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Performance of juvenile *Pangasianodon hypophthalmus* cultivated in a recirculating aquaculture system with tanks of different colors

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Abstract

The tanks used in RASs can be manufactured in any color. RAS tank color can have a great influence on fish, with direct impacts on food capture and, consequently, performance and survival. This study investigated the influence of different tank colors on the performance and coloration of *Pangasianodon hypophthalmus.* Juvenile were cultivated in tanks of different colors (white, blue, and black) for 60 days.One hundred and forty-four juvenile P. hypophthalmus, weighing 2.18±0.5 g and measuring 6.76±0.17 cm in total length, were distributed among three RASs. Each RAS was equipped with a 200-liter rectangular filter, with mechanical and biological filter, a heating and water pumping system and four 30-liter tanks covered with colored adhesive (white, blue or black) that were filled with 28 liters of water. Therefore, each RAS was considered a color treatment (white, blue or black) with four replicates (tanks), which had a density of 0.43 juveniles per liter (12 juveniles in each replicate). Juveniles cultivated in darker tanks exhibited darker coloration. Juveniles cultivated in blue tanks showed higher final weight (FW), total length (TL), and weight gain (WG) and lower feed conversion ratio (FCR). Juveniles cultivated in white tanks had lower TL and higher FCR. In conclusion, P. *hypophthalmus* juveniles performed better when cultivated in blue tanks.

Keywords: Aquaculture, Catfish, Fish, Panga.

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Contents

Contribution of this paper to the literature
This study evaluates the effect of tank color in a recirculating aquaculture system (RAS) on the performance of juvenile *Pangasianodon hypophthalmus* over 60 days. Blue tanks yielded better growth (weight, length, gain) and feed conversion compared to white tanks, which had the poorest results.

1. Introduction

Pangasianodon hypophthalmus, popularly known as panga, is a freshwater fish native to the Mekong River in Asia. Characteristics, such as resistance, rapid weight gain and tolerance to high stocking densities, make the species appealing for aquaculture [1]. The sustainability of *P. hypophthalmus* production has been questioned in recent years, mainly due to disease outbreaks [2] and water pollution from untreated effluents [2, 3]. Implementation of the recirculating aquaculture system (RAS) for *P. hypophthalmus* cultivation is one way to increase production while mitigating the effects of environmental impacts [2].

The tanks used in RASs can be manufactured in any color, although the majority sold are blue, green or black [4, 5]. RAS tank color can have a great influence on fish, with direct impacts on food capture and, consequently, performance and survival [4-7]; However, the influence of tank color is specific to each fish species, with some performing best in light-colored tanks and others in darker-colored tanks [5].

It was recently reported that juvenile *P. hypophthalmus*, cultured for 20 days, perform better in brighter (green and white) tanks [8]. However, no study has evaluated the influence of tank color on juvenile *P. hypophthalmus* when cultured for longer period.

2. Materials and Methods

This studywas approved by Committee for Ethics in Animal Use (CEUA/UFMG - 106/2021) and aimed to evaluate the influence of tank color on the performance and survival of juvenile P. hypophthalmus. This estud was conducted at the Laboratorio de Aquacultura (LAQUA) of the Universidade Federal de Minas Gerais (UFMG) for a period of 60 days.

One hundred and forty-four juvenile *P. hypophthalmus*, weighing 2.18±0.5 g and measuring 6.76±0.17 cm in total length, were distributed among three RASs. Each RAS was equipped with a 200-liter rectangular filter, with mechanical and biological filter, a heating and water pumping system and four 30-liter tanks covered with colored adhesive (white, blue or black) that were filled with 28 liters of water. Therefore, each RAS was considered a color treatment (white, blue or black) with four replicates (tanks), which had a density of 0.43 juveniles per liter (12 juveniles in each replicate).

The tank colors were analyzed using the CIE L*, a*, b* coordinate system through a calorimeter application created by Research Lab Tools, São Paulo, Brazil (accessible via Google Play) [9]. The values measured included L* (luminosity: white = 100 to black = 0), a* (Red = +60 to green = -60), and b* (Yellow = +60 to blue = -60) [4, 5] (Table 1).

Table 1. Mean chromaticity parameters (mean ± standard deviation) for the tested tank colors (*L*: Lightness; *a*: Redness when positive, grey when zero, and greenness when negative; *b*: Yellowness when positive, grey when zero, and blueness when negative).

Tank colors	L*	a*	b
Write	78.30±1.38	2.37±0.23	2.60±0.15
Blue	64.81±1.64	-12.03±1.07	-45.06±3.90
Black	18.72±0.96	2.18±0.23	-1.70±0.03

Note: The values of L*, a* and b. Are data obtained by the calorimeter application. Where: *L*: Lightness; *a*: Redness when positive, grey when zero, and greenness when negative; *b*: Yellowness when positive, grey when zero, and blueness when negative.

The animals were cultured for a period of 60 days, during which they were fed until apparent satiety twice a day (08:00 and 16:00), with 2–3 mm pellets of extruded commercial diet containing 38% crude protein. The food provided was previously weighed in individual containers. Thirty minutes after feeding, feces were removed using a siphon, and any remaining food was gathered, dried, and weighed to determine the amount consumed. Water quality parameters were assessed every three days. Temperature and pH were measured with a portable COMBO pH meter from HANNA, dissolved oxygen (DO) was determined with a digital oximeter from the same brand, and ammonia was analyzed using a LabconTest colorimetric kit.

In the experiment final (60 days after cultivation), all fish were carefully wrapped in a damp cloth for weighing and measuring to determine their final weight (FW) and total length (TL). These biometric data were used to calculate feed consumption metrics, such as weight gain (WG) [((final weight - initial weight) / initial weight) × 100] and feed conversion ratio (FC) (feed consumption / weight gain). For photographic documentation, three juveniles from each tank (n = 12 per treatment) were euthanized using a eugenol overdose (285 mg/L)[10]. Survival rates were evaluated by counting the remaining individuals.

Data were subjected to the Shapiro-Wilk normality test and Levene's test for homoscedasticity, followed by Analysis of Variance (ANOVA) with Tukey's post hoc test at 5% probability. Infostat software was used for all data analyses.

3. Results

There were no differences in water quality parameters among RASs (P>0.05) (Table 2). Juvenile *P. hypophthalmus* cultivated in white tanks had lighter skin color and those cultivated in black tanks had darker skin color (Figure 1 A).

Table 2. Water parameters obtained after 60 days of the cultivation of juveniles of *Pangasianodon hypophthalmus* in tanks of different colors.

Tank colors	Temperature (°C)	pH	Toxic ammonia (mg/L)	Dissolved oxygen (mg/L)
Write	27.2±1.3a	6.97±0.21a	0.010±0.003a	8.02±1.12a
Blue	27.1±1.1a	7.01±0.19a	0.012±0.001a	7.98 ±1.03a
Black	27.2±0.9a	6.98±0.21a	0.012±0.003a	8.12±0.98a

Note: The letters inserted in the table indicate the statistical difference in the results. Since all treatments received the same letter (a), it indicates that there is no difference in the results. Results with distinct letters represent a significant difference (p<0.05) according to ANOVA followed by Tukey's test at 5%.

Figure 1. Photograph of *Pangasianodon hypophthalmus* after 60 days of cultivation in tanks of different colors. White (A), blue (B) and black (C). The background of the photographs was removed using photoshop software.

Survival did not differ significantly among treatments (P>0.05) (Table 3). No dead individuals were found inside tanks and reductions in survival were due to animals jumping out of the tanks, which occurred during the night.

Table 3. Performance parameters (Mean ± standard deviation) obtained after 60 days of the cultivation of juveniles of Pangasianodon hypophthalmus in tanks of different colors.

Tank color	FW (g)	FL (cm)	WG (%)	FC	SUR (%)
White	16.6±0.8b	12.9 ±0.2b	636.0±99.47b	0.92±0.07a	96.4±7.1a
Blue	20.3±1.2a	14.2±0.2a	824.62±30.8a	0.66±0.08b	97.6±4.1a
Black	19.2±0.6 ab	13.9±0.1a	736.0±30.5ab	0.72±0.04b	96.45±4.2a

Note: The letters (a and b) entered in the table indicate the statistical difference in the results. Results with different letters indicate a significant difference (p<0.05) as determined by ANOVA followed by Tukey's test at 5%. Lowercase letters denote a significant difference (p<0.05) between treatments. Final weight (FW) in g, final length (FL) in cm, weight gain (WG) in %, feed conversion (FC), and survival rate (Sur) in %.

Juveniles cultivated in the blue tanks had significantly higher FW, FL and WG and lower FC than juveniles cultivated in white tanks (P<0.05) (Table 3). Juveniles cultivated in black and blue tanks did not differ significantly for FL and FC. Juveniles cultivated in black tanks had FW and WG values intermediate to those cultivated in blue and white tanks. Juveniles cultivated in white tanks had the lowest FL and highest FC (P<0.05).

4. Discussions

During the experiment, water temperature remained within the optimal range indicated for the cultivation of *P. hypophthalmus* [11]. The remaining parameters (pH, oxygen and toxic ammonia) remained within acceptable levels for fish cultivation in general [12, 13]. The difference in color observed for juveniles cultivated in thanks of different colors may be related to a change in skin pigmentation for camouflage in the environment, which is common to several species of fish [5] and explains the darker colors for fish cultivated in black tanks.

There were no significant differences in survival rate among the juveniles cultured in tanks of different colors. Sebesta, et al. [14] studied the cultivation of *Coregonus peled* larvae in tanks of different colors and found that those cultivated in black tanks had the highest survival rate. Takeshita and Soyano [15] studied the effects of green, white, red and black tanks during juvenile *Epinephelus coioides* cultivation and found that those cultivated in black tanks had a higher mortality rate, which was attributed to a greater incidence of cannibalism. Monk, et al. [16] studied the cultivation of *Gadus morhua* larvae in white and black tanks and found no significant difference in survival rate. Nawang, et al. [8] also found no differences in survival rate for juvenile *P. hypophthalmus* cultured in green, black and white tanks. Therefore, the survival rate of fish in tanks of different colors can vary depending on the species and its cultivation phase.

The influence of tank color on animal performance is specific to each species and may depend on dietary characteristics and vision capacity. Boaventura, et al. [4] evaluated the influence of different tank colors (white, blue, green and black) on the cultivation of juvenile *Colossoma macropomum* and found that those cultivated in lighter colored tanks performed better than those cultivated in darker tanks. These authors hypothesized that this difference may have been due to a greater ease in locating and capturing food. Furthermore, these authors also reported that juveniles cultivated in darker tanks (black) had higher hemoglobin and lower triglyceride levels in the blood, which was attributed to greater movement, mainly to locate and capture food. In contrast, studying the influence of different tank colors on the catfish *Lophiosirulus alexandri*, Costa, et al. [17] found no significant differences in performance and survival, which was attributed to the ability of the species to locate food through smell, taste buds and free neuromasts. Still, Okomoda, et al. [18] studied the influence of tank color on juvenile *Clarias gariepinus* and found the highest performance for those cultivated in darker tanks (black), which was attributed to their preference for darker environments and possession of barbels to locate food in the absence light. Ferosekhan, et al. [19] reported that *Pangasius pangasius* larvae had their best performance when cultivated in darker colored (black) tanks. In contrast, Nawang, et al. [8] found juvenile *P. hypophthalmus* to have their best performance when cultivated in green and white tanks for a period of 20 days. The juveniles of the present study were cultivated for 60 days, so the difference found in relation to the data for larvae presented by Ferosekhan, et al. [19] may have been due to the adaptation of juveniles to the colors. Juveniles of several fish species were reported to have their best performance when cultivated in blue tanks, such as: Nile tilapia, *Oreochromis niloticus* [20]; beluga, *Huso huso* [21]; European catfish. *Silurus glanis* [22] and the betta fish *Betta splendens* Saekhow, et al. [23]. Opiyo, et al. [20] found better performance for Nile tilapia, *O. niloticus*, cultivated in blue tanks, but this improved performance was accompanied by a worsening feed conversion rate.

5. Conclusion

In conclusion, juvenile *P. hypophthalmus* perform best when cultivated in blue tanks, with better food conversion when cultivated in white tanks. Nonetheless, studies aimed at understanding the influence of tank color at different phases of cultivation, as well as its influences on physiology, metabolism and well-being, should continue as they are fundamental for more sustainable breeding.

References

[1] H. Ali, M. M. Rahman, K. Murshed-E-Jahan, and G. C. Dhar, "Production economics of striped catfish (Pangasianodon hypophthalmus, Sauvage, 1878) farming under polyculture system in Bangladesh," *Aquaculture*, vol. 491, pp. 381-390, 2018. https://doi.org/10.1016/j.aquaculture.2017.12.004

[2] P. T. A. Ngoc, M. P. Meuwissen, T. C. Le, R. H. Bosma, J. Verreth, and A. O. Lansink, "Adoption of recirculating aquaculture systems in large pangasius farms: A choice experiment," *Aquaculture*, vol. 460, pp. 90-97, 2016. https://doi.org/10.1016/j.aquaculture.2016.03.055

[3] P. T. Anh, C. Kroeze, S. R. Bush, and A. P. Mol, "Water pollution by Pangasius production in the Mekong Delta, Vietnam: Causes and options for control," *Agricultural Science & Technology*, vol. 42, no. 1, pp. 108-128, 2010. https://doi.org/10.1111/j.1365-2109.2010.02578.x

[4] T. P. Boaventura *et al.*, "Cultivation of juvenile Colossoma macropomum in different colored tanks in recirculating aquaculture system (RAS): Effects on performance, metabolism and skin pigmentation," *Aquaculture*, vol. 532, p. 736079, 2021. https://doi.org/10.1016/j.aquaculture.2020.736079

[5] E. McLean, "Background color and cultured invertebrates–A review," *Aquaculture*, vol. 537, p. 736523, 2021. https://doi.org/10.1016/j.aquaculture.2021.736523

[6] K. Eslamloo, S. R. Akhavan, A. Eslamifar, and M. A. Henry, "Effects of background colour on growth performance, skin pigmentation, physiological condition and innate immune responses of goldfish, Carassius auratus," *Aquaculture Research*, vol. 46, no. 1, pp. 202-215, 2015. https://doi.org/10.1111/are.12177

[7] D. Escobar-Camacho, J. Marshall, and K. L. Carleton, "Behavioral color vision in a cichlid fish: Metriaclima benetos," *Journal of Experimental Biology*, vol. 220, no. 16, pp. 2887-2899, 2017. https://doi.org/10.1242/jeb.160473

[8] M. S. U. S. Nawang, F. F. Ching, and S. Senoo, "Comparison on growth performance, body coloration changes and stress response of juvenile river catfish, Pangasius hypophthalmus reared in different tank background colour," *Aquaculture Research*, vol. 50, no. 9, pp. 2591-2599, 2019. https://doi.org/10.1111/are.14215

[9] R. Ravindranath, A. P. Periasamy, P. Roy, Y.-W. Chen, and H.-T. Chang, "Smart app-based on-field colorimetric quantification of mercury via analyte-induced enhancement of the photocatalytic activity of TiO 2–Au nanospheres," *Analytical and Bioanalytical Chemistry*, vol. 410, pp. 4555-4564, 2018. https://doi.org/10.1007/s00216-018-1114-7

[10] C. C. Mattioli *et al.*, "The effects of acute and chronic exposure to water salinity on juveniles of the carnivorous freshwater catfish Lophiosilurus alexandri," *Aquaculture*, vol. 481, pp. 255-266, 2017. https://doi.org/10.1016/j.aquaculture.2017.08.016

[11] M. A. Islam, M. H. Uddin, M. J. Uddin, and M. Shahjahan, "Temperature changes influenced the growth performance and physiological functions of Thai pangas Pangasianodon hypophthalmus," *Aquaculture Reports*, vol. 13, p. 100179, 2019. https://doi.org/10.1016/j.aqrep.2019.100179

[12] S.-Y. Zhang *et al.*, "An integrated recirculating aquaculture system (RAS) for land-based fish farming: The effects on water quality and fish production," *Aquacultural Engineering*, vol. 45, no. 3, pp. 93-102, 2011. https://doi.org/10.1016/j.aquaeng.2011.08.001

[13] S. Datta, "Management of water quality in intensive aquaculture," *Respiration*, vol. 6, no. 602, pp. 1-18, 2012.

[14] R. Sebesta, V. Stejskal, J. Matousek, and K. Lundova, "The effect of light intensity and tank wall colour on survival and growth of peled coregonus peled Gmelin 1788 larvae," *Turkish Journal of Fisheries and Aquatic Sciences*, vol. 19, no. 7, pp. 541-549, 2019.

[15] A. Takeshita and K. Soyano, "Effects of light intensity and color of rearing tank on cannibalism in the juvenile orange-spotted grouper (Epinephelus coioides)," *Aquaculture Science*, vol. 56, no. 2, pp. 175-180, 2008.

[16] J. Monk, V. Puvanendran, and J. A. Brown, "Does different tank bottom colour affect the growth, survival and foraging behaviour of Atlantic cod (Gadus morhua) larvae?," *Aquaculture*, vol. 277, no. 3-4, pp. 197-202, 2008. https://doi.org/10.1016/j.aquaculture.2008.02.018

[17] D. Costa *et al.*, "The effect of environmental colour on the growth, metabolism, physiology and skin pigmentation of the carnivorous freshwater catfish Lophiosilurus alexandri," *Journal of Fish Biology*, vol. 90, no. 3, pp. 922-935, 2017. https://doi.org/10.1111/jfb.13208

[18] V. T. Okomoda, L. O. Tiamiyu, and G. Wase, "Effects of tank background colour on growth performance and feed utilization of African catfish Clarias gariepinus (Burchell, 1822) fingerlings," *Croatian Journal of Fisheries: Ribarstvo*, vol. 75, no. 1, pp. 5-11, 2017. https://doi.org/10.1515/cjf-2017-0002

[19] S. Ferosekhan *et al.*, "Influence of rearing tank colour on Asian catfish, magur (Clarias magur) and pangas (Pangasius pangasius) larval growth and survival," *Aquaculture*, vol. 521, p. 735080, 2020. https://doi.org/10.1016/j.aquaculture.2020.735080

[20] M. A. Opiyo, C. C. Ngugi, and J. Rasowo, "Combined effects of stocking density and background colour on growth performance and survival of Nile tilapia (Oreochromis niloticus, L.) fry reared in aquaria," *Journal of FisheriesSciences. com*, vol. 8, no. 3, p. 228, 2014. https://doi.org/10.3153/jfscom.201429

[21] A. Banan, M. Kalbassi, M. Bahmani, and M. Y. Sadati, "Effects of colored light and tank color on growth indices and some physiological parameters of juvenile beluga (Huso huso)," *Journal of Applied Ichthyology*, vol. 27, no. 2, pp. 565-570, 2011. https://doi.org/10.1111/j.1439-0426.2011.01682.x

[22] V. Krasteva, A. Zaikov, and M. Yankova, "Effect of different tank colours on some productive parameters of European catfish (Silurus glanis L.) fingerlings," *Agricultural Science & Technology*, vol. 12, no. 1, pp. 19-23, 2020. https://doi.org/10.15547/ast.2020.01.004

[23] S. Saekhow, K. Thongprajukaew, and W. Phromkunthong, "Blue aquarium background is appropriate for rearing male Siamese fighting fish (Betta splendens)," *Aquaculture International*, vol. 27, pp. 891-903, 2019. https://doi.org/10.1007/s10499-019-00374-6