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Physico-Chemical Analysis of Fish Pond Water in Freshwater Areas of Bayelsa State, Nigeria

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ABSTRACT

The study of Physico-chemical parameters in earthen fish ponds in five Local government areas in Bayelsa State, Nigeria was conducted to determine the quality of water for pond fish culture from June to October, 2005. Water samples were collected from the ponds and analyzed using standard laboratory methods and procedures. The results showed variation in the observed parameters at the different sampling stations. Temperature ranged from 24.9± 0.3°C-25.3±0.30°C, pH 6.24± 0.02-6.68±0.10 and Ammonia-nitrogen (NH_3-N), 0.34±0.20-0.55±0.20mg/l. Dissolved oxygen values were 2.8±0.20-6.6±0.18mg/l, Biological oxygen demand ranged 2.9±0.60-4.52±0.90mg/l and Total alkalinity as 43.1±18.0-93.70±46.53mg/l. Total dissolved solids varied from 27.9±4.7-145.40±91.01mg/l while Total hardness was 19.7±4.1-44.3±15.07mg/l and Turbidity as 20.6±3.2-45.1±15.07ppm. Electrical conductivity was from 117.3±91.01-378.4±130.2µmhos/cm. The values for NH_3-N were higher than accepted values for fish culture while those of other parameters favoured good fish production. The observations in this study suggest that pond fish production in some freshwater areas of Bayelsa State in Nigeria could be practiced without adverse effects posed by the quality of water.

INTRODUCTION

Water is the home of the fish and its quality is one of the most over looked aspect of pond management until it affects fish production. Water quality generally means the component of water which must be present for optimum growth of aquatic organisms (Ehiagbonare and Ogundiran,2010). Water quality is made up of physical, chemical and biological factors which influence the use of water for fish culture purposes. These factors include dissolved oxygen, pH, hardness, turbidity, alkalinity, ammonia and temperature. Other parameters such as biological oxygen demand and chemical oxygen demand indicate the pollution level of a given water body (Ehiagbonare and Ogundiran,2010). Productivity depends on the Physico-chemical characteristics of the water body (Huct, 1986).

In recent years, the inland waters and the terrestrial life in the Niger Delta region of Nigeria which Bayelsa State is part of have been subjected to alteration ecologically. This is partly due to the human activities, population growth, oil exploitation and exploration which resulted in the pollution of the environment. 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 of such poor quality may be acidic, rich in nutrients and organic matter, high in suspended solids or polluted with industrial or agricultural chemicals. Such a deterioration in water quality can result in fish being stressed and vulnerable to disease (ICAR, 2006). Fish ponds in freshwater areas of Bayelsa State in Nigeria play vital role in fisheries to supply the much needed animal protein to the people inhabiting such areas. There is dearth of information on production of fish from ponds in Bayelsa State especially in the freshwater zones. It is therefore important to know about water quality parameters and their management which have influence on growth and survival of aquatic organisms. The purpose of the present investigation was to provide data on water chemistry and biological characteristics of fish ponds in selected freshwater areas of Bayelsa State. Furthermore, to determine any build up of certain parameters that may affect healthy fish production.

MATERIALS AND METHODS

Study area and Sampling stations.

Five Local Government Areas (L.G.A) in Bayelsa State, Nigeria with two sampling stations (fish farm sites): Ogbia (Ewoi and Ogbia towns), Southern Ijaw (Ayama and Ozezebiri towns), Yenagoa (Yenagoa town), Kolokuma/Opokuma (Kaiama and Opokuma towns) and Sagbama (Sagbama town) were chosen for assessment of water quality in fish ponds (Fig.1). Bayelsa State is in the South-South geo-political area of Nigeria. The climate of this area is characterized by dry season (November – April) and wet season (May-October).

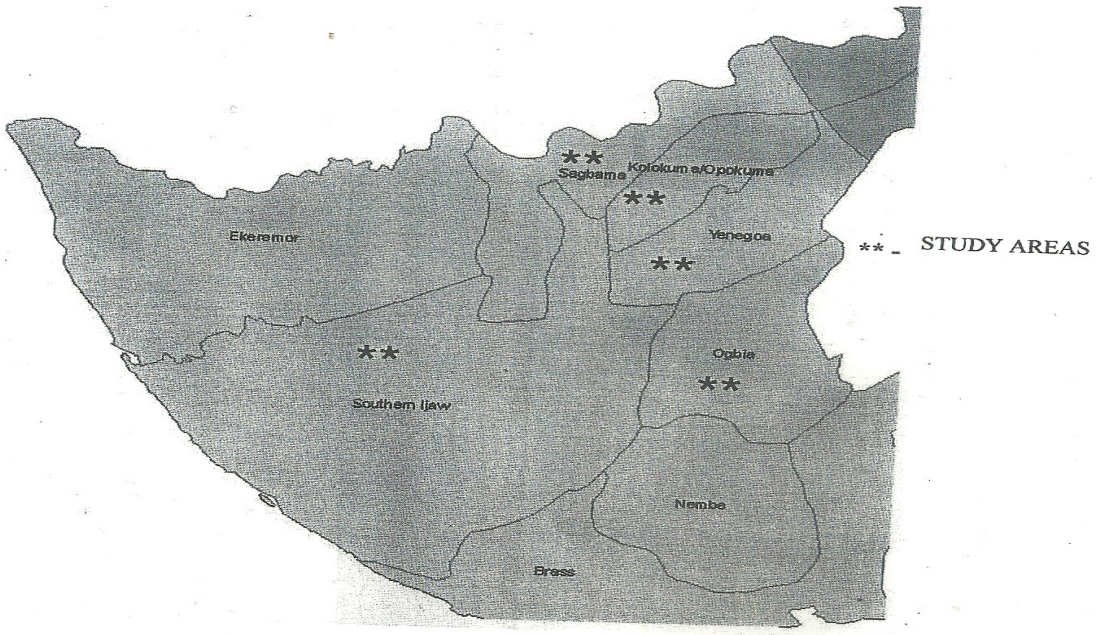

Figure 1: Map of the Study Areas in Bayelsa State, Nigeria.

Table 1: Comparison of Physico-Chemical parameters means with FEPA and WHO limits.

Parameter	LOCAL GOVERNMENT AREAS					FEPA[1]	WHO[2]	DESIRABLE RANGE[3]
	A	B	C	D	E			
Temperature (^{0}C)	24.9±0.30	25.3±0.30	25.1±0.30	25.1±0.30	25.0±0.40	27.0	<35	20-30
pH	6.68±0.10	6.58±0.90	6.24±0.02	6.28±0.20	6.28±0.20	6-9	6.5-8.5	6.5-9
Ammonia (NH_3), ppm	0.55±0.20	0.37±0.20	0.50±0.02	0.40±0.20	0.34±0.20			0.0125ppm
Dissolved Oxygen (ppm)	5.5±0.50	5.1±0.08	2.8±0.20	6.6±0.18	4.8±0.30	8-10	8-10	5.0 ppm to saturation
Biological Oxygen Demand (mg/l)	2.9±0.60	3.0±0.50	4.52±0.90	4.40±0.90	3.18±0.20	10	10	0.29mg/l
Total alkalinity (mg/l)	47.6±18.40	43.1±18.0	77.6±32.63	93.70±46.53	57.4±20.4		1.0	50-400mg/l
Turbidity (ppm)	29.1±4.7	45.1±15.07	56.2±30.50	34.7±6.80	20.6±3.80	1.0	500	10-1000ppm
Total dissolved solid (mg/l)	55.2±19.02	49.8±15.21	95.2±69.40	145.40±91.01	27.9±4.70	500		500mg/l (Sarkar, 2002)
Total hardness (mg/l)	19.7±4.10	25.7±3.90	24.3±3.80	44.3±15.07	22.9±4.10		200	50-400mg/l
Electrical conductivity (µmhos/cm)	137.6±75.37	128.5±75.30	144.3±78.26	378.4±130.20	117.3±91.01	200		20-1500 µmhos/cm

A (Ogbia L.G.A), B (Southern Ijaw L.G.A), C (Yenagoa L.G.A), D (Kolokuma/ Opokuma L.G.A) and E(Sagbama L.G.A).
[1]Federal Environmental Protection Agency (1991), [2]World Health Organization (1986), [3]Boyd (1990).

Sample collection and Analysis

Water samples were collected in duplicate from each of the two fish farms situated in the selected towns of the five local government areas, using oxygen and Biological Oxygen Demand (BOD) bottles and small plastic bottles of 50ml. Each bottle was dipped 15cm below the pond water level at designated sites. Prior to sample collection, all the sampling bottles were thoroughly washed, sun-dried and rinsed with the same water to be collected in the ponds. The sampling bottles were labeled with dates and collection sites. Until analysis, the collected water samples were kept in a cool container. The water samples in these Local government areas under study were of freshwater. One time sampling in duplicate per month was carried out in each site from June to October 2005 for 5 months, between 0900 and 1800 hours.

Water temperature was measured at the pond sites using a mercury-in-glass thermometer graduated in degree Celsius (0-100ºC). The pH, ammonia, total alkalinity and total hardness were determined with Hach's Model FF-2 Aquaculture test kit. Dissolved Oxygen (DO) and BOD were determined by Winkler's method (Welch, 1948). Turbidity of samples was analyzed using a Hach ratio Turbidimeter as in APHA (1992). The electrical conductivity was measured with a conductivity meter (Lovibond US meter, type CM-21). The Total Dissolved Solids (TDS) was measured by filtering the water sample to remove the particulate matter, the filtrate evaporated to dryness and the residue weighed. The TDS was calculated according to Boyd (1979).

Data analysis

The data obtained were subjected to Analysis of Variance using the Statistical Analysis System User's Guide (SAS, 1999). Duncan's Multiple Range Test (Duncan, 1955) was performed to compare the means of the stations at P **=** 0.05 level of significance.

RESULTS

The results of this study are presented in Table 1. A total of 10 different Physico-chemical parameters were analyzed. The analysis was based on the samples taken from earthen fish ponds. The anaylysis show that the highest mean temperature of 25.3±0.30ºC was observed in fish farms from Southern Ijaw area while the lowest temperature of 24.9±0.30ºC was obtained in farms in Ogbia. The highest mean pH of 6.68±0.10 was observed in Ogbia farms while the lowest value of 6.24±0.02 was recorded in Kolokuma-Opokuma farms. Ammonia-nitrogen level of 0.55±0.20mg/l was observed in Ogbia fish farms while the lowest mean of 0.34±0.20mg/l was for fish farms in Sagbama area. Highest DO level of 6.6±0.18mg/l was obtained for Kolokuma/Opokuma farms while 2.8±0.02mg/l was observed in Yenagoa area.

The highest mean total alkalinity of 93.7±46.53mg/l was observed in Kolokuma/Opokuma farm while the lowest mean total alkalinity of 43.1±18.0mg/l was observed in farms in Ogbia area. Turbidity values ranged from 20.6±3.8ppm in Sagbama farms to 56.2±30.50ppm in Yenagoa farms. Total dissolved solid ranged from 27.9±4.7mg/l in Sagbama to 145.4±91.01mg/l in Kolokuma/Opokuma fish farms. The highest electrical conductivity of 378.4±130.2µmhos/cm was observed in Kolokuma/Opokuma farms while the lowest mean value of 117.3±91.01µmhos/cm was recorded for farms in Sagbama area.

Significant variations were observed for the different parameters in the fish farm sites ($P<0.05$). Table 1 also shows values and limits from Federal Environmental Protection Agency (FEPA) and World Health Organization (WHO) for water quality parameters.

DISCUSSION

The water used for the cultivation of fish will not give maximum production if the Physico-chemical parameters are not optimal for fish and other 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 due to increased respiration.These factors commonly result in less available oxygen for fish in water. The observed water temperature in ponds in this study is considered normal for aquatic life in the Niger Delta region which Bayelsa State is part of with its characteristic humid/semi-hot equatorial climate (NEDECO, 1980). The temperature observed in this study corroborate the report of Boyd (1979) for good pond fish production. Water pH affects metabolism and physiological processes of fish and also exerts considerable influence on toxicity of ammonia (ICAR, 2006). Except for the pond

water in Yenagoa, Kolokuma/Opokuma and Sagbama areas, the pH in Ogbia and Southern Ijaw areas agree with the desirable lower limit (Table 1). Generally, the pond water in all areas appeared slightly acidic and may need lime application although their effect may be minimal on acidity (Ewa et al.,2011). Huet (1972) observed that pH values of 6.5 to 9.0 are good for fish production, hence the pond water at Ogbia and Southern Ijaw areas appeared more conducive. Fish growth is limited in water of pH <6.5, reproduction ceases and fry can die at pH <5.0 (Boyd, 1982).

Ammonia is introduced into the pond through dead phytoplankton, uneaten feeds, dead and decaying organic matter. Fish are very sensitive to un-ionized ammonia and needs an optimum range of 0.02-0.05mg/l (ICAR, 2006). Robinette (1976) reported that 0.12mg/l NH_3 caused reduced growth and gill damage in Channel Catfish. All the observed values in this study were higher than desired range and limits and this may affect the growth of fish. Oxygen is needed for the body activities of the fish. It is introduced into the pond mainly through photosynthesis by aquatic green plants and dissolved oxygen from the air. The ponds in Yenagoa area had the lowest value of 2.8±0.20mg/l of oxygen. This is far below the lower limit of the desirable range of 5.0mg/l (Welch, 1948). Dissolved oxygen is a measure of the amount of gaseous oxygen dissolved in an aqueous solution that plays a vital role in the biology of cultural organisms (Dhawan and Karu, 2002 cited by Ehiagbonare and Ogundiran, 2010). The mean DO values obtained for Ogbia, Southern Ijaw and Kolokuma/ Opokuma Local government areas range from 5.1± 0.08 to 6.6±0.18mg/l and can sustain aquatic life. These values also agree with the minimum DO of 5.0 mg/l reported for tropical fishes by Saloom and Duncan (2005).

Biological oxygen demand varied slightly among ponds in the study areas. The BOD values are higher than the desirable levels reported by Boyd (1990) in Table 1 and their magnitudes may depend upon temperature, density of plankton, concentration of organic matter and related factors (Boyd, 1979). Biological oxygen demand indicates a potential for reducing the DO content in water and this could result in organisms being stressed, suffocated and eventual death (APHA, 1992). However, no fish was observed or seen under these stated conditions in this study. Alkalinity is a measure of the total concentration of bases in pond water and it is water's ability to resist changes in pH. A total alkalinity of at least 20ppm is necessary for good pond productivity. The values obtained in this study are appreciable and fall within desirable range (Boyd, 1990).

Turbidities in natural waters seldom exceed 20,000mg/l (Irwin, 1945). Turbidity restricts light penetration, limits photosynthesis and production of undesirable macrophytes in ponds (Boyd, 1979). The turbidity values obtained in ponds though are within the desirable range, are above the lower limit. Turbidity relates to the amount of materials present in the water and this could be as a result of input of wastes by the fish farmers into these ponds especially in Southern Ijaw, Yenagoa and to an extent in Kolokuma/Opokuma areas. Water from the various ponds vary in solids concentrations depending on the degree of mineralization, amount of suspended clay and abundance of plankton (Boyd, 1982). Excessive organic manuring and feed wastage have been reported to increase TDS (Ogbeibu and Edutie, 2006) and often lead to poor water quality (ICAR, 2006). This could have also been responsible for the variation of TDS values (range 27.9±4.70-145.4±91.01mg/l). Water hardness is a measure of the alkaline earth metals such as Calcium and Magnesium concentration in water samples (Ehiagbonare and Ogundiran, 2010). Apart from values for ponds in Kolokuma/Opokuma that are close to the desirable lower limit of 50mg/l (Boyd, 1990), values from other Local government areas were much lower (range 19.7±4.1-25.7±3.9 mg/l). Calcium and Magnesium are essential to fish for metabolic reactions in bone and scale formation. Hard water has a higher concentration of alkaline earth metals, hence the water in the ponds under study were not hard but softer. The content of the electrical conductivity was highest with 378.40±130.20µmhos/cm in Kolokuma/Opokuma Local government area. Other areas had average levels of 117.30±91.01-144.30±78.26µmhos/cm. These values show the extent to which the ponds in Kolokuma/Opokuma contain dissolved solids and were polluted. This could be detrimental to the survival of aquatic life in these ponds. Boyd (1990) stated that specific conductances for fresh water often range from <25 to >500µmhos/cm, hence values obtained in this study fall within acceptable limits. In comparison, the observed values of the parameters fall within FEPA (1991) and WHO (1986) limits for good water for pond fish culture.

CONCLUSION

This study observed that fish farmers in the investigated areas used slightly acidic water for fish production while ammonia, BOD and electrical conductivity levels were fairly high. The high content of BOD will deplete the DO amount which will eventually be harmful to aquatic life. Lime application will correct pH to a more acceptable level for fertilizer use. There is also the desirable need to analyze the pond water at regular intervals. Farmers should be educated on better managerial practices bordering on feeding practices, pond management, good water exchange practice to reduce organic load and waste accumulation. This will ensure that some of the parameters in this study
will not exceed levels that could be harmful to fish in the environment. Such a measure will guarantee the safety of the aquatic ecosystem, humans and environment for good and healthy production of fish for consumption.

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