SOME CHEMICAL PARAMETERS OF A FERTILIZED PRODUCTIVE POND

NWAMBA, Helen Ogochukwu
Department of Applied Biology, Enugu State University of Science and Technology, Enugu State, Nigeria. **Email:** nwambahelen@yahoo.com **Phone:**

ABSTRACT

Some chemical parameters of a rock water productive pond were determined. Chicken droppings were applied at the rate of 1.5kg per day to a pond of mean surface area of 300m$^{2:}$. The experimental period lasted for 10 months, with the first five months as the unfertilized period and the remaining five months as the fertilized period. All water quality parameters were studied titrimetrically and triplicated for accuracy and precision. There was no significant variation (P>0.05) in the conductivity (ionic content) of the pond water whether fertilized or unfertilized. The increased in the mean values of free carbon dioxide during the fertilized period was attributed to increased rate of decomposition of organic matter and a concomitant release of carbon dioxide. Both phosphate-phosphorus (P04-P) and nitrate-nitrogen ($N0_3$-N) were significantly different (P<0.05) when the pond was fertilized. This was attributed to the availability of nitrogen and phosphorus as part of the constituents of chicken droppings. From this study it was observed that the use of fertilizer has favourable effect on the chemical parameters of the pond.

Keywords: Free carbon dioxide, Phosphate-Phosphorus ($P0_4$-P), Nitrate-nitrogen (NO_3-N), Conductivity, Chicken droppings

INTRODUCTION

The manipulation of nutrients concentration in water, especially with organic fertilization, results in greater response in zooplankton abundance, which forms a substantial part of the diet of fish during early culture. Problems associated with excessive application of organic manure in ponds involve rapid depletion of oxygen especially at high temperatures and excessive production of carbon dioxide and hydrogen sulphide as a result of the activities of decomposing organisms. In China organic manure are left for 10 days in compost pits to ferment and reduce chances of pathogen transfer to fish under culture (FAO, 1980).

Low dissolved oxygen limits respiration and growth of aquatic animals (Jobling, 1981). It has been noted that the highest values of dissolved oxygen concentration coincide with periods of most intensive development of algae and vice versa. The most productive water has a pH range of 6.5 – 8.5 (Swingle, I960). However, Wokoma (1986) reported that the low pH tolerant tilapia *(Tilapia guineensis)* can survive for a long period at pH above 3.5, while at pH 3.2 can only survive for few hours. Against this background, the present study aims at determining the effect of fertilization with chicken manure on changes in some chemical parameters of rock water productive pond.

MATERIALS AND METHODS

The experiment was carried out at the University of Jos, Jos, Plateau State, Nigeria Senior Staff Quarters where a polyculture pond was sited. The pond has a mean surface area of 300 m and a depth of 1.2 m. The fish stocked were: *Oreochromis niloticus, Cyprinus carpio, Tilapia zilli* and Koi carp. Chicken droppings were applied at the rate of 1.5kg per day for five months (July to November which represented the fertilized period of the experiment). The remaining five months (February to June) was the unfertilized period.

Weekly sampling of water from the pond was carried out to determine some selected parameters. Diurnal sampling was also done once a month at three-hourly intervals. The chemical parameters investigated were: dissolved oxygen (DO), electrical conductivity, free carbon dioxide, total alkalinity, phosphate-phosphorus, nitrate-nitrogen, hydrogen ion concentration (pH) and dissolved organic matter. All water quality parameter studied were analyzed in triplicates for accuracy and precision. Electrical conductivity was measured with a portable switch gear electrolytic conductivity meter (Model Mc-1 Makr V). To determine the hydrogen ion concentration (pH) of the water sample, a pocket pH-temperature meter (Yew Model 57) was dipped into water in an inclined position and allowed to stabilize for five minutes before readings were taken. The Winkler's titrimetric method (APHA, 1990) and Lind (1979) were applied for the determination of dissolved oxygen concentration. The concentration of oxygen in water samples was expressed in mgl^{-1} using the equation given by Boyd (1979) i.e. 0_2 mgl^{-l} = V(D) X N(D) X 8 X 100 / Volume of sample, where V = volume of sodium thiosulphate solution (0.025N $Na_{:2}$ S_2 O_2).

Free carbon dioxide concentration was determined using the method described by Lind (1979). 100ml water samples introduced into 250ml Erlenmeyer flasks with phenolphthalein as indicator, were analyzed for free carbon dioxide immediately on return from the field. This was to avoid changes in CO_2 concentration that may occur as a result of respiratory process. The concentration was expressed in mgl^{-1}, as: Titre value (ml) of N/44 NaOH X 10.

Dissolved organic matter (DOM) was determined titrimetrically using N/100 potassium permanganate ($KMn0_4$), 25N sulphuric acid (H_2SO_4) and ammonia oxalates solution. A blank titration was carried out using distilled water and the value of dissolved organic matter was computed as: Titre value (ml) of water sample-titre value (ml) of blank X 3.14.

Total alkalinity (mgl^{-1}) was measured through the determination of phenolphthalein and methyl orange alkalinities. Titrimetric procedure was applied for both determinations using 0.02N $H_2SO_{4,}$ 100ml water sample and an indicator depending on what alkalinity was being determined. Phenolphthalein was used as an indicator for the determination of methyl orange alkalinity and vice-versa. The titre value (ml) was multiplied by a factor of 10 on both cases. Total alkalinity was then computed as the sum of phenolphthalein and methyl orange alkalinities and expressed in mgl^{-1}.

Nitrate-Nitrogen (NO-N) was through the method of phenol disulphuric acid as described by Mackereth (1963). The resulting yellowish mixture was stirred and allowed to cool. The absorbance was measured with a calorimeter (Corning Model 252) at 410nm wavelength using distilled water as blank. The concentration of Nitrate-Nitrogen was extrapolated from a standard calibration curve.

The concentration of Phosphate-Phosphorus (PO_4-P) was determined using Deniges reagent method as described by Mackereth (1963), Linb (1979) and APHA (1990). The absorbance of the resulting bluish mixture was measured in 690nm wavelength using a calorimeter (Coming Model 252). Distilled water was used as a blank. The concentration of PO_{4}-P was then extrapolated from a standard calibration curve.

Statistical Analysis: The data obtained were subjected to analysis of variance (ANOVA) (Steel and Torrie, 1990).

RESULTS AND DISCUSSION

Conductivity: Records, of the conductivity of the experimental pond are shown in Tables 1, 2 and 3. The highest mean value was recorded in February, while the lowest was in April. There was no significant variation (P>0.05) between fertilized and unfertilized period of the experiment. The lowest ionic content (conductivity) value was 36.30 ± 0.03 ohms cm^{-1} and the highest recorded was 48.12 ± 0.03 ohms cm^{-1}. Beadle (1981) reported that category 1 of African lakes have 40 ohms cm^{-1}

Table 1: Mean weekly values of some chemical parameters recorded in the pond February-April, 2006

Date	Conductivity ohms. Cm^{-1}	D.O (Mgl^{-1})	Free CO_2 (Mgl^{-1})	pH	Total Alkalinity (Mgl^{-1})	PO_4-P (Mgl^{-1})	NO_3-N (Mgl^{-1})	DOM (Mgl^{-1})
7/2/06	48.12±1.15	7.50±1.16	0.45±0.12	7.70±1.14	39.00±1.13	0.35±0.16	0.44±0.10	4.45±1.12
14/2/06	47.50±1.16	7.06±1.13	0.40±0.11	7.60±1.13	38.60±1.17	0.37±0.14	0.42±0.12	4.52±1.14
21/2/06	39.10±1.12	7.50±1.12	0.32±0.14	7.50±1.18	37.50±1.10	0.36±0.11	0.43±0.15	4.69±1.16
28/2/06	40.05±1.18	7.30±1.15	0.24±0.13	7.45±1.15	38.00±1.15	0.35±0.17	0.41±0.11	4.68±1.12
6/3/06	43.10±1.17	7.30±1.12	0.78±0.17	7.41±1.12	29.00±1.18	0.36±0.15	0.45±0.13	4.76±1.17
13/3/06	42.06±1.15	8.23±1.10	0.65±0.11	7.46±1.16	27.80±1.13	0.57±0.13	0.46±0.16	4.74±1.16
20/3/06	40.10±1.11	7.56±1.13	0.70±0.13	7.40±1.12	28.70±1.12	0.35±0.14	0.48±0.13	4.75±1.12
27/3/06	41.20±1.12	7.00±1.14	0.40±0.10	7.46±1.12	28.48±1.13	0.34±0.11	0.47±0.11	4.78±1.16
3/4/06	36.30±1.18	6.75±1.15	1.00±0.12	7.32±1.14	29.40±1.17	0.41±0.14	0.49±0.13	5.40±1.12
10/4/06	36.60±1.16	7.00±1.16	1.10±0.16	7.33±1.15	28.50±1.13	0.41±0.12	0.46±0.11	5.41±1.16
17/4/06	38.50±1.12	7.50±1.11	0.90±0.12	7.20±1.12	28.50±1.17	0.37±0.15	0.51±0.14	5.41±1.15
24/4/06	39.05±1.10	7.00±1.14	0.95±0.15	7.25±1.13	28.60±1.12	0.38±0.13	0.47±0.10	5.43±1.13

Table 2: Mean weekly values *of* some chemical parameters in the pond May-July, 2006

Date	Conductivity ohms. Cm^{-1}	D.O (Mgl^{-1})	Free CO_2 (Mgl^{-1})	pH	Total Alkalinity (Mgl^{-1})	PO_4-P (Mgl^{-1})	NO_3-N (Mgl^{-1})	DOM (Mgl^{-1})
1/5/06	42.01±1.12	6.55±1.13	0.80±0.11	7.80±1.13	30.50±1.14	0.39±0.10	0.49±0.11	5.42±1.13
8/5/06	43.00±1.10	6.80±1.11	0.60±0.10	7.90±1.12	31.00±1.15	0.40±0.15	0.50±0.13	5.41±1.14
15/4/06	41.00±1.13	6.95±1.10	0.90±0.12	7.50±1.15	31.00±1.16	0.50±0.10	0.41±0.12	5.40±1.13
22/5/06	43.00±1.14	7.00±1.11	0.87±0.14	7.60±1.13	31.00±1.13	0.50±0.12	0.57±0.13	5.50±1.11
29/5/06	43.00±1.11	7.00±1.18	0.89±0.13	7.80±1.13	32.00±1.14	0.60±0.11	0.49±0.14	5.50±1.12
5/6/06	44.00±1.13	7.00±1.13	0.88±0.14	7.80±1.13	32.01±1.15	0.62±0.13	0.48±0.15	5.51±1.13
12/6/06	42.00±1.15	7.90±1.17.	0.70±0.12	7.80±1.17	34.00±1.13	0.70±0.15	0.60±0.16	7.55±1.14
19/6/06	43.00±1.13	7.90±1.13	0.80±0.11	7.80±1.16	31.00±1.11	0.60±0.10	0.70±0.17	7.58±1.16
26/6/06	41.00±1.10	7.80±1.16.	0.70±0.10	7.00±1.15	35.00±1.12	0.65±0.14	0.85±0.18	7.56±1.15
3/7/06	41.00±1.13	8.90±1.15	0.70±0.12	7.90±1.14	31.00±1.14	0.70±0.15	0.90±0.10	7.78±1.14
10/7/06	42.00±1.11	8.90±1.13	0.87±0.14	7.80±1.13	36.00±1.13	0.75±0.13	0.90±0.19	7.84±1.13
17/7/06	43.00±1.13	8.50±1.14	0.89±0.13	7.00±1.12	37.00±1.15	0.76±0.11	0.85±0.11	7.82±1.12
24/7/06	42.01±1.10	8.70±1.12	0.87±0.15	7.60±1.11	37.00±1.16	0.75±0.12	0.78±0.14	7.90±1.13
31/7/06	43.00±1.13	8.80±1.11	85.00±0.10	7.50±1.13	38.00±1.17	8.00±0.11	0.86±0.13	7.82±1.12

Table3: Mean weekly values of some chemical parameters in the pond August-November, 2006

Date	Conductivity ohms. Cm^{-1}	D.O (Mgl^{-1})	Free CO_2 (Mgl^{-1})	pH	Total Alkalinity (Mgl^{-1})	PO_4-P (Mgl^{-1})	NO_3-N (Mgl^{-1})	DOM (Mgl^{-1})
7/6/06	43.00±1.00	9.00±1.10	0.70±0.14	7.80±1.10	37.60±1.13	0.80±0.10	0.85±0.10	7.92±1.16
14/6/06	42.50 ±1.13	8.50±1.14	0.90 ±0.17	7.80±1.13	38.00±1.14	0.90±0.11	0.82±0.11	7.94±1.17
21/8/06	41.50±1.11	8.60±1.11	0.75±0.15	7.50±1.15	39.00±1.15	0.83±0.17	0.84±0.12	7.96±1.14
28/8/92	44.00±1.10	8.75±1.13	0.82±0.10	7.90±1.14	37.80±1.10	0.90±0.16	0.85±0.15	7.94±1.12
4/9/06	43.00±1.11	8.00±1.10	0.90±0.12	8.00±1.13	36.90±1.12	0.58±0.11	0.77±0.17	7.50±1.12
11/9/06	41.02±1.15	9.00±1.12	0.85±0.10	7.00±1.18	37.50±1.11	0.79±0.13	0.85±0.13	7.55±1.13
18/9/06	41.30±1.10	8.00±1.13	0.88±0.14	7.60±1.13	39.00±1.15	0.81±0.10	0.85±0.15	7.52±1.11
25/9/06	42.40±1.14	8.00±1.03	0.90±0.11	7.50±1.11	0.92±1.13	0.92±0.14	0.89±0.11	7.54±1.12
2/10/06	43.10±1.11	8.50±1.11	0.70±0.13	7.40±1.10	34.00±1.12	0.79±0.15	0.87±0.10	7.70±1.10
9/10/06	41.20±1.10	8.60±1.10	0.90±0.15	7.50±1.13	35.00±1.10	0.78±0.10	0.88±0.17	7.72±1.10
16/10/06	42.30±1.15	8.40±1.14	0.70±0.13	7.30±1.14	36.00±1.13	0.61±0.14	0.74±0.11	7.74±1.12
23/10/06	41.20±1.12	9.10±1.11	0.90±0.10	7.60±1.11	37.00±1.10	0.79±0.17	0.81±0.16	7.65±1.14
30/10/06	42.10±1.14	9.20±1.13	0.80±0.12	7.40±1.14	36.00±1.15	0.81±0.11	0.81±0.13	7.70±1.11
6/11/06	43.00±1.15	8.30±1.14	0.90±0.13	7.40±1.12	35.00±1.12	0.78±0.16	0.81±0.11	5.59±1.10
3/11/06	41.00±1.10	8.40±1.03	0.70±0.10	7.40±1.17	34.00±1.14	0.81±0.10	0.71±0.17	5.60±1.13

value of conductivity. This implied that the value in this study is high. High value resulted from nutrient in-put which in turn resulted in more ionization.

Dissolved Oxygen: The highest and lowest values of dissolved oxygen were obtained in October (9.20 ± 0.05 mgl^{-1}) and May (6.55 ± 0.03 mgl^{-1}), respectively. The lower values were obtained during the fertilized period (Table 1 – 3). The values of dissolved oxygen recorded were conducive for most aquatic live (Chidobem, 1987). High dissolved oxygen resulted from higher photosynthetic rates, low algal and microbial respiration (Biswas, 1978). The lowest dissolved oxygen (DO) value recorded was 7.07 mgl^{-1} and the highest was 8.85 mgl^{-1}. Fish do not feed or grow well when DO levels remain continuously below 5 mgl^{-1} (Andrew, 1977). The value recorded in this experiment fell within a suitable range for aquatic life. Chidobem (1987) reported higher photosynthetic rate due to high biomass and a corresponding high level of dissolved oxygen.

Free Carbon Dioxide: Tables 1, 2 and 3 showed values obtained for the level of the carbon dioxide in the productive pond during the study. The highest value (1.10 ± 0.03 mgl^{-1}) and lowest value (0.24 ± 0.05 mgl^{-1} were rounded in April and February, respectively. There was increase in mean values of the above parameter during the fertilization period. This may be due to increase in the rate of decomposition of organic matter with the release of large amounts of carbon dioxide. Self shading of algal cells which led to low photosynthetic rate was also possible. In this pond, carbon dioxide released during respiration of aquatic organisms was not effectively utilized. A range of 0.24 ± 0.05 mgl^{-1} to 1.10 ± 0.03 mgl^{-1} free carbon dioxide was recorded. The mechanism of photosynthesis which required sunlight cannot occur in the absence of carbon dioxide. Generally, water supporting good fish populations have less than 5 ppm carbon dioxide (Mackereth, 1963). The low value of CO_2 obtained in this work came as a result of phytoplankton abundance arising from sufficient nutrients supplied by chicken droppings.

Hydrogen Ion Concentration (pH): There was slight variation in the values of pH between fertilized and unfertilized periods during the study, the increment probably result from the neutralizing effect of total alkalinity, though carbon dioxide was also high. Highest value (8.00 ± 0.5 pH) was recorded in September while the lowest value (7.20 ± 0.03 pH) was obtained in April (Tables 1 – 3). The range of pH values recorded during the experiment was 7.2 – 8.0. Since the acid and alkaline death points according to Swingle (I960) are approximately 4 pH and 11 pH. It is clear from this study that the effect of fertilization on pH was slight. Therefore, pH was not a limiting factor for the production of plankton and fish.

Total Alkalinity: The mean values of total alkalinity values increased during the fertilized period. The increment in alkalinity level regulated the pH levels. Highest value was nonetheless recorded in February, while the lowest in March (Tables 1 – 3). The values obtained fell within the range conducive to the growth of fish and planktons (Akpan, 1991). The total alkalinity obtained fell within 28.48 – 39.00 mgl^{-1}. Likens (1975) associated high alkalinity values with high productivity for autotrophic waters. If alkalinity was low, the buffering capacity of water will be low for survival of fish. The alkalinity values obtained in this study fell within the limit of alkalinities for the survival of freshwater fish as observed by Mackereth (1963). Therefore, alkalinity was not a limiting factor in the productivity of the pond.

Dissolved Organic Matter: There were significant differences in the values of dissolved organic matter (DOM) during the fertilized and unfertilized periods. The increased value of dissolved organic matter possibly resulted from dead planktons as well as nutrients supplied by chicken droppings. The highest and lowest values were obtained in August and February, respectively (Tables 1 – 3).

Phosphate-Phosphorus (PO_4-P): The highest mean value of phosphate-phosphorus (PO_4-P) (0.90 ± 0.29 mgl^{-1}) and lowest (0.34 ± 0.02 mgl^{-1}) were recorded in August and March, respectively. Highest values were obtained during the fertilized period (July to November). This was probably due to the application of chicken droppings, which has phosphorus as part of its constituents. There was significant difference (P<0.05) between mean values obtained during fertilized and unfertilized periods. A range of 0.34 ± 0.02 mgl^{-1} to 0.92 ± 0.03 mgl^{-1} of phosphate phosphorus was recorded. The value of PO_4-P obtained in this study was very high. Mackereth (1963) reported that Lakes that consistently contain more than 0.I5 mgl^{-1} orthophosphate may experience more algal growth. The high orthophosphate level in this work resulted from the application of chicken droppings and about 0.54% phosphate may be present in the droppings (Omisore *et al.,* 2009).

Nitrate-Nitrogen (NO_3-N): The weekly mean values of nitrate-nitrogen are provided in Tables 1 – 3. The highest and lowest values were recorded in July and May, respectively. There was significant difference (p<0.05) between values during fertilized and unfertilized periods of the experiment. As mentioned in the case of PO_4-P, nitrogen is also part of the constituents of chicken droppings. Akpan (1991) suggested that lakes consistently containing more than 0.3 mgl^{-1} nitrogen may experience algal bloom. This implied that the value obtained in the work was high. Chidobem (1987) observed that nitrate was as important as phosphate in the productivity of plankton as well as the synthesis of pigment. This is attributed to 1.3% nitrogen composition of chicken droppings (Omisore *et al.,* 2009). Therefore the application of chicken droppings had effects on nitrate-nitrogen composition.

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