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Research article

DETERMINATION OF SOME PHYSICOCHEMICAL PARAMETERS OF WATER FROM ARTIFICIAL CONCRETE FISH PONDS IN ABRAKA AND ITS ENVIRONS, DELTA STATE, NIGERIA

*Agbaire, Patience Odafevejiri, Akporido, Samuel Omorovie and Emoyan Onoriode Onos

Chemistry Department, Delta State University, Abraka
*Corresponding author, e-mail: patagbaire@gmail.com

ABSTRACT: This work studied some physicochemical parameters of water from artificial concrete fish ponds in Abraka and its environs with a view of finding the fitness of the water environment for fish farming. Water samples were collected according to standard methods. pH, and temperature were determined in-situ while the other properties were determined out-situ. All determinations were carried out according to standard approved methods. The mean and standard deviation of results obtained are as follows: pH (7.03±0.06), conductivity (15.88±1.96µS/cm), Temperature (26.73±1.73^{0}C), DO(10.11±0.63mg/L), BOD(3.02±0.77mg/L), TDS(22.11±2.4 mg/L), TSS(87.97±9.63mg/L), Turbidity (9.23±1.63NTU), Total hardness (4.91±0.90mg/L), Acidity (87.90±5.62mg/L), alkalinity (37.67±06.19 mg/L), phosphate (1.41±0.45mg/L), chloride (8.60±1.53mg/L), nitrate (3.81±0.55mg/L), sulphate (3.71±1.00 mg/L), Magnesium (1.16±0.15 mg/L), calcium (0.42±0.27mg/L), potassium (11.74±2.01 mg/L). These results were largely within the WHO, SON and FEPA limits for drinking water. They were also within the recommended values for optimal survival for fish in ponds. The implications are that the water sampled in the various ponds studies are fit for fish production as well as fit for irrigation purpose.
Key words: Artificial concrete fish ponds, Physicochemical parameters, Fish farming, Abraka, South-South Nigeria

INTRODUCTION

Water which is a neutral oxide of hydrogen with formular H_2O is one of the most important oxide known. It is abundant in the earth's crust. Its presence or otherwise is said to influence human settlement. The importance of water to living things cannot be overemphasized. It is believed to be the reason for life on planet earth. Human needs water for various purposes, ranging from domestic to industrial uses. All living things depend on water for its existence [1, 2]. Water being a universal solvent has many substances dissolved in it. These include those that are beneficial and those harmful to man. Its quality therefore depends on factors such as geological morphology, vegetation and land use[3,4]. Water is the natural habitat of fishes and other aquatic animals, it is therefore of great importance to study water quality while studying fish production especially when done in an artificial setting. Artificial fish farming is generally carried out in ponds. Ponds could be referred to as man-made or natural water a body which holds water for four months of the year or more [5]. It could also be referred to as an artificial lake intended for fish breeding [6]. Eze and Ogbaran [6] further described a pond as a quiet body of water that is so small for wave action and too shallow for major temperature difference from top to bottom. Generally in a pond, the temperature changes with the air temperature and it is relatively uniform. Lakes are similar to ponds, but their temperature is dependent on the seasons [6]. It is said that the productivity of a pond depends on the quality of water [7, 8, 9, 10]. The importance of the environment to good fish farming practices has been reported, [9 , 11 12, 13, 14, 15]. It has been pointed out that animal protein is in shortfall in Nigeria, especially in the Niger-Delta region of Nigeria. The reason, being the constant pollution of the natural water bodies arising from the activities of oil exploration and exploitation [16]. Fish cultivation is therefore a necessity in order to meet the protein demand of the ever increasing populace. This work is therefore aimed at providing relevant information to fish farmers in order to help improve the quality of fish farming. This work therefore determined some physicochemical properties of selected fish ponds in Abraka, Delta State, South-South, Nigeria.

MATERIALS AND METHODS.

Sampling Site: Samples were collected from concrete ponds within Abraka. Abraka lies about 45 m above sea level and between longitudes 06^{o} and 6^{o} 15^{1} East and latitudes 05^{o} 45^{1} and 5^{o} 50^{1} North. It is the main campus of the State Owned University. It was originally an agrarian community, but with the University, there is some form of commercial activities. Four major commercial fish ponds were selected for study. These were all concrete artificial fish ponds that were very much in use. These were sampled weekly for one month. At every occasion of sampling, composite water samples were collected in 1L plastic containers.

METHODS

Unstable parameters such as temperature and pH were measured in-situ. Temperature was determined using the mercury in bulb thermometer while pH was measured with a portable pH meter (Hann pHep pH Tester) after calibration with pH buffer 4, 7 and 9. Conductivity was determined using DDS-307 that measures in microsimens/centimeter (µS/cm). Turbidimeter (WGZ-B). Total Dissolved Solids (TDS) and total suspended solids (TSS) were determined gravimetrically [17]. Samples for dissolved oxygen and biochemical oxygen demand were sampled with a 250mL dark coloured reagent bottles. These water samples were fixed at site by adding 1.0 mL of Winkler's solution 1 (Manganese (II) tetraoxosulphate (VI), Monohydrate – $MnS0_4$. H_2O) and 1.0mL of Winkler's solution II (Sodium hydroxide and Sodium iodide) using a micro-pipette. To this solution 1.0mL of concentrated tetraoxosulphate (VI) acid was added below the solution inside the reagent bottle with a pipette. This is to dissolve the precipitate of Manganese (II) hydroxide formed. All samples were then taken to laboratory in ice slurry for further determination. Dissolved oxygen (DO)) was then determined on the fixed sample using the Winkler's titration [18, 19]. The biochemical oxygen demand (BOD) was then determined on the DO sample after incubation in the dark for 5 days at $\pm 20\ ^{o}C$.

Alkalinity was determined by titration procedure where a known volume of water sample was titrated with 0.02M HCl [20]. Total water hardness was measured by titrating 0.01N ethylenediammetetracetic acid (EDTA) using Eriochrome black T as indicator. Phosphate – Phosphorous was determined by the ascorbic acid method [15].

Nitrate – nitrogen in water sample was determined using the phenoldisulphonic acid method [15, 21]. Sulphate was determined using the colorimetric method.

RESULTS

Table 1: Physicochemical Parameters of the Various Concrete Fish Pond

Parameters	Pond A	Pond B	Pond C	Pond D	Range	Mean ± SD
pH	6.97±0.13	7.01±0.20	7.03±0.02	7.12±0.16	6.97-7.12	7.03±0.06
Conductivity µs/cm	14.10±0.00	14.33±0.58	17.10±0.17	18.00±0.00	14.10-18.00	15.88±1.96
Temperature ^{o}C	24.66±0.94	28.70±1.10	27.40±0.58	26.17±0.15	24.66-28.70	26.73±1.73
DO mg/L	9.33±0.24	9.81±0.22	10.71±0.29	10.57±0.20	9.33-10.71	10.11±0.65
BOD mg/L	3.88±0.54	2.01±0.07	3.18±0.02	3.02±0.02	2.01-3.88	3.02±0.77
TDS mg/L	24.25±0.32	19.19±0.52	24.15±0.04	20.14±0.03	19.19-24.25	22.11±2.41
TSS mg/L	75.97±0.10	94.48±0.58	96.90±0.50	84.53±0.51	75.97-96.90	87.97±9.63
Turbidity NTU	8.00±2.83	7.73±0.04	9.80±0.01	11.33±0.38	7.73-11.33	9.23±1.68
TotalHardness mg/L	5.80±0.14	5.50±0.12	3.84±0.20	4.50±0.10	3.84-5.80	4.91±0.90
Alkalinity mg/L	32.00±4.32	45.33±0.58	40.00±0.91	33.33±0.50	32.00±45.33	37.67±6.19
Phosphate mg/L	1.25±0.00	1.19±0.06	1.13±0.12	2.08±0.14	1.25-2.08	1.41±0.45
Chlorine mg/L	10.74±0.87	7.27±0.12	8.60±0.07	7.78±0.14	7.27-10.74	8.60±1.53
Nitrate mg/L	4.50±0.07	3.85±0.01	3.70±0.10	3.17±0.15	3.17-4.50	3.81±0.55
Sulphate mg/L	4.50±0.00	2.25±0.01	4.13±0.12	3.96±0.49	2.25-4.50	3.71±1.00
Magnesium mg/L	1.04±0.01	1.19±0.03	1.36±0.30	1.06±0.17	1.04-1.36	1.16±0.15
Calcium mg/L	0.04±0.00	0.59±0.04	0.64±0.08	0.40±0.01	0.04-0.64	0.42±0.27
Potassium mg/L	10.03±0.00	11.90±0.10	14.51±0.20	10.51±0.27	10.03-1.51	11.74±2.01

Table 2: Comparism of Result with other Standar ds

Parameters	Mean ± SD	WHO	FEPA	SON	Acceptable Range (BD)
pH	7.03±0.06	6.5 – 8.5	6 – 9	6.5 – 8.5	7.0 -9.5
Conductivity µs/cm	15.88±1.96	300	_	1000	_
Temperature ^{o}C	26.73±1.73	<35	27	Ambient	15 – 35 ^{0}C
DO mg/L	10.11±0.65	4 - 6	8-10	_	3-5
(BOD) mg/L	3.02±0.77	6	10	_	3-6
TDS mg/L	22.11±2.41	500	500	_	_
TSS mg/L	87.97±9.63	_	_	_	_
Turbidity NTU	9.23±1.68	10	<7	5	_
TotalHardness mg/L	4.91±0.90	600	_	150	>20
Alkalinity mg/L	37.67±6.19	600	_	–	50 -200
Phosphate mg/L	1.41±0.45	_	_	–	_
Chlorine mg/L	8.60±1.53	250	_	200-600	0-100
Nitrate mg/L	3.81±0.55	50	20	_	_
Sulphate mg/L	3.71±1.00	500	500	_	_
Magnesium mg/L	1.16±0.15	_	_	–	–
Calcium mg/L	0.42±0.27	200	_	_	4-160
Potassium mg/L	11.74±2.01	_	_	–	_

WHO – World Health Organization (2009) FEPA – Federal Environmental Protection Agency (1991)
SON – Standard Organization of Nigeria (1970) BD – Bhatnargar and Devi (2013)

DISCUSSION

The results are as shown in tables 1 and 2 above.

pH: This is the negative logarithm of hydrogen ion concentration [22]. This value is an indication of the level of acidity or alkalinity of a solution. Fish are known to have an average blood pH of 7.4; therefore pond water with pH within this average is optimum [23, 24]. It has been reported that the pH between 6 and 9 was appropriate for increased fish production [24]. The pH values obtained for this study ranged between 6.97 and 7.12. This value is tending towards neutrally which is also within the values for optimum fish survival [24]. These values compared very well with results of other workers [6, 25, 26]. They are also within the international standards; FEPA, SON, WHO. [27,28 ,29]

Water Temperature: Temperature of an organism is defined as the level of hotness or coldness in the body of a living organism either in water or land [22,30,31,32]. Fish is a cold blooded animal, so its temperature is dependent on the temperature of its environment. It changes with the temperature of the surroundings. The temperature changes affect the metabolism and physiology of fishes and so its productivity. The optimum water temperature for fish survival has been reported to be between 20 – 30 ^{o}C [24, 33]. The results obtained from this work showed temperature values ranging from 24.66 – 28.70 ^{o}C with an average value of 26.73 ± 0.13 ^{o}C. The results are in agreement of other workers [6, 25]. The results are within the standards (FEPA, 1991; SON 2007 and WHO 2009). The temperature range showed that the pond water studies were good for fish productions.

Conductivity: This is a measure of the ability of water to conduct electricity. It is dependent on the ionic concentration and water temperature. The total load of salts in a water body is directly related to its conductivity [34,35]. Conductivity is also regarded as an indication of its freshness or otherwise of a water body [36, 37]. It has been reported that high values of conductivity are an indication of pollution [38]. Verheust, 1997[39], reported that conductivity can be used as an indication of primary productivity and thus fish production. Sikoku and Veen (2004)[40], opined that fishes differ in their ability to maintain osmotic pressure, therefore the optimum conductivity for fish production differ from one specie to another. Varies conductivity have been reported for fish ponds. These are 0.006- 0.017 mS/cm [25] , 15.00 – 19215.40 µS/m wet season, 19.61 – 17215.30 µS/cm dry season for Sombreiro River, Niger Delta, Nigeria [41]. Boyd in 1979 [22], however, reported that freshwater conductivity varies between 50 to 1500 hS/cm and that some polluted water could get up to 10,000 hS/cm. He further stated that sea water has conductivity around 35,000 hS/cm and above. Conductivity reported in this study range from 14.00 to 18.00 µS/cm with a mean of 15.88 ± 1.96 µS/cm. These values fall within the WHO and SON limits, so the water would be regarded as safe for fish production.

Total Dissolved Solids (TDS): This is related to such factors as the geological character of watershed, rainfall and the amount of surface runoffs [20]. It is an indication of the load of dissolved substances. The TDS values obtained from this work ranged from 19.91 to 24.25 mg/L with a mean value of 22.11± 2.41mg/L. These values compare reasonably well with results obtained those of Eze and Ogbaran, 2010 [6]. It has been reported that farmers use artificial animal feeds to supplement pond, nutrients which has been reported to increase total dissolved solids [25, 37, 42].

The Total Suspended Solids (TSS): The total suspended solids are made up of carbonates, bicarbonates, chlorides, phosphates and nitrates of metals such as calcium, magnesium sodium, potassium, magnesium as well as other particles. TSS affects the turbidity of water bodies [43]. It has been reported that effluents water increase TSS [25]. The values obtained from this study ranged from75.97 to 96.90 mg/L with a mean of 87.97±9.63 mg/L. The values obtained relatively low which is good for optimum fish productivity.

Dissolved Oxygen (DO): This is defined as the measure of the amount of gaseous oxygen dissolved in an aqueous solution. [44]. It has been reported that natural waters are saturated with dissolved oxygen in equilibrium with air. The concentration at this saturation is known to decrease as the temperature of water increases[6]. It was reported that the optimum dissolved oxygen for fish ponds is >4mg/L [45]. DO is known to affect such attributes as growth, survival distribution, behavior and physiology of aquatic organism [46]. The DO obtained from this study had ranged between 9.33 to 10.74 mg/L with a mean value of 10.11± 0.63mg/L. These values are within the FEPA limit of 8-10 mg/L.

Biochemical Oxygen Demand (BOD): It is the measurement of total dissolved oxygen consumed by micro-organism for biodegradation of organic matter [24] Clerk, (1986), [47] reported that a BOD level above 5 mg/L is an indication of water pollution. In this study values obtained ranged from 2.01 to 3.88 mg/L with a means of 3.02 ± 0.77 mg/L. These values are with the WHO and FEPA values. The BOD level between 3.0 to 6.0 mg/L has been reported as optimal for normal activities for fishes [48]. These BOD values are therefore within the values for optimum fish activities and so the fish ponds studied are were not polluted and therefore safe for fish farming.

Turbidity: This is a measure of the ability of water to transmit the light that restricts light penetration and limit photosynthesis [24]. Turbidity consists of suspended particles in water and is usually affected by factors such as clay particles, dispersion of plankton organism, particulate organic matters as well as pigments caused by decomposition of organic matter. Turbidity obtained in this work ranged from 7.73 to 11.33 NTU. These values are quite close to those obtained by other researchers [25,45]. There are also within the WHO limit of 10NTU.

Total Hardness: Total hardness of water is the parameters used to describe the effect of dissolved minerals (mainly Ca and Mg), determining suitability for domestic and industrial purposes which is attributed to the presence of bicarbonates, sulphates, chlorides and nitrates [20, 49].Calcium and Magnesium are essential for bone and scale formation [24]. Swann, 1997[50] recommended hardness value of 20 mg/L as ideal for fish culture while Santhosh and Singh, 2007[51] recommended a ranged of 30- 180 mg/L. Bhatnagar *et al.,* in 2004 [48], opined that the total hardness value of less 20 mg/L would cause stress, an optimum value of 75- 150 mg/L with a lethal value of >300 mg/L. Total hardness of these samples ranged from 3.84 to 5.80 mg/L with a mean of 4.91 ± 0.90 mg/L. This value is very low which could be mean that fishes may be stressed up due to lack of calcium and magnesium needed for bone and scale formation. It might therefore be necessary to add some calcium, and magnesium supplements since these are necessary for bone and scale formation.

Alkalinity: Water alkalinity is a measure of its capacity to neutralize acids. It can be referred to as the buffering capacity of water. Waters with high alkalinity are undesirables. The obtained alkalinity ranged from 32.00 – 45.33 mg/L with a mean of 37.67 ± 6.19 mg/L. According to Bhatnagar and Devi, 2013[24], optimum alkalinity for fish productivity is between 25 to 100 mg/L. The values obtained were within this ranged which makes these ponds suitable for fish farming.

ANIONS

Chlorides: Chlorine gas is highly toxic, but the chloride ion is a common constituent of all natural water and it's generally regarded as non harmful constituent [45, 52]. Though chloride is present in all natural water bodies, high concentration is an indication of pollution from sewage, industrial or intrusion of seawater or saline water into fresh water aquifer [20, 53]. Chloride content obtained from this study ranged from 7.22 to 10.74 mg/L with a mean of 8.60±1.53 mg/L. These values are reasonable since higher concentration may be harmful to aquatic life. At even small concentration, it burns the edges of the gills with long term after effects [24].

Nitrate: It is thought to be produced by autotrophic *Nitrobacter* combining oxygen with nitrite in the bioconverter and on the walls of the pond [6]. It is important that the level of nitrate in a pond is controlled to avoid eutrophication. Nitrates are however not harmful to fish. Nitrate concentrations in this study ranged from 3.17 – 4.50 mg/L with a mean value of 3.81 mg/L. Scanthosh and Singh, 2007 [51], gave the favorable range of 0.1mg/L to 4.00 mg/L. The values obtained are within WHO and FEPA limits. They are also within the acceptable range as recommended by Bhatnagar and Devi, 2013[24]. There is therefore no fear of eutrophication. The ponds are suitable for fish farming.

Sulphate: Water samples investigated had sulphate values ranging from 2.25 mg/L to 4.50mg/L with a mean value of 3.71±1.00mg/L. Sulphate is known as one of the least toxic anions [45]. Sulphate may occur in water as a result of industrial discharge.

Phosphate: This is the main nutrient for algae. The values observed from this study range from 1.25 to 2.08 mg/L with a mean value of 1.41 ± 0.45 mg/L. This value is within the acceptable range of 0.03 to 2.00 mg/L as recommended by Bhatnagar and Devi, 2013[24]. Higher values could lead to eutrophication.

CATIONS

Magnesium: Magnesium content of these ponds ranged from 1.04 to 1.36 mg/L with a mean of 1.16 ±0.15 mg/L. These values are in agreement with those obtained by Ehigbonare and Ogunrinde, 2010[25]. Other workers had higher values [54,55].

Calcium: The values obtained ranged from 0.04 to 0.64 mg/L with a mean value of 0.42 ± 0.27 mg/L. This value is very low when compared with the WHO values 200 mg/L and 25 – 100 values for optimum productivity of fish [24]. It would therefore be necessary to have some calcium supplement since calcium is necessary for bone and scale formation.

Potassium: The result from this worked revealed that potassium in those water samples ranged between 10.03 to 14.51 mg/L with a mean of 11.74 ± 2.01 mg/L.

CONCLUSION AND RECOMMENDATION

The pond water investigated were in general fit for pond fish productivity except for calcium and magnesium deficiency which could be corrected with some supplement. It is also important to note that regular water monitoring is worthwhile in order to improve water quality.

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