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Full Length Research Paper

Physico-chemical analysis of fish pond water in Okada and its environs, Nigeria

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Water samples were collected from concrete and earthen fish ponds in different locations in Okada and its environs, Edo State, Nigeria. Twenty-one different physiochemical parameters were analyzed using standard laboratory methods and procedures. In the present study, the values of the parameters ranged from pH 6.75 - 7.10, conductivity 0.012 - 0.017 mS/cm, TDS 22 - 906 mg/l, COD 162 - 397 mg/l, turbidity (NTU) 5 -170, TSS 85 -206 mg/l, BOD 1.69 - 3.38 mg/l, DO 9.3 - 16.2 mg/l, acidity 100 - 575 mg/l, alkaline 35 - 135 mg/l, calcium 16.01 - 50.06 mg/l, magnesium 1.21 - 5.46 mg/l, hardness 0.40 - 1.47 mg/l, chloride 7.1 - 10.65 mg/l, sulphate 0.66 - 0.96 mg/l, phosphate 1.40 - 4.51 mg/l, nitrate 2.21 - 4.91 mg/l, copper 0.01 - 0.07 ppm, and zinc 0.01 - 0.07 ppm; cadmium and lead were not detected in the samples. There was significant variation of values from location to location; generally there was no significant difference from desirable and acceptable standards. Although there is economic advantage to the fish farmers, there is the desirable need to analyze the fish pond water at regular intervals. This quality assurance process is to ensure that there are no toxic substances in ponds leading to possible bio-accumulation and magnification. In this way the good health of aquaculture, humans and the environment can be guaranteed.

Key words: Physiochemical parameters, concrete fish ponds, desirable and acceptable standards.

INTRODUCTION

A pond is referred to as a man-made or natural water body which is between 1 m^2 and 2 ha (~5 acres or 20,000 m^2) in area, which holds water for four months of the year or more (Biggs et al., 2005). Water quality generally means the component of water which must be present for optimum growth of aquatic organisms. The determinant of good growth in water body includes dissolved oxygen, hardness, turbidity, alkalinity, nutrients, temperature, etc. Conversely, other parameters like biological oxygen demand, and chemical oxygen demand indicate pollution level of a given water body. In most water bodies, various chemical parameters occur in low concentrations.

This concentration level increases due to human activities, and lack of environmental regulation (Mehedi et al., 1999). The fish ponds in Okada and environ play a role in fisheries. Some published data reflect adverse effects at concentrations higher than acceptable limit (GESAMP, 1985). The productivity depends on physio-chemical characteristics of the water body (Huct, 1986). There is dearth of information on the fish ponds in Okada and it's environ. The purpose of this present investigation was to determine the values of the major physiochemical parameters of Okada fish ponds and it's environ. Furthermore, to determine if there is any build up of toxic substances which could lead to bio-accumulation and magnification leading to health implications.

MATERIALS AND METHODS

The study area is located between longitude 50 30'E and latitude 60 30'N. The plates of the different sites used for this investigation are shown in Plates 1, 2, 3, and 4. This analysis was made on samples from three different concrete ponds from different sites and

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Abbreviations: TDS, Total dissolved solids; **BOD,** biochemical oxygen demand; **COD,** chemical oxygen dissolved.

Plate 1. Concrete pond located in Oloku (1).

Plate 2. Concrete pond located in Oloku (2).

an earthen pond in a different site, one being a rectangular earthen pond located at Afuegbe, Okada Junction; the other two been rectangular concrete ponds located in Oloku and Iguosa. Each pond is stocked with catfish and surrounded by plants. Water sample was taken under water, closed beneath to avoid skewed results and at a temperature of 32°C. The pH was determined using a pH meter (Suntex model Sp- 701), which was first calibrated with buffers 4 and 7 (these were solutions already prepared for

Plate 3. Concrete pond located in Iguosa.

Plate 4. Earthen pond located at Afuegbe.

calibration of the meter). Turbidity was measured using a spectrophotometer (HACH model DR/2010), using distilled waster as a blank and read at a wavelength 860 nm. Total suspended solids was also determined using the spectrophotometer but on a wavelength of 810 nm. Total dissolved solids was obtained using a TDS meter (Analytic TDS meter) with the electrode rinsed in distilled water before measurements, this was done to avoid any error or contaminant that could skim the result. Conductivity was taken using Suntex Sc - 120 which measures in milli Siemens/ centimetre (mS/ cm).

Dissolved oxygen (D.O.) was determined by a titration method; 2 ml of manganese sulphate and 2 ml of alkali Iodide azide reagents were added and a brownish colour was obtained. The solution was then made to stand until it formed clear supernatants. Concentrated sulphuric acid was added for preservative purpose and was shaken to distribute iodide evenly. Sodium thiosulfate was used in titrating to get a pale yellow colour and 1 ml of 1% starch was added to get blue-black colour. At a point, the blue-black colour disappeared which is referred to as the end point, and this coincided with the amount of D.O. in the water samples methods described by (Ademoroti, 1996; APHA, 1992). Sulphate was determined using the colorimetric method where 25 ml of each sample was measured into a Nessler tube; 25 ml of Barium chloride was added. The solution, which gave various colours, was allowed to stand for 15 min and its turbidity was measured at a wavelength of 420 nm in a spectrophotometer. Nitrate was determined by measuring 10 ml of the sample into a Nessler tube and the same amount of distilled water was measured into another Nessler tube, 0.5 ml of brucine and 20 ml of concentrated sulphuric acid was added to each, then the turbidity of the colour produced by each tube was measured using a spectrophotometer at a wavelength of 470 nm.

Chemical oxygen demand (COD) was determined using a digestion solution by HACH (with a range of 0 - 1500 ppm). The samples (this included the blank - distilled water) in the digestion solution were heated for 2 h, it gave various colours for each water sample and the meaning of the colours were read using the spectrophotometer. Total hardness was also determined titrimetrically, where 20 ml of each sample was measured each into conical flask with 50 ml of water. Different reagents were added like ammonia buffer, potassium cyanide (KCN), few drops of hydroxylamine-hydrochloride and Erichrome Black T was added as an indicator after the solution is left for five minutes for reaction to take place. It was then titrated against Ethylene diamine tetra acetic acid (EDTA) to yield a permanent blue colour. In determining the level of magnesium in the water sample, the level of calcium was determined first using the reagents potassium cyanide, potassium hydroxide, calcium red, and hydroxylamine - hydrochloride, titrated against EDTA which turned the red colour to permanent blue. The value of total hardness was read off the burette and then the value of magnesium was then determined by subtracting the value of calcium from the value of total hardness.

Two ways were used in determining biological oxygen demand (BOD) in the water samples collected by aerating for five days (BOD 5) or aerating for seven days (BOD 7) using an aerating device. For this analysis, BOD 5 was used where the water sample was aerated for five days at 20°C in an incubator in a BOD bottle with a volume of 355 and 105 ml was the volume of the sample used. Distilled water was used as water for dilution and as a blank was aerated for five days too using a clean supply of compressed air, then the D.O. was then taken after five days of incubation and the BOD was determined using the mathematical formula below;

BOD (mg/l) = DOo - DOd × (Volume of BOD/ ml of sample).

Heavy metal analysis was made using Atomic Adsorption Spectrophotometer a Buck Scientific machine, model 210 VGP. Each heavy metal was determined using a special lamp called the Hollow Cathode lamp where electrons move from the cathode to the anode creating an electron stream after which the electrons build up at the anode then moves through a screen to the machine's screen, then the amount of each heavy metal was determined off the machine. Acidity was determined titrimetrically adding two drops of Phenol naphthalene to 50 ml of sample which is then titrated against 0.02 M sodium hydroxide (NaOH), pink colour appears because of the indicator in the sample. Alkalinity was also determined by adding methyl orange to 50 ml of each sample, it is then titrated against 0.02 M of hydrochloric acid which produced an orange colour when it reached its end point.

RESULTS AND DISCUSSION

Water quality study is essential for setting base line conditions and standards. Against these standards results of further studies can be evaluated. The results of this study are presented in Table 1. A total of twenty - one (21) different physiochemical parameters were analyzed. The analysis was based on the samples taken from concrete and earthen fish ponds. The parameters are presented in (Table 1). pH range was 6.89 - 7.10 with earthen pond having the value of 6.89; Conductivity, range was 0.006 - 0.017 mg/l and the earthen pond had the least value of 0.006. Turbidity ranged from 5 - 170 mg/l, the earthen pond had the lowest value of 5 NTU. TDS range was 22 to 960 mg/l with the least value of 22 mg/l from Iguosa concrete pond. TSS was in the range of 85 - 605 mg/l with Iguosa concrete pond having a value of 85 mg/l. COD ranged from 162 - 397 mg/l. BOD (mg/l) ranged from 1.69 - 3.38 mg/l, DO was from 9.3 - 16.2 mg/l, acidity ranged from 100 - 145 mg/l, alkaline was in the range of 35 to 135 mg/l, calcium values ranged from 16.01 to 43.05 mg/l, magnesium values ranged from 1.24 to 5.46 mg/l, hardness was in the range of 0.40 - 1.47 mg/l, chloride was 7.1 - 10.65 mg/l; sulphate had the range of 0.66 to 1.09 mg/l, phosphate had a range of 1.40 - 4.51 mg/l, nitrate values ranged from 2.21 - 4.91 mg/l, copper was in the range of 0.01 - 0.07 ppm while zinc values were 0.01 - 0.08 ppm. Cadmium and lead (ppm) were not detected in the samples.

Significant variations in values were observed in the various locations. Generally, the parameters analysed fell within the desirable and acceptable limits. Although, there were values higher than the acceptable limit, the situation can be remedied by change of water in the ponds. However, significant pollution of the fish ponds was not indicated from the result of the parameters analyzed.

pH

The desirable range for pond pH is 6.5 - 9.5 and acceptable range is 5.5 - 10.0 (Stone and Thomforde, 2003). The range of the pH obtained from this study was 6.89 - 7.10 (Table 1). This agrees with Stone and Thomforde (2003). Thus, good pond productivity and fish health can be maintained. Furthermore, a similar range was obtained by Kamal et al. (2007) who reported a range of 7.3 - 8.3.

Table 1. Physio-chemical analysis of water from concrete and earthen fish ponds.

Parameters /Sample sites	Concrete Ponds			Earthen pond At Afuegbe
	Oloku1	Iguosa	Oloku2	
pH	7.10	6.75	6.92	6.89
Conductivity (Ms/cm)	0.016	0.012	0.017	0.006
Turbidity (NTU)	170	5	136	145
TDS (mg/l)	360	22	960	796
TSS (mg/l)	206	85	107	605
COD (mg/l)	309	171	397	162
BOD (mg/l)	2.20	2.36	3.38	1.69
DO (mg/l)	13.4	9.3	11.9	16.2
Acidity (mg/l)	NIL	145	100	575
Alkalinity (mg/l	35	35	75	115
Calcium (mg/l)	43.05	17.02	50.06	16.01
Magnesium(mg/l)	2.43	1.21	5.46	1.82
Hardness (mg/l)	1.17	0.47	1.47	0.40
Chloride (mg/l)	7.1	14.2	10.46	28.4
Sulphate (mg/l)	0.96	1.09	0.90	0.66
Phosphate (mg/l)	2.10	2.04	4.51	1.40
Nitrate (mg/l)	2.80	4.11	4.91	2.21
Copper (ppm)	0.02	0.01	0.05	0.07
Zinc (ppm)	0.07	0.02	0.01	0.08
Cadmium(ppm)	ND			
Lead (ppm)	ND			

TDS, total dissolved solids; TSS, total suspended solids; COD, chemical oxygen demand; BOD, biological oxygen demand; DO, dissolved oxygen; ND, not detected.

Conductivity (mS/cm)

The conductivity varied from location to location and ranged from 0.006 - 0.017 mS/cm (Table 1). In comparison, Ehiagbonare et al. (2009) reported higher conductivity values for Okada natural water and therefore not supportive of the present findings with respect to conductivity. The Okada water body was observed to have been polluted with cassava effluent. This may have accounted for the difference in conductivity values.

TDS

Total dissolved solid varied from 22 - 960 mg/l. The highest value being 960 mg/l and the least value being 22 mg/l. Farmers use feeds to supplement pond nutrients. Among others the feeds have been reported to increase total dissolved solids (Ogbeibu and Victor, 1989; Ogbeibu and Edutie, 2006). This may have been responsible for the variation from location to location of the ponds in this study. The result is supportive of the findings of this study.

TSS

Pillay (1992) reported that effluent water increases TSS of ponds. In this study, there was no evidence of effluent water flow into the ponds. Omitoyin et al. (2005) reported that 15% fish meal contains crude protein and has been known to increase TSS. This may be the reason obtained values are high and thus the result of this investigation is in harmony with those of these authors.

COD

Chemical dissolved oxygen varied from pond to pond (Table 1). The result of this investigation corroborate with the results of Das et al. (1990) who had a similar result like those obtained from this investigation.

BOD

Biochemical oxygen demand varied significantly among the ponds. The highest value was 3.38 and least was 1.69 mg/l. These are all below FEPA standard (Federal Environmental Protection Agency of Nigeria, 1991). The FEPA limit is 30 mg/l. This is suggestive that the pond water is not polluted and the fishes are not being negatively affected. However, permissible limit as reported by APHA (1992) is 4 mg/l. This was not significantly different from the highest of 3.38 mg/l obtained from this study. Accumulation of low BOD results in organisms being stressed, suffocated and death (APHA, 1992). This was not observed in the ponds under study.

DO

This is a measure of amount of gaseous oxygen dissolved in an aqueous solution that plays a vital role in the biology of cultured organisms (Dhawan and Karu, 2002). The DO (mg/l) obtained from this study was in the range of 9.3 - 16.2 mg/l. These values agree with those of Saloom and Duncan, (2005). They also pointed out that the minimum DO should be 5 mg/l for tropical fish.

Acidity

The range of acidity was 0 - 575 mg/l. The variation was such that there were zero values in one pond (Table 1) and increase and decrease in others. This pattern was observed by Kamal et al. (2007), thus, it is supportive of the present result.

Alkalinity

The alkalinity ranged from 35 - 135 mg/l. The alkalinity of unpolluted pond was reported by Shastree et al. (1991) to be 171.2 - 235.5 mg/l. This is at variance with results of this study as lower values were obtained.

Calcium

Calcium ranged from 16.01 - 50.06 mg/l from the results of this study. Trivery and Khatavker (1986) had similar result when the highest value they reported was 50 - 66 mg/l. The result of this study is therefore in consonance with Trivery and Khatavker (1986).

Magnesium

Magnesium was present in the ponds and the concentration was 1.21 - 5.46 mg/l. Trivery and Khatavker (1986) reported magnesium concentration which ranged from 7.32 to 18 mgl, these are higher values than the result of this study. Also Desia (1982) reported higher value of 70 mg/l. The two are not supportive of the result of this study.

Hardness

Hardness values from this study varied from pond to pond, it ranged from 0.04 - 1.47 mg/l. The values are lower than the recommended value of 25 - 100 mg/l (Wurts and Durbow, 1992). Thus, the result of this study in terms of hardness is not supportive of Wurts and Durbow (1992). Water hardness is important in fish culture. It is a measure of the calcium and magnesium concentration in water samples.

Chloride

The range fluctuated between 7.1 - 28.4 mg/l (Table 1). Trivery and Khatavker (1986) reported a similar range 10 - 25 mg/l which is in harmony with the findings of the present investigation.

Sulphate

The concentration of sulphate in the ponds in the present study varied from 0.66 - 1.09 mg/l. These values are lower than those of Mishra (1991) who reported 42.46 - 57.36 mg/l. He suggested that the high values he obtained may have been caused by the used detergent and soaps by neighbours which got into the water body. This was not the case in the present study, hence possibly the low values obtained from this study.

Phosphate

In this study phosphate was found to vary from 1.40 - 4.51 mg/l. These values were higher than those of David (1963), Pahawa and Mehrotra (1966). They added that the area from which the samples were taken was polluted. Their reported value was 1.00 mg/l. The result is suggestive of possible pollution of the fish ponds under study.

Nitrate

The nitrate level in this study was in the range of 2.21 - 4.91 mg/l. The desirable limit is 0 - 2 mg/l and acceptable limit less than 4 mg/l (DWAMD, 1994). These desirable and acceptable limits are lower than those from previous study and therefore not in consonance with the result of this study. The high values suggested that there is the presence of pollutants like bacteria and pesticides. This can be remedied by water change and increase in plant density.

Copper and zinc

These ranged from 0.01 - 0.07(ppm) for copper and 0.01 - 0.08 (ppm) for zinc. There was no significant difference in the level of concentration between the two. These are heavy metals. This range of values was lower than those of Kuz'mina and Ushakova (2007) which was 10.6 (ppm). The presence of heavy metals significantly decreased hemoglobinlytic proteinase activities (Kuz'mina and Ushakova, 2007). Cadmium and Lead were not detected in samples used for this study.

Conclusion

Although there are economic advantages to the fish farmers, there is the desirable need to analyze the fish pond water at regular intervals. This is a quality assurance process to ensure that there are no toxic substances in the ponds leading to possible bio-accumulation and magnification. In this way the good health of the aquatic ecosystem, humans and environment can be guaranteed.

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