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Full Length Research Paper

Some Physicochemical Parameters of Selected Fish Ponds in Gwagwalada and Kuje Area Councils, Federal Capital Territory, Nigeria.

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The levels of the physicochemical regime of two selected fish ponds in Gwagwalada and Kuje Area Councils of the Federal Capital Territory were determined from July to September (rainy season) by using standard methods and equipment. The values of physico-chemical parameters of both fish ponds in the rainy season in Gwagwalada and Kuje respectively was between 87.75 ± 7.26 to185 ± 7.43ppm, for total alkalinity, 0.78 ± 0.44mg/L to4.06 ± 0.43 mg/L for BOD, 58.75 ± 7.81µs/cm and 262.23 ± 53.90µs/cm for conductivity, 7.13 ± 1.10 mg/L to 8.50 ± 0.23 mg/L for DO, 7.74 ± 1.03 to 9.02 ± 1.06 for pH, 24.5 ± 1.41 to 28 ± 0.70^{o}C for temperature and 2.15 ± 0.49 m to 4.45 ± 0.46m for turbidity. There was no significant difference ($p > 0.05$) in the levels of physico-chemical parameters between the fish ponds in Gwagwalada and Kuje. Fish pond A Kuje had the highest fish mortality 480 (24.10%) and fish pond B Gwagwalada had the highest 1050 (52.60%).Strong positive correlation(r=0.7,0.9,1) existed between fluctuation in physicochemical parameters and fish mortality in all the ponds except fish pond B Gwagwalada. Most of the Physicochemical parameters were also strongly correlated with one another. The essence of monitoring water quality in fish ponds, clearing ponds of rotten leaves, unconsumed feed and faecal matters to reduce organic matter which can impact adversely on water quality is also highlighted.

Keywords: Fish ponds, Physicochemical, monitoring, mortality, water quality**.**

INTRODUCTION

Fish and other organisms live in water. Thus, It is no surprise that professional fish culturists state that “water quality determines to a great extent the success or failure of a fish culture operation” (Piper *et al.,* 1982). Water quality includes all physical, chemical and biological factors that influence the beneficial use of water. A pond with good water quality will produce more and healthier fish than a pond with poor quality water (Boyd, 1998).

Some of the physico-chemical parameters that are regularly measured within an aquaculture pond include dissolved oxygen, alkalinity, hardness, pH, conductivity, temperature, turbidity and biological oxygen demand (BOD). Water qualities in ponds changes continuously and are affected by each other along with the physical and biological characteristics (USDA, 1996).

Water quality is frequently a prominent concern where aquaculture is practiced. Maintaining a healthy environment is not only important to the organisms being

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cultured, but also, to the flora and fauna that are indigenous to the site, as well as the migratory species that circulate through and around the site (Environmental Review, 2008). Maintaining a good water quality in aquaculture ponds will require effective monitoring to detect changes in environmental quality that results from aquaculture operations.

Despite, the existing studies (Adeniji and Ovie, 1982; Joseph *et al.,* 1993; Curtis, 1994 and Roberts, 2007) on some natural water bodies with respect to water quality, information about these critical water quality parameters in fish ponds are scanty in many areas of Nigeria, particularly in the Federal Capital Territory where there is a rise of this fledgling industry. The Federal Capital Territory needs to develop reliable information on water quality in aquaculture. This information is necessary to enhance the development of a balanced, comprehensive and effective policy which will promote aquaculture enterprises.

Monitoring of water quality can quantify the scope and duration of fish culture. Early identification of water quality degradation through routine monitoring permits aqua culturists to implement minor operational changes to correct identified problems before it reaches an extreme condition.

Early identification of environmental problems prevents cumulative environmental degradation which may save the life of cultured organisms. When degradation reaches an extreme level, cultured organisms experience depressed growth rates, increased disease conditions and even death. A situation fish farmers dread.

Some water quality factors that are more likely to be implicated with fish losses include dissolved oxygen, temperature and ammonia. Others, such as pH, alkalinity, hardness and clarity can affect fish, but usually not directly toxic (Stevens, 2007). Each water quality factor interacts with and influences other parameters, sometimes in complex ways (Meade, 1989). The determination and frequency of monitoring water quality depends upon the rearing intensity of the production system used.

All biological and chemical processes in an aquaculture operation are influenced by temperature. Each species of fish has a preferred or optimum temperature range where it grows best. At temperatures above or below optimum, fish growth is affected. Mortalities may occur at extreme temperatures (Piper *et al.,* 1982).

Turbidity determines light penetration in water. This in turn will have an effect on the temperature of the water and the amount of vegetation and algae that will grow in the pond, thus affecting the rate of photosynthesis and primary productivity (USDA, 1996; Environmental Review, 2008).

Chemical characteristics include water quality parameters that are chemical in nature within an aquaculture pond. These change continuously and are affected by physical and biological characteristics that have been mentioned previously (Boyd, 1990b). Some important chemical parameters include alkalinity, Biological Oxygen Demand (BOD), Conductivity, Dissolved Oxygen (DO), and pH which are considered to be important and critical water quality parameters in aquaculture (Boyd, 1998; Environmental Review, 2008).

The determination of these parameters will provide useful information to farmers in raising fish at a site for long period of time while minimizing impact to the environment, hence the essence of this study.

Description of Study Area

The study areas were Gwagwalada and Kuje Area Councils of the Federal Capital Territory. Gwagwalada Area council lies between latitude $8^0$55'N and $9^0$00'N and longitude $7^0$00'E while Kuje Area Council lies between latitude $7^0$05'N and $9^0$10'N and longitude $9^0$15'E (Mabogunje, 1977).

SAMPLING AND METHODOLOGY

Simple randomized sampling method was used in collection of water samples. Concrete fish ponds were selected based on size and consistency of stocking the ponds. Samples were collected from two fish ponds located in each of the Area Councils from July to September 2008 in the rainy. Sampling was done four times in a month (i.e once every week) for each of the fish ponds. The features of the pond such as depth, length and breadth were taken using a metre rule once at the beginning of sampling before determination of physico-chemical parameters. Other important information about the ponds such as source of water supply, period or length of use was obtained by interview and through questionnaire.

Determination of Physico-Chemical Parameters

The modified Winkler method (Annes, 1966) was used to determine dissolved oxygen. 300ml BOD bottles labeled appropriately were used in collecting water samples from different fish ponds at the different locations (U.S EPA, 2007).

The total alkalinity was determined using the methyl orange method (U.S EPA, 2007; Environmental Review, 2008). The pH was measured using a pH meter model British Milwaukee Smart Meter S204. Turbidity of the different water samples was taken *in-situ* using a Secchi disc. Temperature readings were taken using the mercury in bulb thermometer. The readings were taken *in-situ.* The procedures for collecting samples for BOD testing were as described for dissolved oxygen. For BOD measurement, two samples were taken at each site. One was tested immediately for dissolved oxygen and the second was

Table 1. Dimension of Fish Ponds in Gwagwalada and Kuje Area Councils.

Gwagwalada			Kuje	
	POND A	POND B	POND A	POND B
Length(metres)	3.2	3.5	7.2	7.2
Breadth(metres)	3.2	3.5	7.2	7.2
Depth(metres)	4.5	4.5	4.8	4.8
Volume(metres^3)	46.08	55.13	248.83	248.83

Table 2. Values of physicochemical parameters for fish pond A and B from July to September (rainy season).

	Alkalinity (ppm)		BOD (mg/L)		Conductivity (µs/cm)		DO (mg/L)		pH		Temperature (°C)		Turbidity (Metres)	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
July	112-128	100-126	0.86-1.56	102-1.48	72-112	74-138	7. 68-8.86	7.38-8.73	7.96-8.38	7.98-8.20	25-26°C	24-26	3.2-3.8	2.3-2.9
Mean/S.D	122.5±3.54	116±9.70	1.16±0.32	1.21±0.18	91.25±15.39	107.75±52.86	8.34±0.44	8.45±0.34	8.18±0.15	8.05±0.08	25.5°C±0.61	25±0.71	3.53±0.24	2.63±0.24
August	128-158	110-116	1.28-2.98	1.21-2.28	98-121	81-138	7.20-8.46	7.88-8.38	7.50-10.14	8.00-8.28	25-28°C	25-27	2.6-3.2	1.3-2.9
Mean/S.D	141.5±4.06	87.75±25.15	1.16±1.12	1.70±0.57	109.5±6.01	107.25±21.00	7.89±0.49	8.09±0.19	9.02±1.06	8.12±0.10	26.5°C±1.12	26.25±0.83	2.98±0.22	2.15±0.49
September	100-175	42-198	0.47-2.30	1.36-2.88	72-350	74-478	5.94-8.68	5.34-8.24	7.62-8.01	5.43-9.54	25-28	26-29	1.2-3.2	4.2-4.8
Mean/S.D	125.75±2.42	104.75±58.55	1.29±0.69	2.29±0.59	172.5±10.53	262.23±186.51	7.6 ± 1.01	7.13±1.10	7.79± 0.16	7.74±1.03	27 ± 1.22	27±1.22	2.83±1.01	4.45±0.46

incubated in the dark at ± 20°C for 5 days and then tested for the amount of dissolved oxygen remaining

Conductivity was measured using conductivity meter of model America Phillips Hanna H19813-0.

Data was analyzed by using Analysis of Variance (ANOVA), Student'sTest and correlation co-efficient analysis ,correlation matrix to test for significance, variation of the mean values and variables tested (Mahajan, 1997; Matur, 2008).

RESULTS

In fish ponds A and B in Kuje Area Council, the length and breadth were 7.2m x 7.2 m respectively and the depth of each pond was 4.8m. Fish pond A in Gwagwalada Area Council had length and breadth of 3.2m x 3.2m respectively and the depth was 4.5m. For Fish pond B in Gwagwalada area Council, had length and breadth of 3.5m x 3.5m and the depth was 4.5m (Table 1). The volumes of fish pond A and B in Gwagwalada Area Council were 46.08m^3 and 55.13m^3 respectively while fish ponds A and B in Kuje Area Council were 248.83m^3 each.

The result of physico-chemical parameters in pond A and B in Gwagwalada are shown in figure Mean alkalinity values rose from July to August and declined in September for fish pond A, while in the contrary, it decreased from July to August and increased slightly in September for fish pond B (Table 2). Generally, pond A had higher values than pond B in all the three months.

BOD value increased from July to August and declined sharply in September for fish ponds A and B (Table 2).Conductivity values increased from July to September in fish ponds A and B as shown in figure 1, however, the conductivity values were higher for fish pond B than A Gwagwalada (Table 2).

Dissolved oxygen values decreased gradually from July to September for fish pond A (Gwagwalada) in fish pond B, a gradual and steady decrease was observed from July to September (Table 2).

The pH values of ponds in Gwagwalada increased from July to August and experienced a sharp decline in September (Table 2), but a slight decline in September in pond B. The pH values of fish pond B was lower than that of pond A (Table 2).

Temperature values had a continuous pattern of increase from July to September in fish ponds A and B with higher value recorded in fish pond A (Table 2).Turbidity values decreased gradually from July to September in fish pond A (i.e a more turbid to clearer water) (Table 2), while fish pond B experienced a gradual decrease from July to

Table 3. Record of fish mortality in fish pond A and B (Gwagwalada Area Council) between July and September.

	Total Fish Stock (Pond A)	Number Dead (Pond A)	Percentage Mortality (Pond A)	Total Fish Stock (Pond B)	Number Dead (Pond B)	Percentage Mortality (Pond B)
July	1500	150	10.00%	2000	241	12.10%
August		225	15.00%		301	15.10%
September		275	18.30%		508	25.40%
Total		650	43.30%		1050	52.60%

Table 4. Record of fish mortality in fish pond A and B (Kuje Area Council) between July and September.

July	2000	92	4.60%	1700	176	10.40%
August		129	6.50%		206	12.10%
September		259	13.00%		433	25.50%
Total		480	24.10%		815	48.00%

August with a sudden increase in September (a clearer water in September than in July and August).

Similarly for Kuje, a gradual and steady pattern of increase was observed in total alkalinity from July to September in fish ponds A and B with a higher value in fish pond A (Table 2).

BOD values also showed a gradual increase from July to September in fish ponds A and B with the same BOD values for both fish ponds in August (Table 2). However, pond A had a higher BOD value than pond B.

A continuous and steady pattern of increase was observed for fish ponds A and B of Kuje from July to September in terms of conductivity with a lower value for fish pond B (Table 2).

Dissolved oxygen values decreased gradually from July to August with a sharp decline in September for fish pond B, while a continuous gradual decrease was observed for fish pond A from July to September (Table 2). Pond B had the highest DO value.

A steady and gradual increase was observed in pH from July to September in fish pond A of Kuje (Table 2), while pH values decreased slightly from July to August with a sudden rise in September for fish pond B.

Temperature values increased steadily from July to September in fish ponds A and B with higher value recorded in pond B (Table 2).

Turbidity values decreased greatly from July to August with a sharp increase in September for fish ponds A and B of Kuje (i.e a more turbid to clearer water in September) with higher value observed in fish pond B (Table 2).

From the record of fish mortality in fish ponds A and B (Gwagwalada Area Council) between July and September, fish pond A had higher mortality rates 650 (43.30%) than fish pond B 1050 (52.60%) as seen in Tables 3 and 4.

Similarly, in Kuje, fish pond B had a higher mortality rate 815 (48.00%) than fish pond A 480 (24.10%) between July and September (Table 4). The mortality rates between the two Area Councils were compared. Fish pond B (Gwagwalada) had the highest mortality rate of 1050 (52.60%) of all the fish ponds while fish pond A (Kuje) had the lowest mortality rate 480 (24.10%).

There was no significant difference ($p > 0.05$) in the physico-chemical parameters in fish ponds A and B in Gwagwalada and Kuje Area Councils during the rainy season (July to September).

DISCUSSION

The physicochemical parameters of the ponds studied Gwagwalada and Kuje Area Councils have shed some light into their productivity.

For instance, the mean temperature range (25-31^{o}C) of all ponds in wet. and dry seasons is still within the optimum temperature at which *Clarias gariepinus* which is the most common species cultured in these areas grow and reproduce. Adeniji and Ovie (1982) and Madu (1989) reported that the best temperature range for optimum production of *Clarias* species is 25 - 31^{o}C. This mean temperature values could explain why *Clarias gariepinus* thrive so well, and remains the most common species cultured within these areas.

In the rainy season the mean dissolved oxygen contents of both fish ponds in the two areas remained at optimum level of 7.13 ± 1.10mg/L to 8.50 ± 0.23mg/L within temperature range of 25 to 28^{o}C.The dissolved oxygen requirement for fish varies with species. Generally, the water quality for any fish cultured in tropical region must be such that the dissolved oxygen concentration must not be less than 3mg/L (Robert, 1979; 2007). The mean dissolved oxygen contents of these fish ponds in

Gwagwalada and Kuje showed that they are conducive for aquaculture in terms of the dissolved oxygen content. All the fish ponds have trees and vegetation grown around the ponds, this could account for the high DO level due to their shading effect which lowers the temperature resulting in more oxygen dissolved in the water. Brian (2006) and Ita *et al*., (1995) noted that increased DO level is needed to support an increase in metabolic rates and reproduction.

The rise in mean BOD values caused by fallen leaves and debris especially in September during the rainy season may have been caused by increase in organic matter. Abohweyere (1990) and Curtis (1988) reported that water quality is commonly impacted by the introduction of organic matter. The mean BOD value was 4.06 ± 0.43mg/L in September. Generally, the mean BOD values for both fish ponds in both areas was between 0.78 ± 0.44mg/L. ± 0.63mg/L, BOD value was high in the rainy season especially in September. Fallen leaves, and debris, and waste product of fishes and other insect population within the pond can cause possible increase in BOD. Eutrophication resulting from unused feed present in water is another possible reason for a sudden rise in BOD (Curtis, 1988; USDA, 1996). According to Curtis (1988) increased BOD can threaten the survival of fish and other aquatic organisms. Occasional increase in BOD levels can be handled through regular monitoring of water quality (Madu, 1989; USDA, 1996; U.S EPA, 2007).

Mean conductivity values for both fish ponds in Gwagwalada and Kuje was between 58.75 ± 7.05µs/cm to 262.23 ± 186.51µs/cm during the rainy season. This high surface water conductivity (262.23 ± 186.51µs/cm) is a pointer to the pollution status of the pond caused by fallen leaves, debris, excessive nutrient from feeds, and run-off during rains into ponds (a consequence of improper sitting of ponds) and waste products of fishes and other insects population within the pond.

The fish mortality in the wet season was 3, 196 (49.2%) for the fish ponds in the two Area Councils. The strong positive correlation (r = 0.5, 0.7, 0.9 and 1.0 at P < 0.05) observed between fish mortality rates and fluctuation in some physicochemical parameters in ponds B Gwagwalada and Kuje in the rainy reason suggests that high turbidity and low oxygen could be responsible for high fish kill. Low oxygen, high BOD, conductivity, pH as observed particularly in September, could be responsible for high fish kills recorded. According to Swann, (2007) and Robert, (2007) extreme levels of physico-chemical parameters such as BOD, Conductivity, DO, pH and Temperature could be lethal to fish. The lower mean conductivity values in the rainy season was as a result of the effect of rainfall on the amount of total dissolved solids (U.S EPA, 2007; 2008).Weak positive correlation (r=0.4) observed between physicochemical parameters and fish mortality in pond B Gwagwalada suggest that other factors might have been responsible for the high fish mortality.

The pH range for the two fish ponds in Kuje (6.58-7.74) and Gwagwalada (9.02-9.41) during the rainy season indicates high alkalinity. This extreme alkaline pH in August and September coincided with period of high fish mortality in both ponds. This showed that the pH at those periods rendered the ponds unfavourable for the fishes. Huet (1972), USDA (1996) and Robert (2007) indicated that the best water for fish cultivation is that which is neutral or slightly alkaline with a pH range of 7 to 8. Swann (2007) discovered that productive ponds, especially those with low alkalinity may have daytime pH of 10, which can be lethal to young fishes especially hybrid species. Robert (2007) also noted that fish can die from pH shock, a consequence of a sudden change in pH. According to Balarin and Hatton (1979), environmental factors are about the closest one in determining the survival of fish, the effective utilization of nutrient and the general performance of cultured fish. Such factors included water quality parameters like temperature, dissolved oxygen, turbidity and pH (Balarin and Hatton, 1979).

Turbidity in ponds results from colloidal clay particles and colloidal organic matter originating from decay vegetation. Mean turbidity range of both fish ponds in the two areas in the rainy season was between 1.90 ± 0.43m to 4.45 ± 0.46m .The high turbidity recorded in the rainy season was a result of mixing of water during rain fall. According to Henderson (1977) and Walker (1994), high levels of nutrient resulting from stocking densities and overfeeding can increase turbidity in aquaculture ponds. Turbidity restricts light penetration and limit photosynthesis (Boyd, 1979). The result is in line with previous works of Forsberg *et al*., (1996) and Balarabe (1998).

The physicochemical parameters studied showed that the levels obtained are suitable for the cultivation of *Clarias gariepinus*, and hence for aquaculture. But pH values of these ponds during the rainy season tended towards high alkalinity, which may not be suitable for fingerlings and fry culture.

Fluctuations in physicochemical parameters exist but these would not impair the suitability of the ponds for fish production. Continuous monitoring of these physicochemical parameters would give farmers firsthand information on strategies to employ in preventing and reducing fish kill. Furthermore it will help farmers, maintain good water quality in fish ponds pertinent to producing larger and healthier fishes for human consumption.

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