EFFECT OF VARIATIONS OF PHYSICOCHEMICAL PARAMETERS AMONG SELECTED FISH PONDS IN GOMBE STATE, NIGERIA

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ABSTRACT

Fishing activities has been known to be the common sources of food and employment to the people leaving around riverine area. As such, increase in agricultural activities such as fertilizer application has led to the severe alteration of the chemistry nature of the water body thereby affecting the fishing activities. Analysis of the physicochemical parameters of some selected Ponds at Kwadon area of Yamaltu Deba LGA, Gombe State were conducted with the aim of determining the effect changes in physicochemical parameters on aquatic biota. Standard laboratory techniques were employed for the analysis of the parameters. Results of the study showed that, the average values of the temperature, pH, dissolve oxygen (DO), Biochemical oxygen demand (BOD), Total hardness, Conductivity and Total dissolve solid (TDS) were found to be at ranged of 27.4°C±0.56-27.6°C±1.2, 6.68±0.1-7.62±0.30, 4.66±4.45-13.84±3.96mg/L, 1.69±1.13-7.7 7±2. 89 mg/L, 23.50±1.7-31.20±0.80 mg/L, 15.90±0.68- 22.10±0.78 mg/L, 139.70±3.90-247.40±1.5 S/cm, 66.90±12.28-113.90±75.86 mg/L. These values were found to be within the ranges recommended for good fish production, indicating the minimal effect of agricultural activities on the healthy state of the ponds. Hence suggesting good environmental conditions for fish survival and growth.

Keywords: Fish, Pond, Physicochemical parameters, Water, Agricultural Activities

INTRODUCTION

Pond ecosystems are often teaming with rich vegetation and a diverse organism life. Pond is a body of fresh water smaller than a lake which is naturally formed by a depression on the ground filling and retaining water. It can also be man-made which can be created by damming a stream, and digging holes (Muhammad *et al*., 2018). The bottom of a pond is usually sediment of sand, decaying matter and micro-organisms. Pond water is usually stagnant with a wide variety of microbial life. Nutrients are brought to the pond by streams that feed into, run off during rain, or by the human anthropogenic activities (Ehiagbonare and Ogunrinde, 2010). The water in soil, animal waste and decaying plant matter in the pond are broken down and used to fuel the pond ecosystem (Boyd, 1990).

Water quality refers to the chemical, physical, biological, and radiological characteristics of water (Vyas *et al.*, 2009). Water quality describes the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking, fishing, swimming or to ascertain the suitability of such pond water for artificial fish culture (Ayanwale *et al.*, 2012). According to Burnett (2008), ponds have an average of 184.5 different types of microbes. In some bodies of water, the concentration of microscopic algae and quantities of pesticides, herbicides, heavy metals, and other contaminants may also be measured to determine water quality (Ayanwale *et al.*, 2012). Conversely, other parameters like biological oxygen demand and chemical oxygen demand indicate pollution level of given water body (Ehiagbonare and Ogundiran, 2010). The components of the pollution contribute to greater oxygen demand and nutrient loading of the water bodies, promoting toxic algal blooms and leading to destabilized aquatic ecosystem (Morrison *et al*., 2001).

Water is the culture environment for fish where they perform all their bodily functions. They are totally dependent upon water to breathe, feed and grow, excrete wastes, maintain a salt balance, and reproduce (Saidu *et al*., 2018). Water quality focuses on the various aspects of the physicochemical parameters of water by which state of a water body can easily be observed. It is the first most important limiting factor in fish culture which is normally governed by a number of parameters including color, odor, temperature, pH, DO, BOD, TDS, EC, transparency, acidity, alkalinity and hardness (Boyd, 1990). Each of these parameters has a standard value for fish culture (James, 2000).

The increasing demands for animal protein by man, coupled with the dwindling supply from livestock and poultry, has shifted attention to fishery for meeting human needs. Fish is an inexpensive source of protein in many regions of the world whereas water serves as the physical support in which they carry out their function such as feeding, swimming, breeding, digestion and excretion (Bromnark and Hansson, 2005). Studies have shown that production of protein through fishery is cheaper, less laborious and the protein is of comparatively high quality. For instance, Adekoya (2001) noted that fishes are responsible for about 55% of the protein intake sources of Nigeria citizens. According to James (2000), one of most the important factor that limits productivity in fish production is lack of controlled environmental conditions which is the main objective of the Committee for Inland Fisheries and Aquaculture of Africa (CIFAA) according to Food and Agricultural Organization of the United Nations (Saloom and Duncan, 2005).

FAO (2012), reported that the major environmental impacts of aquaculture have been associated mainly with high-input intensive systems which result in water pollution. However, little or no information is available to the farmers on the factors leading decline of economic viability of aquaculture around the region. In view of these, this study seeks to ascertain the effect of water quality variation on growth performance of fish in aquaculture.

MATERIALS AND METHOD

Study Area

Gombe State is located between latitude 9°30' and 12°30' N and longitude 8°45'E and 1 1°45'E of the Greenwich meridian. The state share borders with Yobe and Borno to the north and east, Adamawa and Taraba to the south and Bauchi to the east. Kwadon which is an area of Yamaltu Deba Local Government is located at eastern part of the state.

Method of Sample Collection

Eight ponds were first sampled and physically surveyed twice in the first week of the study for preliminary survey. Four sampling stations were chosen using Random selections method and were designated as A, B, C and D.

Pond water was collected using plastic container of one-liter capacity. The bottles were rinsed with pond water before collection. During sampling, containers were dipped and filled at a depth of 30cm below the surface of the pond. The samples were labeled and transported to the laboratory. Samples were collected at two-week intervals for the period of the study.

Determination of Physicochemical Parameters

The physicochemical parameters analyzed during the study include pH, temperature, turbidity, alkalinity, DO, BOD and heavy metals as per standard methods (APHA 2005).

Measurement of pH

pH meter were first be calibrated with buffer 4 and 7 (using 1M NaOH and 1M HCL). The probes of the pH meter were rinsed with distilled water. Samples of 20 ml of pond water were measured in labeled beakers, and then the probes were inserted into the sample collected. The reading were taken when the pH meter display a stable value (Ehiagbonare and Ogunrinde, 2010).

Total Alkalinity

50 mL of the water (sample) was added in a conical flask, followed by the addition of three drops of phenolphthalein indicator. Methyl orange indicator was later added and the resultant solution was titrated against 0.05M HC1 until pink color was observed. The final burette reading were recorded as volume of acid used and the total alkalinity was determined using the equation below as adopted from (Ehiagbonare and Ogunrinde, 2010);

$$\text{Total Alkalinity} = \frac{\text{Vol. of Acid} \times \text{Molarity of Acid}}{\text{Vol. of Sample}} \times 1000$$

Dissolved Oxygen (DO)

2 mL of manganese sulfate ($MnSO_4$) and 2 mL of alkali (sodium) iodide azide reagent were added to 100 mL of pond water. The solution was left to stand until it formed clear supernatant, then 2 mL of concentrated sulphuric acid were added for preservative purpose then was swirl to ensure uniform distribution of iodide. The prepared sample was then stored in the laboratory for three days. Later it was titrated against Sodium

thiosulfate (Ehiagbonare and Ogunrinde, 2010).

Biological Oxygen Demand (BOD)

Water samples were aerated for five days at 20°C in an incubator in a BOD bottle. Distilled water was used as water solution for dilution and as a blank. BOD reading was determined based on the expression below (Ehiagbonare and Ogunrinde, 2010):

BOD_5 (mg/L) = $DO_o - DO_d$

DO_o = dissolved oxygen of the first day,

DO_d = dissolved oxygen after five days.

Total Hardness

A buffer solution was prepared by dissolving 1.179g EDTA and 780mg $MgSO_4.7H_20$ in 50 cm^3 of distilled water. 2 cm^3 of the buffer solution and 2 drops of Eriochrome black T. indicator was added to 50 cm^3 of the sample pond water. The resultant reddish solution was titrated with standard ethylene-diamine-tetraacetic acid (EDTA) with gentle drops of the EDTA at 5 seconds intervals until a blue colour appeared (Ntengwe, 2008).

$$\text{Total hardness, } MgCaCO_3/dm^3 = \frac{(A \times B) \times 100}{\text{Vol. of Sample } (cm^3)}$$

Where A =1.179 g (weight of EDTA), B = 780 mg (weight of $MgSO_4$. $7H_20$)

Chloride ion

100 cm^3 of the sample water were measured and placed in a beaker. The pH of the water was adjusted to 8.0 using sodium hydroxide solutions and 10 cm^3 of K_2Cr2O_4 indicator were also added. The resultant mixtures were titrated with 0.04 mol/dm^3 $AgNO_3$ (APHA, 1992).

$$\text{Chloride ion, Cl} = \frac{\text{Titre value} \times M}{\text{Vol. of Sample } (cm^3)} \times 1000$$

Where M = Molarity of $AgNO_3$ = 0.04 mol 3.4.7

These were used to determine the concentration of the dissolved mineral salt and to determine the ionic effect in water sample. The conductivity was determined using a digital conductivity meter (HI 9853). Pond water samples of 20 mL were measured and dispensed into the labeled beakers. The meter were switched on and its probe rinse with distilled water, then inserted into the pond water samples, and the read button were pressed on the meter to take the readings in us/cm (micro Siemens per cm) (Ehiagbonare and Ogunrinde, 2010).

Total dissolved Solid (TDS)

This test was determined by the concentration of total dissolved solid particles in the water samples. A digital meter (HI 9853) was used to determine the TDS of the sample pond water in ppm (Ehiagbonare and Ogunrinde, 2010).

Statistical Methods

Data were analyzed using Statistical Package for Social Sciences (SPSS) statistical software for Windows version 23. Means and Standard deviation were used to compare the data from individual ponds while Pearson's correlation was used to ascertain the level of significance between the different ponds, parameters and their values a: r = 0.01 level of significance.

RESULTS

The results for the physicochemical analysis (pH, DO, BOD, Total hardness, Chloride, Conductivity and TDS) of the four waters sample are shown in the Table 1. Pond A have the highest value of BOD of 6.95ppm, Pond B have the highest value of Conductivity and TDS of 247.4is/cm and 113.9 ppm respectively. Pond C has the highest value of Total hardness and chloride of 31.2 ppm and 22.l ppm respectively while Pond D have the highest value of DO and pH of 13.84mg/L and 7.62 respectively.

Table 1: Physicochemical parameters of the four ponds as compared with FEPA and WHO Standard

Parameters	Pond A	Pond B	Pond C	Pond D	FEPA[1]	WHO[2]	Desirable Range[3]
Temperature (ºC)	27.4±1.30	27.5±0.69	27.6±1.28	27.4±0.56	27.0	<35.0	20-30
pH	6.68±0.16	7.01±0.34	7.29±0.40	7.62±0.30	6-9	6.5-8.5	6.5-9
DO (mg/L)	8.64±3.75	4.66±4.45	6.26±4.37	13.84±3.96	8-10	8-10	5.0
BOD (mg/L)	1.69±1.13	2.20±1.29	2.56±2.24	7.77±2.89	10	10	0.29
Total Hardness (mg/L)	23.5±1.71	25.7±0.66	31.2±0.80	28.9±0.64	-	200	50-400
Chloride (mg/L)	21.6±1.30	15.9±0.68	22.1±0.78	19.3±0.87	-	-	-
Conductivity (us/cm)	139.7±30.9	247.4±175.77	215.7±68.4	161.2±107.59	200	-	20-1500
TDS (ppm)	80.7±61.03	113.9±75.86	90.2±12.28	66.9±12.28	500	-	500

Federal Environmental Agency (1991) 2World Health Organization (1986) 3Boyd (1990)

Table 2: Comparison between the parameter, pond and the values obtained

	Properties	Result	Location
Properties	1.000	0.614**	0.000
Result	0.614**	1.000	0.002
Location	0.000	0.002	1.000

**Correlation is significant at the 0.01 level (2-tailed).

In table 4.2 above, Pearson's correlation was used to indicate which of the ponds correlate better in terms of properties, results and locations. It shows that there's strong correlation between location, results and properties (r =1.00). There's also strong correlation properties and result (r = 0.614), while there's no correlation between location to pond location to result in all the study ponds.

DISCUSSION

The water used for the cultivation of fish will not give maximum production if the physicochemical parameters are not optimal for fish and another aquatic organism. Water temperature, an important parameter in this study, influences the onset of fish spawn, aquatic vegetation growth and the biological demand for oxygen in ponds. As water temperature increases, it holds less oxygen. Also, plants and animals use more oxygen dependent due to respiration. These factors commonly result in less available oxygen for fish in water.

Temperature

A prior knowledge of maximum and minimum water temperature of the water is essential for fish culture. Ideal temperature of 27°C holds good for fish culture in pond (FEPA, 1999). In the present study, the average temperature reading for sample A, B, C and D were found to be 27.40±1.30°C, 27.5±0.60°C, 27.40±0.56ºC and 27.40±0.56°C respectively which falls within the guidelines given by FEPA. These temperatures was found to be similar to the research of Mishra *et al.*, (2014), Shrivastava and Kunungo (2013), as well as Ntegwu and Edema (2008) who reported optimum temperature range of 20°C - 30°C for increased fish productivity. Also, this finding corroborates the report of Fafioye (2011) who reported a temperature range of 27°C-28°C in his preliminary studies and water characteristic of microbial population in Kojalo fish pond.

pH

pH is an important limiting factor in fish culture. It indicates the acid - base balance of the water which serves as a major factor that determines the growth of microorganisms. The survival and growth of fish is also depending on pH of the water since it helps to determine if the water is a proper environment for fish, plants and algae. The desirable range for pond pH is 6.5 - 9.5 and acceptable range is 5.5 - 10.0 (Stone and Thomforde, 2003) and 7.0 to 10.0 is required for aquaculture as reported by Njoku *et al.*, (2015). The ranges of the pH obtained from this study were 6.68+0.16, 7.01±0.34, 7.29±0.34 and 7.62±0.30 in Pond A, B, C and D respectively. This agrees with values reported by Stone and Thomforde (2003) as acceptable range. It was also within normal range when compare with the reports of Kamal *et al.*, (2007); Ehiagbonare and Ogunrinde (2010), and Mishra *et al.*, (2014) also reported a range of 6.28 - 7.30.

DO

Dissolved oxygen is a measure of amount of gaseous oxygen dissolved in an aqueous solution. Among all the dissolved gases in water, oxygen is the most important for the survival of organism under aquaculture. Dissolved oxygen plays a vital role in the biology of cultured organisms (Dhawan and Karu, 2002). The DO obtained from this study varied significantly but all are within the required ranges of 8.64±3.75, 4.66±4.45, 6.26±4.37 and 13.84±3.96 mg/L in pond A, B, C and D respectively. Most of the values obtained corroborate with the findings of Onome and Ebinimi, (2010) who reported DO of 4.34 mg/L and 6.33mg/L from the surrounding industries near fish farm, and Ehiagbonare and Ogunrinde (2010) who reported DO value of 9.3 mg/L - 16.2 mg/L. According to Guidelines given by Water Quality Management for fish culture by FEPA, the minimum concentration of 8.0 mg/L should be maintained in fish ponds at all times. However, Saloom and Duncan (2005) suggested that the minimum DO should be 5 mg/L for tropical fish. DO concentrations in the present study were generally at the desirable value. This may be as a result of high levels of photosynthetic organisms in the ponds.

BOD

Biochemical oxygen demand varied significantly among the ponds. The BOD obtained from Pond D (7.77±2.89mg/L) was higher than the findings of Ehiagbonare and Ogurinde (2010) who reported BOD of 3.38 mg/L in Oloku, 2.4 mg/L in concrete ponds in Igusa and 1 .6 mg/L in earthen pond at Afugle during the study of physiochemical analysis of pond water in Okada and its environs. The increase in BOD might be due to excreta of the fish, feed use or high organic matter (Kay *et al*., 2008). The study also revealed that the values of 1.69±1.13, 2.20±1.29 and 2.56±2.24mg/L were recorded in Pond A, B and C respectively. According to the guidelines for Water Quality Management for fish culture in Tripura, the optimum BOD level for aquaculture should be less than 10 mg/L (APHA, 1992). The values are below FEPA recommended standard (FEPA, 1991) of 30 mg/L and those of APHA (1992) which is 4 mg/L. This implies that the pond water is devoid of pollution and the fishes are not affected negatively.

Total Hardness

Water hardness is important in fish culture. It is a measure of the calcium and magnesium concentration in water samples. Hardness gives a measure of the total concentration of the divalent cation of Calcium, Magnesium and Strontium. Hardness in all the ponds were not varied widely occurring at 23.50±1.71, 25.70±0.66, 31.2±0.80 and 8.9±0.64 mg/L in pond A, B, C and D respectively.

According to Guidelines for Water Quality Management for fish culture in Tripura, the ideal value of hardness for fish culture is 30-l80 ppm (APHA, l992). The concentration are also within the recommended value of 25-l00 ppm (mg/L) (Wurts and Durbow, 1992) indicating well management of the parameter in all the water ponds.

Chloride

Results of the chloride ion were found to be 21.60±1.30, 15.90±0.68, 22.10±078 and 19.30±0.87 mg/L for pond A, B, C and D respectively. These are typical levels in fresh water systems and are therefore considered normal (APHA, 1992).

Conductivity

Conductivity value obtained in all the ponds were measured and found to be 139.70±30.90, 247.40±175.77, 215.70±68.49 and 162.20±107.59 us/cm for pond A, B, C and. D respectively. The FAQ acceptable limit for conductivity in aquaculture is between 20 to 1500 µs/cm (DWAF, 1996). In comparison, Ehiagbonare and Ogurinde (2010) reported lower conductivity values of 0.012-0.01 7µs/cm for Okada natural water but were comparable to those of Utang *et al*., 2012) in fish ponds. The conductivities are however typical of fresh water and are considered normal.

TDS

Total dissolved solids readings obtained from the ponds were found to be 80.70±61.03, 113.90±75.86, 90.20±16.93 and 66.90±12.28 ppm for pond A, B, C and D respectively. The different feeds supplements used in feeding the fishes including both industrial and local processing may be the cause of high TDS between the ponds. Fish feeds have been reported to increase total dissolved solids of a particular water body (Ogbeibu and Victor, 1989; Ogbeibu and Edutie, 2006). Also, high values may also be as a result of the boundaries of the ponds which disallow inlet waters from nearby sources.

Pearson's correlation results indicated that the ponds correlate better in terms of properties, results and locations (r = 1.00) (Table 2). There's also strong correlation between properties and result (r=0.614), while there's no correlation between location to properties and location to result in all the study ponds.

CONCLUSION

This study observed that fish farmers in the investigated areas used very close to normal pH of water fish production, while the high content of BOD in pond A and D will deplete the DO amount which will eventually be harmful to aquatic life. Findings from this work revealed that regularly monitoring water parameter such as temperature and pH provide insight to the health of the aquatic ecosystems.

There is the desirable need to analyze pond water at regular intervals monitoring Pond water quality. Farmers should be educated on better managerial practices bordering on practices, pond management, good water exchange practice to reduce organic load and waste accumulation.

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