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THE ASSESSMENT OF THE WATER QUALITY PARAMETERS OF AGAIE/LAPAI DAM IN NIGER STATE, NIGERIA

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ABSTRACT
The physic-chemical parameters of Agaie-lapai dam were analyzed weekly for a period of 11months from January to November, 2012, and five (5) stations were identified within the dam for the investigation. The physico-chemical parameters like temperature, dissolve oxygen, P^H, alkalinity, hardness, conductivity, chloride, transparency, phosphate, biochemical oxygen demand and nitrate were assessed. Results of some of the parameters were recorded on the field and others were taken to the laboratory for analysis. For dissolved oxygen, reagent 1 and reagent 2 were fixed on the field before samples were taken to laboratory for further experiment. There was significant difference in most results obtained whilst there was no significant difference $p>0.05$ in pH regardless of stations and weeks. But significant difference $p<0.05$ were observed in dissolved oxygen, nitrate, temperature, conductivity, hardness, alkalinity, biological oxygen demand, transparency in regard to the stations. These variation could be due to influx or organic waste from surface run offs and inorganic waste deposited by man. The physic-chemical parameters observed, indicated that most of them falls with the recommended range or standard by the federal ministry of environment (FMENV, 2000).

KEYWORDS: Dissolved Oxygen (DO), Alkalinity, Conductivity, Transparency and Total hardness.

INTRODUCTION

Water is the most valuable resource to man and other living organisms. About 70% of the human body weight is water and many body function depend on it (FMENV, 2000) Water is used by man for activities like domestic, agricultural, aquaculture, recreational and transportation. It also serves as a shelter for organism living in it. Ofojekwu (1990) stated that human activities and a lot of natural process many direct or indirectly alter the composition and condition of natural water. The importance of water as a resource is not only in its availability and quantity but also its quality. Studies have shown that the conservation of lotic ecosystem to lacustrine one causes changes in water quality (Ajayi, 2006 and Oluwarotimi, 2007).Variations in water quality have been explained in terms of dominance of precipitation chemistry, bedrock chemistry or evaporation, the crystallization process within the dam and its entire basin (Kolo and Oladimeji, 2004; Ajayi, 2006 and Adegun, 2005), surface and ground water have been associated with toxic synthetic chemicals such as heavy metals and pesticides, nutrient enrichment and recently, acidification (FEPA,1991). The dynamics of aquatic ecosystem depends on the properties of water, and the ultimate objective of limnology is to understand the factor upon which the continued existence of the organism depends and also find out causes of reduction and in some cases extinction of the organisms (Kolo and Oladimeji, 2004), and also it can be of immense value in drawing management plans for such water bodies and as a reference point, when assessing changes caused by nature and man over time. Drinkable water must be of international standard that is free of contamination in terms of physico-chemical parameter and organisms load.

Water contamination is caused by chemical, physical and biological processes, which also serve as factors controlling the composition of natural water (Boyd and Froshbish, 1990). It stated that a good water quality for fish culture must not be of high acidic or alkaline value, it must contain optimum dissolved oxygen, and it must not be muddy or turbid, not offensive to organs of smell and sight and must be free from pollutants such as industrial wastes or effluents, including detergent and pesticides. Agricultural activities have been known to contribute to surface water quality deterioration. Evaporation has also been known to consume much of the water applied during irrigation, thus concentrating the salts into the water and soil. The remaining may either infiltrate where it becomes more highly mineralized or flow across the surface into streams, lakes and rivers. Sediments from agricultural lands and construction sites could add their load to surfaces, waters, smoother benthic organisms and impair water quality for fish spawning and breeding (FMENV. 2000).

MATERIALS AND METHODS

Study area

Agaie/ Lapai Dam is located at latitude 9 ^{o}39N and longitude 6^{o}33E, westward of Minna Located around the dam are Tunga Gana, Nakopita, Sabon gari (Shugaba), Dagban, Jyankpa, Unguwa umar in Niger state. It is a small water body with a mean depth of 6.IM (20.2FT). The main purpose of the Dam is for portable water supply and irrigation. The resources in the Dam are conserved and protected.

Temperature

Temperature readings were taken in the morning hours (9-11am) at a depth of about 5cm, using mercury in glass thermometer (D-100^{o}C) by allowing it to in the water for at least 2 minutes to be able take the accurate readings. Readings were taken at the six stations differently one at a time, where water samples were collected. The air temperature was taken and recorded reading was taken as mean temperature in ^{o}C.

Transparency

The seechi disc was used to determine the transparency of the water. The seechi disc was lowered into the water body, immediately it disappeared the reading was recorded as (d1) and it was raised again until it reappeared then another reading was recorded as (d2). The average of the two readings was taken and recorded as the transparency of the water measured in cm.

Hydrogen ion concentration (P^H)

Water samples were collected from the different stations and taken to the laboratory where the pH was monitored using a digital pH meter model. Kent EH 7045/46 at room temperature. Buffer solution of pH 4.0 and 9.0 were used to standardize the pH meter before readings were taken. After standardizing the pH meter, the probe was rinsed thoroughly before inserting it into the water samples and recorded.

Conductivity

The electrical conductivity of water samples was determined in the laboratory using a digital conductivity meter model WPA CMD 400, and values expressed as µs/cm. The probe of the meter was rinsed before inserting it into the water samples and conductivity was recorded.

Alkalinity

The Alkalinity of the water samples were determined by taken 50mls of water in a conical flask, and then 3 drops of methyl orange indicator was added. The solution was titrated using 0.02N sulphuric acid until the colour of the solution changed from yellow to orange or pink which marks the end point. The total alkalinity is calculated using the equation below.

$$\text{Total alkalinity mg/l} = \frac{\text{Vol (H2SO4)x molarity (H2 SO4)}}{\textit{Volume of sample}} x\ 100$$

Total hardness

This was determined by adding 1ml of Ammonium chloride buffer solution to 50mls of water and followed by adding a pinch of Eriochrome Black-T indicator (say0.2g). The solution was shaken thoroughly to ensure that the Eriochrome Black-T indicator dissolved completely which gave a red wine colour. The resultant wine colour was titrated using 0.01IN Etheyline- Diamine ethanoic Acid (EDTA) until a blue end point was observed. Hardness in milligram per liter was calculated using the formula below:

$$\text{Total hardness in mg/l as CaCO3 } = \frac{\text{VolVol. of EDTA x N}}{\textit{Volume of sample}} x\ 1000$$

Dissolved oxygen

Dissolved oxygen content of the dam water was monitored using the Azide modified Winkler's method as recommended by (APHA, 2012; Stirling and Philips, 1990). Water samples were collected in BOD stopper bottle and fixed on the field with reagent 1 (Managanons sulphate) and reagent 2 (alkaline iodine solution). Concentrated sulphuric acid was then added to each sample in the laboratory and mixed gently. 10mls of the sample was collected into a conical flask and a sodium thiosulphate until the dark blue or purple colour turned colorless.

Dissolved oxygen was calculated as given below:

DO (mg/L)= Titer value x 0.025 x 8 x 1000/ Water sample

Biochemical oxygen demand

Biochemical oxygen Demand BOD was determined principally by incubating water sample. The samples were incubated using the BOD stopper bottles, stored in a dark place at room temperature for five (5 days). The oxygen content of the incubated sample was determined after 5 days using the Azide modified Winkler's method. The difference between initial and final oxygen content in milligram per litre was used to calculate the BOD. Therefore BOD, mg/l BOD 1-BOD 5.

Chloride

This was determined by adding two drops of methyl indicator to 50mls of the sample and titrates with 0.05 sodium hydroxide till a pink color was observed. The chloride is calculated using equation below

$$\text{Cl mg/l} = \frac{\text{Tv x 0.014 x 35535}}{50}$$

Phosphate

Phosphate calibration standards were prepared by adding volumes of phosphate solution corresponding to between 5 and 6µg or 0.5-6ml of standard solution to a series of 50mls volumetric flasks. Pipette 40mls of sample into 50mls of volumetric flask. Each flask, add 8mls of the reaction into a 50mls flask and making up to mark of water, mix the solution thoroughly and allow to standard for at least 10 minutes, but no longer than 30 minutes. The water blank was used in the reference cell of the spectrophotometer. The absorbance of each solution was measured at 88onm in 1cm cell. The amount of phosphorous in the sample was read and concentration was calculated thus; $MgLp^{-1}$ = µg p/v

Nitrate

Nitrate standard solutions were prepared in the range 0.1-5mg NL $^{-1}$ by pipetting 1,5,10,20,40 and 50mls of the working nitrate solutions into a series of 100mls volumetric flask and making up to mark with water. 2mls of aliquots of samples standards and water blank into a 10mls volumetric flask and add 1 drop of the sulfite urea reagent to each flask. Flasks were placed in a tray of cool water with a temperature between 10 and 20^{0}C and 2mls of antimony reagent was added, the flasks were swirled when adding each reagent. After standing the bath for 4minutes 1ml of chromotopic reagent was added to the flask. Swirl the flask again and allow standing in the cooling bath for another 3 minutes, then making up the mark with conc. H_2SO_4 and mixing the content by inverting them 4 times. Allow the flask to stand at room temperature for 45minutes and adjust the volume to 10mls with conc. H_2SO_4. Finally mix very gently to avoid introducing gas bubbles. Allow the flask to stand for at least 15 minutes before measuring the absorbance reading of the water flask from that of the samples and standards. Based on the standard measurement read off directly, the concentration of NOg $^-$ was expressed as MgNL in the samples.

Statistical analysis

The statistical analysis of the samples were carried out using the one way Analysis Of Variance (ANOVA) to determine the variation of parameters within the weeks and from station to station. The Duncan multiple range test for the separation of mean was used to compare parameters between weeks and also between stations.

RESULTS

Temperature

The finding of the research work on Agaie/Lapai Dam revealed that temperature was highest week 5 (29.56^{o}C) and lowest in week 1 (28.50^{o}C). Duncan multiple range test for separation of menu showed that temperature at weeks 1,3,4 and 6 were not significant different p>0.05) but significantly different from (p>0.05) from those of weeks 2 and 5 which were also not significantly different from each other.

Duncan multiple test also showed that temperature at situations 1 and 5 were significantly higher (29.72 + 0.699) and (29.72 + 0.725) and significantly lower at station 3 (28.00 + 0.767). There was much significant difference in temperature at all stations except station 1 and 5 which were significantly indifferent (p>0.05).

Transparency

Duncan multiple range test for separation of mean revealed that transparency in weeks 3 was the highest (103.39cm) and lowest in week 5. Transparency in weeks 1, 2 and 3 were not significantly different from each other p>0.05. In terms of stations, the highest transparency value was recorded at station 4 (103.08cm) and the lowest was at station 6 (101.61cm). There was significant difference p<0.05 between stations 1 and 3 and also between stations 2 and 5.

P^H

With the result obtained from the Duncan multiple range test of separation of mean, p^H in week 2 was significantly higher (7.20) and that in week 5 was significantly lower (6.88). There was no significant difference p>0.05 in p^H in weeks 2,3,4,5 and 6 but were significantly different p<0.05 from the P^H in week 1.

In terms of stations, station 2 had significantly higher p^H (7.20) than stations 2,3, and 4. Stations 5 had the lowest p^H (6.88). The p^H at stations 2, 3, 4, and 5 showed no significant difference p>0.05 from each other but were significantly different p<0.05 from p^H at station 1.

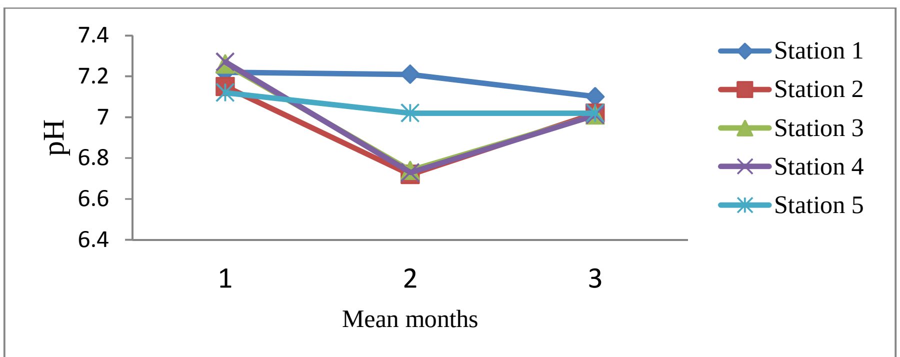


FIGURE 1: P^H of water at different samples stations

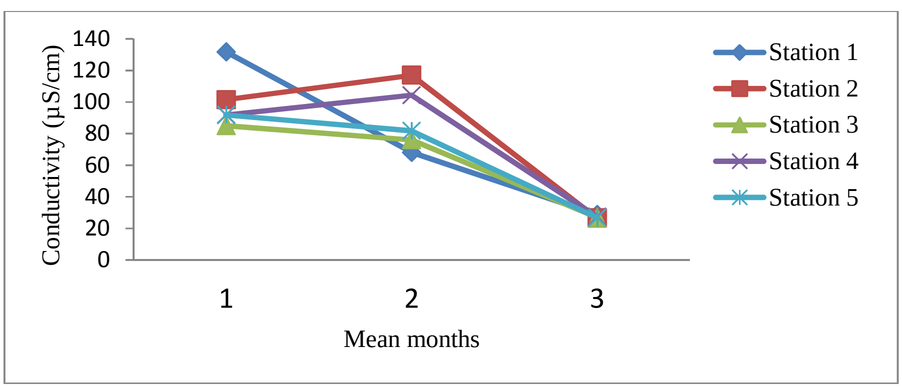
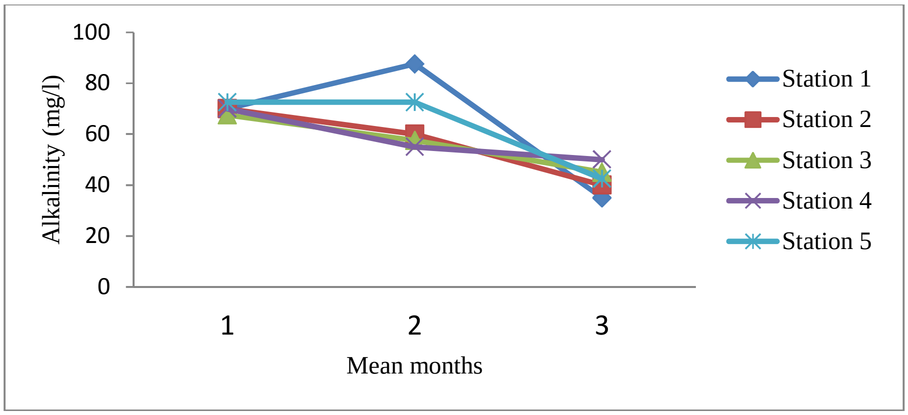


FIGURE 2: Conductivity of water at different samples station

Conductivity
The conductivity of water in Agaie/Lapai Dam showed a high value (100.30µs\cm) in week 4 and a low value (27.25µs/cm) in week 3. Duncan multiple range test for separation of mean revealed that there was significant difference $p<0.05$ in conductivity in all weeks having slight difference in values. The Duncan multiple range test for separation of mean showed that at station 1 the highest conductivity value (100.30µs/cm) was recorded and the lowest value (27.25µs/cm) recorded at station4. There was no significant difference $p>0.05$ in conductivity at stations 2, 3 and 4 which were significantly different $p<0.05$ from stations 1, and 5.

Alkalinity
In weeks 1, the highest value (70.00mg/l) was recorded and the lowest (40.20mg/l) was recorded in weeks 5 and 4.There was no significant difference $p>0.05$ between weeks 2 and 3, whereas weeks 1, 4, and 5 were significantly different $p<0.05$ from each other. N terms of stations, the highest alkalinity value (70.00mg/l) was recorded at station 1, and the lowest value (40.20mg/l) was recorded at station 5.There was no significant difference $p> 0.05$ in alkalinity between stations 2 and 3. Stations 1, 4, and 5 were significantly different $p<0.05$ from each other.



Alkalinity of water at different samples stations

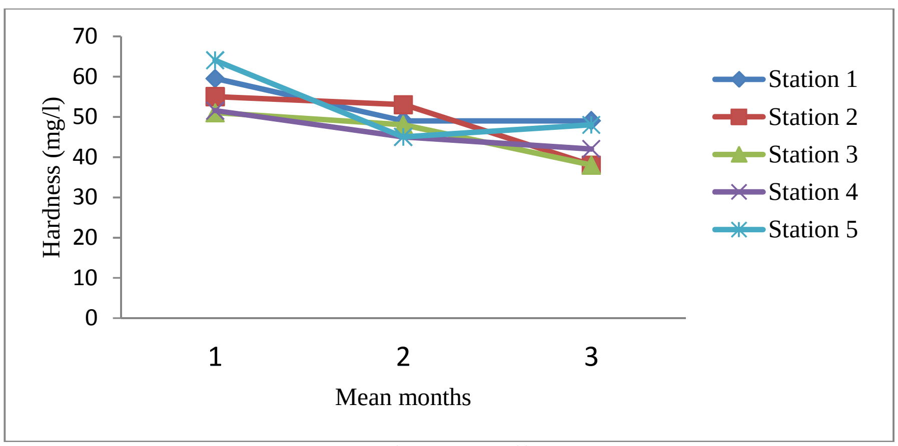


FIGURE 3: Hardness of water at different samples stations

Hardness
Duncan multiple range test for separation of mean showed that in week 1 the highest hardness value (56.20mg/l) was recorded. Week 5 had the lowest hardness (40.32mg/l) compared to each other weeks. The analysis revealed that weeks 4 and 5 were significantly indifferent $p>0.05$ from each other but significantly different $p<0.05$from weeks 1, 2, 3 and 5 which were also significantly different each other. For the stations, highest hardness value (56.20mg/l) was recorded at stations 1 and the lowest (40.20mg/l) recorded at stations 5. Duncan multiple range test for separation of mean revealed that there was no significant difference $p>0.05$ between stations2 and 4 but were significantly different $p<0.05$ from stations 1, 3, 5 and which were also significantly different from each other.

Dissolved oxygen (DO)
The Duncan multiple range test for separation of mean showed that: DO in week 2 was significantly higher (13.00mg/1) than in weeks 1, 3, 4, and 5. The DO values in weeks 1 and 5 were not significantly different $p<0.05$ from each other but significantly higher than they DO in weeks 2, 4, and 5 which were which were also not significantly different $p>0.05$ from each other. In terms of stations, the Duncan multiple range tests revealed that station 2 had the highest DO value (13.00mg/l) with the lowest DO value (6.00mg/l) was recorded station 5. There was significant difference $p<0.05$ in DO between stations except for stations 5 which were not significantly different but significantly different $p<0.05$ from each other.

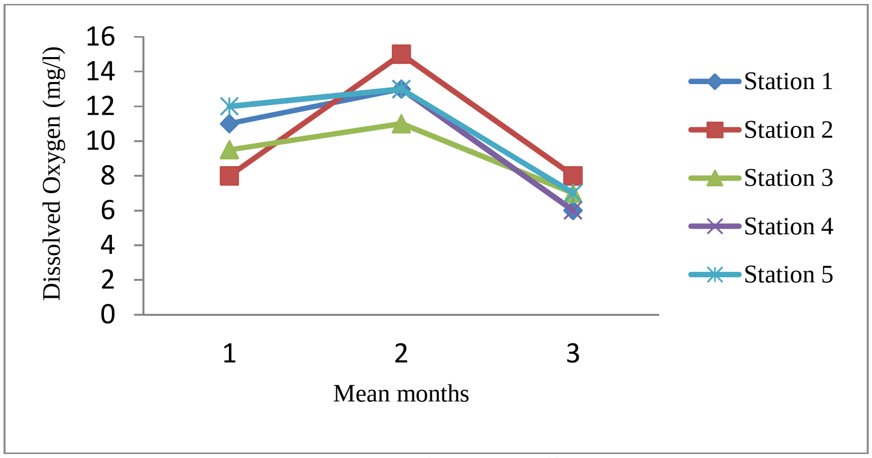


FIGURE 4: Dissolved oxygen of water at different samples stations

Biological oxygen demand (BOD)

The analysis result of the weekly mean values of Biological Oxygen Demand (BOD) revealed that week 2 has the highest value (8.80mg/l) and that of week 5 was the lowest (4.56mg/l). There was no significant difference $p<0.05$ in BOD between weeks 3 and 5 and also between weeks 2, 4 and 5. In terms of stations, the highest BOD value (8.80mg/l was recorded at stations and the lowest (4.56mg/l) at stations 5. Duncan multiple range test for separation of menu revealed that there was no significant difference $p>0.05$ in BOD between stations 1 and 2 and also between stations 3 and 4. Stations 5 showed no significant difference from each other.

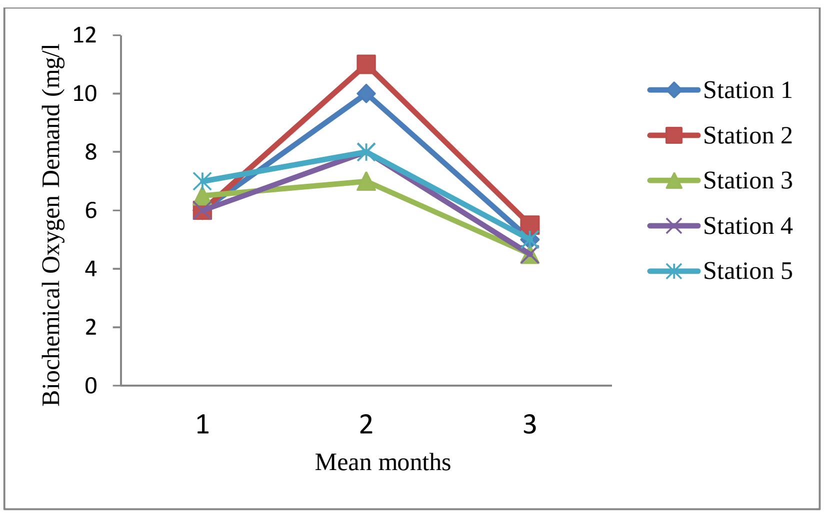


FIGURE 5: Biochemical oxygen demand of water at different samples stations

Nitrate

Nitrate was significantly higher in weeks 4 and 2 and significantly lower (1.45mg/l) in weeks 1 and 5. There was no significant difference $p<0.05$ in nitrate between weeks 1, 2 and 3 but significantly different $p<0.05$ from weeks 4, and 5 which were also significantly different from each other. Duncan multiple range test for separation of mean also revealed that station 1 has the highest nitrate value (2.49mg/l) and stations 1 and 5 had significantly low. Value (1.45mg/l). There was no significant difference $p<0.05$ between stations 2 and 3. Stations 1, 4, and 5 were significantly different $p<0.05$ from each other.

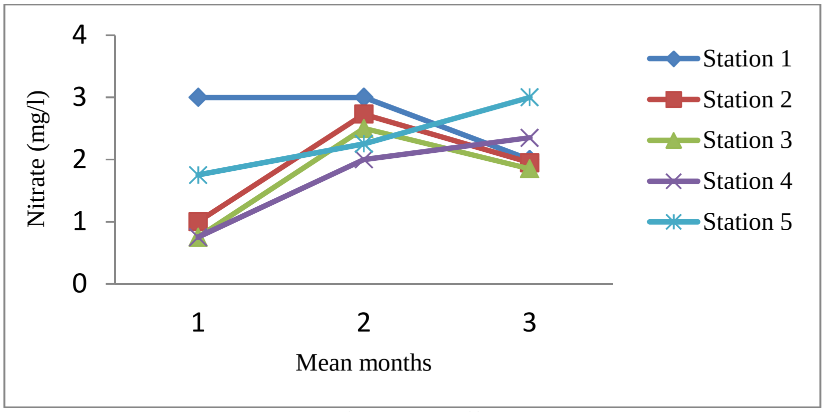


FIGURE 6: Nitrate of water at different samples stations

Phosphate

There was no much difference in the values of phosphate within the weeks as the values were relatively close to each other. Week 3 had the highest phosphate value (0.32mg/l) while the lowest phosphate value (0.18mg/l) recorded in week 2. There was no significant difference p<0.05 in phosphate in weeks 1, 3, 4 and 5 but were significantly different p<0.05 from those of weeks 2 and 5 which were also significantly different from each other.

In terms of stations, stations 1 and 3 were significantly higher (0.32mg/l) week 2 was significantly lower (0.18mg/l). There was no significant difference p<0.05 in phosphate between stations 1 and 2 and also between stations and 5. Stations 3 and 4 were significantly different from each other.

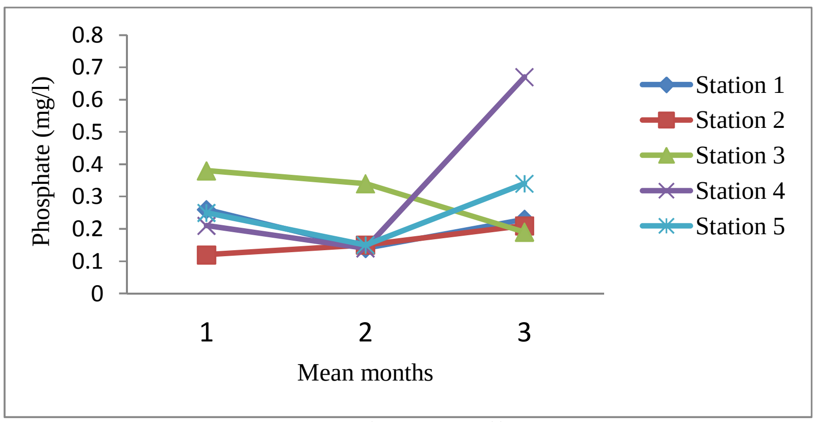


FIGURE 7: Phosphate of water at different samples stations

Chloride

Duncan multiple range test for separation of mean showed that in 2 the highest chloride value (40.79mg/l) was recorded. Week 1 has the lowest chloride value of (5.27mg/l) compared to other weeks. The analysis revealed that week 1, 3 and 5 were significantly indifferent p<0.05 from each other but significantly different p<0.05 from weeks 1, 3 and 5 which were also significantly different from each other.

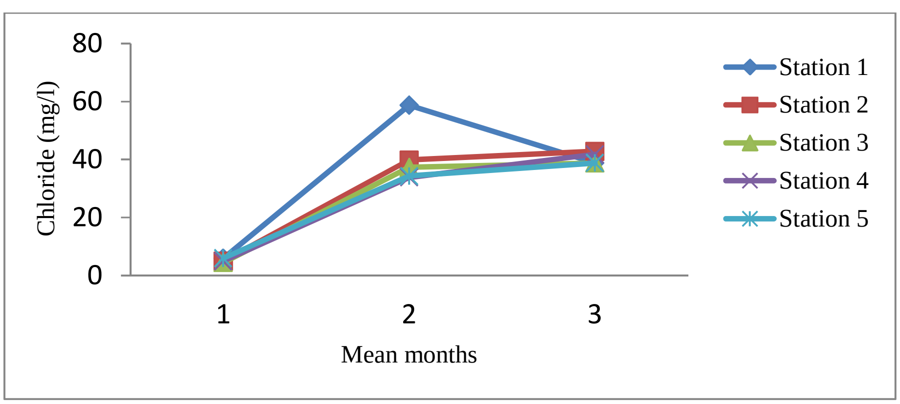


FIGURE 8: Chloride of water at different samples stations

DISCUSSION

There was no much significant difference in temperature between weeks and also between stations. The average mean value of temperature of Agaie/Lapai Dam observed ranges from 28.5^{o}C to 29.6^{o}C. This is within the recommended temperature range as it agrees with the findings of Reynolds, 2000; Alphones, 2002; and Adegun, 2005 that the recommended temperature ranges between 25^{o}C and 32^{o}C for good performance of warm water fish. The low temperature recorded I n week 1 may be attributed to the time and period of sampling since it was recorded immediately before rain. It could also probably be due to the onset of raining season. This agrees with findings of Brown (2003) that water temperature varies with season, elevation, geographic location and climatic condition and is influenced by stream low, streamside vegetation, ground water inputs and water effluents. The slight increase in temperature observed in mean week 4 could be due to mineralization, which is in agreement with (Boyd and Lichtklopper, 1990). In terms of stations, the low temperature recorded in station 3 could be due to the shade provided by trees and vegetation around the station. High temperature values were recorded at stations 1 and 4 and these may be attributed to the shallowness of the sampling stations i.e. stations 1 and 4.The high transparency recorded in mean week 4 could be due to high sedition rate of suspended materials as it was recorded some days during the rain period. Low transparency level in mean week 4 may be attributed to the increase in photosynthesis activities and the inflow of water from the different rivers within the water which may lead to the growth of planktons and also may be due to the decomposition of organic materials in the water which affects the color of water and also contribute to plankton growth. Transparency Values recorded during the research were within the range reported by Kemdirin (1990) who stated that the recommended range for transparency is between 11.0cm-108.5cm for productive waters. The high transparency level at station of could be due to low organic material around the station, and how transparency level at station 5 could be attributed to the color of the soil around the station and may also be due to the influx of organic materials. This agrees Khan and Ejike 1985, who reported that hour seechi disc transparency in rainy season was due to increase in nutrient load and re-suspension of organic materials from the stream and river inflows.

The P^{H} values recorded in this study were between the range of 7.12 to 7.26 for the weeks and 7.94 to 7.39 for the stations. This is within the recommended range of 6.5-9.0 for Tilapia culture (Natrivadad 1984) and generally suitable for fish production water. The gradual decrease of pH in mean week 2 to week 4 could be due to continuous increment in water volume and the decomposition of organic material. In terms of station, there was decrease in pH from stations 1 to 5 which could be as a result of higher input of allocthonous organic matter and higher temperature which enhances decay process (Kolo *et al*., 2009). P^{H} correlated negatively with dissolved oxygen. The ability of water to transmit electric current is known as the electrical conductivity of that particular water. Electrical conductivity usually depends on the presence of inorganic dissolved solids such as chloride, phosphate sodium, magnesium, calcium, nitrate, sulphate etc. (Ojutiku and Kolo, 2008). The highest weekly mean value 'for conductivity recorded was in mean week 4.' This may be due to reduced volume of water in the dam as a result of the onset of dry season. The warmer the water, is the higher the conductivity (Kolo *et al*., 2009). The value of conductivity in recorded in mean week 2 (131.65µs/cm) and mean week 1 (84.95µs/cm) could be as result of the dilution of water from runoffs since the sample were collected few days during the rainy period. Stations 1 and 5 had higher conductivity values 131, 65µs/cm and 27.25µs/cm respectively. This could be as a result of dissolve solute from decaying organic material highly deposited at these stations form surface runoffs. The positive correlation which exists between conductivity, hardness, temperature and alkalinity could be attributed to increase in the above water parameters which lead to greater solubility of ions (Kolo and Yisa, 2000). The range of alkalinity recorded during this research work within the weeks and station 67.50-72.50mg/l and 42.00mg/l – 45.00mg/l respectively. This is within the recommended range of 50mg/l as C_2CO3 to 300mg/l as $C_aCO3$for fresh water fish culture (Stirling 1985). This could be as result of little or minute deposited of line stone in and around the Dam to raise the alkalinity level of the dam to the recommended values reported by Stirling 1985 and Hem 1970.The high alkalinity observed in week 2 (46.33mg/l) could be attributed to the reduction in water volume, which agrees with the observation of Ovie and Adeniji (1993) of higher alkalinity during low water level. Alkalinity correlates positively with hardness, pH, conductivity, temperature, nitrate, and phosphate, and negatively with BOD, DO, transparency. The highest value of hardness recorded during this research for both weeks and stations were 65.50mg/l in week 4 and 51.00mg/l at station 3 respectively. The lowest values were 6.77mg/l in week 1 and 7.37mg/l at station 5.

These values falls within the range classified for soft water observed by Thurston *et al*. (1979) who classified water as being soft when it falls within the range of 0.75mg/l. the above classification Thurston *et al*. (1979) implies that the water in Agaie/Lapai Dam is a soft water. It was observed that hard waters are more productive biologically than soft water (Hadrain, 1985). High hardness observed in week 4 may be due to low temperature (28.56^{o}C). This agrees with the findings of Rand and Ptrocelli (1985) that water hardness could to be a result of mineralization of the water body and lower temperature. This is also known to enhance water hardness. The high hardness observed a station 3 may be due to decay process as a result of less water movement and low temperature (28.00C). Low water hardness observed in weeks 1,2 and 3 and stations 1 and 5, could be as a result of low concentration calcium and magnesium carbonates, since carbonate mineral have been implicated in influencing the degree of water hardness (Boyd, 1979). It could also be attribute to higher temperature especially around the stations.

The dissolved oxygen recorded during this research was not stable. The range of DO recorded were 8.00mg/l-7.73mg/l within weeks and 6.69mg/ l-6.60mg/l within stations. These values agree with the recommended minimum of 5.0m/l by EIFACT (1973) for fish culture.

The high values of DO obtained in week 3 and 4 may be due to cool water, which agrees with APHA (1995) that cool water more DO than warm water. It could be as result of the aeration of water by wind which consequently increased the DO content in the water. High DO value obtained at stations 4 and 5 could be due to water movement which lead to the agitation of water and subsequently increased the DO content in the water. Low DO at station 1 could be due to discharge of organic and inorganic waste into the water around the station. This agrees with the findings of Michael (1986), who reported that water with high organic or inorganic pollution may have very little oxygen in them.

High BOD value were recorded at stations 4 (12.00mg/l) and Station 5 (12.00mg/l).This could be attributed presence of decay processes. It could also be as result of the shakiness of the stations; therefore the organic decay process might have used up the Do, thus resulting to lower DO content and higher BOD. The lower values recorded at station 1 and 2 could be due to little organic matter and low temperature process which subsequently leads to decrease in biodegradation of organic matter. There was no much difference in nitrate between the weeks and stations. The values of nitrate recorded in mg/l during this research were very low potential for primary productivity. This does not fall within the recommended range by Beadle (1981) who observed that in more production in land lakes of Africa, nitrate-nitrogen level range from 9.8-49mg/l. The low nitrate level of Agaie/Lapai Dam could be attributed to the absence of farming activities round the dam.

The values of phosphate-phosphorous recorded were generally low when compared to the standard recommended by Beadle (1981). 3.2-630mg/l which could be due to dilution and movement of water which prevented rapid sedimentation and decay of organic matter. The low level of phosphate in Agaie/Lapai Dam could be attributed to the absence of farming activities upland around the dam. Meanwhile stations 1 and 2 recorded higher values of phosphate; this may be due to phosphate in the water at the stations from the decomposition of dead animals or microorganisms. It could also be from droppings of animals defecating in the water.

CONCLUSION

The differences observed between stations and weeks and other variations in the physico chemical parameters of Agaie/Lapai Dam could be attributed to the site/location of the Dam, the amount of precipitation obtained annually as well as the anthropogenic activities taking place around the Dam. The physico-chemical parameters analyzed indicated the most of them fall within limit standard set by the Federal Ministry of Environment (FMENV, 2000) for Nigeria. The only exceptions are conductivity, hardness and alkalinity which are below the recommended standard.

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