AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 12, No 1, pp 19-23, 2020
Published by Faculty of Agriculture, Trakia University, Bulgaria
ISSN 1313-8820 (print)
ISSN 1314-412X (online)
http://www.agriscitech.eu
DOI: 10.15547/ast.2020.01.004

Production Systems

Effect of different tank colours on some productive parameters of European catfish (*Silurus glanis* L.) fingerlings

V. Krasteva*, A. Zaikov, M. Yankova

Institute of Fisheries and Aquaculture, 4003 Plovdiv, Bulgaria

(Manuscript received 20 June 2019; accepted for publication 1 December 2019)

Abstract. *The present study investigated the growth performance, weight gain, feed conversion ratio, growth and survival rate of European catfish (Silurus glanis L.) fingerlings reared for one month in tanks with different colours. Four colours were used: light blue, white, green and black. The experimental unit was a flow-through system (0.8 L.min^{-1}) consisting of eight tanks with water volume of 30L, continuous air supply and water heaters. Two hundred fish with an average weight of 1.85±0.62g were stocked in each tank. Results from the study demonstrated that the weight gain and the feed conversion ratio were poorly affected by the tested tank colours. Weight gain is slightly higher in groups A (blue) and B (white) than in groups C (green) and D (black). However, no significant difference was found in terms of weight gain among the experimental groups (p>0.05). Survival rate was the highest in group C (91%) followed by group D (88.5%). Thus, for rearing of European catfish fingerlings it is preferable to use dark coloured tanks, which resemble the natural habitat of the fish.*

Keywords: *European catfish,* fingerlings, tank colour, growth performance

Introduction

In the modern intensive fish farming the fish are usually placed in new artificial rearing conditions, like tanks, aquariums, concrete ponds and other production facilities. Many of the environmental factors are completely different from those in their natural habitat and can negatively affect their eating efficiency, growth performance and health status, especially when the conditions are stressful (Strand et al., 2007). One of the characteristics of the surrounding environment which has effect on the behavior and the overall physiological state of the fish is the colour of the tanks or other units in which the fish are cultured. Few studies have been conducted regarding the potential advantages and disadvantages of different colours and the extent of their effect on the characteristics of the production process, growth performance and survival rate of economically valuable fish species (McLean et al., 2008).

According to Barton (2002) in controlled conditions the colour of the tank has an influence on the growth of fish. Some colours can affect physiological processes and behavioral responses, such as nutrition, growth, propagation and stress response (Volpato and Barreto, 2001). Increasing the contrast between the feed pellets and the background colour facilitates the locating of the food, therefore the process of feeding in controlled conditions is improved (Strand et al., 2007; Luchiari and Pirhonen, 2008; McLean et al., 2008; Monk et al., 2008; Jursa et al., 2009; El-Sayed and El-Ghobashy, 2011; Banan et al., 2011).

Although the background colour has a profound effect on fish behavior and physiological processes, its influence on the production process is often neglected in aquaculture (Solomon and Ezigbo, 2018). The effect of different background colours have caused high interest in the fish farming practice in terms of its impact on the fish (Papoutsoglou et al., 2000; Tamazoust et al., 2000; Rotlland et al., 2003; Martinez-Gardenas and Purser, 2007). Colours may affect fish behavior, for example their motor activity and position in the tanks (Mesa and Shreck, 1989). It has been established that stress has a negative influence on the efficacy of food intake and growth rate (Strand et al., 2007).

Few experiments, investigating the influence of background colour on the productive indicators or its role as a stress factor for different fish species, have been carried out. Papoutsoglou et al. (2000) conducted an experiment with carp stocking cultured in a closed recirculation system with blue, green and white background of the tanks. A similar study was carried out with juveniles of rainbow trout (*Oncorhynchus mykiss)* using tanks in beige, grey, dark and light green colour (Ustundag and Rad, 2015). Experiments in this field were conducted with perch (*Perca fluviatilis*) by Tamazouzt et al. (2000), Caspian kutum (*Rtilusfrisii kutum*) by Imanpoor and Abdollahi (2011), European seabass (*Dicentrarchus labrax*) by Kesbic et al. (2016), carassius (*Carassius auratus)* by

*e-mail: vasilka_mitrova@abv.bg

Eslamloo et al. (2013), African catfish (*Heterobranchus bidorsalis)* by Solomon and Ezigbo (2018), Chinese yellow catfish (*Pelteobagrus fulvidraco)* by Raghavan et al. (2013), African catfish (*Clarias gariepinus)* by Bardocz et al. (1999), Dada (2009), Ekokotu and Nwachi (2014) and Okomoda et al. (2017).

The results from different studies on the effect of background colours on the productive indicators are contrary. In some cases light colours have better effect, while in others – the dark colours. The different effects of the colours may be due to the impact of the species, age, stage of development, weight and length of the cultured fish.

Until now, there are no published data on the effect of tank colours on the main productive parameters, irrespective of age and weight of European catfish (*Silurus glanis* L.).

Material and methods

The research was carried out at the Institute of Fisheries and Aquaculture, Plovdiv for one month from 8th June to 9th July 2018. For the aim of the study, 1600 fingerlings of European catfish (*Silurus glanis* L.) at the age of 2 months were used.

The experiment was conducted in 8 tanks, 65x35x28 cm in size and volume of 30L. The chosen test colours were four: two from the light colour range: light blue and white, designated as A_1 and B_1, respectively and two from the dark colour range: dark green and black, designated as C_1 and D_1, respectively. The duplicates of the studied colours were designated with the same symbols, A_2, B_2, C_2, D_2, respectively. The tanks were stocked with 200 specimens per tank at the same density.

The experimental unit was a flow-through production system (water exchange rate: once per hour) supplied with drill water with temperature of 12ºC. In each tank heaters and micro compressors were installed for sustaining constant temperature and air supply. The water was mechanically filtered through zeolites for purification. Daily cleaning of the system was carried out.

During the experiment water quality parameters were sustained as follows: temperature 24.1±1.9ºC, dissolved oxygen 4.9±0.9 $mg.L^{-1}$, pH 7.9±0.1, nitrates (NO_3^-) 17.3±2.5 $mg.L^{-1}$ and nitrites (NO_2^-) 3.2±1.5 $mg.L^{-1}$. Weight assessments were performed with 50 randomly selected specimens at the beginning, in the middle and at the end of the experiment. The specimens were weighed with analytical balance „Kern AEJ".

Mortality rate of each of the tanks was daily registered and dead fish were removed. The juveniles of European catfish were fed with commercial dry pellet food „Coppens-Advance" (with pellet size: 1.2-1.5mm; protein content: 56%) during the first two weeks. Following an established ratio of 5-3% from the average total weight the daily feed portions were weighed, and manually given four times a day. At the beginning of the 3rd week the forage was changed with dry food, from the same manufacturer, with bigger fraction (pellet size: 3mm, protein content: 45%). In order for the fish to adapt to the new forage, they were temporarily fed with mixture of 50% from big and 50% from the small-sized pellets of "Coppens-Advance".

The growth performance of the fish in the four experimental groups was compared in terms of absolute weight gain (WG), specific growth rate (SGR), daily growth rate (DGR), feed conversion ratio (FCR) and survival rate (SR) using the following formulas:

Absolute weight gain (WG, g): $WG = Wt_2 – Wt_1$;

Specific growth rate (SGR, %/day):

$SGR = \{(\ln Wt_2 – \ln Wt^1)/P\}.100$;

Daily growth rate (DGR, g/day): $DGR = (Wt_2 – Wt_1)/P^{-1}$,

Where:

Wt_1 = initial weight;

Wt_2 = final weight;

P = duration of the experiment (days);

Food conversion ratio (FCR): FCR = FI/WT,

Where:

FI = total feed intake (g);

WT = total weight gain (g); (Total weight gain = mean individual weight gain x number of survival fish).

Survival rate (SR, %): SR = (NF/NI).100,

Where:

NF = final number of fish;

NI = initial number of fish.

The results are presented as mean±S.E.M. and were analyzed via Data Analysis (Excel 2010). T-test (Two Sample for Means) was used to compare the effect of tank colour on the fingerlings of European catfish growth performance (WG, SGR, DGR, FCR, SR) at significant level of $p<0.05$. Correlation analysis (Pearson coefficient) was calculated to determine the correlation between tank colour and growth performance characteristics.

Result and discussion

Growth patterns of fish in light blue, white, green and dark coloured tanks are presented in Table 1. The initial body weight of the fish in the light blue and white tanks is higher than the initial body weight of the specimens placed in the green and dark tanks with an established statistically significant difference of $p<0.001$. The control weight of the fish reared in the blue and white tanks is higher compared to the weight of the fish in the green and dark tanks, with a statistically significant difference between variant A (blue) and B (white). There is a statistically significant difference between variant A and all experimental variants ($p<0.05$), with the highest level of significance established between variant A (blue) and variant D (black) ($p<0.01$).

Table 1. Growth patterns (live weight) of European catfish juveniles (*Silurus glanis* L.)

Experimental variants	Body weight (BW), g		
	Initial	Control	Final
A- blue	2.46±0.50^{a}	4.79±1.42^{a}	9.44±1.97^{a}
B- white	2.03±0.47^{b}	5.37±1.41^{b}	8.09±2.06^{b}
C- green	1.60±0.46^{ab}	4.09±1.65^{ba}	7.11±2.14^{ab}
D- black	1.29±0.27^{ba}	3.81±1.60^{bc}	6.54±2.34^{ac}

a, b, c = means in the same column denoted by different superscripts indicate significant statistical difference between tank colours ($p<0.05$)

The final body weight of European catfish juveniles is higher in variant A and B compared to the other experimental variants, with values from 6.54 to 9.44g. There is a statistically significant difference between variant B and all experimental variants ($p<0.01$).The highest level of significance is established between variant B and variant A and D ($p<0.001$).

The highest weight gain was obtained in variant A (blue) followed by variant B (white), where the final body weight was also the highest, 6.98g and 6.06g, respectively (Figure 1). T-test proved statistically significant difference between variant A and variant B ($p<0.05$). Regarding variant C (green) and D (black), the values of weight gain were relatively close with no significant statistical difference between the two colours ($p>0.05$).

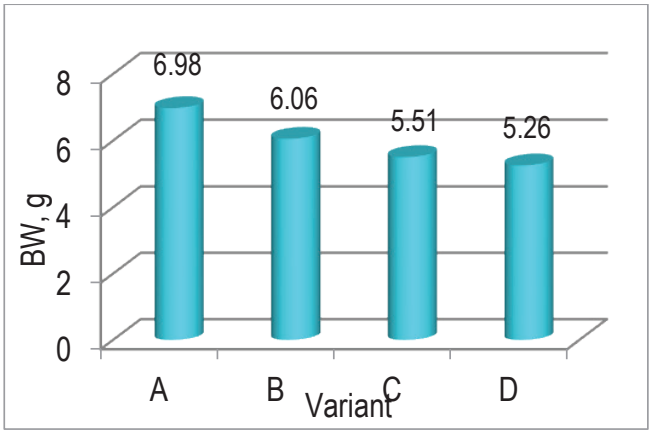

Figure 1. Absolute weight gain (g)
(A- blue, B- white, C- green, D- black)

Specific growth rate (SGR) of the European catfish fingerlings cultured in black and green tanks was higher than those reared in the experimental tanks with white and blue colour. Nevertheless, there were no significant differences between the green and the black tank colour ($p>0.05$) or between the white and the blue variants (Figure 2). However, the only significant difference ($p<0.05$) was recorded between the white and the green colour variants. A high positive correlation was established between SGR and tank colours ($r=0.79$). The present results regarding specific growth rate are in contrast to the results published by Okomoda et al. (2017). The authors did not discover any difference in the specific growth rate values of the African catfish fingerlings from tanks with different background colour.

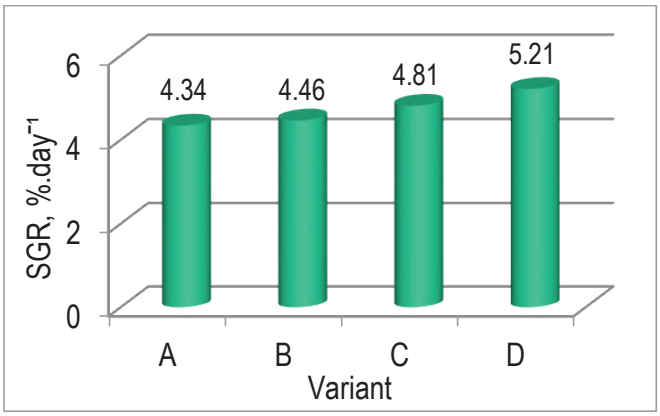

Figure 2. Specific growth rate (SGR, %/day^{-1})
(A- blue, B- white, C- green, D- black)

Opposite to the specific growth rate, the highest value of daily growth rate (DGR) was recorded in variant A followed by variant B (Figure 3). DGR was the lowest in the C and D variant of tank colour. Statistical analysis did not reveal any significant differences in terms of the daily growth rate and the experimental variants ($p>0.05$). A negative moderate correlation was determined between DGR and different tank colours ($r=0.65$).

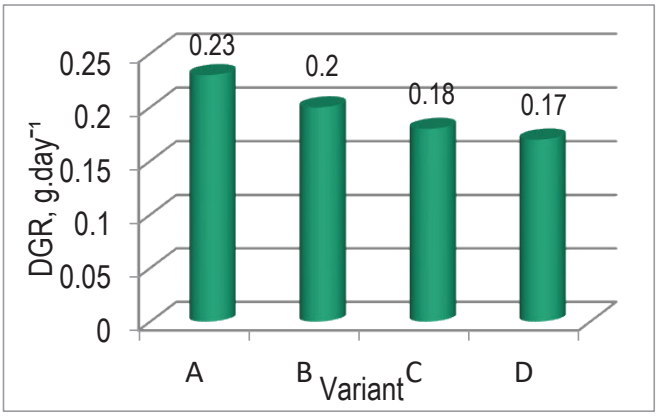

Figure 3. Daily growth rate (DGR, g/day^{-1})
(A- blue, B- white, C- green, D- black)

An important point when discussing the weight gain results is the difference between initial body weight of fingerlings from variant A – blue and variant B – white colour and between variant C – green and variant D – black tank colour. As a rule, the specimens with higher body weight achieve higher absolute weight gain, while the specimens with lower body weight achieve higher relative weight gain. The results from the current research completely corresponded to this rule,

as the initial body weight difference is kept during the whole experiment.

The present results have also been established by Bardocz et al. (1999) who generalize that there is no significant difference in the weight gain of African catfish larvae and fry cultured in tanks with dark and white background colour. The same conclusion was reached by Ekokotu and Nwachi (2014) using tanks with blue, white and green colour. In contrast to the mentioned authors, Okomoda et al. (2017) recorded better growth performance of African catfish fingerlings reared in black tanks than in the ones with white, green, blue and red background colour. The results by Dada (2009) regarding African catfish fry cultured in black, blue, green, white and maroon tank colour were almost the same, as the author underlined the overall tendency towards higher weight gain and survival rate of fish cultured in black tanks.

The recorded feed conversion ratio (FCR) was within 0.57-0.68 (Figure 4). The values of FCR in variants A and B were similar and also for C and D variants. FCR was higher in light blue and white tanks than in green and dark ones despite the fact that there was no significant difference between each variant ($p>0.05$). FCR is measured based on feed intake and total weight gain. Higher FCR means more feed intake at the expense of higher total weight gain. Lower FCR means that a higher total weight gain is obtained with smaller amount of feed. Overall, FCR for all variants of tank colour was low, consequently the total weight gain was higher than the amount of feed intake. Therefore, the used feeding method was adequate and efficient. European catfish fingerlings reared in variant D and variant C had lower FCR, i.e. more efficient way of feed intake. The statistical analysis did not reveal any significant differences in terms of food conversion ratio between the experimental variants ($p>0.05$). A negative moderate correlation was established between FCR and different tank colour ($r=0.64$). As opposed to the results of the present study, Okomoda et al. (2017) did not record the difference regarding feed conversion ratio in their research on culturing African catfish in different tank colours.

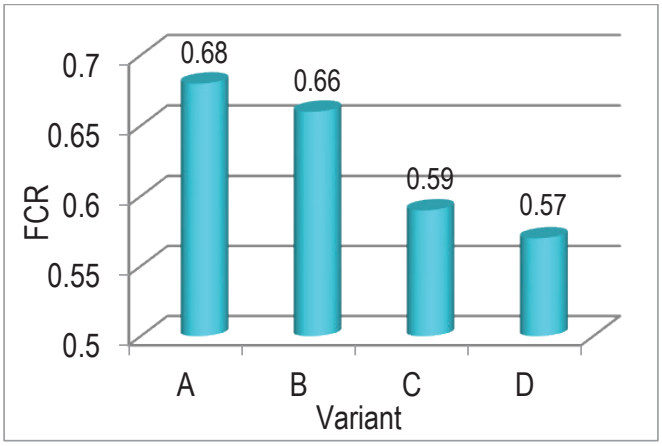

Figure 4. Food conversion ratio
(A- blue, B- white, C- green, D- black)

The survival rate during the experiment was between 82.5 and 91.0% (Figure 5). The highest survival rate was recorded for variant C followed by variant D. The lowest survival rate was recorded for variant A, with no significant difference between the experimental sets ($p>0.05$). The correlation between survival rate and different tank colour was positive with Pearson coefficient of $r=0.48$. It can be suggested that the reason for the higher mortality rate for the light coloured tanks (variant A and B) is the stress experienced by the European catfish fingerlings cultured in them. Okomoda et al. (2017) registered a higher level of glucose in fish reared in tanks with light colours, which is an indicator of stress. For that reason the authors recommend tanks with dark colour for culturing African catfish fingerlings.

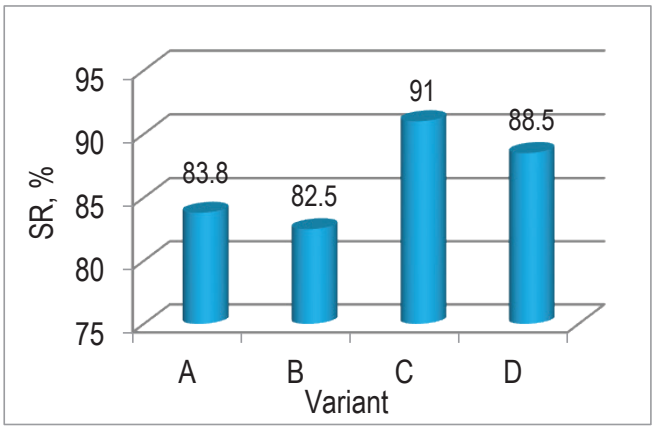

Figure 5. Overall survival rate (%)
(A- blue, B- white, C- green, D- black)

Conclusion

Based on the results of the conducted study it can be concluded that dark coloured tanks (C – green and D – black) are better for rearing fingerlings of European catfish based on the values registered for the specific growth rate, feed conversion ratio and survival rate. A disadvantage of the black colored tanks is difficult visual control of fish behavior, their condition, feed intake and the cleaning of the accumulated waste products on the bottom of the tank. Despite that, dark colored tanks might be preferred in practice over light coloured ones for their resemblance to the natural habitat of the European catfish.

References

Banan A, Kalbassi R, Bahmani M and Sadati M, 2011. Effects of colored light and tank color on growth indices and some physiological parameters of juvenile beluga (*Huso huso*). Journal of Applied Ichthyology, 27, 565-570.

Bardocz T, Kovacs E, Radics F and Sandor Z, 1999. Experiments for the improved use of decapsulated Artemia cysts in intensive culture of African catfish larvae. Journal of Fish Biology, 55, 227-232.

Barton A, 2002. Stress in fishes: a diversity of responses with particular reference to changes in circulating corticosteroids. Integrative and Comperative Biology, 42, 517-525.

Dada A, 2009. Effects of enclosure colour on growth performance of *Clarias gariepinus* fry. In: 24th Annual

Conference of the Fisheries Society of Nigeria (FISON), 25-28 October 2009, Akure, Nigeria, pp. 22-24.

Dowing GA and Litvak MK, 2000. The effect of photoperiod, tank colour and light intensity on growth of larval haddock. Aquaculture International, 7, 369-382.

Ekokotu A and Nwachi F, 2014. The growth performance of *Clarias gariepinus* fries raised in varying coloured receptacles. Journal of Research in Biology, 4, 1287-1292.

Eslamloo K, Akhavan SR, Eslamifar A and Henry MA, 2013. Effects of background color on growth performance, skin pigmentation, physiological condition and innate immune responses of goldfish, *Carassius auratus*. Aquaculture Research, 41, 202-215.

El-Sayed AF and El-Ghobashy A, 2011. Effect of tank colour and feed colour on *Liza ramada* larvae. Aquaculture Research, 42, 1163-1169.

Imanpoor M and Abdollahi M, 2011. Effects of Tank Color on Growth, Stress Response and Skin Color of Juvenile Caspian Kutum Rtilus frisii Kutum. Global Veterinaria, 6, 118-125.

Jursa D, Drawbridge M and Stuart K, 2009. The effects of tank color and light intensity on growth, survival, and stress tolerance of White seabass, Atractoscionnobilis, larvae. Journal of the World Aquaculture, 40, 702-709.

Kesbic O, Yigit M and Acar U, 2016. Effects of Tank Color on Growth Performance and Nitrogen Excretion of European Seabass (*Dicentrarchus labrax*) Juveniles. In: Proceeding of the National Academy of Sciences, India Section B, Biological Science, 86, pp. 205-210.

Luchiari AC and Pirhonen J, 2008. Effects of ambient colour on colour preference and growth of juvenile rainbow trout *Oncorhynchus mykiss* (Walbaum). Journal of Fish Biology, 72, 1504-1514.

Martinez–Cardenas L and Purser GJ, 2007. Effect of tank colour on Artemia ingestion, growth and survival in cultured early juvenile pot-bellied seahorses (*Hippocampus abdominalis*). Aquaculture, 264, 92-100.

McLean E, Cotter P, Claire T and King N, 2008. Tank color impacts performance of cultured fish. Pisciculture, 66, 43-54.

Mesa MG and Schreck CB, 1989. Electro-Fishing Mark-Recapture and Depletion Methodologies Evoke Behavioural and Physiological Changes in Cut-Throat Trout. Transactions of the American Fisheries Society, 118, 644-658.

Monk J, Puvanendran V and Brown JA, 2008. Does different tank bottom colour affect the growth, survival and foraging behaviour of Atlantic cod (*Gadus morhua*) larvae? Aquaculture, 257, 287-293.

Okomoda V, Tiamiyu L and Vase G, 2017. Effects of tank background colour on growth performance and feed utilization of African catfish *Clarias gariepinus* (Burchell, 1822) fingerlings. Croatian Journal of Fisheries, 75, 5-11.

Papoutsoglou SE, Mylonakis G, Miliou H, Karakatsouli NP and Chadio S, 2000. Effects of background colour on growth performances and physiological responses of scaled carp (*Cyprinus carpio* L.) reared in a closed circulated system. Aquaculture Engineering, 22, 309-318.

Raghavan P, Zhu XM, Lei W, Han D, Yang YX and Xie SQ, 2013. Rearing tank colour influences survival and growth of the early larvae of the Chinese Yellow Catfish, *Pelteobagrus fulvidraco* Richardson. Acta Hydrobiologica Sinica, 37, 177-184.

Rotllant J, Tort L, Montero D, Pavlidis M, Martinez M, Wendelaar Bonga SE and Balm PM, 2003. Background colour influence on the stress response in cultured red porgy *Pargus pargus*. Aquaculture, 223, 129-139.

Solomon JR and Ezigbo MN, 2018. Effects of background tank colour on the growth and survival of juvenile *Heterobrachus bidorsalis* fed with coppens commercial floating pellets and *Cyperus esculentus* meal. Direct Research Journal of Public Health and Environmental Technology, 3, 17-33.

Strand A, Alanara A, Staffan F and Magnhagen C, 2007. Effects of tank colour and light intensity on feed intake, growth rate and energy expenditure of juvenile Eurasian perch, *Perca fluviatilis* L. Aquaculture, 272, 312-318.

Tamazouzt L, Chatain B and Fontaine P, 2000. Tank wall colour and light level affect growth and survival of Eurasian perch larvae (*Percafluviatilis* L.). Aquaculture, 182, 85-90.

Ustundag M and Rad F, 2015. Effect of Different Tank Colors on Growth Performance of Rainbow Trout Juvenile (*Oncorhynchus mykiss* Walbaum, 1792). Journal of Agricultural Sciences, 21, 144-151.

Volpato GL and Barreto RE, 2001. Environmental blue light prevents stress in the fish Nile tilapia. Brazilian Journal of Medical and Biological Research, 34, 1041-1045.