Research Article

# Effects of different shelter materials on growth performance and survival of african catfish (*Clarias gariepinus*) fry and juveniles

Urai Koolboon[1*], Nitichai Utthisin[1], Woraman Maicharoen[2], Sawipa Rattanakorn[1], Jukkarin Treeinthong[1], Bunthom Tubsombat[1], Kasame Chetawan[1], Adcha Heman[4], Wutthi Rattanavichai[1], Thanaphoom Boonmee[2], Prasit Khunsanit[2], Nattapon Kanaroon[2], Wirawan Heman[3] and Keeravit Petjul[2]

[1]*Department of Fisheries Technology, Faculty of Agricultural Technology, Kalasin University*

[2]*Department of Interdisciplinary Agriculture, Faculty of Agricultural Technology, Kalasin University*

[3]*Department of Science and Mathematics, Faculty of Science and Health Technology, Kalasin University*

[4]*Department of Agricultural Machinery Engineering, Kalasin University*

*Corresponding author email: aurai.ku@ksu.ac.th

| Date Received | Date Revised | Date Accepted |
|---|---|---|
| June 5, 2025 | June 13, 2025 | June 19, 2025 |

## Abstract

African catfish (*Clarias gariepinus*) farming is economically important in many countries, particularly in high-density systems where early-stage survival is often compromised by stress and cannibalism. The use of shelter materials has shown potential in reducing aggressive behavior and improving fry welfare, yet comparative studies in this species remain limited. This study investigated the effects of different shelter materials on the growth and survival of African catfish (*Clarias gariepinus*) fry using two sub-experiments under a Completely Randomized Design. Sub-Experiment 1 involved fry reared with PVC pipes, netting debris, or no shelter for 45 days, while Sub-Experiment 2 examined larger juveniles reared for 30 days with two or three pieces of netting debris or no shelter. The results showed no significant differences in growth or survival rates in either experiment ($p > 0.05$). However, PVC pipes tended to promote better growth in early stages, while netting debris increased survival rates, especially in larger juveniles. These findings highlight the potential use of low-cost shelter materials to mitigate cannibalism and improve fish welfare in intensive rearing systems, although further studies are needed to optimize shelter design and placement.

**Keywords**: Giant catfish, growth, survival, shelter materials, rearing system

## Introduction

The farming of African catfish (*Clarias gariepinus*) is an economically significant aquaculture activity in many countries, including Thailand. This species is favored for its rapid growth, adaptability to diverse environmental conditions, and suitability for high-density stocking [1,2]. Catfish farming plays a crucial role in supporting the livelihoods of small-scale farmers, particularly in rural areas with limited water resources, where recirculating or semi-closed water systems can be efficiently implemented [3].

However, during the fry and early juvenile stages, survival rates are often low due to environmental stress, high stocking density, and cannibalistic behavior—a common issue among Clariid catfish species [4–6]. Such behavior frequently results in substantial losses during the early rearing phases, negatively impacting overall productivity and increasing production costs [7,8].

One widely adopted approach to improve larval survival is the use of shelter materials. These shelters provide refuge for fry, reducing vulnerability to aggression from conspecifics and lowering stress levels. The presence of shelters has been reported to mitigate aggressive interactions and enhance feeding behavior and growth performance [9–11]. For instance, Methawee et al. (2017) demonstrated that shelter materials significantly increased survival rates in giant freshwater prawn larvae [12], while Kriangkrai et al. (2019) found that different shelter types influenced the growth and survival of sand goby juveniles [13]. The type and structural design of shelters can affect their effectiveness, with commonly used materials including PVC pipes, netting sheets, nylon ropes, and artificial aquatic plants, each influencing fish behavior in different ways [14–16].

Studies by Gwak (2003) and Benhaïm et al. (2010) reported that shelters significantly affected feeding behavior, encounter frequency, and growth rates in marine and cold-water fishes [17,18]. Similarly, in hybrid catfish and yellow mystus (*Hemibagrus filamentus*), shelters were found to reduce cannibalism and improve survival rates [19,20]. In Thailand, research on shelter materials has been conducted on various aquatic species such as bagrid catfish, swamp eels, and blue swimming crabs, revealing improved growth and survival under appropriately managed environmental conditions [21–23]. However, in the case of African catfish—particularly under intensive or recirculating aquaculture systems—there remains a lack of comprehensive and comparative studies on the effectiveness of different shelter types for fry rearing [24].

Therefore, the objective of this study was to investigate the effects of various shelter types on the growth and survival of African catfish fry. The findings aim to provide practical guidance for optimizing rearing conditions, reducing mortality rates, and enhancing farm productivity. Ultimately, the results are expected to contribute to the development of more sustainable and efficient freshwater aquaculture practices.

## Objective

The study aimed to investigate the effects of various shelter types on the growth and survival of African catfish (*Clarias gariepinus*) fry and juveniles.

## Experimental Methodology

### Preparation of Experimental Animals

The effect of different shelter materials on the growth performance and survival of African catfish (*Clarias gariepinus*) fry and juvenniles, the experiment was conducted in a roofed facility covered with shade netting. The fry were reared in 200-liter plastic tanks.

**Experiment 1**: A total of 1,350 African catfish (*Clarias gariepinus*) fry (3 days) were obtained from Suphawat Farm and acclimatized in 200-liter plastic tanks for 1 day to adapt to the new environment. During this period, the fry were trained to feed on red worms twice daily, in the morning (approximately 07:30) and evening (approximately 16:00). Subsequently, 150 fry were randomly selected and placed into each experimental plastic tank, with random assignment of experimental units to 9 tanks according to the design of Experiment 1.

**Experiment 2**: From the same batch of juveniles as Experiment 1, aged 45 days, 25 juveniles were randomly selected and placed into each experimental plastic tank. Random assignment of experimental units was performed to allocate juveniles to 9 tanks according to the design of Experiment 2.

### Experimental Design

The experiment investigated the effects of different shelter materials on the growth and survival rates of African catfish fry, using a Completely Randomized Design (CRD). The experiment was divided into two sub-experiments:

**Sub-Experiment 1**: Effects of different shelter materials on growth performance and survival of african catfish (*Clarias gariepinus*) fry, consisting of 3 treatments with 3 replicates each, as follows:

- **Treatment 1**: Control group (reared without shelter materials).
- **Treatment 2**: Group reared with 5 pieces of 1-inch diameter PVC pipes, 70 cm long, per tank.
- **Treatment 3**: Group reared with one piece of used fishing net (20 x 40 cm) per tank.

Fry were reared in 200-liter plastic tanks, with 150 fry per tank, fed red worms twice daily (morning and evening) for 45 days.

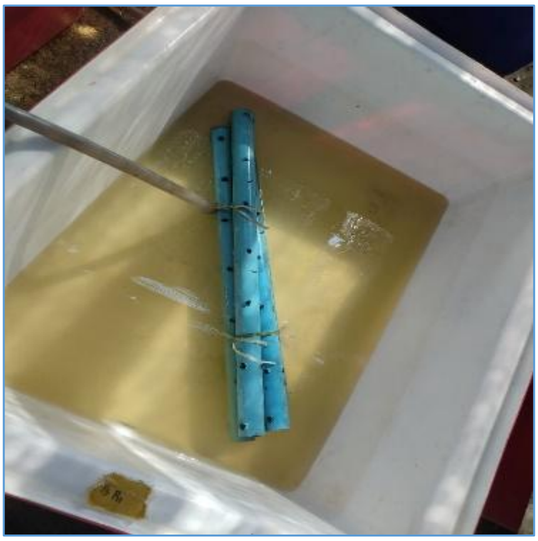

**Figure 1** PVC pipes, 70 cm long per tank

**Sub-Experiment 2**: Effects of different shelter materials on growth performance and survival of african catfish (*Clarias gariepinus*) juveniles with an average length of 7.74 cm, consisting of 3 treatments with 3 replicates each, as follows:

- **Treatment 1**: Control group (reared without shelter materials).
- **Treatment 2**: Group reared with two pieces of used fishing net (20 x 40 cm) per tank.
- **Treatment 3**: Group reared with three pieces of used fishing net (20 x 40 cm) per tank.

Fry were reared in 200-liter plastic tanks, with 25 juveniles per tank, fed commercial pelleted feed with 36% protein content for 30 days.

**Figure 2** Fishing net (20 x 40 cm) per tank

Kalasin University Journal of Science Technology and Innovation
Volume: 4 Issue: 1 (January – June 2025)

## Data Collection and Analysis

**Sub-Experiment 1**: Effects of different shelter materials on the growth and survival rates of African catfish fry. Data on survival numbers, length, and weight of fry were collected at four time points: at the start of the experiment, and at 15, 30, and 45 days of age. The collected data were analyzed.

**Sub-Experiment 2**: Effects of different shelter materials on the growth and survival rates of African catfish juveniles with an average length of 7.74 cm. Data on survival numbers, length, and weight of fry were collected at three time points: at the start of the experiment, and at 15 and 30 days of age. The collected data were analyzed.

The data from Sub-Experiments 1 and 2 were used to calculate the following parameters:

1. **Length Gain (LG, cm per fish)**
   = Average final length (cm) - Average initial length (cm)
2. **Weight Gain (WG, g per fish)**
   = Average final weight (g) - Average initial weight (g)
3. **Percentage Weight Gain (PWG, %)**
   = 100 × (Average final weight - Average initial weight) / Average initial weight
4. **Percentage Length Gain (PLG, %)**
   = 100 × (Average final length - Average initial length) / Average initial length
5. **Survival Rate (%)**
   = (Number of surviving fish at the end of the experiment / Number of fish introduced at the start) × 100

## Statistical Analysis

The mean values of the collected data, including weight, length, weight gain, length gain, percentage weight gain, percentage length gain, and survival rate, were analyzed using One-Way Analysis of Variance (ANOVA). Differences between treatment means were compared using Duncan's New Multiple Range Test (DMRT) at a 95% confidence level, using the SPSS software package.

### Water Quality Monitoring

Throughout the experimental period, water quality was assessed every seven days by measuring pH, alkalinity, dissolved oxygen, and temperature.

## Results

Results of Sub-Experiment 1: Effects of different shelter materials on growth performance and survival of frican catfish (*Clarias gariepinus*) fry.

Kalasin University Journal of Science Technology and Innovation
Volume: 4 Issue: 1 (January – June 2025)

**Table 1** Growth and survival of giant catfish fry at 15 days under different shelter treatments

| Parameter | Control | PVC Pipe | Netting Debris | p-value |
|---|---|---|---|---|
| Survival rate (%) | 11.77 ± 9.36 | 4.44 ± 2.69 | 16.21 ± 13.73 | 0.201 |
| Final length (cm/fish) | 4.24 ± 1.57 | 7.58 ± 0.38 | 4.54 ± 3.04 | 0.094 |
| Length gain (cm/fish) | 3.51 ± 1.57 | 6.85 ± 0.38 | 3.81 ± 3.04 | 0.094 |
| Final weight (g/fish) | 1.31 ± 2.04 | 0.68 ± 1.14 | 2.01 ± 3.44 | 0.536 |
| Weight gain (g/fish) | 1.29 ± 2.04 | 0.66 ± 1.14 | 1.99 ± 3.44 | 0.536 |

**Note**: Values are presented as mean ± standard deviation.

At 15 days, the highest survival rate was observed in fry provided with netting debris (16.21%), although no significant differences were detected. PVC shelters promoted the greatest growth in both length and weight, suggesting potential benefits in early larval development, though variability was high.

**Table 2** Growth and survival of giant catfish fry at 30 days under different shelter treatments

| Parameter | Control | PVC Pipe | Netting Debris | p-value |
|---|---|---|---|---|
| Survival rate (%) | 1.33 ± 0.00 | 1.10 ± 0.38 | 2.21 ± 1.38 | 0.166 |
| Final length (cm/fish) | 8.50 ± 0.66 | 10.16 ± 0.28 | 8.46 ± 1.34 | 0.063 |
| Length gain (cm/fish) | 7.75 ± 0.66 | 9.44 ± 0.28 | 7.74 ± 1.34 | 0.063 |
| Final weight (g/fish) | 3.92 ± 1.58 | 4.69 ± 0.55 | 2.12 ± 2.56 | 0.137 |
| Weight gain (g/fish) | 3.89 ± 1.58 | 4.66 ± 0.55 | 2.10 ± 2.56 | 0.137 |

**Note:** Values are presented as mean ± standard deviation.

At 30 days, all treatment groups showed low survival, with netting debris showing the highest value (2.21%). PVC shelters led to better length and weight gains. However, differences among treatments were not statistically significant.

**Table 3** Growth and survival of giant catfish fry at 45 days under different shelter treatments

| Parameter | Control | PVC Pipe | Netting Debris | p-value |
|---|---|---|---|---|
| Survival rate (%) | 1.33 ± 0.00 | 1.10 ± 0.38 | 2.21 ± 1.38 | 0.166 |
| Final length (cm/fish) | 21.39 ± 9.87 | 20.14 ± 7.77 | 27.86 ± 20.35 | 0.532 |
| Length gain (cm/fish) | 20.66 ± 9.87 | 19.41 ± 7.77 | 27.13 ± 20.35 | 0.532 |
| Final weight (g/fish) | 4.98 ± 1.05 | 7.38 ± 0.27 | 5.01 ± 1.62 | 0.974 |
| Weight gain (g/fish) | 4.95 ± 1.05 | 7.35 ± 0.27 | 4.99 ± 1.62 | 0.974 |

**Note:** Values are presented as mean ± standard deviation.

By 45 days, survival remained low across all treatments, while substantial gains in size and weight were recorded. Netting debris yielded the highest growth in length, while PVC shelters achieved the highest weight gain. Nevertheless, these differences were not statistically significant.

Kalasin University Journal of Science Technology and Innovation
Volume: 4 Issue: 1 (January – June 2025)

Results of Experiment 2: Effects of different shelter materials on growth performance and survival of african catfish (*Clarias gariepinus*) juveniles

**Table 4** Survival and growth performance of giant catfish juveniles at day 15

| Parameter | Control | Netting debris ×2 | Netting debris ×3 | p-value |
|---|---|---|---|---|
| Survival rate (%) | 62.66 ± 12.20 | 72.00 ± 12.00 | 80.00 ± 0.00 | 0.084 |
| Final length (cm/fish) | 8.40 ± 0.12 | 8.42 ± 0.09 | 8.32 ± 0.14 | 0.287 |
| Length gain (cm/fish) | 0.58 ± 0.17 | 0.74 ± 0.13 | 0.59 ± 0.21 | 0.336 |
| Percentage length gain (%/fish) | 7.48 ± 2.36 | 9.64 ± 1.81 | 7.74 ± 2.86 | 0.325 |
| Final weight (g/fish) | 5.31 ± 0.13 | 5.09 ± 0.20 | 5.02 ± 0.15 | 0.086 |
| Weight gain (g/fish) | 1.01 ± 0.26 | 0.87 ± 0.28 | 0.63 ± 0.14 | 0.114 |
| Percentage weight gain (%/fish) | 23.64 ± 7.05 | 20.88 ± 7.11 | 14.68 ± 4.17 | 0.142 |

**Note:** Values are presented as mean ± standard deviation.

At 15 days of culture, the highest survival rate was observed in fish provided with three pieces of netting debris (80.00%), although no significant differences were found among treatments ($p = 0.084$). Growth performance, both in terms of length and weight, did not differ significantly among the groups. However, fish in the netting debris ×2 group showed numerically higher length gain and percentage length gain, whereas the control group showed the highest weight gain and percentage weight gain. These results suggest that the presence of shelter may enhance survival but has limited impact on early growth performance over 15 days.

**Table 5** Survival and growth performance of giant catfish juveniles at day 30

| Parameter | Control | Netting debris ×2 | Netting debris ×3 | p-value |
|---|---|---|---|---|
| Survival rate (%) | 54.66 ± 18.03 | 61.33 ± 9.23 | 78.66 ± 2.30 | 0.053 |
| Final length (cm/fish) | 9.13 ± 0.22 | 8.94 ± 0.12 | 9.05 ± 0.25 | 0.319 |
| Length gain (cm/fish) | 1.31 ± 0.21 | 1.25 ± 0.34 | 1.32 ± 0.67 | 0.734 |
| Percentage length gain (%/fish) | 16.79 ± 3.64 | 16.34 ± 7.72 | 17.22 ± 19.18 | 0.755 |
| Final weight (g/fish) | 7.40 ± 0.36 | 7.21 ± 0.39 | 6.99 ± 0.50 | 0.299 |
| Weight gain (g/fish) | 3.10 ± 0.21 | 2.99 ± 0.34 | 2.61 ± 0.67 | 0.251 |
| Percentage weight gain (%/fish) | 72.01 ± 3.64 | 71.04 ± 7.72 | 60.17 ± 19.18 | 0.291 |

**Note:** Values are presented as mean ± standard deviation.

At 30 days of rearing, fish exposed to netting debris ×3 exhibited the highest survival rate (78.66%), which was close to statistical significance ($p = 0.053$). No significant differences were found in any growth parameter across treatments. Length and weight gains were comparable, indicating that the shelters

Kalasin University Journal of Science Technology and Innovation
Volume: 4 Issue: 1 (January – June 2025)

primarily improved survival rather than promoting faster growth during the 30-day period. These findings highlight the potential role of physical shelters in reducing cannibalism or stress-related mortality during juvenile development.

Throughout the experimental period, all water quality parameters in the experimental tanks were within acceptable limits for aquaculture, with the exception of alkalinity, which tended to be relatively low.

## Discussion

The findings suggest that although statistical significance was not observed, trends indicate certain advantages of using shelter materials in African catfish (*Clarias gariepinus*) fry rearing. PVC pipes provided early growth enhancement, possibly by promoting spatial separation and reducing competition. This observation aligns with previous studies on other species, such as black sea bass and Arctic charr, where shelters contributed to better growth performance (Gwak, 2003; Benhaïm et al., 2010) [17, 18].

In contrast, netting debris appeared more effective in improving survival rates, especially in older juveniles. This may be attributed to its higher surface complexity, providing more effective spatial partitioning and hiding spots that reduce aggressive interactions and cannibalism. This supports earlier findings on Clariid catfish and Japanese flounder, where enriched environments helped mitigate cannibalistic behavior (Garcia-Franco, 1993; Dou et al., 2000) [5, 6]. Similar trends have also been reported in hybrid catfish and *Mystus nemurus* (Yuwono et al., 2019; Soesanto et al., 2015) [19, 20].

These results are consistent with the conclusions of Mohapatra et al. (2017), who noted that shelter use influences fish behavior, improves fish welfare, and enhances both growth and survival in freshwater aquaculture systems [11]. The benefits of shelter use were further supported by findings in other studies focusing on climbing perch, sand goby, and giant freshwater prawns (Saengchan, 2020; Sitaphan et al., 2019; Rotmongkoldi et al., 2017) [12–14].

However, it should be noted that substantial variability in outcomes—especially in Sub-Experiment 1—suggests that external factors such as inconsistent water parameters, light intensity, or shelter positioning might have influenced results. A refined experimental design is essential for better elucidating these effects.

As environmental enrichment becomes increasingly recognized as a practical strategy for improving fish health and welfare in intensive systems (Näslund & Johnsson, 2016) [10], the incorporation of shelters offers a promising and low-cost method for optimizing African catfish fry rearing. Future investigations should examine interactions among shelter type, density, and spatial arrangement to identify the most effective combinations. Such insights will be invaluable in designing sustainable hatchery protocols and improving survival outcomes in commercial catfish farming operations.

## Conclusion

This study provides initial insights into the effects of different shelter materials on African catfish fry rearing. Although no significant differences were found, the trends suggest that PVC pipes may support growth, while netting debris can enhance survival. The use of shelters presents a promising approach to mitigate cannibalism and environmental stress in intensive fry production systems. To maximize these benefits, further research is needed to optimize shelter configurations and evaluate long-term performance outcomes.

## Acknowledgements

The author would like to express gratitude to Mr. Dee-Den Tangcharoendamrong for his kind support in providing knowledge about marketing and the network for giant catfish, as well as for his assistance in providing tools and equipment at Suphawat Farm. The author also extends thanks to the Department of Fisheries Technology, Faculty of Agricultural Technology, Kalasin University, for their support in providing laboratory facilities.

## References

1 Cherdchan Amatyakul et al. Catfish (*Clarias sp.*). Bangkok: Department of Fisheries; 1995.
2 Anlaks Wachiraichayakarn, Uthairat Na-Nakorn. Application of population genetics knowledge in addressing giant catfish breed issues. In: Proceedings of the 45th Kasetsart University Conference; 2007.
3 Praphat Pannin. Farming African catfish in a 200-liter plastic tank recirculating system. Ranong: Ranong College of Agriculture and Technology; 2010.
4 Hecht T, Pienaar AG. A review of cannibalism and its implications in fish larviculture. Journal of the World Aquaculture Society. 1993; 24(2):246–261.
5 Dou S, Seikai T, Tsukamoto K. Cannibalism in Japanese flounder juveniles reared under controlled conditions. Aquaculture. 2000; 182(1–2):149–159.
6 Garcia-Franco M. Intra- and interspecific relationships of the Clariid catfish *Clarias batrachus* [PhD thesis]. Tokyo: Tokyo University of Fisheries; 1993.
7 Amporn Buathi et al. Effects of PVC pipes and plastic boxes as shelter materials on blue swimming crabs. Prachuap Khiri Khan: Klong Wan Research Station; 2017.
8 Suphakorn Phochalasang. Effects of low-cost feed on African catfish farming. Kalasin: Kalasin University; 2018.
9 Huntingford FA, Kadri S. Stress and fish welfare. Biological Reviews. 2009; 84(3):517–529.
10 Näslund J, Johnsson JI. Environmental enrichment for fish in captive environments. Neuroscience & Biobehavioral Reviews. 2016; 60:1–12.
11 Mohapatra S, Chakraborty T, Prusty AK, Das P, Paniprasad K, Mohanta KN. Use of shelters influences growth and survival of freshwater fish: A review. Reviews in Aquaculture. 2017; 9(2):204–217.

12 Methawee Rotmongkoldi et al. Effects of shelter materials on survival rates of giant freshwater prawn larvae. Journal of Agriculture. 2017; 33(2):257–265.

13 Kriangkrai Sitaphan et al. Effects of shelter materials on sand goby. Phayao: University of Phayao; 2019. Research report. pp. 33–40.

14 Wipharat Saengchan. Effects of stocking density and shelter materials on climbing perch fry rearing. Khon Kaen: Khon Kaen Fisheries Research Station Technical Paper. 2020;7.

15 Wikit Phinrap et al. Growth of blue swimming crabs in different shelter materials. Technical Paper. 2019;18.

16 Li Y, Hellemans B, Pouyaud L, Volckaert FAM. Origin and genetic diversity of aquacultured catfish (*Clarias gariepinus*) in SE Asia. Catfish Asia Workshop; 2000 Jun 9–20; Bogor.

17 Gwak WS. Effects of shelter on growth and survival in age-0 black sea bass (*Centropristis striata*). Aquaculture Research. 2003; 34(15):1387–1390.

18 Benhaïm D, Leblanc CA, Lucas G. Impact of a new artificial shelter on Arctic charr behaviour and culture. Aquaculture. 2010; 297(1–2):38–43.

19 Yuwono E, Marzuqi M, Rachmansyah. Shelter utilization in hybrid catfish. Aquaculture Indonesia. 2019; 20(3):147–152.

20 Soesanto V, Prakoso VA, Sugiharto S. Shelter types and growth of *Mystus nemurus*. Indonesian Aquaculture Journal. 2015; 10(2):103–110.

21 Jaidee Sangngern. Effects of shelter materials on survival rates of *Nile tilapia* fry. Journal of Agriculture. 2018; 34(2):99–105.

22 Manop Tangtrongpairot et al. Bighead catfish, a new economic fish species. Bangkok: Freshwater Fisheries Research Institute, Department of Fisheries; 1990.

23 Berg LS. Classification of fishes both fossil and recent. Ann Arbor (MI): J.W. Edwards; 1965.

24 Putra DF, Legowo D, Ekasari J. Shelter materials and survival of *Clarias gariepinus* larvae. Aquaculture Studies. 2020; 20(1):23–30.