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Influence of environmental color on zootechnical performance and feeding behavior during masculinization of Nile tilapia

Influência das cores ambientais sobre o desempenho zootécnico e comportamento alimentar durante a masculinização da Tilápia do Nilo

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Abstract The rise of tilapia in Brazil and the world increasingly needs the best growing conditions. Despite the Nile tilapia has diurnal, your vision is considered a strong sensory stimulus, and as the perception of the color contrast of medium, production losses may be evidence due to stress caused too. Thus, an experiment was conducted at Biotechnology Aquaculture Applied Center (CEBIAQUA), The Fishing Engineering Department, Federal University of Ceará, with the aim of evaluating the influence of the background color translucent on zootechnical performance and feeding behavior of Nile tilapia during masculinization. We used 200 post-larvae (average weight = 0:02 ± 0.01g; mean initial length = 1.10 ± 0.01 cm) of Nile tilapia, packed in 40 L aquarium, covered with cellophane, for 28 days. Fish were distributed in a completely randomized in two treatments (blue and green) and five replications. Environmental variables analyzed were dissolved oxygen, temperature, pH and photoperiod and productive performance was evaluated weight, total length, condition factor and lot uniformity. Behavioral observations occurred twice daily, immediately before the first feeding and 2 minutes after each feeding treatment. We found no significant difference in water parameters in two treatments. The weight, length and condition factor did not differ between treatments. There was a higher survival rate, more lot uniformity, and an obvious grouped behavior during feeding in aquaria translucent greens than blues. So for the masculinization of Nile tilapia, it is recommended to translucent green, because the results were most satisfactory.

Keywords ambience, ethology, *Oreochromis niloticus*

Resumo A ascensão da tilapicultura no Brasil e no mundo necessita cada vez mais de melhores condições ambientais de cultivo. Apesar da tilápia do Nilo possuir hábito diurno, sua visão é considerada um forte estímulo sensorial, e conforme a percepção do contraste das cores do meio, perdas produtivas podem ser evidencias devido ao estresse demasiadamente causado. Assim, foi conduzido um experimento no Centro de Biotecnologia Aplicada a Aquicultura (CEBIAQUA), da Universidade Federal do Ceará com o objetivo de avaliar a influência da cor do ambiente translúcido sobre o desempenho produtivo e comportamento alimentar da tilápia do Nilo durante a masculinização. Foram utilizadas 200 pós-larvas (peso médio inicial = 0.02 ± 0.01 g; comprimento médio inicial = 1.10 ± 0.01 cm) de tilápia do Nilo, acondicionadas em aquários de 40 L, recobertos com papel celofane, por 28 dias. Os peixes foram distribuídos em delineamento inteiramente casualizado em dois tratamentos (azul e verde) e cinco repetições. As variáveis ambientais analisadas foram oxigênio dissolvido, temperatura, pH e fotoperíodo e para o desempenho produtivo foi avaliado o peso, comprimento total, sobrevivência, fator de condição e uniformidade do lote. As observações ocorreram duas vezes ao dia, de forma imediata antes de alimentar e durante dois minutos após última refeição, totalizando em média 56 observações focais e visuais. Não houve diferença significativa nos parâmetros da água nos dois tratamentos, e estes se encontravam dentro do recomendável. O peso, comprimento e fator de condição não diferiram entre os tratamentos. Houve maior índice de sobrevivência e lotes mais uniformes nos aquários translúcidos verdes do que nos azuis. Portanto, para a masculinização da tilápia do Nilo, recomenda-se a cor verde translúcida, pois os resultados foram mais satisfatórios.

Palavras-chave ambiência, etologia, *Oreochromis niloticus*

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Introduction

Feeding is the most important activity of aquaculture and that more explores and provides improvements to production. The animal-cultivated activities should match with biological rhythms of fish to achieve higher efficiency production. Thus, knowledge of food and its influence on the metabolism of cultured fish species can contribute to feed proper utilization by providing better quality product in the short term. Moreover, visual location, smell, taste and physical characteristics of food intake directly influence their feeding behavior (Junior and Mourgues-Schurter 2001).

Several environmental factors can alter the behavior and physiology in fish larvae, among them: the photoperiod (Schültiz et al 2008), which has great influence on the biorhythm of the animals influencing in the weight gain (Mendonça et al 2009), food intake (Puvanendran and Brown 2002), energy expenditure, locomotor activity, among other physiological parameters (Biswas and Takeuchi, 2003), such as light intensity (Behr et al 1999) and environmental color (Quarry et al 2008).

The predominant color in environment may interfere in biology of animals, especially, regard their behavior (Soares et al 2001). Fanta (1995) also states that the color may act on the nervous system and interfere in some experimental situations even have false results. The colors of tanks and lighting have been reported as factors affecting the distribution and development of larval fish (Rieger and Summerfelt, 1997; Faria et al 2001). The larval locate, capture and ingest prey to an specific range of brightness, which varies from species and stage of development (Schültiz et al 2008; Zaniboni-Filho et al 2008).

Studies have reported the importance of color vision of the feeding behavior, survival and performance of fish, especially in the larval period of several species. However, there are few studies focusing on possible changes in behavior or maintenance of physiological parameters of the animals ahead the coloring of the environment (Meringue 2004). Thus, the aim at this study was to evaluate the influence of environmental color on growth performance and feeding behavior of Nile tilapia during its masculinization.

Materials and Methods

The experiment took place at the Biotechnology Aquaculture Applied Center (CEBIAQUA), The Fishing Engineering Department, Federal University of Ceará. We used 200 post-larvae (average weight 0.02 ± 0.01g, length averaging from 1.10 ± 0.01 cm) of Nile tilapia from the National Department of Works against the Droughts (DNOCS) located in Pentecoste city, 89 km for Fortaleza, Ceará state, which went through a period of acclimatization to artificial conditions lasting before one day to start of observations and masculinization.

The animals were randomly distributed into 10 aquariums with volume of 40 L each, with a stocking density of 20 post larvae per replicate, three post-larvae per liter. To achieve the translucent color, the aquarium was covered with cellophane plastic, provided with constant aeration and without water recirculation. The completely randomized design consists of two treatments (green and blue) with five repetitions each. The productive performance was analyzed at the end of experimental period of 28 days, i.e., weight, total length, condition factor and lot uniformity.

Tilapia were fed the commercial extruded incorporated into the masculinizing hormone, with the following chemical composition: Moisture (max.) 12%, Crude Protein (min.) 50%, Fibrous matter (max.) 6%, Ether extract 8%, Mineral matter (max.) 13%, Calcium (max.) 8% and Phosphorus (min.) 1.20%. Fish from both treatments was fed "ad libitum" for 5 times a day (8 h, 10 h, 12 h, and 14h to 16h). Due to the increased weight of fish during the experimental period, the amount of the feed offered was increased periodically per lifetime (week).

The aquariums were fitted with a constant artificial aeration system through the porous stone, connected to compressor air. Every day before first and last feeding, the aquaria was siphoned to removal of excreta and leftover feed, provided daily renewal about 40% water. Environmental variables of water: dissolved oxygen (DO), temperature and pH were measured once a week using digital oximeter for the first two and potentiometer to the last parameter. The aquariums were placed a distance of 2 m for fluorescent lamps. The photoperiod was maintained for 12 hours light and 12 hours dark. The room temperature was controlled by an air conditioner, staying an average at 25 ° C.

To analyze the feeding behavior during the experimental period was observed fish actions before the first feeding and after 2 minutes each feeding treatment. The observer had clear outfit, and offered food in same place the aquarium in order to minimize stress caused by their presence during the analysis.

The behavior analysis corresponded to 10 daily observations, one for each repetition, five (5) in the morning and five (5) in the afternoon. During the analysis we evaluated "pooling" patterns of individuals, filling spreadsheet "observations versus day" during the food administration (morning at 8 h, afternoon at 16 h), which was attributed to the standard "A" when the observed aggregate behavior and "S" for separate patterns, totaling 280 observations during the 28 days of experiment. At the end, we calculated the percentage of observations with "household" pattern for each treatment (blue or green).

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The allometric condition factor (Kn) was determined by the ratio between the real weight and the expected weight, calculated by expression $Wt = a.Lt^b$, where *a* is the linear coefficient and *b* is angular coefficient in relationship between Wt (weight) and Lt (length) for each treatment (Froese, 2006). The lot uniformity (U) was calculated by expression $U = (N_{\pm 20\%}/N_T) \times 100$ where $N_{\pm 20\%}$ is the number of animals with a total weight within 20% above or below the weight and N_T is total number of specimens in the aquarium for each treatment (blue or green). The values of final weights, lengths and Kn between two treatments (blue and green) were subjected to ANOVA, adopting $\alpha = 0.05$, using the statistical software Statsoft Statistica 7.0.

The values of the environmental parameters temperature (°C), dissolved oxygen (mg.L) and pH were analyzed by t Student test to verify statistical difference between treatments (green or blue) adopting $\alpha = 0.05$.

Results and Discussion

The mean values of abiotic parameters of water were monitored for treatment 1 (blue staining aquarium) and treatment 2 (green staining aquarium) are, respectively, temperature (24.52°C ± 0.28°C and 24.12°C ± 0.35°C), pH (7.60 ± 0.18; 7 37 ± 0.24) and dissolved oxygen (5.28 ± 0.30 mg/L and 5.50 ± 0.63 mg/L). These values were not statistically different in the two treatments ($p > 0.05$). And they were within the ranges recommended for aquaculture (Egna and Boyd 1997).

The weight (g) and length (cm) values were plotted on the scatterplot Wt × Lt. Admitted to an exponential relationship between the variables for both the "blue aquarium" (Figure 1) and for "green aquarium" (Figure 2).

The allometric condition factor of both treatments "translucent blue colorations" and "green translucent colorations" were equal statistically ($p > 0.05$). However, considering only lot uniformity and survival, the “green color” treatment achieved greater results than with "blue color" (Table 1).

Fregadolli (2003) studied the influence of various environmental colors (blue, white, black and green) on mortality of larvae *Pseudoplatystoma corruscans* and found lower survival rates also in blue treatment. Some authors disagree this opinion (Volpato 2000; Quarry 2001), found that blue color increased the survival rate of confined animals. The welfare caused by such color decreases of the clashes of studied species. This result can be explained by Volpato (2000), who found that larvae *Brycon cephalus*, when confined in blue environment, the clashes had significantly decreased. Pedreira (2001) in study of same species also obtained similar results. However, Fanta (1995) observed in studies to Nile tilapia, that blue color makes fish more aggressive, which theoretically would cause greater unevenness in lot.

Although there was no significant difference in final weight and length in both experiment analyzed (blue and green), Andrade et al (2004) observed lower weight uniformity in *Leporinus macrocephalus* kept in environments with refuges of brown, green, blue and red colors. This author also found that the use of refuges of blue color showed better weight uniformity than white color and better length uniformity than red color refuges. The brown color also excelled higher condition factor when compared to treatment without refuge.

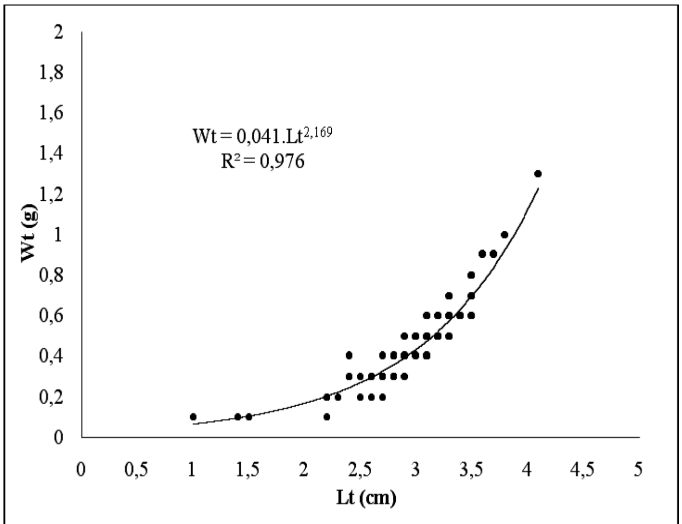

Figura 1 Exponential trend curve between values of length (Lt) and weight (Wt) of Nile tilapia (*Oreochromis niloticus*) put in translucent blue color aquariums.

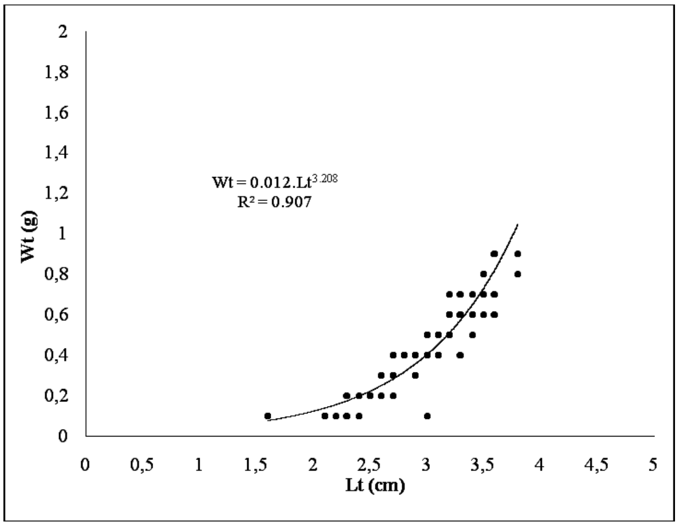

Figura 2 Exponential trend curve between values of length (Lt) and weight (Wt) of Nile tilapia (*Oreochromis niloticus*) put in translucent green color aquariums.

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Although there was no significant difference in final weight and length in both experiment analyzed (blue and green), Andrade et al (2004a) observed lower weight uniformity in *Leporinus macrocephalus* kept in environments with refuges of brown, green, blue and red colors. Already Andrade et al (2004b) also found that the use of refuges of blue color showed better weight uniformity than white color and better length uniformity than red color refuges. The brown color also excelled higher condition factor when compared to treatment without refuge.

In relation to photoperiod, Petrell and Ang (2001) in reserach of salmonids found that "attack" to diet was lower in the presence of bright light and the food came to the bottom sooner than under dark, giving chance of animals to avoid confrontations between the food provided. White-adapted carp showed higher specific growth than confined in dark environments (Papoutsoglou et al 2000). In other research, Siluriformes of nocturnal habit was greater length and weight growth in animals confined in dark environments (Piaia et al 1999). The aggression and stress activities are more observed when the African catfish is exposed to 24 hours light (24L:0D) (Amazan-Rueda et al 2005). Already Biswas et al. (2004) studied on the occurrence of acute and chronic stress in Nile tilapia in photoperiods of 6L:6D and 12L:12D and found these artificial photoperiod not induce significant stress. Therefore, photoperiod embedded in this work did not negatively affect the studied organisms.

Volpato et al (1989) explains that some individuals in group feed more than others and thus grow more food due to food competition. Moreover, the success in obtaining food may be related to social position in the group. In this work, we were confirmed that aquarium colors influenced grouping of organisms on the surface of the water during feeding, indicating a lower food competition larger grouping of fish at this time. Thus, in the green aquarium was significantly higher the fish grouping to the surface than blue aquarium, indicating that color more environmentally favorable to feed comfort of individuals. This fact which may explain the presence of larger lot uniformity and survival of organisms cultured in green aquarium. Merighe (2001) found that environments with green wall cause lower stress levels, unlike environments blue staining, which showed more aggressive behavior and competition feed fish, corroborating the results found in this work.

Cestarolli (2005) states that during change food source, habitat or modifications in certain social and environmental factors affecting growth, may account for changes in the structure of fish eye. The results of weight and length of larvae indicate greater difficulty in detecting visual feed or lack of attractiveness of food, which could explain the worse performance of the animals. The contrast of food with environment can be considered an important factor for food capture by fish that swim actively in the water column, which consequently lead to better performance (Quarry et al 2008). Moreover, in this work there was no significant difference in weight and length in both treatments, consequently, all treatments showed efficient detection of feed.

Studies like these are scarce and deserve special attention, since the authors have consulted divergent observations, because the conditions of experiments were different. Thus, we suggested that further more detailed studies regarding the effect of color and feeding behavior analyzes the development of Nile tilapia are performed.

Tabela 1 Mean values of growth performance of Nile tilapia (*Oreochromis niloticus*) undergoing refuges with and green.

Parameters	Blue		Green	
	$\bar{X} \pm SD$	CV (%)	$\bar{X} \pm SD$	CV (%)
Final Weight (g)	0.456 ± 0.209[a]	45.848	0.423 ± 0.193[a]	45.643
Final Lenght (cm)	2.939 ± 0.492[a]	16.751	2.934 ± 0.419[a]	14.263
Kn Alometric	1.024 ± 0.247[a]	24.082	1.043 ± 0.225[a]	21.608
Lot Uniformity (%)	41.667		44.086	
Survival (%)	84		93	
Aggregate behavior (%)	25.769		38.077	

*Equal letters represent statistically identical values ($\alpha = 0.05$)

Conclusions

In conclusion, the results of experimental conditions presented here no influence of environmental parameters of the water in staining studied, but the blue color had a smaller group on the surface of the water during feeding, indicating a lower stress and food competition between individuals. Furthermore, the environmental blue staining indicated negatively affect survival and lot uniformity, suggesting then not be suitable for the masculinization of Nile tilapia (*Oreochromis niloticus*). Therefore, when use translucent environment for the masculinization of Nile tilapia, it recommended among the analyzed two colors, the results of green color treatment were most satisfactory.

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