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Physicochemical analysis and fish pond conservation in Kano State, Nigeria

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ABSTRACT

The health of an artificial or natural fish pond is determined by the state of its physiochemical parameters. This study was therefore, designed to examine the level of physicochemical regime of four selected fish ponds, viz; Zogarawa fish pond, Bagauda fish seed multiplication centre, Fagam fish pond and Khasu integrated fish pond in Dawakin Tofa, Bebeji and Kumbotso Local Government Areas of Kano State from July 2014 to December 2014 (rainy season and harmattan season). The techniques for determining the parameters were as described in the instructional manual of the HANNA Instruments (HI©) and JENWAY(®) Water Analysis Kits. The physicochemical parameters of the pond water was analyzed and determined using one way analysis of variance (ANOVA) with the aid of INSTAT 3 statistical software for window version 2003. The values of the physicochemical parameters of four fish ponds in the study area were between 25.7±1.07 to 27.8±1.03°C for temperature, 6.8±0.03 to 7.1±0.62 for pH, 2.01±0.03 to 3.08±0.13mg/L for dissolved oxygen, 2 96.3±1.73 to 613.7±3.03 µs/cm for electrical conduc tivity, 63.0±1.90 to 153.0±2.76mg/L for total hardness and 20.5±2.35 to 100.6±4.98mg/L for total suspended sol ids. There was no significant difference ($p>0.05$) in the levels of temperature, pH and dissolve oxygen but there is significant difference ($p<0.05$) in electrical conductivity, total hardness and total suspended solids between the ponds. The studied ponds are in a stable state and suitable for fish farming with the idea of re-introduction into water bodies with insufficient fish populations.

Keywords: Aquaculture, *Clarias*, Conservation, Physicochemical, Water quality.

INTRODUCTION

Despite the existing studies by Adeniji and Ovie [1]; Joseph *et al*., [2]; Curtis [3] and Robert [4] as cited in Solomon *et al*., [5] 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 Kano State where there is rise of this fledgling industry. A pond is referred to as man-made or natural water body which is 1cm^2 and 2ha (5 acres or 20,000m^2) in area, which holds water for four months of the year or more [6]. Natural Resource Conservation on the other hand is a process involving science or art in which the lays or professionals strife to ensure wise use of our natural resources so as to enable sustainable use: a situation whereby the available resources attains a level that can provide satisfaction for the present generation as well as future generations. Fish is also a part of natural resources requiring urgent conservation effort due to human destructive habit on their natural habitats. Since the natural habitat of fish and its content including fish are highly dynamic, the ex-situ conservation of fish appears to be the best strategy, hence the need for this study. A pond with good water quality will produce more and healthier fish than a pond with poor water quality [7].Water quality generally means the component of water which must be present for optimum growth of aquatic organisms [8]. Water quality is not constant in nature but varies with the time of the day, season, weather conditions, water source, soil type, temperature, stocking density, feeding rate and culture system. For a successful aquaculture venture, the dynamics and management of water quality in culture media must be taken into consideration [9]. All living organisms have tolerable limits of water quality parameters in which they perform optimally. A sharp drop or an increase with these limits has adverse effects on their body functions [10]. Early identification of water quality degradation through routine monitoring permits aquaculturalists to implement minor operational changes to correct identified problems before it reaches an extreme condition [5]. Early identification of environmental problems also prevents cumulative environmental degradation which may save the life of cultured organisms.

When degradation reaches an extreme level, cultured organisms experience depressed growth rate, increased disease condition and even death. A situation fish farmers dread. The determinants of good growth in water body include dissolve oxygen, hardness, turbidity, alkalinity, nutrients, temperature etc. Conversely, other parameters like biological oxygen demand and chemical oxygen demand indicate pollution level of a given body of water [8]. Each water quality factor interacts with and influences other parameters, sometimes in complex ways [11]. The determination and frequency of monitoring water quality depends upon the rearing intensity of the production system used [5]. The present study contributes to the existing knowledge of water quality parameters and conservation of some concrete ponds in Kano State with an objective of estimating the level of some physicochemical parameters. Concrete ponds are established where lands are not suitable or there is scarcity of land for earthen ponds [12]. The art of artificial fish culturing has not been adequately developed and the physical, chemical and biological environment of fish ponds that are springing up particularly in Kano State have not been adequately studied and documented.

Aquaculture is a fishing industry yet has significant linkage with conservation of natural resources with particular emphasis on fish at their natural state. Knowledge of aquaculture is actually being borrowed from the ecology of natural fish ponds. This can be seen in all the important factors such dissolve oxygen, water hardness, turbidity, alkalinity, nutrient content, temperature, water depth etc which have been observed to be responsible for the proper performance of certain fish species in a natural fish pond [8]. This development necessitated the need for the present study and therefore carried out to assess the physicochemical properties of some selected fish ponds in Kano State and ascertain the suitability of such ponds for artificial fish culture. This will also generate significant conservation impact on fish species at their natural state by limiting human pressure on flourishing but limited population that exists in the wild or natural fish ponds, rivers, seas, and ocean as a whole.

MATERIALS AND METHODS

Study Area

The study area is located between longitude 8^0 31'E and latitude 12^0. 00'N. It has a population density of nine million three hundred and eighty three thousand six hundred and eighty three people (9,383,683) [13]. The state is characterised by two seasons. It has a clearly marked rainy season which lasts from May to September and the dry season which lasts from October to April. The mean annual temperature is between 16 - 47^0C while the mean annual rainfall ranges from 700 – 1160 mm [14]. Drainages of the study area include River Kano, Challawa, Watari, Jatau and Dudurun Gaya which join the Hadejia and empties into Lake Chad while Gari, Tomas and Jakara disappear into the sands of the Chad formation further east. Several manmade lakes such as Tiga, Challawa Gorge, Gari, Jakara, Watari, Guzuguzu, KafinChiri, Dudurun Gaya, Bagauda have been constructed to improve portable water supply to towns and villages and to improve water for irrigation. The fish species and population of these rivers are considerably poor while there are 9,383,683 people (one of Nigeria's most populous cities). The population of Kano depend mostly on fish for protein to get rid of the predominant Muslim taboo on certain domestic and wild animal species such as pigs, dogs, donkeys, horses or normally eatable animals that are slaughtered by the minority Christians. The analysis was made from four different concrete ponds stocked with juveniles of *Clarias gariepinus* of 2 - 9 inches. Water samples were taken under water, closed to beneath to avoid skewed results [8]. Temperature of pond water sample was determined using 250 ml glass beaker and a mercury-in-glass portable thermometer at the site of sample collection. The bulb of the thermometer was dipped into the beaker filled with water sample and allowed to remain inside for 5 minutes before reading was taken. The pH value of pond water samples were obtained using a digital pH meter model HI 8424 microcomputer manufactured by HANNA instrument. The pH meter was switched on and allowed to warm up for 10 minutes. It was standardized using buffer 7.0 and 10.0. The electrode was rinsed with distilled water, blot dried with soft tissue paper. The electrode was inserted in the sample pond water until the meter reading stabilized. Conductivity was determined using digital conductivity meter model 4520 JENWAY serial number 01263. The meter was switched on and warmed for 10 minutes. It was standardized with 0.01M KCl solution. The electrode was thoroughly rinsed with distilled water and introduced directly into pond water. The value was taken after reading on display stabilized. Dissolve oxygen was determined using a portable dissolve oxygen analyzer, model JPB-607. It was switched on and warmed for 10 minutes with the electrode calibration solution supplied from the manufacturers. Total hardness was determined by adding 2 ml of buffer 10 solution and 2 ml of aerochrome indicator solution to a 50 ml and water in conical flask. It was swirled thoroughly after which a wine red colour appeared. A standard EDTA titrant was added slowly with continuous stirring until reddish tinge disappeared and the colour changed to sky-blue. Total suspended solids were determined using whatman membrane filter paper 0.45 µm. The membrane filter paper was dried in an oven at 105 ^{0}C for one hour and cooled in desiccators for 30 minutes. 100 ml of well mixed pond water was filtered through the membrane paper and it was again oven dried and desiccated as in above. The weight of membrane filter paper was subtracted from the weight of membrane filter paper containing the residue of sample water.

STATISTICAL ANALYSIS

The physicochemical parameters of the pond water was analyzed and determined using one way analysis of variance (ANOVA) with the aid of INSTAT 3 statistical software for window version 2003.

RESULTS

Zogarawa fish pond in Dawakin Tofa L.G.A had a pond dimension of 10 m x 8 m x 1 m, Bagauda fish seed multiplication centre had 10 m x 7 m x 1 m, Fagam fish farm had 10 m x 10 m x 1 m while Khasu integrated fish farm had 10 m x 7.5 m x 1 m (Table I). The volume of water was 80 m^3, 70 m^3, 100 m^3 and 75 m^3 for Zogarawa, Bagauda, Fagam and Khasu fish ponds respectively.

The size of juvenile ranged between 3.5 - 6 inches with average feeding rate of 13 kg for Zogarawa fish pond, 2 - 6 inches with average feeding rate of 10 kg for Bagauda fish seed multiplication centre, 2 - 9 inches and average feeding rate of 15 kg for Fagam fish farm while Khasu integrated fish farm had 3 - 8.5 inches of juvenile with feeding rate of 12 kg. The number of juveniles was 6000, 5000, 7000 and 5500 respectively (Table II).

The results of physicochemical analysis in four aquaculture ponds in Kano State are presented in Table III as means and standard deviation. The results were compared with the prescribed water quality standard of Kumar [15]. A minor variation was recorded in the values obtained in all the fish ponds.

The temperature range between 25.7±1.07 ^{O}C in Bagauda fish seed multiplication centre to 27.8±1.03^{O}C in Zogarawa fish pond water. pH ranged between 6.8±0.03 in Zogarawa fish pond to 7.1±0.62 in Fagam fish pond. The least dissolved oxygen was recorded in Fagam fish pond 2.01±0.03 mg/l while the highest was 3.08±0.13mg/l in Bagauda fish seed multiplication centre. Electric conductivity ranged between 296.3±1.73 µs/cm in Fagam fish pond to 613. 7±3.03 µs/cm in Khasu integrated fish pond. The least total hardness recorded was 63.0±1.90 mg/l in Bagauda fish seed multiplications centre to the highest 153.0±2.76 mg/L in Zogarawa fish pond. The least total suspended solids recorded was 20.5±2.35 mg/l in Fagam fish pond to the highest 100.6±4.98mg/l in Zogarawa fish pond.

Table I: Dimension of Fish ponds

	Zogarawa	Bagauda	Fagam	Khasu
Length (meter)	10	10	10	10
Breath (meter)	8	7	10	7.5
Depth (meter)	1	1	1	1
Volume (meter^3)	80	70	100	75

Table II: Fish population, size and feeding rate per pond

Fish Pond	Juveniles number (n)	Juvenile size (inches)	Feeding rate (kg/day)
Zogarawa	6,000	3.5 – 6	13
Bagauda	5,000	2 – 6	10
Fagam	7,000	2 – 9	15
Khasu	5,500	3 – 8.5	12

Table III: Physicochemical parameters of fish ponds

Fish pond	T°C	pH	DO	EC	TH	TSS
Zogarawa	27.8±1.03[a]	6.8±0.03[a]	3.01±0.02[a]	603.3±2.18[a]	153.0±2.76[b]	100.6±4.98[c]
Bagauda	25.7±1.07[b]	7.0±0.09[b]	3.08±0.13[b]	571.6±1.26[a]	63.0±1.90[b]	41.0±2.65[c]
Fagam	26.6±0.97[c]	7.1±0.62[c]	2.01±0.03[c]	296.3±1.73[a]	102.3±1.03[b]	20.5±2.35[c]
Khasu	26.8±1.08[d]	7.0±1.15[d]	3.05±1.03[d]	613.7±3.03[a]	98.0±1.24[b]	44.0±1.77[c]
Kumar's Standard	20.30°C	6.5-8	3 to saturation mg/L	1000µs/cm	10-400 mg/L	<80 mg/L

Values are mean ±S.D. Values with different superscripts in the same column are not significant (p>0.05).

DISCUSSION

Water utilized for aquaculture in this study ponds were borehole water for Zogarawa fishpond, Fagam fishpond and Khasu integrated fish pond while Bagauda fish seed multiplication centre uses Bagauda Dam Water. The study was conducted from July to December 2012. The results on the physicochemical parameters of these aquaculture ponds were compared with the water quality standard of Kumar [15]. The mean temperature range of 25.7±1.07 – 27.8±1.03 as shown by the findings of this study could be an indication that the water quality was not affected by this parameter which agrees with Thilza and Mohammed [16] findings on a similar study in Maiduguri. In a similar vein, Adeniji and Ovie [1], Madu [17] and Solomon *et al*., [5] also reported that the best temperature range for optimum production of *Clarias gariepinus*is25 -31^{o}C. This explains why *Clarias gariepinus* thrive so well and remain the most common species cultured in these areas. However, *Clarias gariepinus* has its origin from areas with extreme temperatures suggesting that more factors remain pertinent to an effective production and conservation of this fish species.

The pH range of 6.8±0.03 -7.1±0.62 as part of the findings from this study depict that the water is neutral. This finding is in agreement with Huet [18], USDA [19] and Robert [4] who stated that the best water for fish cultivation is that whose pH is neutral or slightly alkaline ranging from 7 to 8. Stone and Thomforde [20] reported a range of 5.5- 10, furthermore, a similar range was obtained by Kamal *et al*., [21] who reported a range of 7.3 - 8.3. David *et al*., [22], reported a range of 6.89 - 6.92 for Kiri and Gyawana lakes respectively. Swann [23], 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 [4] also noted that fish can die of pH shock, a consequence of sudden change in pH. Throughout the period of this study, there was no casualties recorded probably an indication that the pH-value remained constant at all time of the day and night. This may not be a true reflection on stability of pond water pH but rather suggesting that one or a combination of other important factors probably played a vital role at balancing the defect from the adverse pH-value. Therefore, pond conservation demands for an ecological balance through managerial manipulation of significant eco-systemic factors including both biotic and abiotic as well as the personnel staff in charge of daily routine of the fish farm.

Dissolved oxygen is one of the most important abiotic parameter influencing life in any aquatic environment. The least dissolve oxygen was 2.01±0.03 in Fagam fish pond and the highest was 3.08±0.13 in Bagauda fish seed multiplication centre within the temperature of 25-27^{o}C. This is generally a low dissolve oxygen values for fish ponds. The low oxygen value could be due to the time of sampling which was done between 6 -7 am when there is no photosynthesis by algae to increase the oxygen in the pond water and the oxygen manufactured in the day time has been exhausted by fishes, bacteria and zooplankton in the night. This finding is in agreement with Onome and Ebinimi [9], who reported a range of 2.0- 7.70mg/l dissolve oxygen value in stagnant concrete tanks within the temperature of 24- 29^{o}C. Low levels dissolve oxygen less than 0.3 is a lethal concentration that can put undue stress on fish and are often linked to fish kill incidents [24]. However, it has been reported that African catfish *Clarias gariepinus* can survive in dissolve oxygen level between 0.0 - 0.3mg/L because they have obligate air breathers [25]. The low dissolve oxygen could be due to the presence of microbes and plants as fish are not the only consumers of oxygen in aquaculture system: bacteria, phytoplankton and zooplankton consumes quantities of oxygen as well [26]

[16]. Normally high dissolve oxygen is encountered in unpolluted ponds and low dissolve oxygen in polluted ponds. Further depletion of dissolve oxygen to the level of anaerobic is most critical manifestation of pollution [27] [16]. According to Robert [28] [4], 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. Brian [29] and Ita *et al*., [30] also noted that increase dissolved oxygen level is needed to support an increase in metabolic rates and reproduction.

The conductivity values 296.3±1.73 to 613.7±3.03 µs/cm which could be a pointer to the pollution status of these ponds probably caused by debris, excessive nutrients from feeds, run-off during rains into the ponds (perhaps a consequence of improper citing of the ponds) and waste products of fishes and other insects population within the ponds [5]. Garg *et al*. [31] classified productivity value greater than 500µs/cm as eutrophic. This implies that Zogarawa pond water, Bagauda fish seed multiplication centre pond and Khasu integrated fish farm pond water have excessive nutrients especially nitrogen and phosphorus, dominated by algae. As algae grow in a pond, a population of zooplankton will also develop, on which the fish feed. Algae influence the water quality of the pond mainly affecting the balance among dissolve oxygen, pH, co_2 and nutrient. Algae compete with the fish for available oxygen in water [32].

Zogarawa fish pond has the highest value of total water hardness; this is due to the addition of lime in an objective for a higher better production [33]. Calcium and Magnesium ions comprise hardness, if hardness is deficient, fish do not grow well. Low hardness recorded in Bagauda fish seed multiplication centre pond water (63.0±1.90 mg/L) can be adjusted by addition of lime or calcium chloride [2]. The presence of free (ionic) calcium at relatively high concentration in culture water help reduce the loss of other salts (e.g. Sodium and Potassium are the most important salts in fish blood and are critical for normal heart, nerve and muscle function [34]. In low calcium water, fish can lose (leak) substantial quantities of these salts into the water. A low $CaCo_3$ hardness value is a reliable indication that the calcium concentration is low; however, high hardness does not necessarily reflect a high calcium concentration. A high hardness reading could not result from high magnesium concentration with little or no calcium present [34].

The total suspended solids in Bagauda fish seed multiplication centre (41.0±2.65) Fagam fish farm (20.5±2.25) and Khasu integrated fish farm pond water (44.0±1.77) cannot affect the fish functioning and survival except in Zogarawa fish farm pond water (100.6±4.98) which exceeded the limit set by Kumar [15] of <80mg/L. The high suspended solids sedimentation may be as a result of excreta by fishes and high feeding habits in the pond water as accumulation of uneaten feed could contribute to the high value [16]. High suspended solids in the pond water may interfere with fish finding feeds and may also damage the gills of fish [16]. Total suspended solids are a sign factor in observing water clarity i.e. transparency. The more solids present in the water the less clear the water would be. Some suspended solids can settle out into sediment at the bottom of a body of water over a period of time. Although this settling improves water clarity, the increased silt can smother benthic organisms, eggs of fish and aquatic insects as well as suffocate newly hatched insect larvae. Settling sediments can fill in spaces between rocks which could have been used by aquatic organisms for homes [35]. High total suspended solids in water body often means higher concentration of bacteria, nutrients, pesticides, and metals in water [36]. According to David *et al.* [22], suspension of organic and inorganic matter is a major factor affecting transparency.

Natural Resource Conservation can be considered as successful only when the physiochemical parameters of the species habitat are in order. Too small or too much of these physiochemical parameters will be detrimental to their reproduction, survival and performance. From the findings of this study, it is therefore pertinent to mention that the studied ponds are in a stable state and suitable for fish farming with the idea of re-introduction into water bodies with insufficient fish population.

CONCLUSION

The physicochemical parameters studied show that the level obtained are within permissible limit which is suitable for cultivation of *Clarias gariepinus* and hence for aquaculture. But the dissolve oxygen values of these ponds are worrisome as further depletion could lead to the death of fish. It is therefore, recommended that there should be an immediate aeration of ponds in an emergency, a pump should be placed in the ponds and allow to splash water over the pond surface or installing a long term air pump. Also, sediment filter in Zogarawa fish pond is needed to remove suspended solids matter. Fluctuating in physicochemical parameters existed but these could not impair the suitability of the ponds for fish production. Continuous monitoring of these physicochemical parameters is therefore advocated, as these would provide information on preventing fish kill. It would also aid farmers to maintain good water quality in fish ponds for producing larger and healthier fish for human consumption and for making a good profit. Some fish species that are found in limited number in their natural water bodies should be brought to artificial ponds, multiplied and re-introduced in their natural ecosystem to ensure sustainable use.

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