



**ANALYSIS OF SEASONAL VARIATION ON
PHYSICO-CHEMICAL PARAMETERS OF GANGAMA DAM, JIGAWA STATE, NIGERIA**

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ABSTRACT

The study analyzed the physico-chemical parameters of Gangama Dam, Gwaram, Jigawa State, Nigeria, over a period of 12 months (July 2023–June 2024). Monthly water quality assessments included temperature, turbidity, pH, dissolved oxygen, electrical conductivity, total dissolved solids, phosphorus, and nitrogen using portable instruments, while dissolved carbon dioxide, ammonia, and biological oxygen demand were measured in laboratories. The lowest mean water temperature ($17.40 \pm 0.60^\circ\text{C}$) was recorded at Station C in January, while the highest ($28.5 \pm 0.43^\circ\text{C}$) occurred at Station B in May. Turbidity ranged from 16.52 ± 0.33 cm (April) to 73.45 ± 7.23 cm (March). The highest depth (6.66 ± 0.85 cm) was recorded in September. pH values varied from 6.2 ± 0.52 (June) to 8.9 ± 0.33 (December). Dissolved oxygen peaked at 7.67 ± 0.77 mg/L (April) and dropped to 3.50 ± 0.66 mg/L (October). Significant monthly variations ($P < 0.05$) were observed in some parameters. While most values fell within permissible limits, certain parameters showed notable correlations. The study recommends the preventing of pollution by avoiding disposal of chemicals and toxic substances into the dam.

Keywords: Analysis, Physico-Chemical, Parameters, Variation

INTRODUCTION

Life on earth, all living organisms depend on water for their survival (Smitha, *et al.*, 2007). Thus, fish perform all their bodily function in water. Because fish are totally dependent upon water for feed and growth, maintain salt balance and reproduction, understanding the physical and chemical qualities of water is critical to successful aquaculture. To a great extent water determines the success or failure of an aquaculture operation. Fresh water bodies are important wetlands located in and around human habitations as they are generally semi natural ecosystems constructed by man in landscape suitable for water stagnation (Yadav, *et al.*, 2013). The quality of water for fish and other aquatic resources as well as for human's use is essential. Contaminants such as biotic factors (e.g. bacteria, fungi, viruses etc) and abiotic factors (e.g. alkalinity, calcium, magnesium, nitrogen etc.) have polluted water as a result of inadequate treatment and disposal of water by humans, livestock, industrial discharges, domestic discharges and extensive use of limited resources (Onwughara, *et al.*, 2013). West African inshore water is rich in fish resources in quantities that can support commercial exploitation on a sustainable basis. However, later development in fisheries studies has pointed to the depletion of the fish stock due to over exploitation, deterioration of water qualities among others. Water quality is one of the most important components to the ecosystem. Better quality of water is described by its physical, chemical and biological characteristics. Understanding lakes physical, chemical and biological properties is essential to determining the lakes condition and gathering information for lake management decision. Water quality monitoring is an important component of lake stewardship activities. It provides a scientific basis for understanding lake characteristics and how activities around the lake may impact water quality, and can determine whether changes in water quality have occurred over time. Water quality is not common varies with the time of the day, season, weather conditions, water source, soil type, temperature, stocking density, and feeding rate (Ali, 2007). However, water sources have different physical, chemical and biological characteristics (Saeed, 2000), which

correspondingly affect the quality of fish (Ali, 2007). In virtually every case a change in one of these factors may result in change to one or more of the other factors. Therefore, water quality management must be grouped in an interaction for fish production to be maximized. There are many water quality variables in fish production but only a few of these usually play important role. Some water quality factors are more likely to be initials in mortalities while others are usually not directly toxic. However, some parameters interact with others and influence the overall water quality (Adigun, 2005).

MATERIALS AND METHODS

Study Area

Gangama dam is in Jigawa state Nigeria and was constructed between 1971 and 1974 by the Kano state government in an attempt to improve food security through irrigation projects and fishing. The dam has a total surface area of 3km and is located at Gwaram about 480m opposite Gwaram local government secretariat, which lies on Latitude 11° 14' 38.17 N and Longitude 9° 54'1.86 E. Rainfall is the main source of the water, with an outlet from the west embankment across Malaji road.

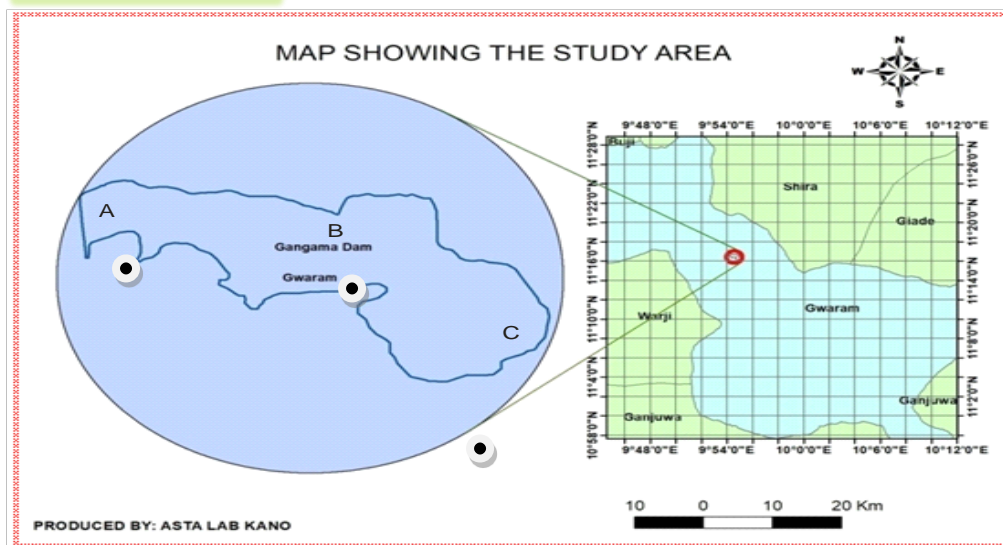


Figure 1: Map showing Gangama Dam and sampling stations A, B and C.

Sampling Stations

After preliminary survey of the dam, three sampling stations were established and marked at intervals based on water level, distance of the dam, fishing and public activities. Station A at the western end of the dam on Malaji road, station B about 1km away from station A likewise station C, also close to Sabon Garin Gadala.

Data Collection

Water Sample

Water sample from three sampling stations were measured in triplicates and recorded and the mean values were taken and computed. The water samples were measured once every month for the period of twelve months (July 2023 to June 2024) and Samples were collected between 7:00am to 9:00pm on each sampling day. However, temperature, turbidity, depth, pH, dissolve oxygen, alkalinity,



phosphorus, nitrogen, electrical conductivity and total dissolve solids were measured in-situ. While ammonia and biological oxygen demanded was measured ex-situ in the laboratory.

Field and Laboratory Measurement of Parameters

The temperatures were measured in-situ using portable mercury in glass thermometer, pH were measured with the aids of portable (pH meter Hanna ISTRPHEPR 1,), Dissolve oxygen with dissolve oxygen meter (JPB 607A), alkalinity level using photometer (WAGTECH 7100), Phosphorus and nitrogen with photometer (WAGTECH 7100A), Total dissolve solids with portable TDS meter, conductivity with conductivity meter, Unicon, BOD with dissolve oxygen meter J(BP 607A) five days after determination of DO all were achieved when the mercury part and bulb or cells was placed and dipped a little in to the water for about 2-4 minutes to stabilize and the correct result were shown and the reading were taken three times and recorded and also the average (mean) were recorded. Both carbon and ammonia were measured in the laboratories using standard method of APHA 2015. BOD was calculated using formula the $BOD = DO_1 - DO_2$ (mg/l).

Data Analysis

The physico-chemical parameters of Gangama dam measured for the period 12 months were processed and analyzed using Analysis of variance (ANOVA) that determined the differences between the treatments (stations) at significance rate of $P < 0.05$. Correlation coefficient also used which shows the correlation between the physico-chemical parameters.

RESULTS

Physico-Chemical Parameters of Gangama Dam

Table 1 – 4 showed the highest and lowest mean of all physico-chemical parameters of Gangama analysed throughout the period of the research. Though, all the parameters were analysed and presented in such format. The result showed that, lowest mean water temperature value of $17.40 \pm 0.60^\circ\text{C}$ was recorded at the station C in the month of January while the highest value $28.5 \pm 0.43^\circ\text{C}$ at the station B in the month of May (Table 1). The monthly mean variation of water temperature ranged 17.33 ± 1.47 in the month of January to $28.5 \pm 0.43^\circ\text{C}$ in the month of May (Table 1). There was significant difference in variability in stations and within months at ($P < 0.05$). The result between the months ranged from 17.23°C to $28.5 \pm 0.43^\circ\text{C}$ which was recorded in the month of January (dry season) and the minimum which was recorded in the month of January. The highest mean value of turbidity $73.45 \pm 7.23\text{cm}$ was recorded at the station B in the month of March. While the lowest value $16.52 \pm 0.33\text{cm}$ at the site B in the month of April (Table 2). The monthly mean variation fluctuated between $43.24 \pm 0.17\text{cm}$ in the month of October to 46.55 ± 1.01 in the month of July (Table 2). There was significant difference in variability in both stations and within months there was significant difference at ($P < 0.05$). The mean value results of monthly turbidity ranged between $17.33 \pm 0.23\text{cm}$ to $63.44 \pm 6.98\text{cm}$. Which were recorded in the month of April and March respectively (Table 2). There was variation in between the months with significant difference ($P < 0.05$). The highest mean value of depth $6.66 \pm 0.85\text{cm}$ was recorded at the station A in the month of September. While the lowest value $2.25 \pm 0.64\text{cm}$ at the station A in the month of -March (Table 3). The monthly mean variation fluctuated between $2.50 \pm 0.55\text{cm}$ in the month of March to 6.55 ± 0.09 in the month of September (Table 3). There was significant difference at ($P < 0.05$) in variability between stations and months at ($P < 0.05$). The lowest mean pH value of 6.2 ± 0.52 was recorded at station B in the month of June while the highest value 8.9 ± 0.33 was recorded at the station B in the month of December (Table 4). The monthly mean variation of the pH ranged between 6.2 ± 0.52 in the month of September to 8.6 ± 0.513 in the month of February (Table 4). There was significant difference in variability between stations and within months at ($P < 0.05$). The highest mean value of dissolved oxygen $7.67 \pm 0.77\text{mg/l}$ was recorded at the station A and C in the month of April. While the lowest value $3.50 \pm 0.66\text{mg/l}$ at the station B in the month of October. The monthly mean variation fluctuated between 3.55 ± 0.09 in the month of October and December to $7.55 \pm 0.09\text{mg/l}$ in the month of April. There was significant difference in variability in all the stations and within months at ($P < 0.05$). Alkalinity was recorded lowest $7.2 \pm 0.52\text{mg/l}$ at station B in the month of October. While the highest value $13.5 \pm 4.33\text{mg/l}$ at the site B in the month of February. The monthly mean variation fluctuated between $7.6 \pm 0.75\text{mg/l}$ in the month of October to 12.7 ± 0.70 in



the month of December. There was significant difference in variability in both sites and within months. Biological Oxygen demand was measured every month throughout the period of study and the mean values were recorded. Biological Oxygen Demand was recorded lowest $2.16 \pm 0.64 \text{ mg/l}$ at station C in the month of April while the highest value $5.56 \pm 0.36 \text{ mg/l}$ at the station C in the month of July. The monthly mean variation fluctuated between 5.66 ± 0.23 in the month of September to $2.42 \pm 0.64 \text{ mg/l}$ in the month of April. There was significant difference in variability in both sites and within months at ($P < 0.05$). Total dissolve solids was measured every month throughout the period of study and the mean values were recorded lowest $48.67 \pm 5.7 \text{ mg/l}$ at station B in the month of May while the highest value 117.66 ± 1.53 at the station A in the month of February. The monthly mean variation fluctuated between $49.878 \pm 5.77 \text{ mg/l}$ in the month of November to $110.67 \pm 6.35 \text{ mg/l}$ in the month of February. There was significant difference in variability in both sites and within months at ($P < 0.05$). Phosphorus was recorded lowest $3.50 \pm 0.45 \text{ mg/l}$ at station C in the month of January. While the highest value $4.50 \pm 1.66 \text{ mg/l}$ at the site B in the month of February. The monthly mean variation fluctuated between 3.55 ± 0.09 in the month of January to $4.55 \pm 0.09 \text{ mg/l}$ in the month of February. There was significant difference in variability in both stations and within months with significant at ($P < 0.05$). Ammonia was recorded lowest $0.54 \pm 0.07 \text{ mg/l}$ at station A in the month of January. While the highest value $0.59 \pm 0.08 \text{ mg/l}$ at the site C in the month of August. The monthly mean variation fluctuated between 0.54 ± 0.005 in the month of September to 0.58 ± 0.010 in the month of December. There was significant difference in variability in both stations and within months at ($P < 0.05$). The highest mean value of Nitrogen $0.20 \pm 0.06 \text{ mg/l}$ was recorded at the station B in the month of July. While the lowest value $0.16 \pm 0.03 \text{ mg/l}$ at the station A in the month of August. The monthly mean variation fluctuated between 0.15 ± 0.005 in the month of December to $0.19 \pm 0.000 \text{ mg/l}$ in the month of July. There was significant difference in variability in all stations and months at ($P < 0.05$). Dissolve carbon dioxide was recorded lowest $0.49 \pm 0.01 \text{ mg/l}$ at station C in the month of July. While the highest value $0.59 \pm 0.08 \text{ mg/l}$ at the station C in the month of September. The monthly mean variation fluctuated between $0.53 \pm 0.005 \text{ mg/l}$ in the month of November to $0.58 \pm 0.010 \text{ mg/l}$ in the month of August (Table 12). There was significant difference in variability in both sites and within months at ($P < 0.05$). Electrical conductivity was recorded lowest $0.16 \pm 0.06 \text{ }\mu\text{s/cm}$ at station A in the month of April. While the highest value $0.29 \pm 0.08 \text{ }\mu\text{s/cm}$ was recorded at the station A in the month of February. The monthly mean variation fluctuated between $0.16 \pm 0.002 \text{ }\mu\text{s/cm}$ in the month of November to $0.19 \pm 0.005 \text{ }\mu\text{s/cm}$ in the month of August. There was significant difference in variability in both stations and within months at ($P < 0.05$).

Table 1: Monthly Mean Temperature of Gangama Dam July 2023 to June 2024

Months	Station A	Station B	Station C	Mean and Std
	Mean \pm Std	Mean \pm Std	Mean \pm Std	
July 2023	26.50 ± 0.55^a	27.50 ± 0.45^a	26.50 ± 0.55^b	27.50 ± 0.45^{bc}
August 2023	26.32 ± 0.52^{bc}	25.52 ± 0.65^b	26.32 ± 0.52^b	25.52 ± 0.65^b
September 2023	25.40 ± 0.85^b	25.33 ± 1.47^b	25.40 ± 0.85^b	25.33 ± 1.47^b
October 2023	25.35 ± 0.52^b	25.77 ± 0.52^b	25.35 ± 0.52^b	25.77 ± 0.52^b
November 2023	22.50 ± 0.50^b	23.50 ± 0.45^b	22.50 ± 0.50^b	22.50 ± 0.45^b
December 2023	19.32 ± 0.52^b	20.52 ± 0.65^b	19.32 ± 0.52^b	20.52 ± 0.65^b
January 2024	17.40 ± 0.80^b	18.33 ± 1.47^b	17.40 ± 0.62^b	17.33 ± 1.47^b
February 2024	19.35 ± 0.52^b	17.77 ± 0.52^b	19.35 ± 0.52^b	18.77 ± 0.52^b
March 2024	23.2 ± 1.47^b	24.2 ± 0.45^b	23.2 ± 1.47^b	24.2 ± 0.45^b
April 2024	27.4 ± 0.45^b	26.8 ± 1.47^b	27.4 ± 0.45^{bc}	26.8 ± 1.47^b
May 2024	27.5 ± 0.52^b	28.5 ± 0.43^b	27.5 ± 0.52^a	27.5 ± 0.43^a
June 2024	26.7 ± 0.45^{ab}	26.8 ± 0.65^b	26.7 ± 0.45^b	26.8 ± 0.65^b

Means with the same superscript within the same column are not significantly different ($P > 0.05$).

Table 2: Monthly Mean Turbidity of Gangama Dam July 2023 to June 2024

Months	Station A	Station B	Station C	Mean and Std
	Mean±Std	Mean±Std	Mean±Std	
July 2023	30.99±5.77 ^b	30.67±5.33 ^b	31.66±5.73 ^b	30.66±5.76 ^b
August 2023	38.44±6.44 ^b	38.67±6.44 ^b	37.44±6.44 ^b	38.44±6.44 ^b
September 2023	36.67±4.77 ^b	36.67±4.71 ^b	35.67±4.77 ^b	36.67±4.77 ^b
October 2023	36.27±6.98 ^b	25.67±4.23 ^b	34.67±6.98 ^b	35.67±6.98 ^b
November 2023	48.54±5.77 ^b	48.67±5.7 ^b	49.28±5.77 ^b	28.44±5.77 ^b
December 2023	49.44±6.44 ^b	50.67±6.65 ^b	60.44±6.44 ^b	60.44±6.44 ^b
January 2024	53.67±4.77 ^b	56.67±4.70 ^b	54.67±4.77 ^b	53.67±4.77 ^b
February 2024	53.67±6.98 ^b	56.67±4.77 ^b	63.67±6.98 ^a	56.67±6.35 ^b
March 2024	69.44±6.54 ^a	73.45±7.23 ^a	63.67±6.77 ^a	63.44±6.98 ^a
April 2024	17.44±0.41 ^b	16.52±0.33 ^b	17.31±0.45 ^b	17.33±0.23 ^b
May 2024	23.5±2.21 ^b	24.55±4.35 ^b	24.55±2.24 ^b	24.34±3.34 ^b
June 2024	26.5±4.23 ^b	25.67±4.55 ^b	26.55±0.85 ^b	25.67±0.55 ^b

Means with the same superscript within the same column are not significantly different (P>0.05)

Table 3: Monthly Mean Depth of Gangama Dam July 2023 to June 2024

Months	Station A	Station B	Station C	Mean and Std
	Mean±Std	Mean±Std	Mean±Std	
July 2023	3.50±1.00 ^b	4.55±1.00 ^b	3.50±1.00 ^b	3.58±0.10 ^b
August 2023	6.25±0.64 ^{ab}	5.50±1.66 ^b	5.25±0.64 ^b	5.35±0.13 ^b
September 2023	6.66±0.85 ^a	6.50±0.90 ^a	5.66±0.85 ^{bc}	6.55±0.09 ^a
October 2023	5.67±0.77 ^b	6.50±0.66 ^{bc}	5.67±0.77 ^a	5.55±0.09 ^b
November 2023	5.50±1.00 ^b	5.55±1.00 ^b	5.50±1.00 ^b	5.58±0.10 ^b
December 2023	6.25±0.64 ^b	5.70±1.66 ^b	5.25±0.64 ^b	5.35±0.13 ^b
January 2024	3.26±0.85 ^b	3.50±0.90 ^b	3.26±0.85 ^b	3.55±0.09 ^b
February 2024	3.67±0.77 ^b	3.50±0.66 ^b	3.90±0.77 ^b	3.55±0.09 ^b
March 2024	2.25±0.64 ^b	2.50±1.00 ^b	2.67±0.77 ^b	2.50±0.55 ^b
April 2024	2.26±0.85 ^b	2.25±0.64 ^b	2.50±1.00 ^b	2.30±0.33 ^b
May 2024	3.90±0.77 ^b	3.26±0.85 ^b	2.25±0.64 ^b	3.24±0.56 ^b
June 2024	4.67±0.77 ^b	4.90±0.77 ^b	4.26±0.85 ^b	4.45±0.43 ^b

Means with the same superscript within the same column are not significantly different (P>0.05)

Table 4: Monthly Mean pH of Gangama Dam July 2023 to June 2024

Months	Station A	Station B	Station C	Mean and Std
	Mean±Std	Mean±Std	Mean±Std	
July 2023	6.2±0.70 ^b	6.4±0.45 ^b	6.3±0.50 ^b	6.3±0.10 ^b
August 2023	7.2±0.60 ^b	7.5±0.33 ^b	7.4±0.55 ^b	7.3±0.15 ^b
September 2023	6.4±0.44 ^b	6.2±0.54 ^b	6.2±0.40 ^b	6.2±0.11 ^b
October 2023	6.5±0.40 ^b	6.2±0.52 ^b	7.2±0.70 ^b	7.6±0.13 ^b
November 2023	7.2±0.70 ^b	6.4±0.45 ^b	6.3±0.50 ^b	6.3±0.10 ^b
December 2023	8.7±0.60 ^a	8.9±0.33 ^b	8.8±0.55 ^a	8.3±0.15 ^a
January 2024	8.4±0.44 ^b	7.2±0.54 ^a	6.2±0.40 ^b	7.2±0.11 ^b
February 2024	8.5±0.40 ^b	7.2±0.52 ^{ab}	8.2±0.70 ^b	8.6±0.13 ^b
March 2024	6.2±0.70 ^b	6.4±0.45 ^b	6.3±0.50 ^b	6.2±0.65 ^b
April 2024	7.2±0.60 ^b	7.5±0.33 ^b	7.4±0.55 ^b	7.2±0.45 ^b
May 2024	6.4±0.44 ^b	6.2±0.54 ^b	6.2±0.40 ^b	6.4±0.46 ^b
June 2024	6.5±0.40 ^b	6.2±0.52 ^b	7.2±0.70 ^b	6.5±0.56 ^b

Means with the same superscript within the same column are not significantly different (P>0.05).

The Relationship between Physico-Chemical Parameters

The correlation between the physico-chemical parameters of this research is presented in Table 5. The result showed low correlation for Temperature $r = -0.26924$ and Turbidity $r = -0.12051$ while Depth, pH, DO, Alkalinity, were weak correlated $r = -0.21001$, $r = 0.141662$, $r = 0.331958$, $r = -0.34314$



and BOD, $r = -0.49347$ which had medium correlation Phosphorus and Electrical Conductivity shows low correlation $r = 0.191239$ and $r = -0.27331$ respectively.

Table 5: Correlation between Physico-chemical Parameters in Gangam Dam January 2023 to December 2024

	Temp	Turb	Depth	pH	DO	Alk	BOD	TDS	P	Ammonia	N	CO ₂	EC
Temp	1												
Turbidity	-0.78907	1											
Depth	-0.03012	-0.02579	1										
pH	-0.53495	0.452798	0.039086	1									
DO	0.594123	-0.53205	-0.52597	-0.33934	1								
Alkalinity	-0.19515	0.174864	0.052721	0.368496	-0.47155	1							
BOD	0.093572	0.058713	0.548862	-0.08137	-0.40865	0.588097	1						
TDS	-0.5511	0.6305	0.293043	0.544918	-0.55286	0.541135	0.632501	1					
Phosphorus	-0.03879	0.001103	0.386726	-0.13863	-0.16997	0.145202	0.474026	0.209115	1				
Ammonia	0.014806	-0.11753	0.018227	-0.01475	-0.26086	0.795832	0.368038	0.101629	0.059851	1			
Nitrogen	0.783657	-0.78854	0.379435	-0.41072	0.285286	-0.28435	0.228481	-0.3445	0.065391	-0.22949	1		
CO ₂	0.058206	-0.32493	-0.0435	-0.12881	-0.30636	0.112412	-0.1748	-0.33986	-0.26843	0.221156	0.215395	1	
EC	-0.34434	0.103977	0.235675	0.503202	-0.33723	0.332262	0.107299	0.472784	-0.30454	0.338922	-0.1637	0.12526	1

DISCUSSION

The monthly mean water temperature of the Dam fluctuates between 17.13°C to 28.13°C. The range of temperature recorded during the period of the research was almost in line with (26.0-29.0°C) obtained by Adeyemi (2011) in Gbedikere Lake Basssa, Kogi state and (25.8-28.0°C) recorded by Ali *et al.*, (2000) in Lake Geriyo, Adamawa State respectively. The high temperature observed in this Lake at station B could be due to the shallow nature of the Lake, which could be favorable to fish growth and development (Haruna, 2003). The metabolic rate of aquatic organisms is also related to temperature in warm waters, respiration rates increase, leading to increased oxygen consumption and increased decomposition of organic matter (Haruna, 2003).

The maximum temperature degree was recorded in the month of January (dry season) and relatively low in May (dry season) which fall within the adapted range of tropical water bodies (Adedeji, *et al.*, 2019). The relative low temperature in January station C may be attributed due to harmattan which makes the weather condition very cold thereby affecting the water temperature and fish. The temperature is related with temperature of Lake Ribadu recorded by Adedeji, *et al.*, (2019). This study corresponded with the study of seasonal variation in the physico-chemical parameters by (Gwana, *et al.*, 2017). However, Boyd (1990) observed that in tropical climates, water temperatures are high in the year round never less in temperature between dry and rain season which is not correspond with this study that shows seasonal variation between the months.

Minimum turbidity was obtained in month of April (16.52±0.33cm) at the station B in the month of April (dry season) this remarkable decrease of turbidity obtained is truly due to fishing activities at the station. Though, at beginning of rain season the turbidity consequently decreases due to water run-off from tributaries and from agricultural land including irrigated carried debris. The maximum obtained in July (dry season) is associated with low fishing activities. The decreases of the transparent in the water bodies in the rain season is the result of floods draining into the dam were responsible for the low water transparency which is not correspond with the result of this study. The maximum turbidity in July also may be due to absence of over fishing that result the settling effects of the suspended solids. Using the criteria proposed by Environmental protection agency. The mean value obtained in March fall within the range accepted as safe for aquatic life. Ayodele and Ajani (1999) as cited in (Gwana, *et al.*, 2017) reported that turbidity value of 30 and 60 cm are within acceptable value for fish production, the value obtained also compared and corresponded with most tropical water bodies



likewise corresponded with WHO standard 2006. However, this shows that the turbidity of Gangama Dam will have no negative effects on fish diversity and abundance.

The maximum depth was obtained in September station A (rain season) which in fact associated with peak period of rainfall when the dam 100% filled off and start going out via the out let which is normal every season.

The minimum mean value for depth recorded in May station C (end of dry season when the water level decreases. Hydrogen ion (pH) is an important parameter in evaluating the acid base balance of water. The pH of Gangama dam values slightly fluctuates between 6.7 at station B to 8.9 in two different months February (dry season) during so cold weather and June (rain season). The result obtained indicated that the pH is neutral and slightly fluctuates to alkalinity at 6.70. So the mean values within the stations and the months falls within pH of normal range of surface waters recommended by European Economic Community (EEC) standard (Gwana, *et al.*, 2017), also corresponded with World Health Organization (WHO) standard 2006. The pH value obtained is similar with the work of (Idowu and Gadzama, 2011) in Alau dam. pH between 7 to 8.5 is ideal for biological productivity, fishes can become stressed in water with a pH ranging from 4.0 to 6.5 and 9.0 to 11.0 and death is almost certain at a pH of less than 4.0 or greater than 11.0 (Ekubo and Abowei, 2011). (Gwana, *et al.*, 2017) explained that (Adeniji, 1986) fresh waters with a pH range of 6.0 to 9.0 have been noted to be productive and thus recommended for fish production. Outside this range water may have sour taste and could be corrosive to metals.

Dissolved Oxygen values obtained during this study at station B in the month March and September is similar with 6.1-6.8 for Lake Alau (Gwana, *et al.*, 2017) which falls within the range for optimum fish growth. Similar result (5.15-6.35 mg/l) was obtained by (Idowu, *et al.*, 2004). The maximum value obtained in March station B may be due to agitation and frequent wind current in the water that normally happen in April (dry season). Bhatnagar, *et al.*, (2004) reported that, DO level >5ppm is essential to support good fish production

In this study alkalinity was measured every month throughout the period of the study and the maximum value obtained maximum value obtained in October station B (raining season) is associated with water from rocks and clayey nearby areas and minimum was recorded in February (dry season) and the result is similar with the ranges given by USEPA 1979, is an indicative to the good quality water. Adigun (2005) reported that alkalinity above 40mg/l is an indicative of high productivity.

Biological oxygen demand the results obtained shows high values in the month of July, station C (rain season) this may be associated with several microbes present in the dam with accelerated their metabolic activities with concentrated amount of organic matter any waste that enter the dam from agricultural land and tributaries and hence make required much amount of oxygen so that the demand of oxygen increased. The result obtains revealed that Gangama dam remain clean and unpolluted. This is in line with Ekubo and Abowei (2011) which reported that water body with BOD 10mg/l is said to be definitely polluted; 5mg/l doubtful clean and polluted; 3.0mg/l average ;1-2.0mg/l said to be considered clean.

Total dissolve solids maximum values were recorded in February station A (dry season) which is associated with daily public used of the water by villages around, and trucks drivers always use the dam as their washing points which may cause the accumulation of various elements/metals since the water is static after rain cease and water level reduced.

Phosphorus is very important element that plays vital role in aquatic environment both for fish, phytoplankton and zooplankton because it improves the production of plants that aquatic living feed on. The maximum value of phosphorus obtained in February station B. High value of phosphorus in raining season may be associated with runoff water that enters the dam from agricultural land especially irrigated field where phosphorus containing fertilizer is used. Likewise, the minimum obtained in the month of October. Therefore, phosphorus showed low correlation with fish diversity and abundance.

High level of ammonia was obtained in the month of August station C (rain season). This is associated with the fact that fish survive with enough feed during the raining season this makes the availability of biotic and abiotic concentrations which reduced when the dam full off and discharges with little or more ammonia, The minimum value in the month of January station A (dry season) the



accumulation must be high due to the fact that the dam become static and fish feed and survive freely due to moderate weather condition before December a stating month for high cold weather and also associated with high pH. The result is low compared with the result obtained by (Gwana, *et al.*, 2017) in Alau dam. The minimum value also may be associated with unavailability of phytoplankton and zooplankton that fish consume and discharge waste. Ammonia formation in aquatic environment depends on water pH, where at high pH free toxic Ammonia is released to critical value.

Nitrogen enters water in several chemical forms or particulate forms such as tissues of living and dead organisms so nitrogen makes about 78% of air which also a key to life of aquatic living organisms (fish) the maximum result obtained in month of July at station B (rain season) and the minimum obtained in the month of August station A (dry season). The maximum result may be attributed to high nitrogen fixation by nitrogenous fixing micro-organisms and minimum may be associated low nitrogen fixation by micro-organisms. The result is slightly low permissible standard set by WHO, 2006.

Carbon dioxide results obtained in this study ranged between 0.12 to 1.87. The maximum mean value was recorded in the month of September station at C. The carbon dioxide results obtained within the station and months are recommended for fish survival. Conductivity measures the capacity of water to pass electrical flow which is related with ions in the water. The result obtained showed high conductivity obtained in February station A (dry season) and the minimum was obtained in April. The result similar with Umuzukwu water (66.1); Uwalaka water 42.5; and Timber shed water (55.5) (Unwughara, *et al.*, (2013) which fall (50-500 μ s/cm) within the water standard of World Health Organization 2006. There is no relationship between conductivity and fish species diversity and abundance in Gangama dam.

The correlation between the physico-chemical parameters indicated the degree of low correlation between temperature and turbidity some parameters such as depth, pH, DO and alkalinity with similarity in weak correlation among each. However, other parameters correlated at medium level. The condition of the Dam showed highly statically significant difference ($P < 0.05$) with Temperature, transparency, and pH while Electrical conductivity, phosphate, nitrate correlated negatively.

CONCLUSION AND RECOMMENDATION

The paramount objective for the construction of Gangama dam was an attempt to improved food security through irrigation projects and fishing. Thus, provision of portable water to Gwaram metropolis is an unintended output of the dam but assumed prominent dimension in the livelihood of Gwaram and villages around. Water quality parameters measured using portable instruments and some was taken to the laboratory where they analyzed. The parameters include both physical i.e. temperature, depth, turbidity and chemical which includes pH, dissolve oxygen, electrical conductivity, alkalinity, carbon dioxide, total dissolve solids, ammonia, phosphate and nitrates which were measured in-situ and ex-situ. The mean values were computed and analyzed using ANOVA, correlation coefficient though some parameters show no significant difference between the months while some with significant difference, likewise some correlated with others positively, negatively or not. The study recommended the avoidance of chemicals and toxic substances disposal into the dam maintain the water quality standard.

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