported by Adeyemi and Ipinjolu, (1997). Temperature values are known to be dependent on climatic conditions at a particular geographical area and period of the day and therefore can be different from the ones reported.

pH: Test for pH of water was carried out to determine whether it is acidic or alkaline in nature. The tests reveal the pH values of 6.933±0.11 and 6.97±0.61 for Ajiwa and Zobe dams respectively. The mean values obtained for the two dams are within the range of 6.5-7.0 as recommended by WHO (2008) for drinking water and are also within the range of 6.0-8.5 as recommended by FAO (1997) for irrigation water. The finding also indicates that at 95% confidence level, there is no significant difference between the calculated pH values of the two dams. Although, the values indicate that the water samples are weakly acidic which is in agreement with what was reported by other researchers in similar study (Edimeh *et al.*, 2011; Aremu *et al.*, 2011; Igwemmar *et al*, 2013)?

Total Dissolved Solids (TDS): In the present study, the values for TDS at the two dams are 735.83 ± 42.69 mg/L and 708.17 ± 87.70 mg/L for Ajiwa and Zobe dams respectively. In both case, the values recorded exceeded the maximum permissible limits of WHO for drinking purpose and lower than the limit given by FAO for irrigation water (FAO, 1997; WHO, 2008). A significant difference between the calculated TDS values of the two dams was observed at 95% confidence level. Similar results for TDS were reported by other researchers (Aremu *et al.*, 2008; Jabbo *et al.*, 2012). Higher TDS can be toxic to aquatic life through increase in salinity or changes in the composition of the water and can harbor the growth of harmful microorganism rendering the source of water unfit for consumption. Primary sources for higher TDS in the dams might be due to agricultural runoff, discharge of domestic waste from the town and other human activities (Annalakshmi and Amsath, 2012).

Dissolved Oxygen (DO): Dissolved oxygen is essential for aquatic life, however, decomposing organic matter, dissolved gases, industrial wastes, mineral wastes and agricultural runoffs results in lower DO levels (Srivastava *et al*., 2011; Addo *et al*., 2013). Concentration levels of DO below 5.0 mg/L adversely affect aquatic life (Sinha and Biswas, 2011). DO values in the present study are 8.71± 1.65 mg/L for Ajiwa dam and 7.19 ± 0.82 mg/L for Zobe dam which is suitable for life of the aquatic ecosystem. The findings also indicated that at 95% confidence level, there is significant difference between the two dams and are within the permissible limits set by WHO and FAO (FAO, 1997; WHO, 2008).

Biochemical Oxygen Demand (BOD): The observed BOD values for Ajiwa dam is 22.1 ± 3.65 mg/L while that of Zobe dam is 23.65 ± 5.80 mg/L. The BOD of the two water bodies exceed the permissible limit for drinking water set by WHO and FAO standard for irrigation water (FAO, 1997; WHO, 2008). At 95% confidence level, significant difference was observed between the calculated BOD of the two dams. High BOD might be as the result of agricultural fertilizers brought by the runoff. High BOD also encourages the growth of harmful microorganisms.

Nitrate: The concentration of nitrates in water samples depends on the nitrification activities of micro-organisms (Igwemmar *et al.*, 2013). The results of nitrate from Ajiwa dam was recorded as 13.22 ± 6.95 mg/L while that of Zobe dam 11.58 ± 5.07 mg/L. The values are higher than the permissible limit for drinking water set by WHO (0.30 - 4.60 mg/l) but are well below the 50mg/L permissible level set by FAO for irrigation water (FAO, 1997; WHO, 2008). The findings also indicated that at 95% confidence level, there are no significant differences between the calculated nitrates of the two dams. In general, vegetables are the main source of nitrates intake when level in drinking water is below 10 mg/l. Makhijani and Manoharan (1999) reported high level of nitrates in drinking water due to excessive use of agricultural fertilizers, decayed vegetable water, domestic effluents, sewage disposal, industrial discharges, leachable from refuse dumps, and atmospheric precipitation has become a serious problem in both rural and urban areas.

Phosphate: The standard deviations and mean phosphate concentrations of each of the two dams are higher than the limits set by WHO for portable drinking water and are also higher than the limit set by FAO for irrigation water (FAO, 1997; WHO, 2008). The finding also indicates that at 95% confidence level, a significant difference exists between the calculated phosphates of the two dams. The observation is also in agreement with the findings of Aremu *et al.*, (2008).

Calcium and Magnesium: The value of calcium was found as 109 ± 15.86 mg/L from Ajiwa Dam and 105 ± 17.78 from Zobe dam. The values are higher than 100 mg/L recommended by WHO and lower than the limit set aside by FAO for irrigation water (FAO, 1997; WHO, 2008). Excess calcium contributes to formation of kidney and bladder stones. Aremu *et al.* (2008) reported that calcium and magnesium are predominant minerals in surface and ground water. Calcium also contributes to the hardness of water and may cause problems with laundering, washing and bathing. The Mg concentrations from Ajiwa and Zobe dam lie within the prescribed limit of WHO (2008) and FAO (1997). Similar case was reported by (Gebreyohannes *et al.,* 2015).

Chlorides: Chlorides in the water bodies such as dam result from the leaching of chloride-containing rocks and soils with which the water comes in contact. The standard deviations and mean values obtained in the samples from the two dams are within the limits set by WHO (2008) for drinking water and FAO for irrigation water. The findings also indicate that at 95% confidence level, there is significant difference between the calculated chlorides of the two dams. Chlorides are the most stable components in water and their concentration is largely unaffected by most natural physico-chemical and biochemical processes. Hence the value of its concentration is a useful measure in water sample.

CONCLUSION

Some of the parameters studied from Ajiwa and Zobe dam’s water of Katsina State were found above the recommended limit of standards for drinking and irrigation water set by WHO and FAO (FAO, 1997; WHO, 2008). Other parameters such as nitrate, Ca, Mg and Cl are within the acceptable limits. Higher BOD, TDS, nitrates and phosphates indicate the presence of fertilizer application by farmers in the two studied area which encourages plants growths thus further deteriorating the water quality as a result of their decomposition. It is also important to note that increase in the concentration of the total dissolved solids and biochemical oxygen demand, encourages the growth of harmful microorganisms in water. Therefore, based on the parameters analyzed, the water from the two dams was concluded to be unsafe for drinking and domestic purposes without some forms of physical and chemical treatments. However, based on the range of the parameters present, the water bodies may be utilized for agricultural purposes if the agricultural product produced would be carefully washed and sanitized before consumption.

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