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EFFECT OF DIFFERENT PHOTO PERIODS ON GROWTH PERFORMANCE, SURVIVAL RATE AND SKIN COLOUR OF NILE TILAPIA FINGERLINGS

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SUMMARY

*Nile tilapia (O. niloticus) fingerlings averaging 15.2 g in weight were reared under four photoperiod regimes (24L:0D, 18L:6D, 12L: 12D as control and 6L: 18D) for 90 days to investigate their growth performance, survival rate, skin colour and proximate body composition using eight fiberglass tanks with capacity of 240L water. Fish were fed a commercial diet containing 26.58 % protein .Different growth measurements of tilapia were recorded every 15 days intervals. The physico-chemical analysis of water was recorded daily. The body composition and skin colour of the whole fish were determined at the stocking and at the end of the experiment. Results showed that growth performance for tilapia was significantly (P≤0.05) increased with increasing photoperiod. No mortality occurred in any of the experimental groups. Also, the photoperiod of 24L: 0D showed the best food conversion ratio, Skin luminosity L*and body protein and lipid content. The findings revealed that photoperiod 24L: 0D was more suitable for optimum growth performance, survival rate and skin colour of Nile tilapia fingerlings than any other photoperiods.*

Keywords: Nile tilapia, Photoperiod, Skin colour, Body composition, Performance, Survival rate.

INTRODUCTION

Nile tilapia *Oreochromis niloticus* is one of the most important food fishes in the world and is prized as an aquaculture species because of, among other characteristics, the ease with which they can be bred in captivity and the wide variety of water conditions in which they will grow (Biswas *et al*., 2005a). The intensive culture of tilapia under controlled management systems is widely expanding to meet the increasing demands for these fishes, especially in developing countries. In this regard, the use of closed culture systems has received a considerable attention, and is becoming more common worldwide, particularly in arid areas that face shortage in fresh water or brackish water, tilapia can tolerate a wide range of water temperature, dissolved oxygen (DO), salinity, pH, light intensity and photoperiods (El-Sayed and Kawanna, 2004). However, the determination of optimal environmental conditions for cultured tilapia in closed systems is essential for the maximization of its production, profitability and sustainability (Muir *et al*., 2000). For a long time, the influence of environmental factors on fish has been studied in respect to their effects on growth and reproduction. Fish, as ectotherms, are highly dependant on temperature. But other factors are also involved in the control of physiological functions: Salinity, pH and oxygen availability, the presence of 'natural toxicants', such as ammonia, are also known to play a major role on the capacity to develop and grow also Sunlight is the main natural light source. Also, (Porter *et al*., 1999 and Biswas *et al.*, 2008) reported that several fish species react to longer photoperiod growth-stimulating light applications by directly improving their feed efficiency rate or reducing the incidence of sexual maturation so enabling redirection of energy from gonad development to muscle tissue and fat in the abdominal cavity. The determination of light conditions is further complicated by the fact that there may be different light requirements for different populations of the same species, as reported by (Puvanendran and Brown, 1998). Moreover, fish growth is influenced by photoperiod which stimulating the endocrine System and influence circulating growth hormone (Bjornsson, 1997). Long photoperiod has been used successfully to improve the larval, juvenile and adult growth, reproduction, gonadal maturation, locomotor activity, metabolic rates, body pigmentation and are now widely used in aquaculture to alter spawning season, manipulate maturation and stimulate growth of some species (Biswas and Takeuchi, 2002; Biswas *et al.*, 2002; Petit *et al.*, 2003 and Biswas *et al.*, 2005a,b and 2006 and Freitas *et al.*, 2009). Moreover, photoperiod acts as an artificial Zeitgeber (cue or synchronizer), regulating the daily endogenous rhythms in fish (Biswas *et al.*, 2002). Also, light and dark alternation is generally thought to be the main synchronizer of feeding activity (Hossain *et al.*, 1999).

MATERIALS AND METHODS

This study was conducted in tanks located indoor at fish research center, Suez Canal University Ismailia, Egypt.

Experimental fish

Nile tilapia (*Oreochromis niloticus*) with average initial weight 15.2 g and average total length 7.25cm was obtained from Fish Research Center, Suez Canal University . Fish were homogenous in size, body weights and apparently healthy. The fish were fed on the same diet used in this study for seven days prior to the start of the experiment to adapt them to the experimental conditions. Prior the experiment fish were starved for 24 h and their total length and body weight was measured.

Experimental tanks

Eight fiberglass tanks (110 × 60 × 50 cm) with capacity of 240l of water for each experimental tank were used. Water in tanks was aerated by a constant supply of compressed air pump and tanks were siphoned daily to remove faeces and uneaten feed. Twenty-five percent (25.0%) of water in each tank was renewed daily with dechlorinated tap water (Rad *et al* ., 2006).The photoperiod in all tanks was set to 12L:12D (natural photoperiod) during the acclimation period (Biswas *et al* ., 2005a and Biswas *et al*., 2006). During this adaptation period the dead and the weak fish were eliminated daily.

Experimental design

Fish were subjected to four different photoperiod regimes 24 L:0 D, 18 L:6 D, 6 L:18 D artificial photoperiods and natural light-dark cycle (12L:12D) as control, each tank was covered with black cloth, control tank was kept un covered. Tilapia was stocked at a rate of 40 fish/tank for 90 days with two replicates for each photoperiod feeding on commercial diet (26.58% protein). Light in each photoperiod tank was provided by florescent lamp (36w) suspended by about100 cm over the water surface and photoperiod regimes were achieved by manual control but in 24 L:0 D photoperiod light were continuously on. Light intensity was kept constant in artificial photoperiod groups at 356 LX through out the study and ambient light intensities in control tanks were measured in the morning at 09:00 h as 350-360 LX and afternoon at15:00 h as 100-120 LX. During the experimental period the physico-chemical characteristics of water and survival were monitored daily and growth performance of tilapia was determined every 15 days. At the end of the experimental period body composition and Skin colour of the whole fish were determined.

Experimental diet

The diet used from El Bardeny Company, pellets size 2 mm contained 26.58% crude protein according to Stickney (1997). The diet was stored in a refrigerated area (4°C) during the experimental duration to avoid the nutrients deterioration. Contents and proximate chemical analysis of the experimental diet are provided in Table (1).

Table 1. Ingredients composition and proximate analysis of the diet fed to Tilapia fish

Ingredients	%
Fish meal	19.76
Soya bean meal	19.76
Yellow corn	25.69
Wheat bran	25.69
Fish oil	3.95
Mineral mix*	2.68
Vitamin mix**	2.47
Total	100
Proximate chemical analysis (% DMB)	
Ash	15.03
Crude protein	26.58
Crude fat	13.75
Crude fiber	4.00
Nitrogen-free extract	40.64

*Mineral mix (El Bardeny Company),each 0.25 kg contains: Iron 30,000 mg ; Manganese 60,000 mg ; Zinc 50,000 mg ; Copper 4,000 mg ; Cobalt 100 mg ; Iodine 300 mg and Selenium 100 mg .

** Vitamin mix. ,each 0.25 kg contains: (A) 10,000,000 IU ; (D3) 2,200,000 IU; (E) 10,000 mg; (K3) 1,000 mg ; (B1) 1,000 mg ; (B2) 5,000 mg ; (B6)1,500 mg ; (B12) 10,000 mg ; Panthotenic acid 10,000 mg ; Niacin 30,000 mg ; Folic acid 1,000 mg ; Biotin 50,000 mg ; Colinechloride 600,000 mg.

Feeding regime

The daily feeding rate was 4% of the total stocking biomass during the first week of the experimental period, and there after the daily feeding rate was readjusted biweekly according to new tilapia biomass in each tank. Fish were fed twice daily (09:00 and 15:00 h) in 6 L:18 D and three time daily in other treatments. The daily feeding rate (percent of the body weight) were assigned to a particular range of wet weight according to NRC (1993). The experimental diet was offered spreading by hand for tanks.

Physico-chemical analysis of water

Water temperature was measured using oxygen-temperature meter (YSI model L57) and the average was taken per 15 days. Water pH was measured using pH meter (model 56, NR 87 BB 203).The pH values of each tank were recorded daily in the late afternoon (Rad *et al*., 2006). The average of pH values of water was recorded at15 days. The dissolved oxygen of the water was measured daily in the early morning by using oxygen-temperature meter (YSI model L57) and the average was recorded at15 days intervals during the experimental period (Pullin and McConell, 1982). The total ammonia concentration in the water was measured biweekly by using ammonia ion specific meter (HI93715) which measures the ammonia nitrogen (NH4-N) content in the water and the average was recorded every 15 days during the experimental period, un-ionized ammonia (toxic to fish) it was calculated from total ammonia using temperature –

pH tables(Emerson *et al.*, 1975). Light intensity was measured at the center of water surface of each tank by a digital Lux Meter (Digital Instrument LX-101) (Freitas *et al.*, 2009).

Skin color measurements

Skin color of the whole fish was measured along a lateral line at the level of the anterior insertion of the dorsal fin using a color reader CR-10 (Doolan *et al.* , 2009) to obtain representative values of L*(lightness=black 0 to white 100), a* (green - 60 to red +60) and b* (blue - 60 to yellow +60) for each fish .

Chemical analysis of body component:

The crude protein content of fish body was determined by microkjeldahl technique; the fat content was determined by Soxhelt extraction with petroleum ether; the ash content was determined by burning sample in a muffle furnace at 550º C for 5 h and the moisture content and the crude fibers were determined according to the method described by the AOAC (1995).

Growth parameters

The following parameters were used to evaluate tilapia growth performance

Body weight gain (WG)=W1–W0, Average daily body weight gain (ADG): ADG=(W1–W0)/t(according to De-Silva and Anderson, 1995) ,Specific growth rate (%/day): SGR=(Ln W1–Ln W0)×100/t) (as reported by El-Sayed and Kawanna 2004), Food conversion ratio: FCR=Df/(W1–W0), Survival rate (%): SR=Ni×100/N0 (according to Biswas *et al* ., 2005a), where:W1=Final wet weight, Wo=Initial wet weight, t=Time interval in days, Ni=Number of fishes at the end, N0=Number of fishes initial stocked and Df = Dry feed intake.

Statistical analysis

The data obtained were analyzed by one-way ANOVA Procedure of Statistical Analysis System (SAS, 1988). Means were compared by Duncan's new multiple range test (Zar, 1996).

RESULTS AND DISCUSSION

Environmental conditions

The recorded values show a suitable environmental condition for rearing Nile tilapia fingerlings during the experiment (Table 2).Water temperature ranged from 24°C to 26°C, these values were in the preferred range of temperature recorded for Nile tilapia. Changes in pH values of water showed that the minimum pH value was 7.9 and the maximum pH was 8.0, this range was in the optimum values recorded for Nile tilapia. Dissolved oxygen ranged from7.2 and 7.5 mg/l, this range was suitable for tilapia feeding and growth. These results are in agreement with those obtained by (El-Sayed and Kawanna, 2004; Rueda *et al*., 2005; Rad *et al*., 2006 ;El-Sherif and El-Feky, 2009a and Duy *et al*., 2012), they showed that optimal water temperature, pH values and DO for optimum growth of Nile tilapia were 23-27°C, 7.9-8.2 and 6.7to 8 mg/l, respectively. The minimal and maximal value of NH_3 in the rearing period, were 0.02 and 0.08 mg/l . It is clear from the tabulated data that UIA-N was suitable for growth of Nile tilapia (*O. niloticus*). This was in full agreement with those obtained by Saber *et al.* (2004), El-Sherif and El-Feky (2009a,b) and Duy *et al.* (2012). They showed that Nile tilapia produced the best growth rate when UIA-N ranging from 0.01 to 0.08 mg/l.

Growth parameters

Mean final body weight (FBW), mean body weight gain and Specific growth rate of Nile tilapia fingerlings (Table 3) were increased as the photoperiod increased, No mortality occurred in any of the experimental groups through out the experimental period, the maximum and the minimum average weight, weight gain and SGR were (43.04 and 31.40 g/ fish), (28.04 and 16.00 g) and (0.73 and 0.51%/day) at photoperiods of 24 L:0 D and 6 L:18 D, respectively and the differences between all groups were significant ($P \geq 0.05$). Also, photoperiod of 24 L:0 D showed the best feed conversion ratio and amount of feed consumption while the photoperiod of 6 L:18 D showed the boorest FCR and feed consumption, such results were in agreement with Al Jerian and Younis (1998), Biswas and Takeuchi (2002); El-Sayed and Kawanna (2004), Rad *et al*. (2006) and Cruz and Brown (2009). They showed that long-day photoperiods resulted in significantly higher mean final weights, SGR and FCR in tilapia than natural light regime. In the same trend, in marine fish (Skilbrei *et al.*, 1997; Karlsen *et al*., 1999; Ballagh *et al.*, 2008; Bani *et al.*, 2009; Yue *et al.*, 2009; Danışman-Yağcı and Yiğit, 2009; Freitas *et al.*, 2009 and Lohne *et al.*, 2012) reported that fish FBW, SGR , feed intake and FCR increase under long day photoperiod, it was attributed to fish being more active, and having a greater foraging activity when feed is delivered, hormonal stimulation of appetite, improvement of feed conversion efficiency and higher feed intake or suppression of sexual maturity and redirection of feed energy towards somatic growth rather than gonadal development. Moreover, Biswas *et al.* (2002) and Biswas *et al*. (2005a) attributed this to the negatively correlation between light periods and (metabolic rate and energy loss). Also, the effect of photoperiod on synchronizing an endogenous rhythm to the external environment may also require more energy in the shorter light periods, leading to a reduction of somatic fish growth; also dark period reduced the digestive performance because of the reduced activity of fish during this period. On the other hand, Crear *et al*. (2003), Rueda *et al*. (2005) and McCarron *et al.* (2010) noted an increased in growth

when fish (southern rock lobsters,*Jasus edwardsii*, African catfish *Clarias Gariepinus* and European sea urchin *Paracentrotus lividus*) exposed to short periods or no light, they concluded that The effect of photoperiod perhaps attributed to the species specific (differences between fish species).

Table 2. Mean values of physico-chemical characteristic of water during rearing period (90 days) for first and second experiments Period of rearing

(days)	Water temperature (ºC)	pH	Dissolved oxygen (mg/l)	Ammonia (mg/l)*	
				Total ammonia	NH_3
15	24.0	7.9	7.2	0.50	0.02
30	24.5	7.9	7.2	0.74	0.03
45	25.1	8.0	7.3	0.93	0.05
60	25.8	7.9	7.2	1.38	0.06
75	25.9	8.0	7.5	1.39	0.08
90	26.0	8.0	7.5	1.39	0.08

Un – ionized ammonia (toxic to fish). It was calculated from total ammonia ($NH4^+$ + NH_3) using temperature – pH equilibrium tables (Emerson *et al*., 1975).

Table 3. Growth performance of Nile tilapia (*O.niloticus*) fingerlings reared in tanks for 90 days under different photoperiod regimes

Treatment / Parameter	Different photoperiod regimes			
	24L:0D	18L:6D	12L:12D (Control)	6L:18D
Initial weight (g/fish)	15 ±0.0	15.1 ±0.05	15.2 ±0.14	15.4 ±0.15
Final weight (g/fish)	43.04±0.31 [a]	37.32±0.21 [b]	34.72±0.12 [c]	31.40±0.14 [d]
Body weight gain (g/fish)	28.04±0.28 [a]	22.22±0.16 [b]	19.52±0.1 [c]	16.00±0.14 [d]
Specific growth rate (%/d)	1.17±0.04 [a]	1.01±0.04 [b]	0.92±0.01 [c]	0.79±0.02 [d]
Feed consumed (g)	73.12±0.07 [a]	68.92±0.09 [b]	66.20±0.08 [c]	62.96±0.07 [d]
Feed conversion ratio	2.60±0.03 [d]	3.10±0.05 [c]	3.39±0.04 [b]	3.93±0.06 [a]
The condition factor(CF)	1.87±0.02 [d]	2.49±0.03 [c]	2.88±0.04 [b]	3.52±0.02 [a]

Skin colour measurements

Table (4) showed the skin colour values of Nile tilapia fingerlings reared in tanks for 90 days at different photoperiod regimes. A thorough study of this table indicated that only luminosity (L*) differed significantly between treatments (≤0.05). Fish reared under 24 L:0 D conditions displayed the highest values (85.70) relative to the other three treatments, it can be concluded that skin luminosity was highest in fish reared under the longest photoperiod. On the other hand, a* and b* skin colour values are not significantly (P≤0.05) affected by photoperiod. Similar results were obtained by Gines *et al*. (2004) it could be attreputed to an adaptive effect.

Proximate body composition

The proximate body composition of (*O. niloticus*) fingerlings reared in tanks for 90 days at different photoperiod regimes (24 L:0 D , 18 L:6 D , 12L:12D and 6L:18D) at the stocking and at the end of the experimental period showed in Table (5) , fish exposed to 18L:6D and 24L:0D photoperiods showed a significantly(≤0.05) higher whole body protein and lipid content than those exposed to a (12L:12D and 6L:18D) photoperiod. The poorest body protein content and lipid was recorded in (6L:18D). Also, it can be seen that moisture and fat percentages were highly inversely correlated with each other. This is in agreement with the findings of Biswas *et al*. (2005a), Kissil *et al*. (2001) and Biswas *et al*. (2008) who noted an increase in body protein and lipid with increasing photoperiod, This may be attributed to the protein being deposited in the body to enhance growth because the major share of growth in terms of body weight increase consists of protein growth and fish may have used lipids to mobilize energy to compensate for a greater energy demand for growth and an elevated metabolic rate.

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Table 4. Skin colour values (Mean ± SE) of Nile tilapia (*O.niloticus*) fingerlings (at the stocking and at 90 days) reared in tanks under different photoperiod regimes

Skin colour values	Different photoperiod regimes				
	At zero time (At the Stocking)	At 90 days			
		24L:0D	18L:6D	12L:12D (Control)	6L:18D
L*	76.02±2.1[b]	85.70±0.7[a]	81.45±0.7[a]	76.20±2.1[b]	70.70±0.3[c]
a*	2.14±0.23	2.40±0.41	2.53±0.12	2.20±0.15	1.73±0.49
b*	13.90±0.74	14.00±0.79	13.90±0.72	14.50±0.51	13.43±0.48

Means with the same letter in each row are not significantly different ($P \leq 0.05$).
L*: Lightness (0 – 100).
a*: Redness (green – 60 to red + 60).
b*: Yellowness (blue -60 to yellow+60).

Table 5. Proximate body composition (Mean ±SE) of Nile tilapia (*O.niloticus*) fingerlings at the stocking and at 90days reared under different photoperiod regimes (values are expressed as dry weight basis)

Parameters	Different photoperiod regimes				
	At zero time (At the Stocking)	At 90 days			
		24L:0D	18L:6D	12L:12D (Control)	6L:18D
Dry weight (%)	19.21±0.30[a]	22.93±0.16[d]	22.23±0.07[c]	21.90±0.05[c]	21.17±0.78[b]
Crude protein (%)	80.56±0.22[d]	79.44±0.05[a]	79.03±0.05[a]	78.77±0.11[b]	78.30±0.07[c]
Crude fat(%)	7.55±0.08[d]	9.41±0.22[a]	9.22±0.20[a]	8.62±0.11[b]	8.33±0.21[c]
Ash (%)	10.84±0.07[b]	10.45±0.05[e]	11.02±0.11[d]	11.07±0.14[c]	11.33±0.07[a]

Means with the same letter in each row are not significantly different ($P \leq 0.05$).

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تأثير فترات الإضاءة المختلفة على أداء النمو و معدل البقاء و لون جلد اصبعيات البلطي النيلي

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تم تربية اصبعيات اسماك البلطي النيلي بمتوسط وزن 15.2 جرام تحت أربعة فترات إضاءة مختلفة (24 ساعة إضاءة مستمرة , 18 ساعة إضاءة و 6 ساعات إظلام , 12 ساعة إضاءة و 12 ساعة إظلام ككنترول ,6 ساعات إضاءة و 18 ساعة إظلام) لمدة 90 يوم لدراسة أداء النمو و معدل البقاء و لون الجلد و مكونات الجسم باستخدام 8 تانك فيبرجلاس (110 × 60 × 50 سم)سعة 240 لتر من الماء، تم تغذية الأسماك على عليقه تجارية تحتوى 26.58% بروتين ، سجلت قياسات النمو المختلفة كل 15 يوم طوال مدة التجربة ، سجلت أيضا التحاليل الفيزوكميائية للمياه يوميا ، تم تقدير مكونات الجسم و لون الجلد في بداية و نهاية التجربة. أظهرت النتائج أن أداء النمو لأسماك البلطي كان يزداد معنويا بزيادة طول فترة الاضاءة . لم يلاحظ وجود وفيات في اى معاملة خلال مدة التجربة ، اظهرت 24 ساعة إضاءة مستمرة احسن معدل تحويل غذائي و احسن شدة سطوع للجلد و اعلى محتوى للجسم من البروتين و الدهون . أوضحت هذه الدراسة أن الإضاءة المستمرة (24 ساعة إضاءة مستمرة)كانت أكثر ملائمة لأمثل أداء نمو و معدلات بقاء و لون جلد لاصبعيات البلطي النيلي .