

## EVALUATION OF WATER QUALITY PARAMETERS IN THE EARTHEN PONDS OF THE UNIVERSITY OF AGRICULTURE, MAKURDI FISH FARM.

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### ABSTRACT

*The evaluation of the Earthen Ponds of the University of Agriculture Fish Farm was to determine the various water quality parameters that are very imperative to the survival of the fish. The result obtained from the evaluation of the water quality parameters showed that brownish red colouration was seen in some of the production ponds on the farm. Meanwhile, the brownish red colouration was found to be boom caused by *Batrachospermum*, *Ectocarpus*, *Chlamydomonas* and *Spirogyra* which are brown, red and green algae respectively. Though no fish kill was observed in the course of the study which was an indication that the algae have no harmful effect on the fish. However, the bloom was found to have affected some physico-chemical parameters of water, particularly the temperature, water transparency and concentration of dissolved oxygen. Results showed that the water in ponds B and C were turbid, hence a low transparency of  $32.00\text{cm} \pm 6.70\text{cm}$  and  $30.60\text{cm} \pm 10.27\text{cm}$  were recorded. There was significant difference between the water transparency of ponds A, B and C. The results obtained from table 2 showed a Mean Dissolved Oxygen concentration of  $7.08 \pm 0.24\text{mg/l}$  for pond A.  $5.00 \pm 0.277\text{mg/l}$  and  $4.90 \pm 0.224\text{mg/l}$  for ponds B and C. This result also showed a significant difference in the concentration of Dissolved Oxygen between ponds A, B and C ( $P < 0.05$ ).*

**Keywords:** Evaluation, Water quality, Parameters, Earthen ponds, University, Agriculture, Markurdi, Fish farm.

### INTRODUCTION

In recent times, a persistent brownish red colouration has been observed on the surfaces of some ponds of the university fish farm, particularly when the sun is rising. It is believed to be caused by algae. This has informed our decision to investigate and identify the causes and possibly assess its impact on the pond water quality. Therefore, this study is justified by the need to have optimum levels of water quality parameters of the experimental ponds to enhance fish production.

Pond waters usually contain planktonic algae of diverse types. These algae are critical to food chains as they provide food for the microscopic animals which are in turn eaten by fish and other aquatic organisms. Occasionally, planktonic algae can bloom to nuisance levels which may necessitate using control methods. Planktonic algae are least abundant in winter when cold water temperatures inhibit their reproduction and growth (Abowei, 2010). This is why most ponds are transparent during that period. As ponds warm at the beginning of summer,

reproduction by algae increases greatly and the algae bloom occurs. The dense concentrations of planktonic forms which are responsible for these blooms are caused by some species of non-filamentous micro-organisms. (Adefemi et al 2007)

Algae bloom can be defined as a sudden discolouration of water caused by the explosion of dino-flagellates producing a red colour. A bloom can also be defined as an aggregation of planktonic sufficiently visible. The colour of a bloom may be green, brown or red, all depending species of algae dominating the water (Lynch, 2002).

A bloom may occur at any time when conditions are favourable, but it is more common in spring and early summer when primary production increases ahead of the growth in consumer population (Boyd, 2001) Optimum conditions for algae blooms are the result of the interaction of many factors which includes: exposure to long hours of sunlight, shallow warms water which is high in Nitrogen and phosphorus. In other words, blooms may be caused by the addition of plant nutrients to water, for

example, phosphates on nitrates in sewage or fertilizers run-off from farmlands and they are characteristic of eutrophication in fresh waters (Boyd, 2001). Extreme conditions of this bloom become unfit for humans and livestock consumption and may be toxic to fish or other aquatic organisms. Algae blooms cause the water to appear pea soup green or brown in colour, that is the turbidity is usually high hence this causes clogging of fish gills and consequently death. It also causes oxygen depletion in water as a result of retarding photosynthetic activities. Bloom die-off will also result to low dissolved oxygen as a result of decay or decomposition (Lynch, 2002, Basu, 2011, Buentello et al, 2000)

Planktonic bloom will also cause blocking of pond inlet and outlets and water supply channels. For pond owners who desire a clear pond for swimming or for aesthetic reasons, this situation is unacceptable.

The quality of water plays an important role in fish culture; hence attempts must be made to control and manage water quality parameters effectively in order to yield optimum results, because good quality water will produce more and healthier fish than poor water quality (Maitland, 1990). Water can be assessed to be of good or bad quality when the water parameters or variables are determined to be at optimum levels or not (Egwusi et al, 2014). Some of these variables include: water temperature, turbidity, hydrogen ion concentration (pH), dissolved oxygen, biological oxygen demand, free carbon dioxide and total alkalinity.

Nevertheless, the availability and quality of water sources for aquaculture production in Nigeria have been impacted upon by both natural and activities of man resulting to poor water quality and decline in yield and productivity of aquaculture in aquatic ecosystem (Obasohan, 2009). Water quality is the chemical physical and biological properties of water suitable for intended use as it is applicable in aquaculture (Islam et al, 2013).

The quality of water is a major economic and environmental issue in developing Nature of the World like Nigeria (Utang and Akpan, 2012)

Boyd and Gross (2000) stated that the different form 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. This is a line with the work done by (Okayi et al, 2011).

## **MATERIALS AND METHOD**

### ***Study Sites.***

University of Agriculture, Makurdi Fish Farm is located at the South Core of the campus, about 200m away from the River Benue, which is its primary source of water supply. Three fish ponds were selected in the fish farm for the purpose of this study. Pond A. This pond was not affected by the bloom. It served as the control for this research.

Pond B. This pond was affected by the bloom.

Pond C. This was also affected by the bloom.

### ***Sampling***

#### ***Algae Sampling***

Algae sampling was done between June and August during the rainy season. Algae were sampled using a sampling bottle. The specimen in the samples were concentrated at the bottom of the bottle using formalin and identified immediately in the Biological Science Laboratory of the University. Sample was placed in the Petridish and identified using a light microscope with the aid of a taxonomic guide.

#### ***Water Sampling***

The water samples were collected in triplicate from each location: two 250ml reagent bottles and one 1litre jerry can. One of the two reagent bottles from each station was fixed for dissolved oxygen on the fields. The samples in the jerry can were used for analysis of other physico-chemical parameters, while the other set of samples in the reagent bottle were incubated for BOD analysis. Samples were collected between June and August.

#### ***Water Analysis***

The water samples collected from the field were subjected to analysis in the fisheries laboratory and food chemistry laboratory of the University.

## **METHODOLOGY**

***Temperature:*** This was determined for water temperature *insitu* using a mercury-in-glass thermometer (0-100°C) which was immersed in water at above 10cm depth for 3 minutes to stabilize.

The temperature was read on the stem according to the rise in mercury level.

**Turbidity:** This was determined using the seechi disc. The seechi disc was slowly lowered into the water and keeping the line vertical, the depth at which it just disappeared was recorded as d1. The disc was lowered a little more and then raised, until it just reappeared and the depth was recorded as readings. (d1-d2)/ 2 cm.

**Dissolved Oxygen:** This was determined titrimetrically using the Alterberg.Azide (Winkler's) method. The water sample collected in 250ml reagent bottle was filled with 2ml alkaline Iodide and 2ml Manganese sulphate at the field. This formed a white precipitate of manganous hydroxide in the laboratory, the precipitate was dissolved when 2ml of concentrated H<sub>2</sub>SO<sub>4</sub> acid was added. This yielded a yellowish solution 100ml of the solution was transferred into a conical flask and 0.025N sodium thiosulphate was titrated against it to a pale straw colour. 1ml of 1% starch solution was then added to form a dark blue colouration and the titration continued until a colourless solution was obtained. The volume of the sodium thiosulphate(v) was recorded and the value of dissolved oxygen determined from the relationship.

Do (mg/l) = volume of titre (APHA 1985).

**Biological Oxygen Demand (BOD).** This was determined in the same way Dissolved oxygen according to APHA, 1985 using AlterbergAzide method except that the raw water samples were incubated in bottle for 5 days in the dark. The BOD was then determined in the relationship BOD (mg/l) = Do (before incubation)-Do (after incubation).

#### **Hydrogen Ion Concentration**

This was determined using the pH meter (Model/Labtech digital 152R) values were displaced

on the screen after the pH meter was conditioned or equilibrated the values displayed were recorded.

**Free Carbondioxide:** This was determined trimetrically using the sodium hydroxide method described by Saxena (1990). 100ml of water sample was placed into a conical flask. 2-3 drops of phenolphthalein indicator was added and 0.002m of Sodium hydroxide solution was titrated until it turns to a pink colouration.

Free CO<sub>2</sub> mg/l = V1 = 100/Vs

V1 = Volume of titrant (sodium hydroxide)

Vs = volume of sample

**Total Alkalinity:** This was determined by titration using H<sub>2</sub>SO<sub>4</sub> acid method described by Saxena (1990). To obtain total alkalinity, 2 indicators were used (phenolphthalein and methyl orange. 100ml of the sample was transferred into a conical flask. 2-3 drops of phenolphthalein indicator was added and no colour change was observed. Meanwhile, 2-3 drops of methyl orange was also added and titred against 0.02N solution of H<sub>2</sub>SO<sub>4</sub> acid to a pink colouration. The value of total alkalinity was then determined in the relationship.

Total alkalinity as Ca CO<sub>3</sub> mg/l = TX100/V

T = Total Volume of H<sub>2</sub>S O<sub>4</sub> acid used

V = Volume of Sample

## **RESULTS AND DISCUSSION**

Three ponds on the fish farm were studied between June and August of the experimental year. The algae responsible for the brownish red colouration were identified, the physicochemical parameters of the water were assessed and the results are as shown below.

#### **Identification of Algae**

The species of algae identified in the course of study are as shown below:

**Table 1: Brown Algae**

Division	Phaeophyta
Class	Phaeophyceae
Order	Ectocarpales
Family	Ectocarpidae
Genus	Ectocarpus
Species	Fasciacutus

**Table 2: Red Algae**

Division	Rhodophyta
Class	Batrachospermales
Family	Batrachoidae
Genus	Batrachospermum

**Table 3: Green Algae**

Division	Chlorophyta
Class	Conjugophyceae
Order	Zygnematales
Family	Zygnemataceae
Genus	Spirogyra

**Table 4: Green Algae**

Division	Chlorophyta
Class	Chlorophyceae
Order	Volvocales
Family	Chlamydomonadaceae
Genus	Chlamydomonas
Species	refusa

**Table 5: Values Obtained for the Physico-chemical Parameters in Ponds A, B and C**

Week	Pond	Dissolved Oxygen (mg/l)	Biochemical Oxygen Demand (mg/l)	Water Temperature (°C)	Water Transparency (cm)	Free Carbon-dioxide (mg/l)	Total Alkalinity (mg/l)	Hydrogen Ion Concentration (mol/l)
1	A	6.90	0.45	28.5	N.D	2.20	32.50	7.20
	B	5.20	0.40	28.0	N.D	2.60	30.80	7.26
	C	4.50	0.50	29.0	N.D	2.45	33.50	6.80
2	A	6.70	0.48	29.0	60.00	1.70	33.40	6.57
	B	4.50	0.47	28.5	45.00	2.50	33.50	6.50
	C	4.80	0.49	28.7	50.00	2.60	32.60	6.50
3	A	7.20	0.47	29.0	65.00	1.90	31.20	7.50
	B	4.80	0.50	28.0	30.00	2.30	34.10	6.20
	C	4.90	0.46	29.0	30.00	2.47	29.30	7.70
4	A	7.70	0.45	29.0	68.00	2.40	33.60	7.50
	B	5.20	0.48	28.0	32.00	2.75	28.90	6.65
	C	5.10	0.48	29.2	20.00	2.30	30.55	6.90
5	A	7.00	0.46	28.7	64.00	1.90	33.70	6.80
	B	5.00	0.50	29.0	28.00	2.80	31.20	7.20
	C	5.20	0.47	28.5	25.00	2.70	31.60	7.05
6	A	7.30	0.50	29.0	62.00	2.20	35.40	6.90
	B	5.30	0.49	28.9	25.00	2.40	32.80	6.95
	C	4.90	0.30	28.8	28.00	2.65	29.50	7.05

**Note:** N.D Means Not Detected

#### **Water Temperature**

The water temperature of the various sample ponds are presented in Table 5. The results show that water temperature was in the range of 28-29°C in the three sample ponds. This reveals that there is no significant difference in the water sample ponds. The results also show that there is no significant difference in water temperature of the three ponds ( $p > 0.05$ ).

#### **Hydrogen Ion Concentration**

**Table 6: Mean Values of the Water Quality Parameters of the Different Ponds at the University Fish Farm and their Standard Deviations.**

Parameter	Pond A	Pond B	Pond C
Dissolved Oxygen (mg/l)	7.08 $\pm$ 0.241 <sup>a</sup>	5.00 $\pm$ 0.277 <sup>b</sup>	4.90 $\pm$ 0.224 <sup>b</sup>
Biochemical Oxygen Demand (mg/l)	0.47 $\pm$ 0.018 <sup>a</sup>	0.49 $\pm$ 0.016 <sup>a</sup>	0.48 $\pm$ 0.015 <sup>a</sup>
Water Temperature ( <sup>o</sup> C)	28.87 $\pm$ 0.197 <sup>a</sup>	28.50 $\pm$ 0.392 <sup>a</sup>	28.87 $\pm$ 0.229 <sup>a</sup>
Water Transparency (cm)	63.80 $\pm$ 7.81 <sup>b</sup>	32.00 $\pm$ 6.70 <sup>a</sup>	30.60 $\pm$ 10.27 <sup>a</sup>
Free Carbon Dioxide (mg/l)	2.05 $\pm$ 0.236 <sup>b</sup>	2.56 $\pm$ 0.179 <sup>a</sup>	2.53 $\pm$ 0.136 <sup>a</sup>
Total Alkalinity (mg/l)	33.13 $\pm$ 1.288 <sup>a</sup>	31.88 $\pm$ 1.775 <sup>a</sup>	31.18 $\pm$ 1.545 <sup>a</sup>
Hydrogen Ion Concentration (mol/l)	7.08 $\pm$ 0.351 <sup>a</sup>	6.89 $\pm$ 0.275 <sup>a</sup>	6.83 $\pm$ 0.195 <sup>a</sup>

**Note:** The mean values with the same superscript on the same row are not significantly difference from each other at 5% level of probability (P> 0.05)

The Variation in the pH between the three ponds was also presented in Table 6. The pH of the ponds varied from almost neutral to slightly alkaline. The results also show that there is no significant difference between the pH of the three ponds (p>0.05)

#### **Dissolved Oxygen**

The dissolved oxygen concentration of the three samples ponds are presented in Table 6. Pond C recorded the lowest mean value of 4.90  $\pm$  0.224 mg/l while pond A recorded the highest value of (7.08  $\pm$  0.241 mg/l). The results show that the concentration of dissolved oxygen in pond A differs significantly with pond B and C (p<0.05) but pond B does not differ significantly with pond C (p<0.05)

#### **Free Carbondioxide**

Variations in free carbondioxide are presented in Table 6. The results show that the concentration of free carbondioxide in pond A differs significantly with pond B and C (p<0.05)

#### **Total Alkalinity**

The results for the total alkalinity of the three ponds are presented in Table 6, and pond A recorded the highest concentration of 13.13  $\pm$  1.288 mg/l. The variation between the three ponds shows that there is no significant difference in the total alkalinity between the ponds (p>0.05)

#### **Biochemical Oxygen Demand (BOD)**

The Biochemical Oxygen Demand content of the water at the various ponds is shown in table 6. The results show that BOD was in the range of 0.47-0.49 mg/l. The results also revealed that there is no significant difference between the three stations (p>0.05)

#### **Water Transparency**

The result for water transparency is also shown in table 6. The results revealed that water transparency decreased from pond A to pond B and C. Pond B and C have in high turbidity with water transparency of 32.00  $\pm$  6.70cm and 30.6  $\pm$  10.27cm respectively. Pond A has a water transparency of 63.80  $\pm$  7.81cm. These results show that there is a significant difference between pond A and ponds B and C (p<0.05)

The algae identified were Ectocarpus, Batrachospermum, Spirogyra and Chlamydomonas, which were brown, red and green algae respectively. These divisions of algae were found to be the cause of the brownish colouration. This is in line with the work of Lynch (2002): that the colour of the water body may be greenish or brownish depending on the species of algae present in it. It is also certain that they are not toxic because from the observations during the study, no incidence of fish mortality was observed in any of the ponds colonized by the algae. However works done by Akaahan et al (2015): has reported cases of toxic as a result of algal bloom usually caused by blue-green algae for example *Gymnodiniumbrevis* bloom caused massive fish kills of Florida Coast. Also in the course of study, observations were made that the bloom did not impact any odour in the affected ponds. This is in line with the work of Lynch (2002): that some species of Planktonic algae primarily blue green can

be toxic to animals and impart an odour of taste to the water.

On the other hand, this bloom has been observed to have affected some water quality parameters particularly water transparency and dissolved Oxygen as shown in Table 6.

### Water Quality Parameters

The water temperature varied between 28-29<sup>0</sup>c in the three ponds under investigation. Statistical analysis has shown that there was no significant difference in the water temperature of the ponds. This shows that the algae bloom does not have any effect on the water temperature. The range of the temperature also shows that it is normal for optimal growth of aquatic organisms (Boyd, 2001, Okomoda et al, 2016): The range of pH in the three ponds also reveals that it is within the optimal range suitable for fish production. Abowei (2010): described pH range of 6.5-9.0 as being the most suitable for fish production and also 5.0-9.5 as suitable for aquatic life (Bhatnaga et al, 2013, Okayi et al, 2011):

The high mean value of dissolved oxygen observed in pond A and low values in ponds B and C shows that the algae bloom has an effect on this water quality parameters. Statistical analysis reveal that there is a significant difference in the concentration of dissolved oxygen between pond A which is not affected by the bloom and the other two ponds (B & C) which had the bloom. This is probably because the bloom has retarded photosynthetic activities by impeding the penetration of the sunlight, which is the source of energy in the process to produce oxygen. Also, the algae compete with the fish over the oxygen for respiration. This is in line with the work of Boyd (2001): that almost all problems with dissolved oxygen fish culture are as a result of heavy plankton blooms. However, pond B and C whose range of dissolved oxygen is 4.80-5.20 mg/l is still above the critical concentration of 3 mg/l (Boyd, 1990, 2001 and Boyd et al, 2000):

The variation in the concentration of free carbon dioxide show that it is not interfering with the growth and the survival of the fish in the three ponds. The mean value are  $2.05 \pm 0.236$ mg/l,  $2.56 \pm 0.179$ mg/l and  $2.53 \pm 0.136$ mg/l for pond A, B and C respectively. This means that carbon dioxide

concentration less than 5mg/l is good for fish growth. Also the mean values of free carbon dioxide concentration in ponds B and C are higher, indicating that the high density of algae respire hence, increasing the concentration of carbon dioxide.

**The Biochemical Oxygen Demand** concentration in the three ponds shows that there is no significant difference between them. The Biochemical Oxygen Demand concentration in the three ponds shows that there is no significant difference between them. However the concentration in ponds B and C may be as a result of the decomposition of algae after die-off (Lynch, 2002, Olopade, 2013):

\*The Total Alkalinity in the three ponds falls within the range of 20-200mg/l described by Boyd and Lichkoppler (1979): as being suitable for fish production. The mean values of the concentration in three ponds also show that there is no significant difference between them.

\*The transparency of water in the two ponds affected by the bloom is very low compared to pond A. This is the natural consequence of heavy Plankton bloom (Boyd, Lichkoppler 1979): The consequence of this high turbidity is also reflected in the concentration of dissolved oxygen in the two ponds (B and C) as can be seen in the results (Table 6). Turbidity waters restrict the penetration of sunlight hence, retarding photosynthetic activities which are the major source of oxygen supply in water bodies.

### CONCLUSION

The evaluation of the water quality parameters of the earthen ponds of the university showed that there were high levels of turbidity boom in some of the ponds which was caused by certain microscopic organisms such as *Batrachospermum*, *Ectocarpus*, *Chlamydomonas* and *spirogyra* which were brown, red and green algae respectively.

Meanwhile, the organisms were also responsible for the brownish red colouration in some of the ponds but the impacts of such colouration were not toxic to the fish, instead they serve as food to the fish especially the herbivores, but the bloom has been found to have affected some water quality parameters particularly dissolved oxygen and water Transparency, hence may have stressful effect on Fish.

## RECOMMENDATIONS

In view of the results obtained from this study, we wish to recommend that the following actions be taken to ensure that the fish in the production ponds are not affected by turbidity and the effects of the algae bloom.

(i) That the algae bloom be controlled by the application of algaecides such as liquid chelated copper compounds, for example cutrine plus or Algae-pro.

(ii) The seasonal assessment of the algae bloom density and its impact on water quality parameters should be further investigated in all the experimental ponds of the university.

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