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RESEARCH ARTICLE

EFFECT OF CIRCUIT TYPE ON GROWTH PERFORMANCES AND SURVIVAL OF CLARIAS GARIEPINUS CATFISH FRY IN HATCHERY

Kouamé Marcel N'DRI[1]*, Yao Laurent ALLA[2], Moustapha DIABY[1] and Dramane DIOMANDE[3]

[1]Institut of Agropastoral Management, Peleforo GON COULIBALY University (PGCU), Korhogo, Côte d'Ivoire; [2]Oceanological Research Center (CRO), Abidjan, Côte d'Ivoire; [3]Faculty of Environmental Sciences and Management, NANGUI Abrogoua University (NAU), Abidjan, Côte d'Ivoire

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***Corresponding author:**
Kouamé Marcel N'DRI

ABSTRACT

Ivorian national fish production remains low for an ever-growing population. In order to contribute to the improvement of fish production, this study aims to determine the effect of the type of farming circuits on the growth performance and survival of catfish fry. To do that, two batches (Closed circuit and Open circuit) of 30 subjects each were made up with 150 L tanks and monitored for 5 weeks. Each batch was tested in duplicate and the subjects were fed with Koudijs commercial food titrated to 47% protein at a rate of 10 g/d per tank. Weekly samplings were carried out by taking 15 individuals per tank for weighing and individual measurements. The results showed that weight growth, ADG, survival and biomass were improved (26.46 g ± 9.08 g; 1.74 ± 0.65 g/d; 95.00 ± 2.36% 537.25 ± 101.51 g) in fry reared in a closed circuit. Conversely, fry conducted in an open circuit obtained relatively low values with an average weight of 15.08 g ± 6.74 g, an ADG of 0.50 ± 0.15 g/d, a survival rate of 90.00 ± 4.71% and a biomass of 309.28 ± 81.67 g. All in all, closed circuit farming should be favored.

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INTRODUCTION

Fish has always held a special place in human gastronomy. However, the supply of fish from capture fisheries is relatively stable, while the population continues to grow. On a global scale, strong population growth has led to increased demand for fish products. According to FAO (2018), per capita fish consumption rose from 9.0 kg in 1961 to 20.2 kg in 2015, an average increase of around 1.5 % per year. In many developing countries, fish is the main source of animal proteins in people's diets (FAO, 2008). In Côte d'Ivoire, national fish production, at around 106,028 tons, remains well below domestic demand, estimated at over 618,182 tons. The deficit is made up by imports of frozen fish (Yayo N'cho *et al.*, 2020). To reduce these imports, which cause a considerable outflow of foreign currency, the Ivorian Government has adopted the Strategic Plan for the Development of Livestock, Fisheries and Aquaculture.(PSDLFA, 2014-2020) with the target of producing 200,000 tons of fish in 2020 (MIRAH,2014). Research structures, including the Oceanological Research Center (ORC), have been tasked with identifying and studying local species with high aquaculture potential, in order to make them available to fish farmers. Among these species, the *Clarias gariepinus* is of great interest due to its rapid growth, large size, robustness and flesh quality (Wiecaszek *et al.*, 2010).

Notwithstanding the scientific and technical information available on fish farming, the Ivorian aquaculture industry, and in particular fish farming, still faces numerous constraints, including the availability of sufficient quantities of *Clarias gariepinus*. The aim of this study is to determine which type of rearing circuits gives the best results in terms of growth and survival in hatcheries.

MATERIAL AND MATHODS

Study area and period: This work was carried out from May 1st to June 4, 2022i.e. for 35 days at the hatchery of the Oceanological Research Center (ORC) in Abidjan.

Biological material: It consisted of *Clarias gariepinus* juveniles with an initial average weight of 3.68 ± 0.73 g and an average length of 8.58 ± 0.65 cm, produced at the ORC hatchery. Fish were conditioned in tanks in the ORC breeding room for one week, before being put into batches.

Methodology

Experimental setup: For this trial, 120 juvenile catfish (Figure 1) were used to form the different batches.

Figure 1.*Clarias gariepinus* Juveniles

They were divided into two batches of 30 individuals in tanks (Figure 2) each with capacity of 150 liters, i.e. a density of 0.2 individuals//liter of water.

Figure 2. Breeding tanks

These batches consisted of batches 1 (closed circuit) and batch 2 (open circuit), with 30 juveniles per batch. Each batch was tested in duplicate. Fish were fed with Koudijs commercial food titrated at 47% proteins at a rate of 10 g/dper tank in two meals (8 amand4 pm). A weekly sample of 15 fry selected randomly per tank was taken to monitor their growth. They were weighed (in g) and measured (in cm) individually using a Kern EG 620-3 NM precision balance and a transparent ruler graduated in mm. A HANNA multi-parameter was used for weekly determination of physico-chemical parameters of the rearing water. Before the first meal, the tanks were cleaned using the siphoning technique with a flexible plastic hose to remove faeces and the residual uneaten food. At the end of the trial, all fish were weighed and measured individually per batch, then counted manually.

Calculation of zootechnical parameters

Average Weight of juveniles (AW)

AW (g) = sum of weights of individual weighed / Total number of individuals weighed.

Average Length of juveniles (AL)

AL (cm) = Sum of length of individuals measured / Total number of individuals measured.

Average Daily Gain (ADG)

ADG (g/d) = (Faw – Iaw) / t,
Faw: Final average weigh (g);Iaw: Initial average weigh (g); t: rearing time (d).

Survival Rate (SR)

SR (%) = 100 x Fn / In,
Fn: Final number of fish; In: Initial number of fish at loading.

Weight Coefficient of Variation (CV)
CV (%) = (100 x Standard deviation)/Average Mass

Total Biomass (TB)

It is the sum of the weights of individuals remaining in each tank at the end of the experimentation.

Statistical analysis: The data collected was compiled manually and then processed by computer. Results were expressed as mean ± standard deviation. The 5% Threshold t-student test was applied to compare sample averages using Statistica version 10: Stat Soft, Inc. software (2011).

RESULTS

Average weight of juveniles (AW): Figure 3 shows the evolution of the average weight of *Clarias gariepinus* fry depending on the age and circuit type in to main phases. During the first three weeks of breeding, growth was slow. So, the average weight of Fry rose from 3.68 g ±0.73 g to 10.20 g± 5.33g in the open circuit and from 3.68 g ± 0.73 g to 13.94 g ± 4.69 g in the closed circuit. From D21 to D35, weight growth was greater. It increased from 10.20 g ± 5.33 g to 15.08g ± 6.74 g and from 13.94 g ± 4.69 g to26.46 g ± 9.08 g for the open and closed circuits respectively. The closed-loop weight curve remained higher than the open-loop circuit curve until the end of the experiment with no significant difference between batches(P>0.05).

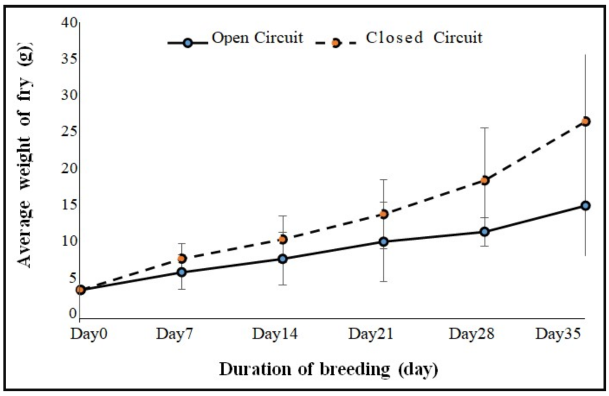

Figure 3. Curves of Fry weight growth depending on the type circuit and the breeding duration

Growth in length: In general, the curves were ascending. From 8.58 cm at the beginning of the experiment, the curve rose to13.22 cm at D35 in the open circuit. However, in the closed circuit, it reached an average length of 0 at D35. At the end of the experiment, the final length in closed circuit was therefore greater than the one in open circuit. No significant difference was observed between the two batches (P>0.05).

Average Daily Gain (ADG): The average daily gains recorded rose in a saw tooth pattern in both circuits (Table 1).

Table 1. Average daily gain of *C. gariepinus* Fry during the experiment

Average Daily Gain (g/d)		
Weeks	Open Circuit	Closed Circuit
1	0.34 ± 0.16	0.60 ± 0.15
2	0.26 ± 0.11	0.38 ± 0.15
3	0.33 ± 0.23	0.49 ± 0.12
4	0.19 ± 0.00	0.73 ± 0.33
5	0.50 ± 0.15	1.74 ± 0.65
0-5	0.33 ± 0.14	0.65 ± 0.19

The highest values were observed at week 5 with 1.74 ± 0.65 g/din the closed circuit and 0.50 ± 0.15 g/din the open circuit. Conversely, the lowest ADG values were recorded at week 2 for the closed circuit

(0.38 ± 0.15 g/d) and at the week 4 in open circuit (0.19 ± 0.00 g/d). Overall, the ADG obtained in closed circuit (0.65 ± 0.19 g/d) was higher than that of fish reared in the open circuit (0.33 ± 0.14 g/d) with no significant difference (P>0.05).

Survival Rate (SR): The survival rate gained were95.00 ± 2.36% for Fry reared in closed circuit and 90.00 ± 4.71% for those reared in open circuit. The rate of the closed circuit was higher than that of open circuit. However, there was no significance difference between batches (P>0.05).

Weight Coefficient Variation (CV): The values obtained ranged from 19.27 ± 4.96% and34.14 ± 6.30%, i.e. an average of 25. 21 ± 7.26% for Fry reared in closed circuit. Conversely, they ranged from 19.27 ± 4.96% and40.11 ± 9.03%, i.e. an average of de 33.80 ± 4.8% for those reared in open circuit. However, no significant differences (P>0.05) were observed. Closed-circuit subjects were therefore homogeneous, whereas open-circuit subjects were heterogeneous (CV > 30%).

Condition Factor (K): In a closed circuit, the condition factor K of juveniles was 0.64 ± 0.03% compared with 0.67 ± 0.01% for those in open circuit. The condition factors obtained in the Fry were all below 1, regardless of the type of rearing circuit. No significant differences were observed between batches.

Total Biomass (Tb): The highest final biomass (537.25 ± 101.51g) was observed in individuals reared in a closed circuit, while the lowest biomass (309.28 ± 81.67) was obtained in those reared in an open circuit. There was a significant difference between batches (P<0.05).

DISCUSSION

The type of circuit (Closed or open circuit) had no significant influence on the weight and length growth of juveniles. Juveniles reared in tanks fed by the closed circuit showed the best growth in weight (26.46 g ± 9.08 g) and length (15.75 cm). These results were superior to those of N'dri *et al.* (2023) for the same species reared in monoculture in aquariums, with an average weight of 17.20 ± 5.43 g and a growth length of 3.55 ± 2.74 cm. Our results can be explained by a good adaptation of the fish to the closed circuit, correlated with a better use of the feed distributed. In terms of ADG, subjects reared in an open circuit produced a lower ADG (0.33 ± 0.14 g/d) than those reared in closed circuit (0.65 ± 0.19 g/d). The low value observed in the open circuit could be due to the cannibalism phenomenon causing stress to juveniles in batch 2. This situation could also be explained by a poor adaptation of juveniles to the open circuit. However, the ADGs recorded were higher than those reported by Zango *et al.* (2017) and Assalé (2019) for juveniles of the same species reared in ponds and closed-circuit aquariums respectively. For these authors, these observations are justified by the fact that *Clarias gariepinus* is more voracious and competes strongly for available food resources. On the other hand, our values were lower than those of Auta and Oniye (2013) and N'dri *et al.* (2023)**,** who obtained3.2 g/dand3.36 ± 1.29 g/d respectively in *Clarias gariepinus* fingerlings. In terms of subjects' survival, the best rate was observed in fry reared in a closed circuit (95%). This higher survival rate may be explained by the fact that rearing conditions were relatively good during the experiment. Whatever the type of circuit, the values obtained were higher than those observed by Kouamé and Prao (2018) and N'dri *et al.* (2023) for *Clarias gariepinus* fry in closed circuits, with 83.73% and 62.22 ± 5.09% respectively. Concerning the coefficient variation of average weight, it was superior to 30% in subjects reared in open circuits, reflecting size heterogeneity. This situation could be attributed to cannibalism, considered as an intrinsic character of this species. This would explain the low survival rate (90%) observed. Our comments are in line with those of Sanou (2017), who showed that cannibalism is one of the main causes of mortality of catfish. For Smith and Reay (1991), there is a negative correlation between the availability of food resources and the impact of cannibalism. For catfish, the work of Baras and D'almeida (2001) showed that a very high initial size heterogeneity is a factor favoring cannibalism. Similarly, Howell *et al.* (1998) then Kestemont and Baras (2001) noted that any restriction on food availability can trigger or reinforce cannibalism, insofar as it leads to food shortage and differential growth. Furthermore, Hecht and Appelbaum (1988) have shown that in *Clarias gariepinus* larvae, size heterogeneity within a population initially appears to be more a consequence than a cause of cannibalism. The condition factors obtained in the Fry were all below 1, regardless of the type of rearing circuit. This could be explained by the fact that the fry had undergone stresses that affected their growth performance and even their survival. These include stress related to handling during sampling and social interactions (cannibalism). Gangbazo *et al.* (2018) have reported that the living environment of fish is a factor that can reduce growth performance due to the effects of social interaction for access to food and space. The total biomass of *C. gariepinus* fry in a closed circuit is greater than that obtained in open circuit. This could be explained by a higher survival rate in the closed circuit than the open circuit. We might therefore conclude that biomass increases with the number of fry.

CONCLUSION

At the end of this work, we retain that survival rate, biomass and average daily gain are better at the level of fry reared in closed circuit than those reared in open circuit. Overall, the closed circuit had the best effect on fry growth and survival. All in all, closed-circuit rearing should be favored. Looking ahead, it would be interesting to repeat this study in aquariums and test other densities; we could also continue this experiment through to grow-out to better assess the effect of the type of circuit on *C. gariepinus* growth and survival.

Competing interests

The authors declare that they have no competing interests.

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