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ORIGINAL ARTICLE

Effect of photoperiod on some biological parameters of *Clarias gariepinus* juvenile

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Photoperiod effect on Growth parameters and cannibalism of *Clarias gariepinus* have been well documented in resent past, but little is known about the response of other biological parameters such as, Condition factor, Shooters composition, Body colouration and Blood glucose of this important tropical fish species to different photoperiods, therefore the present study was designed to evaluate these responses of the African catfish to 24 hours of light (00D:24L), 24 hours of darkness (24D: 00L) and 12 hour light / 12 hours darkness (12D: 12L). The six weeks experiment observed significant differences (P<0.05) in weight gain of the fish reared at the different photoperiods with the highest value of 92.20g±1.10 obtained in fishes reared under a photoperiod of twenty-four hours of darkness (24D: 00L) compared to those reared under a photoperiod of twelve hours of light and twelve hours of darkness (12D: 12L) which had 69.80g±2.50 and the least weight gain of 59.50g±8.2 was obtained under a twenty four hours of light (00D: 24L) photoperiod. Despite the stress induced by light which affected the weight gain of the fish, condition factor of the fishes in the different photoperiods did not vary significantly (P>0.05) at the end of the experiment and were Significantly lower than value obtained at the start of the experiment, Shooters composition was highest in 00D:24L (41.5% i.e. 27 of 65) leading to high mortality (13.33%) due to cannibalism compared to 12D: 12L (Shooters =15.27% i.e. 11 of 72, Mortality= 4%) and 24D: 00L (Shooters=5.33% i.e. 4 of 75, Mortality= 0%) photoperiod. More so, 93.33% (70 of 75) of fish in the dark phase (24D: 00L) exhibited Deep shiny black body colouration, while 6.67% (5 of 75) was observed of Normal fish colouration. However the fishes in the 00D: 24L photoperiod were observed to be predominantly Lighter skin colouration, (80% i.e. 52 of 65= lighter colouration, 18.46% i.e. 12 of 65= Normal skin coloration and 1.53 i.e. 1 of 65= Deep black body colouration) while 12D: 12L were of Normal skin colouration (100% Normal skin colouration), also blood glucose was observed to increase as the light hours increased (P<0.05) with 24D: 00L photoperiod having the highest blood glucose level of 5.7±0.5, while those in 12D: 12L had 4.4±0.3 and 24D: 00L had the least value of 3.9±0.1. This study therefore establishes the fact that photoperiod may have no effect on the condition factor of African catfish, while higher shooters composition is highlighted as one of the causes of increased mortality and could be reduced to a large extent with reduced light phase therefore enhancing higher survival, also the use of blood glucose as an indicator of stress in fish was justified in the present study.

Key words: Condition factor, Shooters composition, Body coloration, Blood glucose.

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Key words: Condition factor, Shooters composition, Body coloration, Blood glucose.

The effects of environmental variables like temperature, pH, and salinity on the growth, survival and physiological responses of fish have been thoroughly investigated in many tropical species. Temperature for instance plays an unquestionable role in the growth of fish belonging to the ectothermic species (Person-Le *et al.,*2006), Photoperiod also is one of the exogenous factors that directly influences the growth of fish through changes in endocrine functioning and hormone secretion, i.e. melatonin and thyroxin (Porter, *et al.,*1999). Growth in fishes however is a measure of the relationship between the length / weight and condition factor of the fish, however works on the condition factor of fish exposed to different photoperiod is scarce and result obtained from the few literatures available are highly varied cutting across different species and sizes of fish, hence the effect of photoperiod as an environmental factor was assessed on condition factor of the African catfish in this present study.

Cannibalism has been a problem in cultured fisheries for ages, as in other fishes, stocking density of African catfish is considered the most important factor affecting cannibalism and aggression (Almaza´n Rueda, 2004). In African catfish, however, the present of large numbers of "shooters" may increase the mortality of fishes due to cannibalism as they are twice the average size of the population though of the same age, and can easily predate the weaklings, therefore any method that can reduce their number in the population will be a better management practice for fisheries development as it will reduce cannibalism as well as reduce continuous disturbance of the culture chamber through sorting a method popularly used in the control of shooters.

Blood glucose levels have long been used as indicators of stress in fish (Wedemeyer and McLeay,1981). Yet, in many studies under stress, blood glucose either remained unchanged or took a longer duration of stress to show the change (Pottinger *et al*., 2002). These differences has been suggested to be related to the nature of the stressor, duration of the stressor or inter-species differences in glucose utilization and turnover during stress, therefore, since Artificial photoperiod regimes are alterations in the natural light/dark cycles and any alteration or manipulation of environmental parameters such as temperature or light results in abrupt changes in the environment which may cause stress thus compromising the welfare and general well-being of the fish (Wendelaar Bonga 1997), the present study was therefore designed to assess the response of African catfish juvenile to different photoperiod as it affects it growth, condition factor, shooters composition, body colouration, and blood glucose.

MATERIALS AND METHODS

Juvenile of *Clarias gariepinus* was obtained from the Department of Fisheries and Aquaculture research farm of the Federal University of Agriculture Makurdi through induced breeding and acclimatized for two weeks at the university fish hatchery where the experiment was conducted. The re-circulatory system where the fish were maintained had an average flow rate of 4 L min^{-1} with water quality within desirable range for growth of fresh water fish species (dissolved Oxygen-7.5-11.5 mg/l; pH 7.1-8.5; water temperature 25-30ºC). Twenty-five (25) *C. gariepinus* fingerlings of mean weight of 9.02g$\pm$0.12 were selected at random and weighed by means of a sensitive weighing balance. The groups of fish were then placed in the nine rearing tanks connected to the water circulatory system. The nine tanks were assigned to three photoperiods namely twenty-four hours of light (00D: 24L), twelve hours of light twelve hours of darkness (12D: 12L) and twenty-four hours of darkness (24D: 00L). The light phase was achieved with the aid of an energy bulb (60W) emitting 150 lux intensity of light measured at the surface of water while the dark phase was by completely covering the assigned rearing tank with tarpaulin material to reduce light intensity to 5lux measured at the surface of the water.

The fishes during the course of the experiment were fed 5% of their body weight with 2mm Coppens feed (8.2% Moisture, 9.5% Ash, 45% Crude protein, 12% Ether extract, 1.5% Crude fiber). The experiment lasted for 42 days.

Data collection

Individual body weights were taken at the start and subsequently once biweekly till the end of the experiment to measure growth increase. All fish were blotted to remove excess liquid and weighed using a sensitive weighing balance fish in the dark phase were weighed in darken containers which weight have been previously determined and zeroed with the weighing balance this is to avoid any form of hormonal interaction which can be caused switch in photoperiod regime. Length was measured at the start and end of the experiment with a meter rule. Condition factor of fish was determined sat the start and end of the experiment by the formular.

$$CF = \frac{Wt \times 100}{Length^3}$$

Shooter composition was determined by estimating the percentage of fish that weighed twice the mean weight of the fish in each photoperiod and this was determined at the end of the experiment.

Body colouration was determined by three teams of previously trained observers composed mainly of four women in each team. Colouration was described as Lighter skin colouration, Normal skin coloration and Deep shiny black body colouration, It is however important to Note that observers were predominantly women because of the Notion that men are colour blind.

Blood glucose was determined using a blood glucose kit obtained from Aboli Medical laboratory Makurdi. Blood samples taken to determine this was gotten from two fishes randomly selected from each treatment, a drop of the blood sample was placed on the strips connected to the Accu-chek active kit model CE00HH and result was obtained in situ.

Statistical Analysis of results was done with a computer Programme Gen stat discovery edition.

RESULTS

Photoperiod effects were observed on most of the parameters measured. Figure 1 shows the growth of fish biweekly of exposure to the different photoperiod. Fish exposed to 24D: 00L had the highest maximum weight of 92.20g±3.10 at the end of the experiment compared to 12D: 12L which had 69.80g±2.50 and 00D: 24L had the least weight gain of 59.50g±8.2 (Table 1). Also it was observed that the condition factor of the fish at the end of the experiment were not significantly different across the treatments and were reduced compared to the value at the start, Shooters composition was highest in 00D: 24L (41.5% i.e. 27 of 65) compared to 12D: 12L (15.27% i.e. 11 of 72) and 24D: 00L (5.33% i.e. 4 of 75) photoperiod. 93.33% (70 of 75) of fish in the 24D: 00L exhibited Deep black body colouration, while 6.67% (5 of 75) was observed of Normal fish colouration. Though the fish in the 00D: 24L photoperiod were observed to be predominantly Lighter skin colouration, (80% i.e. 52 of 65), 18.46% (12 of 65) were of Normal skin coloration while 1.53 (1 of 65) were of Deep shiny black body colouration, however fish in the 12D: 12L were of Normal skin colouration (100% Normal skin colouration), also blood glucose was observed to increase as the light hours increased (P<0.05) with 24D: 00L photoperiod having the highest blood glucose level of 5.7±0.5, while those in 12D: 12L had 4.4±0.3 and 24D: 00L had the least value of 3.9±0.1 (Table 2).

Table 1 Condition factor

Treatment	Total length (cm) *Mean ± S.E.*	Weight (g) *Mean ±S.E.*	N	Mean condition factor ±S.E.
Before.				
Control	10.17±0.245	9.02±0.59	75	**0.872±0.029**
Light	10.33±0.206	9.01±0.62	75	**0.869±0.023**
Dark	10.20±0.235	9.00±0.62	75	**0.929±0.066**
After				
Control	$18.59{\pm}0.93^{ab}$	$69.80{\pm}2.5^{b}$	72	**0.818±0.022**
Light	$17.68{\pm}2.59^{c}$	$59.50{\pm}8.2^{c}$	65	**0.839±0.014**
Dark	$19.35{\pm}0.55^{a}$	$92.20{\pm}1.1^{a}$	75	**0.892±0.035**

N-sample size; S.E.-standard error
Means in the same column with different superscripts differ significantly (P<0.05)
Means condition factor differ significantly before and after the experiment

Table 2: Blood glucose and shooters composition of fish at different photoperiod

PARAMETERS	CONTROL	LIGHT	DARK
Blood glucose	$4.4{+}0.3^{b}$	$5.7{+}0.5^{a}$	$3.9{+}0.1^{c}$
Shooters composition			
No of shooters	11	27	4
No of fish at the end of the experiment	72	65	75
Percentage shooters composition	15.27	41.5	5.33
No of fish at the start of the experiment	75	75	75
Percentage mortality (%)	4	13.33	0

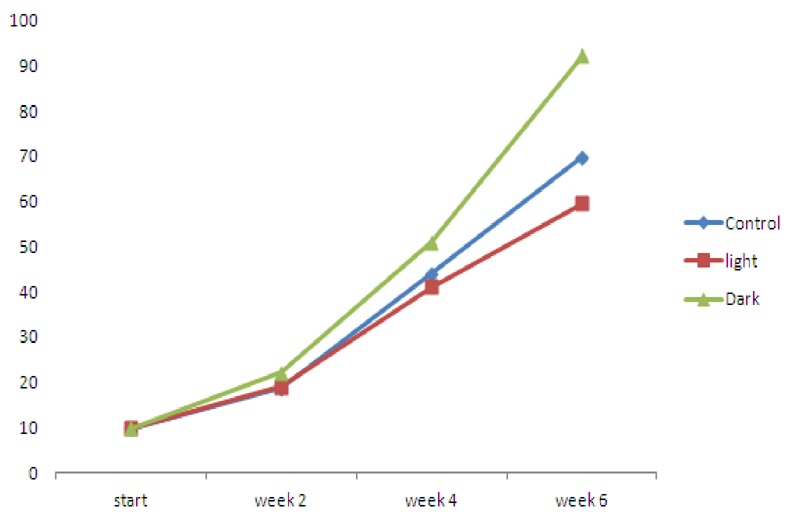

Figure 1: Mean weight of fishes per week reared at the different photoperiods (P<0.05).

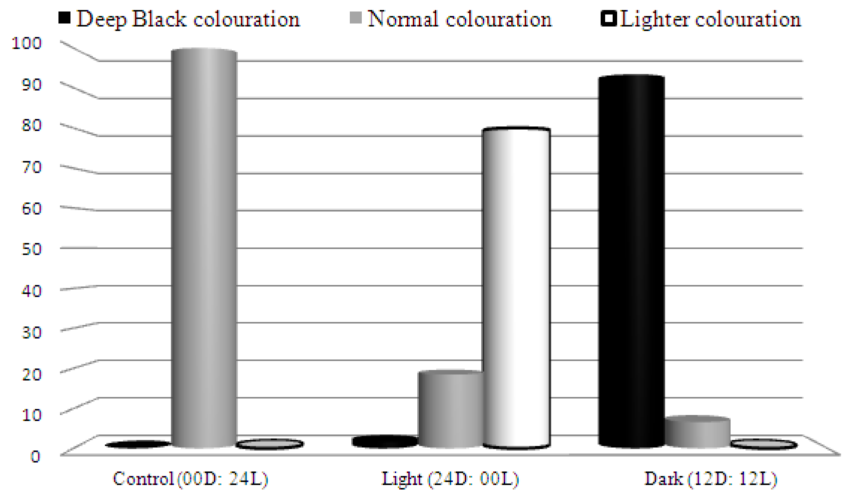

Figure 2: Variation in body colouration of fish exposed to different photoperiod.

DISCUSSION

Results from the present study showed that photoperiod affect growth of the African catfish juvenile. Lower performance is the suggested cause of higher growth in 24D: 00L and is related to the innate behaviour of Africa catfish while increased performance caused lowered growth as a result of the stress by longer periods of light (Appelbaum and Kamler, 2000) because more time is spent searching for cover and display of aggression in territorial behaviour (Appelbaum and McGeer, 1998). However it should be noted that, photoperiod effects on growth in fish are clearly species specific depending on the daily activity rhythms (diurnal/nocturnal) and probably the light sensitivity which has been shown to differ greatly between species (Migaud *et al*., 2008) hence the contradiction of the present study with studies on, Tilapia spp (Abdel-Fattah and Mamdouh Kawanna 2004)

Condition factor of fingerlings reared at the different photoperiod did not differ significant(P>0.05), Luciano *et al.,* 2009 observed that condition factor of *Odontesthes argentinensis* larvae reared at18L: 06D was similar to those exposed to constant illumination (P>0.05) and was higher (P<0.05) than larvae reared in the dark and at 12L:12D, they however concluded that Significantly reduced growth and condition factor of fish larvae reared in the dark was due to reduced feed consumption due to the lower probability of encounter with their prey since the fish is carnivorous in feeding, despite the carnivorous nature of the African catfish the present or absent of light may not be the determinant of feeding, instead extended light stress this species and so affect growth hence response of condition factor to photoperiod may be species specific. The present study also observed a decrease in condition factor after the six weeks experimental period, this reduction in the condition factor of the fish in the different treatments may be due to reduced space, and gonadal development as fishes at the end of the experiment were advanced juveniles. Saliu, (2002) stated that condition factor is not constant for a species or population over time interval and might be influenced by both biotic and abiotic factors such as feeding regime and state of gonadal development. However the insignificant result gotten in this study with respect to condition factor may be due to increased food intake despite stress of fishes reared at artificial photoperiod of 00D: 24L as the study observed 13.33% mortality in this photoperiod with dead fishes missing many parts indicating cannibalism. Therefore with regards to photoperiod as an external environmental factor; there is a possibility that Condition factor of *Clarias gariepinus* is un-affected by photoperiod, hence more research is needed to confirm this position.

With respect to body colouration, fish reared at the different photoperiod exhibited camouflage behaviour taking to the colour of the rearing medium, deep black colouration was observed predominant in 24D: 00L photoperiod possibly because of the darken nature of the facility while lighter body colouration was observed in the completely illuminated medium. Though Photoperiod has earlier been stated to affect body pigmentation, (Biswas *et al*., 2002) literature on changes in the pigmentation of fishes exposed to different photoperiod are scares, and this may be due to the fact that the colour change is not stable and can be lost within few hours of exposure to a different photoperiod, the observation of some fish in the dark phase (24D: 00L) exhibiting 6.67% (5 of 75) of Normal fish colouration as against the Deep black body colouration predominantly (93.33% i.e. 70 of 75) exhibited among the fish, as well as 18.46% (12 of 65) Normal skin coloration and 1.53 (1 of 65) Deep black body colouration as against the predominantly Lighter skin colouration, (80% i.e. 52 of 65) observed in the 00D: 24L brings to mind specific genetic difference which may slow down or accelerate an organism reaction to environmental factor such as photoperiod, However the mechanism of operation leading to this obvious changes in fish colouration is not well understood hence, the need for more research.

As in other fishes, stocking density of African catfish is considered the most important factor affecting cannibalism and aggression (Almaza´n Rueda, 2004). However in African catfish, cannibalism is also affected by factors other than stocking density such as photoperiod (Almaza´n Rueda *et al*., 2004). Although many studies have cling increased cannibalism to stress caused by longer periods of light because more time is spent searching for cover and display of aggression in territorial behaviour (Appelbaum and McGeer, 1998). The present study has however demonstrated that increased shooter composition may have contributed immensely to the mortality observed as it favored cannibalistic behaviour.

Studies on Blood glucose as indicators of stress in fish are highly varied in terms of observations, in many studies under stress, blood glucose either remained unchanged or took a longer duration of stress to show the change (Pottinger et al., 2002). Srivastava and Sanjeev (2010) reported that exposure of Clarias batrachus to artificial photoperiod (24L: 0D and 0L: 24D) for a short duration of 24 hour did not show any significant change in blood glucose concentrations. In the present study however blood glucose increased as the number of light hours increases, fish exposed to 00D: 24L photoperiod had the highest blood glucose level, while those in 24D: 00L had the least ($P<0.05$),. The present study has therefore revealed that with respect to photoperiod under increasing light phase for a period of 6 week blood glucose level increases in the African catfish fingerling.

REFRENCES

Abdel-Fattah M. El-Sayed and, Mamdouh Kawanna

(2004) Effects of photoperiod on the performance of farmed Nile tilapia *Oreochromis niloticus* on Growth, feed utilization efficiency and survival of fry and fingerlings *Aquaculture* **231,** 393–402

Almaza´n Rueda, P. (2004) Towards assessment of welfare in African catfish, *Clarias gariepinus*: the first step. PhD dissertation, Wageningen University, Wageningen, The Netherlands.

Almaza´n Rueda, P., Schrama, J. W. and Verreth, J. A. J. (2004) Behavioural responses under different feeding methods and light regimes of the African catfish (*Clarias gariepinus*) juveniles. *Aquaculture* **231**, 347–359.

Appelbaum, S. and Kamler, E. (2000) Survival, growth, metabolism and behaviour of *Clarias gariepinus* (Burchell 1822) early stages under different light conditions. *Aquaculture Engineering* **22**, 269–287.

Appelbaum, S. and McGeer, J. C. (1998) Effect of diet and light regime on growth and survival of African catfish (*Clarias gariepinus*) larvae and early juveniles. *Aquaculture Nutrition* **4**, 157–164.

Biswas, A.K., Endo, M., Takeuchi, T., (2002) Effect of different photoperiod cycles on metabolic rate and energy loss of both fed and unfed young tilapia *Oreochromis niloticus*: Part I. *Fish. Sci.* **68**, 465– 477.

Luciano S.F, Ricardo V.R, Marcelo H. O., Luiz R. L. and Luios A. S (2009) Effects of photoperiod on survival and growth of the marine pejerrey *Odontesthes argentinensis* larvae *Aquaculture Research*, **40**, 252-255

Migaud, H., Davie, A., Taranger, G.L., Taylor, J., Martinez Chavez, C., Carrilo M. (2008) Diversity of circadian organization and light sensitivities among teleost species. *International Journal of Ichthyology,* **32 (2)**, 37.

Person-Le Ruyet J., Buchet V., Vincent B., Le Delliou H. and Quemener L. (2006) Effects of temperature on the growth of Pollack (*Pollachius pollachius*) juveniles. *Aquaculture* **251**, 340-345.

Porter M.J.R., Duncan N.J., Mitchell D. and Bromage N.R. (1999) The use of cage lighting to reduce plasma melatonin in Atlantic salmon (*Salmo salar*) and its effects on the inhibition of grilsing. *Aquaculture* **176**, 237-244.

Pottinger, T. G., Carrick, T. R. and Yoemans, W. E. (2002) The three-spined stickleback as an environmental sentinel : effects of stressors on whole-body physiological indices; *J. Fish Biol.* **61**, 207-229.

Saliu J.K. (2002) Size sex and seasonal dynamics in the dietary composition of *Brycinus nurse* from Asia reservoir, Ilorin Nigeria, *Rev. Biol*. **22**, 105-109.

Srivastava S and Sanjeev K Choudhary (2010) Effect of artificial photoperiod on the blood cell indices of the catfish, *Clarias batrachus Journal of Stress Physiology and Biochemistry,* **6(1),** 22-32.

Wedemeyer, G. A. and McLeay, D. J. (1981) Methods for determining the tolerance of fishes to environmental stressors. In Pickering, A.D.(ed.). *Stress and Fish*. Academic Press, New York, pp 247-275.

Wendelaar Bonga, S. E. (1997) The stress response in fish; *Physiol Rev* **77**, 591-625.