https://dx.doi.org/10.22161/ijfaf.3.3.2 ISSN: 2456-8791

Interaction of Temperature, Dissolved Oxygen and Feed Energy on Growth Performance of All Male Tilapia Fingerlings

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***Abstract*— *This study was conducted to evaluate the interaction of dissolved oxygen, temperature and feed in fibre glass tanks of all male tilapia (Oreochromis niloticus). It was conducted between August 2017and February 2018 at the Nigerian Institute for Oceanography and Marine Research Sapele out station Sapele. Nine circular fibre glass tanks were used in the experiment.All experimental tanks were identical in shape and size. Tanks capacities were 3.08m^3 and depth of 60.5cm each and diameter 176.78cm.Sex reversed Nile tilapia (Oreochromis niloticus) of 0.80g average size was stocked in triplicates. The treatments were dried chicken manure only, dried chicken manure plus commercial diet (coppens) and commercial diet (coppens) only as control.Three hundred (300) fish were stocked in each tank. Fish were fed at 800hr and 1600hr with dried chicken manure only, chicken manure with coppens and coppens only.. The feeding rate was 5% of the total fish biomass presented in each tank. Data collected were subjected to statistical test using analysis of variance (ANOVA).Test of temperature and dissolved oxygen were taken between 0800 to 1600 hour biweekly using (AMT08 PEN TYPE DO METER) according to Boyd (1992).Results indicated that ponds fed with coppens only performed better but not significant at (P<0.05). The regression equation also indicated that all the tanks are highly correlated and they interacted with each other, temperature also have effect on the dissolved oxygen in the fibre tanks.*
***Keywords*— Temperature, Dissolved Oxygen and Feed Energy.**

I. INTRODUCTION

Nile tilapia, Oreochromis niloticus is likely to bethe most important cultured fish in the 21st century (Ridha (2006). It grows andreproduces in a wide range of environmental conditions and toleratesstress induced by handling (Tsadik, Bart (2007). With the purpose of achieving moreproductivity in growing tilapia, Oreochromis niloticus, at the unit time,it is important to produce monosex culture that constitutes totally ofmales (Mair, Little (1991). The majority of species in which monosex culture is practiced,the male is more economically attractive than the female because offaster growth rate. In addition to the males, the metabolic energy ischanneled towards growth. They benefit from anabolism enhancingandrogens (Tran-Duy *et al*(2008): Angienda *et al*(2010)). In females, there is a greater reallocation of metabolicenergy towards reproduction in mixed culture female.

Temperature is one of the most commonly studied environmental factors that influence sexual determination in fish (Devlin, Nagahama (2002). Particularly, in fish exposure to high water temperatures 35°C during early development or sex differentiation period (Abozaid, *et al*, (2012) was described to induce a male-biased sex ratio. Several studies have reported that increases or decreases in water temperatures also modify the phenotypic sex and shift the sex ratio in other teleost species, such as blue tilapia (*Oreochromis aureus*) (Desprez, Mélard(1998). However, in fish the impact of temperature The long-term exposure of Nile tilapia to high temperature during a masculinizing treatment may decrease their survival and depress.

Hypoxia is a common phenomenon in stagnant water, where currents and convection do not introduce dissolved oxygen (DO) into water body, especially at night, when plants do not photosynthesize. This means fish live in an environment that often shows great variations in DO levels including hypoxia. Hypoxia may retard fish growth, feed utilization, and hence health status so that fish could utilize several mechanisms to cope a reduction in DO uptake. The different coping styles in individual fish may influence fish health and susceptibility to bacterial infection (MacKenzie *et al*. 2009; Huntingford *et al*. 2010), which is one of the limiting factors in fish

https://dx.doi.org/10.22161/ijfaf.3.3.2 ISSN: 2456-8791

culture including Nile tilapia. In particular, Aeromonas hydrophila is the etiological agent of several diseases and causes mass mortalities in several fish species (Rahman *et al*. 2001; Li *et al*. 2006). Fish susceptibility to bacterial infection is associated with size and/or age (Suanyuk *et al*. 2008; Mian *et al*. 2009; Zamri-Saad *et al*. 2010). The farming of Nile tilapia, Oreochromis niloticus (L.), has grown rapidly in the last few decades in Egypt and worldwide (El-Sayed 2006). For fish intensification, DO has to be maintained at levels, which will not affect fish physiology and metabolic activities. Thus, one has to keep in mind that DO requirements depend not only on fish species but also on fish size (FS). With increasing FS during grow-out period, DO requirement increased and DO in ponds water may be insufficient. Therefore, this study was conducted to investigate the interaction of temperature, dissolved oxygen and feed enery on growth performance of all male tilapia fingerlings.

II. MATERIALS AND METHODS

The study was conducted at the Nigerian Institute for Oceanography and Marine Research Sapele out station Sapele Local Government Area of Delta State, Nigeria (N50 54´.5´´E005º39´56.4´´). The experiment was conducted for a period of 6 (six) months (between August 2017 to February 2018).

Nine circular fibre glass tanks were used in the experiment. All experimental tanks were identical in shape and size. Tanks capacities were 3.08m^3 and depth of 60.5cm each and diameter 176.78cm. The tanks were washed and disinfected with salt solution before water was introduced into the tanks from treated bore hole in the station. Sex reversed Nile tilapia (*Oreochromis niloticus)* of 0.80g average size was stocked in triplicates. The treatments were dried chicken manure only, dried chicken manure plus commercial diet (coppens) and commercial diet (coppens) only as control.These treatment was used to determine the interaction of temperature, dissolved oxygen and feed energy on growth of all male tilapia fingerlings in fibre glass tanks.Three hundred (300) fish were stocked in each tank.

Fish were fed at 800hr and 1600hr with dried chicken manure only, chicken manure with coppens and coppens only.. The feeding rate was 5% of the total fish biomass presented in each tank and the feed amount was adjusted every two weeks for each tank separately according to the biomass available which was determined during sampling.Test of temperature and dissolved oxygen were taken between 0800 to 1600 hour biweekly by inserting the probe of the dissolved oxygen meter (AMT08 PEN TYPE DO METER) which was deeped few centimeters below the water surface (approximately 5cm) according to Boyd (1992).

2.1 STATISTICAL ANALYSES

Mean separation was done using Duncan's Multiple Range Test and Least Significance Difference. All test were carried out at 5% probability level ($P < 0.05$) (Duncan, 1955). The Genstat Statistical Package (version 8.1) was used for the statistical analysis of data.

III. RESULTS AND DISCUSION

Regression equation was used to test the relationship between dissolved oxygen level, feed energy, Temperature.

TABLE 1: Mean values of water quality parameters in Time-weeks for three treatments

	TREATMENT I			TREATMENT II			TREATMENT III		
Time Week	DO	TEMP	FEED	DO	TEMP	FEED	DO	TEMP	FEED
2	3.577	27.719	0.83	4.581	27.8	0.77	3.767	27.750	0.80
4	12.797	28.364	1.07	8.058	28.339	1.39	10.525	28.539	1.98
6	14.642	28.412	4.5	10.521	28.4	6.63	9.662	28.822	15.53
8	16.425	28.647	9.14	12.978	28.492	13.64	9.733	29.194	33.17
10	16.736	29.003	14.05	14.114	29.053	20.55	10.700	29.492	51.57
12	17.094	28.633	19.74	11.718	28.114	27.84	7.625	29.069	72.09
14	15.842	29.397	26.57	11.397	29.111	35.79	9.439	29.708	103.81
16	16.603	28.794	40.38	10.792	28.456	58.04	10.125	29.669	135.35
18	16.875	28.506	59.38	10.561	28.156	85.04	10.461	29.594	174.63
20	17.222	28.361	79.27	10.567	28.053	107.67	10.339	29.181	206.73
22	17.211	28.139	111.48	10.461	27.303	139.87	10.428	28.683	239.10
24	16.481	28.119	143.47	10.706	27.222	171.97	10.450	28.606	272.10

To model Dissolved oxygen, temperature and feed Time-WeeksofAllmaletilapiaculturedinfibreglasstanksfor24 weeks for three treatments (Chicken manure only, chicken manure with coppens and coppens only) using the table above.

For treatment I

Let DO = y

Temp = x_1

Feed = x_2

Usingequation 1 below

$y = a + bx$ 1

$\sum y = Na + b\sum x$ 2

4.2

$\sum xy = a\sum x + b\sum x^2$ 3 4.3

Where:

x = Independent variable y = Dependent variable

$\sum$ = sign of summation

a = Constant

b = Constant

ThemodelIintend to bedevelopisoftheform:

$y_t = b_0 + b_1 y_{t-1} + b_2 y_{t-2}$ 4

Uponsubstitution equation4becomes

$y = b_0 + b_1 x_1 + b_2 x_2$ 5

Tosolveforb$_0$,b$_1$ and b$_2$,wehave:

$\sum y = nb_0 + b_1\sum x_1 + b_2\sum x_2$ 6

$\sum x_1 y = b_0\sum x_1 + b_1\sum x_1{}^2 + b_2\sum x_1 x_2$ 7

$\sum x_2 y = b_0\sum x_2 + b_1\sum x_1 x_2 + b_2\sum x_2{}^2$ 8

Usingvaluesfromtables above tosubstituteintoequation 6 to equation 8

$12b_0 + 338.499b_1 + 669.2b_2 = 126.454$

$97.466b_0 + 2752.162b_1 + 5243.221b_2 = 1040.454$

$338.499b_0 + 9552.183b_1 + 18626.018_2 = 3573.489$

Withtheabovevalues,themodelis

$= b_0 + b_1 x_1 + b_2 x_2$

$y = -101.877 + 2.652973x_2 + 0.048414x_3$

$y_{DO} = -101.877 + 2.652973_{Temp} + 0.048414_{yeild}$

For treatment II

Usingequation 9 below

$y = a + bx$ 9

Where:

x = Independent variable y = Dependent variable

$\sum$ = sign of summation

a = Constant

b = Constant

ThemodelIintend to bedevelopisoftheform:

$y_t = b_0 + b_1 y_{t-1} + b_2 y_{t-2}$ 10

Uponsubstitution equation 10 becomes

$y = b_0 + b_1 x_1 + b_2 x_2$ 11

Tosolveforb$_0$,b$_1$ and b$_2$,wehave:

$\sum y = nb_0 + b_1\sum x_1 + b_2\sum x_2$ 12

$\sum x_1 y = b_0\sum x_1 + b_1\sum x_1{}^2 + b_2\sum x_1 x_2$ 13

$\sum x_2 y = b_0\sum x_2 + b_1\sum x_1 x_2 + b_2\sum x_2{}^2$ 14

Usingvaluesfromtables1 above tosubstitute intoequation 12 to equation 14

$12b_0 + 338.499b_1 + 669.2b_2 = 126.454$

$97.466b_0 + 2752.162b_1 + 5243.221b_2 = 1040.454$

$338.499b_0 + 9552.183b_1 + 18626.01b_2 = 3573.489$

With the above values, the model is

$= b_0 + b_1 x_1 + b_2 x_2$

$y = -25.0935 - 0.12374x_1 + 0.009968x_2$ 15

$y_{DO} = -25.0935 - 0.12374_{Temp} + 0.009968_{yield}$

For treatment III

Usingequation 16 below

$y = a + bx$ 16

Where:

x = Independent variable y = Dependent variable

$\sum$ = sign of summation

a = Constant

b = Constant

ThemodelIintend to bedevelopisoftheform:

$y_t = b_0 + b_1 y_{t-1} + b_2 y_{t-2}$ 17

Uponsubstitution equation 17 becomes

$y = b_0 + b_1 x_1 + b_2 x_2$ 18

Tosolveforb$_0$,b$_1$ and b$_2$,wehave:

$\sum y = nb_0 + b_1\sum x_1 + b_2\sum x_2$ 19

$\sum x_1 y = b_0\sum x_1 + b_1\sum x_1{}^2 + b_2\sum x_1 x_2$ 20

$\sum x_2 y = b_0\sum x_2 + b_1\sum x_1 x_2 + b_2\sum x_2{}^2$ 21

Usingvaluesfromtables1 above tosubstitute intoequation 12 to equation 14

$y = b_0 + b_1 x_1 + b_2 x_2$ 24

$y = -67.4073 + 3.149727x_1 + 0.02409x2$ 25

$y_{DO} = -67.4073 + 3.149727_{Temp} + 0.02409_{Yield}$

Water temperature is one of the most influencing environmental factors affectingpond dynamics and both the metabolism and growth of fish (Boyd, 1990).

From the modelling, it shows that dissolved oxygen depend on temperature and yield for the survival of the fish in fibre glass tanks. Increase in the feed energy increases the temperature and consequently increase the dissolved oxygen in the fish water.

From the plot above, the temperature variation in the water is directly related to the atmospheric temperature and shows significant differences ($P<0.05$) among the three Treatments and ranged from 28.191 ºC to in Treatment II to 28.517ºC in Treatment I and 29.044ºC in Treatment III (Table 1) similar to water temperature recorded by Saha (2007, Haroon *et al*. 2002). The water temperature ranged from 28 to 35°C is suitable for fish culture (Aminul. 1996). There was direct increase and significant correlation between temperature,feed and dissolved oxygen, treatment I (r^2 = 0.847), II (r^2 = 0.8861) and III (r^2 = 0.9656) in all the treatments because the study was done in a fibre tanks contratrary to (Hacio glu and Dulger, 2009) who reported that dissolved oxygen is inversely proportional to temperature and the maximum oxygen that can be dissolved in water at most ambient temperature is about 10.00mg/L in wetland. The growth of the fish increase with feed efficiency and this was affected by the DO available, this is in accordance with Bergheim et al. (2006) and Duan et al. (2011).

Fish performance reflects a dynamic balance between supplies of oxygen and energy-yielding substrates for metabolism (Fry 1947; Brett 1979). The balance has been set by evolution to give best performance under an individual's optimum environmental and physiological circumstances. Increased feed energy tends to shift performance optima towards higher temperatures, where more metabolic scope is available (Fry 1947; McLaren 1963; Brett 1971; Brett 1979; Azevedo et al. 1998; Gillooly et al. 2001; Neill et al. 2004; Fontaine et al. 2007).Base on the findings in this study, it is of note that temperature, feed and the dissolved oxygen are directly proportional and highly corrollated in fibre glass tank on like earthern ponds. Also dissolved oxygen affect the growth of fish if it is low. Hence a regular oxygenation of the fibre glass tank is recommended for the optimum growth of tilapia in fibre glass tank.

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