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# THE EFFECT OF ALGAL TURBIDITY ON GROWTH OF *CLARIAS GARIEPINUS* (BURCHELL, 1822) FINGERLINGS UNDER CULTURE

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**ABSTRACT**
The effect of algal turbidity on growth of *Clarias gariepinus* fingerlings was investigated using poultry droppings to fertilize culture tanks. Ten fingerlings each were randomly distributed from the stock tank into six different duplicate tanks labelled tanks $A_1$ & $A_2$ (control) with only borehole water, $B_1$ & $B_2$, $C_1$ & $C_2$, $D_1$ & $D_2$, $E_1$ & $E_2$ and $F_1$ & $F_2$ with 0 kg, 0.5 kg, 1.0 kg, 1.5 kg, 2.0 kg and 2.5 kg of poultry droppings respectively which are equivalent to 0 %, 0.5 %, 1.0 %, 1.5 %, 2.0 % and 2.5 % concentrations of poultry droppings. Significantly ($P<0.05$) higher species and mean number of algae were observed in the treatment tanks than in the control. *Radiocystis geminata* was the most abundant alga in the tanks with the highest mean number recorded in tank F having 2.5% poultry droppings. Weekly measurements of fish growth in total length and weight show that growth was higher ($P>0.05$) in 1 % and 1.5% concentration of poultry droppings than in fish in 0.5 %, 2.0 % and 2.5 % poultry droppings. Least growth ($P<0.05$) was observed in fish in control tank. Culture water with 2.5% poultry droppings was more turbid than water of other concentrations and having the least secchi disk value of 13cm. Culture water of the control tank was clearer and had the highest secchi disk value of 23cm. Hydrogen ion concentration (pH) and suspended matter increased ($P>0.05$) with increasing concentrations of poultry droppings while dissolved oxygen decreased ($P>0.05$) with increasing concentrations of poultry droppings. This study has shown that the use of poultry droppings for pond fertilization is beneficial to enhance fish growth. However, the concentration of poultry droppings per volume of culture water is an important factor in achieving the desired growth of *C. gariepinus* fingerlings. Algal turbidity of 16-18 cm secchi disk turbidity resulted in higher growth in total length and weight of *C. gariepinus* fingerlings. Poultry droppings of between 1.0 and 1.5 kg per 100 litres of culture water are recommended to generate the desired algal turbidity in fish culture tanks.

**KEY WORDS:** Algae, Turbidity, Growth, *Clarias gariepinus* etc.

## INTRODUCTION

Turbidity is a measure of the water clarity or murkiness. Turbidity expresses the degree to which light is scattered and absorbed by molecules and particles. Turbidity results from suspended matter such as clay, silt, organic matter, plankton and other microscopic organisms that interfere with the passage of light through the water (APHA, 1995). Algal turbidity therefore refers to turbidity due to algal abundance in water bodies. A high algal population is essential to successful fish production because of the dissolved oxygen they produce through photosynthesis during the daylight hours and because algae are major primary producers (Martins *et al.* 1994). Pond fertilization through organic and inorganic sources has become a management protocol in aquaculture (Bhakta *et al*., 2006). The purpose of pond fertilization is to augment fish production through autotrophic and heterotrophic pathways (Jha *et al*., 2008). High fish yield can be achieved by higher abundance of plankton in culture system (Jha *et al*., 2004). Pond fertilization practices using animal wastes are widely used in many countries to sustain productivity at low costs (Gupta and Noble, 2001; Majumder *et al*., 2002) since soluble organic matter supplied to ponds by using manure stimulate phytoplankton growth (Sevilleja *et al*., 2001). Consequently, animal wastes lead to increased biological productivity of ponds through various pathways, which result in an increase in fish production (Dhawan and Kaur, 2002).

Turbidity due to plankton bloom is not a major health concern. However, heavy bloom leading to phytoplankton die-offs may cause competition for light and nutrients. Fluctuations in algal production can result in an unstable, unpredictable balance among the bloom, its nutrient sources and the pond oxygen supply. Algal turbidity leads to a decrease in light intensity and a narrowing of the light spectrum below the surface (Seehausen and van Alphen, 1998). Turbidity of water for aquaculture can limit the feeding capabilities of sight feeders such as Salmonids and restrict the light available to algae and plants in the water resulting in die-off or limit growth (Mitchell and Stapp, 1992). George (1998) observed that mismanagement of ponds by over fertilization among other practices like over feeding and overcrowding can lead to oxygen depletion and fish kills. Algae die-off in fish ponds results in high ammonia concentration which can affect fish appetites and growth rates for extended periods.

Tank culture of catfish is rapidly developing in Nigeria and poultry droppings are commonly used as manure for fertilization. However, many interested fish farmers lack the basic knowledge of pond fertilization and the effect of high turbidity due to over fertilization on fish growth. This study determines the effect of algal turbidity on growth of *Clarias gariepinus* fingerlings.

## MATERIALS AND METHODS

The study which lasted sixteen weeks in 2010 was conducted in the Delta State University Teaching and Research Farm. Two hundred four-week old fingerlings of *Clarias gariepinus* ranging in total length of 6.8 cm to 12.3 cm and weight of 4.7 g to 10.1 g were used. Fingerlings were kept in stock tank containing borehole water to acclimate for a period of seven days during which time fingerlings were fed twice daily (10.00 am and 6.00 pm) with commercially available feed. Twelve concrete tanks measuring 1m x 1m x 1m were each filled with 100 litres of borehole water. Poultry droppings obtained from the Poultry Unit of the university farm were used to fertilize the treatment tanks. Ten fingerlings each were randomly distributed from the stock tank into six different duplicate tanks labelled tanks $A_1$ & $A_2$ (control) with only borehole water, $B_1$ & $B_2$, $C_1$ & $C_2$, $D_1$ & $D_2$, $E_1$ & $E_2$ and $F_1$ & $F_2$ with 0 kg, 0.5 kg, 1.0 kg, 1.5 kg, 2.0 kg and 2.5 kg of poultry droppings respectively which is equivalent to 0 %, 0.5 %, 1.0 %, 1.5 %, 2.0 % and 2.5 % concentrations of poultry droppings. The experiment was held in a static non renewal bioassay system.

Weekly measurements of fish growth in total length and weight were taken. The weekly weight gain was determined using the formula (WWG) = (FWT - IWT) / T where FWT = final fish weight (g), IWT = initial fish weight (g) and T= growing period (weeks) between initial and final weight. Behaviour of fish in control and treatment tanks was observed. Water samples were collected weekly for analyses for algae and water quality parameters according to APHA (1995). Secchi disk visibility was used for turbidity. Algae were collected by horizontal tows with 55µm $^{-1}$ mesh size bolting silk plankton net at a depth of 25 cm. Samples were decanted to remove the supernatant. Fresh clean water was added to the sediment and centrifuged. The supernatant was again decanted and fresh water added to make up to10 ml in the centrifuge tube which was agitated and 1 ml of subsample pipetted onto the counting chamber (Neubauer haemacytometer, Marienfeld) for quantitative estimation of species of algae by examining fraction of each sample under the microscope. Algae were identified to generic level as much as possible and enumerated by binocular microscopy (x 100 magnification) using keys according to Willoughby (1976) and Green Water/Cyano Laboratories (2007). The number of algae/ml was calculated according to a formula by Boyd and Lichtkoppler (1979).

$$\text{Number of plankton (algae)/ml} = \frac{T \times 1000}{AN \times \text{Vol. of concentrate in ml/vol. of sample}}$$

Where
T = total number of algae counted
A = area of grid in mm$^2$
N = number of grid counted
1000 = area of counting chamber in mm$^2$

Data obtained were analyzed using Analysis of Variance at P = 0.05 while significant means were separated with Duncan Multiple Range Test (DMRT) using SAS, 1998.

## RESULTS

Algal species found in control and treatment tanks are presented in Table 1. Significantly (P<0.05) higher species and mean number of algae was observed in the treatment tanks than in the control. *Radiocystis geminata* was the most abundant alga in the tanks with the highest mean number recorded in tank F having 2.5 % poultry droppings. *Aphanizomenon* was not found in the treatment tanks.

**TABLE 1:** Mean Algal abundance/ ml in control and treatment tanks with varying concentrations of poultry droppings.

| S/n | Algae | Conc. Of A(Control) 0% | Poultry B 0.5% | Droppings C 1.0% | D 1.5% | E 2.0% | F 2.5% |
|---|---|---|---|---|---|---|---|
| 1 | *Euglena* | 2 | 10 | 19 | 26 | 31 | 37 |
| 2 | *Cyanocystis* | - | 30 | 92 | 38 | 56 | 81 |
| 3 | *Anabaena* | - | 21 | 42 | 59 | 61 | 63 |
| 4 | *Microchaete* | - | 33 | 44 | 51 | 56 | 58 |
| 5 | *Oscillatoria* | 1 | 12 | 23 | 28 | 33 | 40 |
| 6 | *Microcystis* | - | 28 | 34 | 41 | 48 | 52 |
| 7 | *Radiocystis* | - | 65 | 117 | 163 | 188 | 213 |
| 8 | *Spirogyra* | - | 18 | 31 | 46 | 62 | 74 |
| 9 | *Volvox* | - | 7 | 20 | 35 | 43 | 56 |
| 10 | *Chlamydomonas* | - | 1 | 31 | 49 | 56 | 67 |
| 11 | *Synchocystic* | 19 | 4 | - | - | - | 1 |
| 12 | *Aphanizomenon* | 24 | - | - | - | - | - |
| 13 | *Synchococcus* | 11 | - | 1 | 1 | 1 | 3 |
| | Total | 54 | 229 | 454 | 537 | 635 | 745 |

The control tank had significantly (P<0.05) higher numbers of *Synchocystic, Aphanizomenon and Synchococcus* while *Euglena* and *Oscillatoria* were very few in the control tank.

Weekly increase in total length was gradual with fish in 1.0 % poultry droppings having higher growth (P>0.05) than fish in the other concentrations. Fish in the control had significantly lower growth than fish in the treatment tanks. Table 2 shows the mean weekly fish total length for control and treatment tanks. Length gain in treatment tanks were higher (P<0.05) than in the control. Figure 1 shows the final and initial total length of *C. gariepinus*.

Weekly increase in fish weight was also gradual. Fish exposed to 1.5 % poultry droppings had higher (P>0.05) weight than fish in other treatment tanks. Fish in the control had significantly (P<0.05) lower weight than fish in the treatment tanks. Table 2 shows the mean weekly fish weight for control and treatment tanks. Weight gain in treatment tanks were higher (P<0.05) than in the control. Figure 2 shows the final and initial weight of *C. gariepinus*. The increase in total length and weight of fish was higher (P>0.05) in 1 % and 1.5 % concentration of poultry droppings than in fish in 0.5 %, 2.0 % and 2.5 % poultry droppings. Fish in the control tank had the least growth (P<0.05) in total length and weight than fish in treatment tanks. Fish kill was observed in treatment tank F (2.5 %). However, the cause of death could not be determined. The rate of increase in total length and weight of fish in control was lower (P>0.05) than was observed for the treatment groups. Figure 3 show the weekly growth in total length and weight in control and treatment groups.

**TABLE 2:** Mean weekly fish total length for control and treatment tanks.

| | | Fish | Total | Length | (cm) | |
|---|---|---|---|---|---|---|
| Weeks | 0.0% | 0.5% | 1.0% | 1.5% | 2.0% | 2.5% |
| 1 | 10.5 | 8.9 | 7.4 | 6.8 | 12.3 | 11.2 |
| 2 | 10.6 | 9.3 | 8.1 | 7.1 | 12.9 | 11.8 |
| 3 | 10.8 | 9.7 | 8.8 | 7.8 | 13.4 | 12.5 |
| 4 | 11.1 | 10.2 | 9.5 | 8.3 | 13.8 | 12.9 |
| 5 | 11.4 | 10.9 | 10.2 | 8.9 | 14.2 | 13.5 |
| 6 | 11.7 | 11.6 | 10.8 | 9.4 | 14.9 | 14.2 |
| 7 | 12.0 | 12.3 | 11.6 | 9.9 | 15.6 | 14.7 |
| 8 | 12.3 | 12.8 | 11.6 | 10.6 | 16.1 | 15.2 |
| 9 | 12.7 | 13.4 | 12.1 | 11.3 | 16.8 | 15.8 |
| 10 | 13.1 | 13.9 | 12.8 | 11.8 | 17.2 | 16.1 |
| 11 | 13.6 | 14.3 | 13.4 | 12.4 | 18.1 | 17.6 |
| 12 | 13.9 | 14.9 | 14.7 | 13.7 | 19.3 | 18.0 |
| 13 | 14.2 | 15.3 | 15.5 | 14.6 | 19.9 | 18.7 |
| 14 | 14.8 | 15.8 | 16.3 | 15.4 | 20.3 | 19.5 |
| 15 | 15.2 | 16.4 | 17.4 | 16.2 | 20.9 | 20.0 |
| 16 | 15.6 | 17.1 | 18.6 | 17.6 | 21.7 | 20.4 |

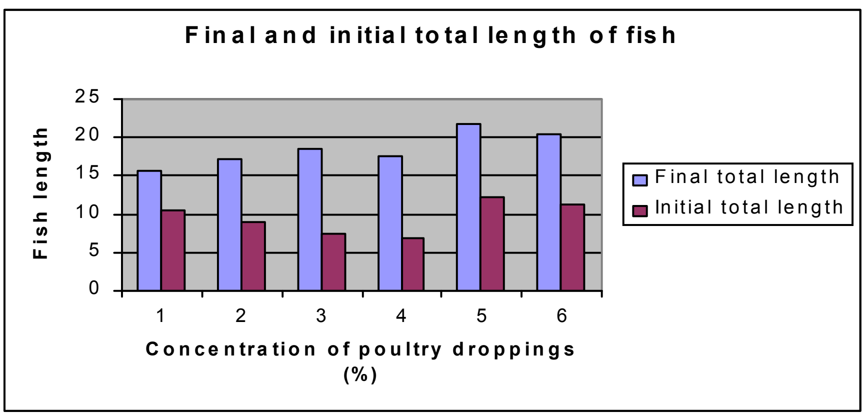


**FIGURE 1:** Final and initial total length of *C. gariepinus* exposed to varying concentration of poultry droppings.

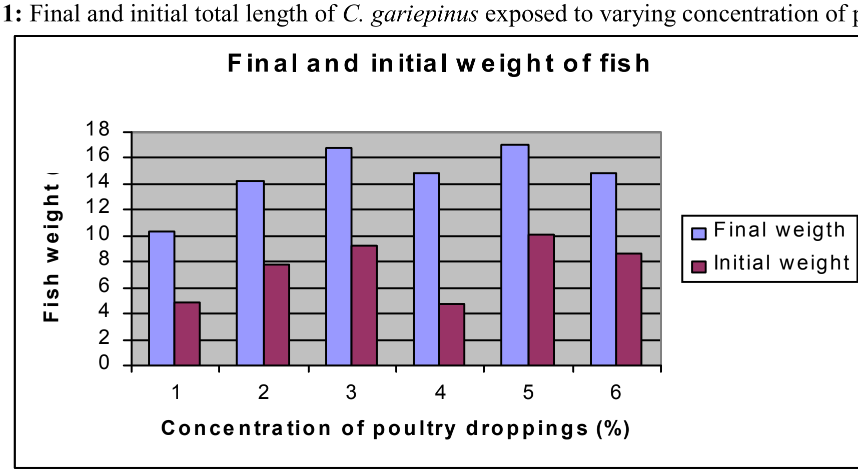


**FIGURE 2:** Final and initial weight of *C. gariepinus* exposed to varying concentration of poultry droppings.

**TABLE 3:** Mean weekly fish total length for control and treatment tanks.

| | | | | Poultry | Droppings | |
|---|---|---|---|---|---|---|
| Weeks | 0% | 0.5% | 1.0% | 1.5% | 2.0% | 2.5% |
| 1 | 4.9 | 7.8 | 9.3 | 4.7 | 10.1 | 8.6 |
| 2 | 5.2 | 8.3 | 9.7 | 5.2 | 10.4 | 8.8 |
| 3 | 5.6 | 8.8 | 10.1 | 5.9 | 10.9 | 9.1 |
| 4 | 5.9 | 9.3 | 10.6 | 6.1 | 11.4 | 9.4 |
| 5 | 6.4 | 9.7 | 11.0 | 6.2 | 11.7 | 9.8 |
| 6 | 6.8 | 10.2 | 11.4 | 6.8 | 12.0 | 9.3 |
| 7 | 7.1 | 10.5 | 11.8 | 7.4 | 12.6 | 9.6 |
| 8 | 7.6 | 10.9 | 12.6 | 7.9 | 13.1 | 10.1 |
| 9 | 7.9 | 11.4 | 13.2 | 8.6 | 13.8 | 10.6 |
| 10 | 7.6 | 11.7 | 13.9 | 9.2 | 14.3 | 11.2 |
| 11 | 7.5 | 11.9 | 14.5 | 9.9 | 14.8 | 11.7 |
| 12 | 8.1 | 12.5 | 15.1 | 10.7 | 15.2 | 12.3 |
| 13 | 8.6 | 12.9 | 15.6 | 11.5 | 15.7 | 12.8 |
| 14 | 9.0 | 13.3 | 16.0 | 12.9 | 16.3 | 13.5 |
| 15 | 9.6 | 13.8 | 16.3 | 13.6 | 16.7 | 14.1 |
| 16 | 10.3 | 14.2 | 16.8 | 14.8 | 17.0 | 14.8 |

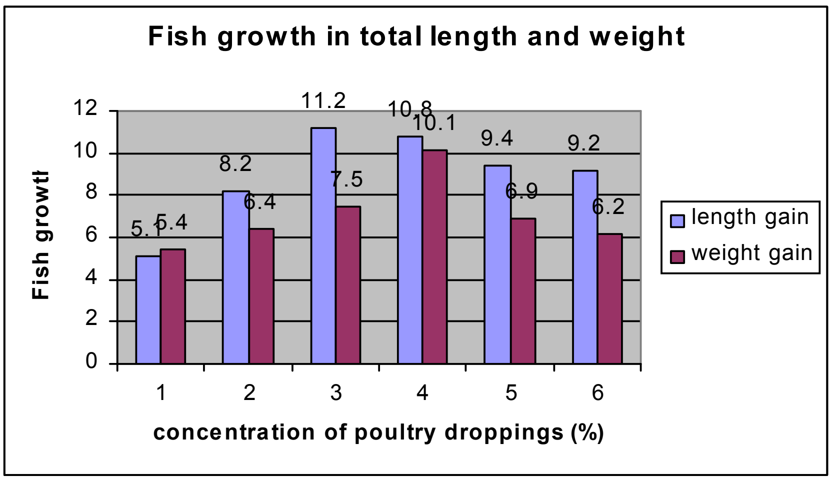


**FIGURE 3:** Fish growth in total length and weight in control and treatment tanks

Culture water of the 2.5 % poultry droppings was more turbid than water of other concentrations and having the least secchi disk value of 13 cm. Culture water of the control tank was clearer and had the highest secchi disk value of 23 cm. Temperature remained fairly constant throughout the study with temperature range of between 28.5 $^0$C and 29.2 $^0$C. Hydrogen ion concentration (pH) and suspended matter increased ($P>0.05$) with increasing concentrations of poultry droppings while dissolved oxygen decreased ($P>0.05$) with increasing concentrations of poultry droppings. Secchi disk turbidity, dissolved oxygen and suspended matter had significantly different ($P<0.05$) values for control and 2.5 % concentration of poultry droppings. Table 4 shows the mean water quality parameters for the control and treatment tanks.

**TABLE 4:** Mean water quality parameters for control and treatment tanks

| | Water quality Parameters | 0% | Poultry 0.5% | 1.0% | Droppings 1.5% | 2.0% | 2.5% |
|---|---|---|---|---|---|---|---|
| 1 | Turbidity (cm) | 23 | 20 | 18 | 16 | 14 | 13 |
| 2 | Temperature ($^0$C) | 28.5 | 28.5 | 29.0 | 29.0 | 29.0 | 29.2 |
| 3 | pH | 7.6 | 7.9 | 8.2 | 8.3 | 8.5 | 8.9 |
| 4 | Dissolved Oxygen (mg/l) | 7.2 | 6.0 | 5.8 | 5.0 | 4.3 | 3.3 |
| 5 | Suspended matter (mg/l) | 0.6 | 1.2 | 1.8 | 2.7 | 3.5 | 3.9 |

## DISCUSSION

The algae found in the control tank varied from algae in the treatment tank. More algae species were recorded for the treatment tanks than in the control. Fish in the treatment tanks had higher growth rate than fish in the control tank. This finding is similar to the observation of Alphonse (1997) who reported that the growth of algae determines the productivity of pond water. Orhibhabor and Ansa (2006) reported that animal wastes lead to increased biological productivity of ponds through various autotrophic (algae production) and heterotrophic (bacterial production) path-ways, which result in an increase in fish production. This resulted in an increase in algae turbidity (concentration) and shallower secchi disk readings in those treatments It has been reported that organic manures contain almost all the essential nutrient elements (Jana *et al.,* 2001) that stimulate the growth of plankton (Wurts, 2000; Ansa and Jiya, 2002; Kadri and Emmanuel, 2003) and consequently, manure contains considerable quantities of nutrients for fish production (Gabriel *et al*., 2007).

Increase in turbidity, that is, a reduction in secchi disk value, resulted in mortality in the treatment tanks containing 2.5kg poultry droppings. Aksnes and Utne (1997) reported that at high turbidity fishes are subjected to mortality. High turbidity leads to loss of appetite in fish resulting in retarded growth. Also, it has been noted that at high turbidity, light penetration into water is low causing a reduced success in ingestion (Boehlert and Morgan, 1985; Miner and Stein, 1993). The ability of pike larvae to catch copepod zooplankton decreases in turbid water.(Salonen and Engström-Öst, 2010). The shallow or reduced value of secchi disk readings during the study is indicative of increased algal growth (Elnady *et al.* 2010).

Changes in turbidity can have direct and indirect effects on fish. At extremely high levels, turbidity can directly affect fish growth and survival, for example, by interfering with gill function or the quality of substrata for egg laying (Bash *et al*., 2001). By limiting the photic zone turbidity can also reduce habitat quality, for example, by reducing macrophyte cover from predators (Goldsborough and Kemp, 1998; Berger *et al*., 1999). Turbidity also limits fish vision, which can interfere with social behaviour (Berg and Northcote 1985), foraging (Gregory and Northcote 1993; Vogel and Beauchamp 1999) and predator avoidance (Miner and Stein 1996; Meager *et al.* 2006). This can have varying effects on fish growth and survival, depending on a range factors such as ambient light levels and depth; relative visual sensitivities of predators and prey, and non-visual sensory abilities.

Water quality parameters such as turbidity, pH was increasing while dissolved oxygen was reducing. Temperature remained fairly the same in all the tanks throughout the period of study. This indicated that average water temperatures in all treatments were optimal for fish growth and algal production (.Elnady *et al*. 2010) Most aquatic organisms require oxygen in specific concentration ranges for respiration and efficient metabolism, and dissolved oxygen (DO) concentration changes above or below this range can have adverse physiological effects leading to fish kill. Boyd (1979) reported DO level of between 8.0 and 3.0mg/l as the best range for tropical fish.

## CONCLUSION

Algal turbidity of 16-18 cm secchi disk turbidity resulted in higher growth in total length and weight of *C. gariepinus* fingerlings. Poultry droppings of between 1.0 and 1.5 kg per 100 litres of culture water are needed to generate the desired algal turbidity in culture tanks which is beneficial for growth of *C. gariepinus* fingerlings.

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