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ASSESSMENT OF WATER QUALITY CHARACTERISTICS FOR AQUACULTURE USES IN ABEOKUTA NORTH LOCAL GOVERNMENT AREA, OGUN STATE, NIGERIA

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Abstract

The physicochemical studies were conducted to assess water resources in Abeokuta North Local Government Area, Ogun State in relation to their potential for aquaculture uses. Water samples were collected from both surface and groundwater sources and analyzed for pH, colour, turbidity, conductivity, total hardness, chloride, BOD, carbonate, iron, lead and copper. The results revealed a fluctuating behaviour of different parameters throughout the study correlations between the physiochemical studied, the result revealed that physicochemical variables were significantly ($P<0.05$) influenced by site but there were no significant difference in the values of Pb and Fe in all the station ($P<0.05$).

Keywords Water quality, aquaculture, physicochemical, surface water, ground water

INTRODUCTION

Aquaculture is a net consumer of water and most form require the use of considerable quantities (Muir and Beveridge 1980; Phillips et al 1991) and quality. Boyd and Gross (2000) stated that the *different forms of aquaculture is quite similar because they all obey the same set of physical and chemical principles. These principles compose the subject of water chemistry and its net results i.e. the water quality*. According to Boyd (1990) *the most serious threat to profitable fish production is poor water quality and lack of our acceptable quantity of water*.

The quality of water in terms of physicochemical and biological characteristics in the fish ponds offers the most favorable conditions for the existence of fish as well as other biota which constitute essential

components of the food chain (Gupta and Gupta, 2006). *The maintenance of good water quality is essential for both survival and optimum growth of culture organisms.*

There are two main categories of water supply for aquaculture, ground water and surface water. However, not all available water is good enough for fish farming. According to United State Environmental Protection Agency (EPA) (2006) Water quality standards vary significantly due to different environmental conditions, ecosystem and intended human uses.

The complexity of water quality as a subject is reflected in many types of measurements of water quality indicators. Adeniji and Ovie (1982) observed that *temperature, turbidity, suspended solids, dissolved oxygen concentration are among other primary factors that determine the quality of a water body*.

There is much variation within and among fish groups with regard to acceptable water quality requirements have been variously defined (Boyd, 1989) to ensure optimum production. Fishes are most dependent on water temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity and some other salts for growth and development (Nikolosky, 1963). Any change in any of these parameters may affect the growth, development and maturity of fish (Jhingram, 1985).

The quality of aquaculture products and its suitability for human consumption may also be affected by water quality. Zweig et al (1999) noted that *even if culture species are able to grow and thrive in a given source of water, low levels of pollutants may cause the aquaculture products to be contaminated or have off-flavour*. They reported that many of the negative chemical and environmental factors associated with most operators have their origin in the source of water selected.

Aquaculture has not yet fulfilled its potential as a major source of fish supply in Nigeria despite the suitability of water resources availability. In Nigeria aquaculture fish production was 16.87% of total domestic fish production for 2007 (FDF, 2008). .However, aquaculture can contribute significantly to domestic fish production if all the water resources are utilized. Therefore, it is important to check the source of water and make sure it can sustain the fish. This paper aims at assessing the present water quality of the Abeokuta North Local Government Area in relation to aquaculture uses.

MATERIALS AND METHODS

Study Area

The study was conducted in six communities in Abeokuta North Local Government Area (ANLGA) of Ogun State. ANLGA falls within latitude 7º 21'N and Longitude 3º 31'E. The study area is located in the semi savannah vegetation area endowed with conducive climate condition for agricultural purpose with annual rainfall of about 1250 mm and mean temperature of 26ºC.

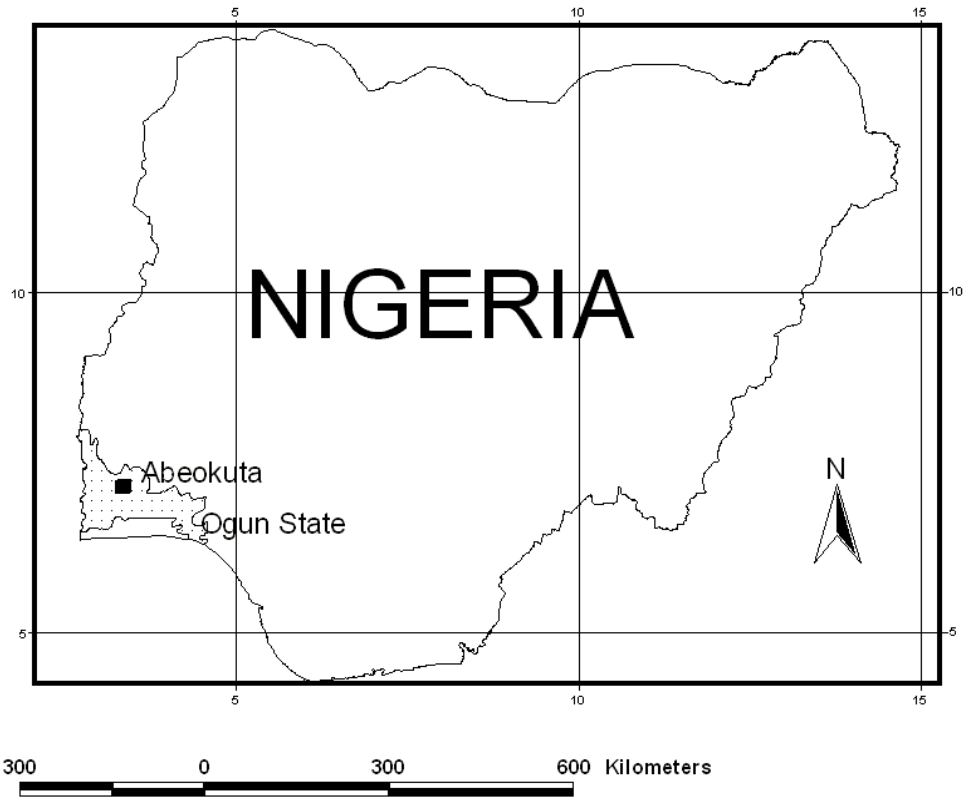

Figure 1: Map of Nigeria showing Abeokuta

Sample Collection and Laboratory Analysis

To ascertain water quality in ANLGA for aquaculture uses, water samples were collected from both surface and ground water. The surface sampled water are (1) River Arakanga (2) River Ogun (3) River Abetu (4) River Apesin (5) while the ground water samples were collected from three open wells at Olomore (6) Ikereku (7) and Imala, communities covering the entire Local Government Area.

Water samples of various sources in the study area were collected using 4 – litre acid washed polypropylene containers and taken to the laboratory for analysis. All samples were stored in the refrigerator at a temperature of less than 4ºC and analysis within one week.

Water samples were collected for the Month of January 2009 (dry season) and June 2009 (wet season). Each station was sampled twice in a month. The water samples were analysed for pH, turbidity, electrical conductivity, total hardness, colour chloride, biological oxygen demand, carbonate, iron lead and copper. pH and Ec meters. Turbidity was measured with a HACH 400P. turbidimeter, chloride by argentometric titration. Hardness was analysed by titration with EDTA, Biological oxygen demand was measured using methods according to APHA (1989) and colour comparator. The metal iron, lead and copper were analysed by AAS technique after doing necessary pre-concentration by the normal procedure.

Statistical Analysis of Data

Simple statistical techniques such mean, analysis of variance (ANOVA) and correlation were adopted from Zar (1978).

RESULTS AND DISCUSSION

A summary of the result of physico-chemical analysis and trace metal parameter of water samples taken from various study sites were presented in Table 1-3. The colour of water samples ranged from 5 to 10 Hz during the dry season with the highest values of 10Hz recorded in stations 1,2,4,6 and 7 with mean value of 9.14Hz. During the wet season the value of colour varied from 5.5 to 15Hz with mean value of 11.54Hz.These values are within 15Hz which is WHO recommended limit for no risk. Although colour does not affect fish directly it restricts light penetration and reduces aquatic plant's growth.

The turbidity values in the dry season ranged from 5 to 14 NTU with mean value of 7.57NTU while turbidity values in the wet season ranged from 6.10% 14.80 NTU with mean value of 8.14 NTU. Studies on warm water fishes have shown that fishes did not show any behavioural reaction until the turbidity approached 20,000 ppm (Gupta and Gupta 2006). The pH values in the dry season ranged from 6.7 to 7.4 with mean season ranged from 6.8 to 7.8 with mean value of 7.43. The best water for fish culture is that which is neutral of slightly alkaline with a pH between 7.0 – 7.5 (Pandey and Shukla, 2005). The EU sets protection limited of pH from 6 to

9 for fisheries and aquatic life (Chapman, 1996). Therefore the water in the study area could be used for aquaculture.

The conductivity values in the dry season varied from 25.20 to 134.40 Us/cm with mean value of 64.95 Us/cm. The conductivity values in the wet season varied from 30.70 to 134.20 Us/cm with mean value of 80.13 Us/cm. The average value of typical, unpolluted river is approximately 350 Us/cm (Koning and Ross, 1999).Therefore the parameter does not give cause for concern and it makes the water suitable for aquaculture use.

The chloride values ranged from 13.5 to 31.00mg/l in the dry season while the chloride value in the wet season ranged from 15.00 to 39.00 mg/l. Chloride and Chloramine as low as 4ppb of hypochlorite can be harmful to fish within four days of exposure (Alabaster and Lloyd 1980).

The total hardness value ranged between 16.0 and 103.4mg/l in the dry season with mean value of 47.06mg/l while the value ranged from 17.0 to 112.5mg/l in the wet season with mean value of 65.3mg/l. Swingle (1967) reported that the pond water having a hardness of 15mg/l or above are satisfactory for growth of fish and do not require addition of line for higher production of fish. Desirable concentrations of total hardness for fish culture generally full with the range of 20-300mg/l (Boyd and Walley 1975).

The alkalinity value ranged from 6.00 to 26.7 mg/l with mean value of 12.67mg/l during the dry season while the wet season values varied from 7.10 to 27.70mg/l and mean value of 14.22mg/l. Alikunhi (1957) reported that in highly productive waters, the alkalinity ought to be over 100mg/l. However, the range of alkalinity as 0.0 – 20.0mg/l for low production, 20 – 40mg/l for medium production an 40-90 mg/l for high production. (Pandey and Shukla, 2005).

The most common cause of low dissolved oxygen in an aquaculture operation is a high concentration of biodegradable organic matter (and thus BOD) in water. The BOD values ranged from 2.50 to 6.00mg/l with mean value of 4.2mg/l in the wet season while the dry season values ranged from 2.50 to 6.70mg/l with mean value of 4.56mg/l. Meade (1989) conservatively recommends a general standard of less than 0.01mg/l.

The iron concentrations in water source in the dry season ranged from 0.20 to 1.35mg/l with mean value of 0.51mg/l. The value in the wet season ranged from 0.20 to 1.35mg/l recorded in al water sources with mean value of 0.59mg/l. The iron concentration showed season dependence iron concentrations were apparently high in dry season in stations 1 and 3.

However, the incidences of iron concentrations were not recorded in the ground water in the study area. Nonetheless, the iron levels were only slightly above the recommended limit. Tucker and Robinson (1985) reported that iron concentrations less than 0.5mg/l would be appropriate for

hatcheries and channel catfish and other warm water species while the optimal iron concentration for cold water temperature is less than 0.15mg/l. But Meade (1989) conservatively recommends a general standard of less than 0.01 mg/l.

Copper level in all water sources ranged from 0.80 to 5.00 mg/l in the wet season with mean value of 2.22 mg/l while copper concentration during the dry season ranged from 0.60 to 3.00 mg/l with mean value of 1.47 mg/l. the relatively high copper concentration values were recorded in the wet season particularly in the ground water in the study area. The maximum recommended concentrations for copper in source water range from 1 to 10 ppb or mouse depending on the physical and chemical properties of the water the species of the fish (Sovobodova et al, 1993).

The water source, investigated in the study area had lead concentrations between 0.14 and 0.19 mg/l recorded only during wet season in all surface water. The range obtained was lower than the set values of less than 20.0ppb (Meade, 1989). Therefore, the water could be used for aquaculture at the level obtained in this study. Correlations results reveal that there were positive relationships in all the parameters investigated. The results further showed that there were no significant differences ($P < 0.05$) in the values of Pb and Fe in all the stations while significant different ($P < 0.05$) were observed in all the remaining parameters (Table 3).

CONCLUSION

The study has provided information about the water quality status of Abeokuta North Local Government Area of Ogun State and its suitability for aquaculture uses. The water quality varies considerably between surface and ground water sources, between sources at different locations and between seasons. The field observations on the water quality revealed that the study area have high potential for aquaculture development based on the values obtained which were in conformity with recommended values for fresh water fish farming.

TABLE 1 MEAN OF PHYSICO-CHEMICAL PARAMETERS OF WATER SAMPLES (WET SEASON)

	STATIONS										
Parameters	**Arakanga River**	**Ogun River**	**Abetu River**	**Apesin River**	**Olomore Well**	**Imala Well**	**Ikereku Well**	**Minimum Value**	**Maximum Value**	**Mean**	**Standard Deviation**
Colour (Hz)	15	15	10	15	5.5	10.20	10.10	5.50	15.0	11.54	± 3.62
Turbidity(NTU)	14.80	7.50	6.10	7.90	6.60	6.90	7.20	6.10	14.80	8.14	± 2.99
pH	7.6	7.8	7.6	6.8	7.3	7.8	7.1	6.80	7.80	7.43	± 0.37
Conductivity (Us/cm)	134.20	60.00	40.23	30.70	72.81	114.80	108.20	30.70	134.20	80.13	± 39.59
Hardness(mg/l)	112.50	17.00	20.10	72.50	40.00	100.00	95.00	17.00	112.50	63.30	± 39.54
Chloride(mg/l)	25.20	18.00	23.50	15.00	32.00	37.00	39.00	15.00	39.00	27.10	± 9.21
Alkalinity(mg/l)	7.10	27.20	9.00	12.00	21.00	11.00	13.00	7.10	27.20	14.32	± 7.17
BOD (mg/l)	3.60	5.80	5.70	2.50	4.20	6.70	3.40	2.50	6.70	4.56	± 1.53
Lead (mg/l)	0.16	0.18	0.19	0.14	ND	ND	ND	0.00	0.19	0.095	± 0.09
Iron (mg/l)	1.20	0.39	1.35	0.20	0.20	0.30	0.40	0.20	1.35	0.586	± 0.39
Copper (mg/l)	0.80	1.40	0.80	4.00	4.00	3.00	5.00	0.80	5.00	2.23	± 1.77

NOTE: ND-NOT DETECTED

TABLE 2 MEAN OF PHYSICO-CHEMICAL PARAMETERS OF WATER SAMPLES (DRY SEASON)

	STATIONS										
Parameters	**Arakanga River**	**Ogun River**	**Abetu River**	**Apesin River**	**Olomore Well**	**Imala Well**	**Ikereku Well**	**Minimum Value**	**Maximum Value**	**Mean**	**Standard Deviation**
Colour (Hz}	10	10	9	10	5.00	10	10	5.00	1.00	9.14	± 1.86
Turbidity(NTU)	14.6	7.2	5.8	7.1	5.00	6.90	6.30	5.00	14.60	7.53	± 3.36
pH	7.00	7.40	7.20	6.70	7.00	7.20	6.80	6.70	7.40	7.04	± 0.24
Conductivity (Us/cm)	134.4	42.8	32.4	25.2	40.00	112.40	102.50	25.20	134.40	69.96	± 44.84
Hardness (mg/l)	103.4	16.00	19.9	19.9	25.00	55.00	45.00	16.00	103.40	47.06	± 30.97
Chloride (mg/l)	13.5	22.3	14.5	14.5	29.00	31.00	31.00	11.00	31.00	21.75	± 8.76
Alkalinity(mg/l)	6.00	26.7	7.00	7.00	20.00	10.00	9.00	6.00	26.70	12.67	± 7.69
BOD (mg/l)	3.50	5.40	4.00	4.00	4.00	6.00	3.00	2.50	6.00	4.20	± 1.17
Lead (mg/l)	ND	ND	ND	ND	ND	ND	ND	0.00	0.00		
Iron (mg/l)	0.90	0.31	0.91	0.23	ND	ND	ND	0.00	0.00		
Copper(mg/l)	0.60	1.0	0.72	ND	2.00	3.00	3.00	0.00	3.00	1.47	± 1.20

NOTE: ND-NOT DETECTED

TABLE 3 VARIATION OF WATER SAMPLE VALUE IN WET AND DRY SEASONS

Parameters	STATIONS						
	Arakanga River	Ogun River	Abetu River	Apesin River	Olomore Well	Imala Well	Ikereku Well
Colour (Hz)	12.500^{a}	12.5000^{a}	9.5000^{ab}	12.5000^{a}	12.5000^{b}	12.5000^{a}	10.0500^{ab}
Turbidity(NTU)	14.7000^{a}	7.3500^{bc}	5.9500^{cd}	7.9000^{a}	5.3000^{d}	7.9000^{b}	6.7000^{abc}
pH	7.300^{a}	7.600^{a}	7.400^{ab}	6.7500^{b}	7.1500^{ab}	7.5000^{ab}	6.900^{ab}
Conductivity(Us/cm)	134.3000^{a}	51.4000^{cd}	36.3150^{cd}	27.9500^{d}	56.4050^{c}	113.6000^{ab}	105.3500^{ab}
Hardness (mg/l)	107.9500^{a}	16.5000^{c}	20.0000^{c}	68.8000^{ab}	32.5000^{ab}	77.5000^{ab}	70.0000^{ab}
Chloride (mg/l)	19.3500^{bc}	20.1500^{bc}	19.000^{bc}	13.0000^{c}	30.5000^{ab}	34.0000^{a}	35.0000^{a}
Carbonate (mg/l)	6.5500^{d}	20.1500^{bc}	8.00^{cd}	11.000^{c}	20.5000^{b}	10.50000^{c}	11.0000^{c}
Lead (mg/l)	8.000E-20^{a}	9.000E-02^{a}	9.500E-02^{a}	7.000E-02^{a}	0.0000^{a}	0.0000^{a}	0.0000^{a}
Iron (mg/l)	0.6450^{a}	0.8300^{a}	0.8550^{a}	0.2150^{a}	0.2150^{a}	0.2000^{a}	0.9300^{a}
Copper(mg/l)	7000^{c}	1.200^{bc}	0.7600^{c}	0.3000^{c}	0.3000^{c}	3.0000^{b}	4.0000^{a}
BOD (mg/l)	3.5500^{cd}	5.600^{ab}	4.8500^{bc}	2.500^{d}	2.500^{d}	6.3500^{a}	3.7000^{d}

Means in the same column followed by the same letters are not significantly different from each other at $p < 0.05$

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