Asian Journal of Fisheries and Aquatic Research

7(4): 8-14, 2020; Article no.AJFAR.59108
ISSN: 2582-3760

The Effect of Stocking Density on Survival Rate of Siamese Catfish (*Pangasianodon hypophthalmus*) Fry in Recirculation System

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Authors' contributions

This work was carried out in collaboration among all authors. Author MAS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors YA and ZH managed the analyses of the study. Authors HH and US managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI:10.9734/AJFAR/2020/v7i430124
Editor(s):
(1) Dr. Matheus Ramalho de Lima, Federal University of South of Bahia, Brazil.
Reviewers:
(1) Subodh Kumar Tripathy, Sambalpur University, India.
(2) Javed Gafur Khan Pathan, Maharashtra Animal & Fishery Sciences University, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/59108

Original Research Article

Received 01 July 2020
Accepted 14 July 2020
Published 18 July 2020

ABSTRACT

The research aims to determine the best stocking density in the maintenance of Siamese catfish seedlings based on the influence exerted on the survival of Siamese catfish seeds and improving water quality in the recirculation system. This research was conducted at the Green House Ciparanje FPIK Unpad Jatinangor in August 2019. Maintenance activities are carried out in a 70x70x70 cm fiber equipped with a recirculation system and filled with 150 L of water per fiber. The study was conducted with four stocking solid treatments as follows 375 fry/fiber (treatment A); 450 fry/fiber (treatment B); 525 fry/fiber (treatment C); and 600 fry/fiber (treatment D). Siamese catfish fry is 1 inch in size with an average weight of 0.307 grams. The parameters observed were the survival of Siamese catfish fry and water quality. Water quality measurements include temperature, degree of acidity (pH), and ammonia (NH_3). Water quality testing was carried out at the Laboratory of Aquatic Resources, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran. During the study, there was no exchange of water or siphon. The method used in this research was

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analyzed descriptively and compared the results of survival rate fish and water quality parameters toward the Indonesian National Standard (SNI). The results showed that the best stocking density was 600 fry/fiber with a survival rate of 100% Siamese catfish and the ammonia value at the beginning of maintenance was 0.140 mg/L and the end of maintenance decreased to 0.137 mg/L.

Keywords: Fry; recirculation system; siamese catfish; stock density; survival rate.

1. INTRODUCTION

Siamese catfish (*Pangasianodon hypophthalmus*) is one of the freshwater fish commodities that is economically important because it has a high enough price and is profitable in aquaculture businesses both in the domestic and international markets [1]. Siamese catfish have white and chewy flesh and high nutritional content which contains 68.6% protein, 5.8% fat, 3.5% ash, and 51.3% water so that people like it for consumption. Biologically, Siamese catfish have several advantages compared to other freshwater fish, including being easy to breed, high fecundity, easy maintenance and fast growth [2]. The number of small and medium-scale fry cultivators (household-scale hatcheries) is increasing in the supply of fish seeds. To support optimal production, it is necessary to supply fry so that it can reach the target of aquaculture production as a superior commodity.

The quality of freshwater aquaculture water needs to be considered such as physicochemical factors/physiochemical factors, that are temperature, dissolved oxygen, pH, carbon dioxide, nitrogen, and toxic contaminants. Poor water quality will reduce the appetite of fish, delay growth, susceptible to disease and can cause fish death [3]. Nitrogen compounds are one of the important factors that must be considered in fish farming. Nitrogen compounds piled up because of the high stocking density of the fish, the remaining feed and the limited space of the container, so it is necessary to control the water quality in order to achieve the success of fish farming. The impact of high stocking densities can effect high feed and oxygen requirements and increase concentrations of ammonia and carbon dioxide [4]. The process of decomposition of proteins produces ammonia (NH_3) or Unionized Ammonia which is toxic to fish.

Low stocking density results in a minimum supply of Siamese catfish fry, so there is a need for technological innovation to increase the yield of fry production from hatcheries. High stocking density is thought to disrupt fish growth due to high competition during maintenance. According to Yunita research [5] that the stocking density arrangement was carried out to minimize competition between fish individuals, one of which was space competition. In general, high stocking densities can affect water quality. This can occur because organic material derived from fish feces and leftover food accumulates at the bottom of the maintenance media. Therefore, optimal high density and controlled media water quality must be considered for maximum production. The stocking density regulation in fry raising stages affects survival rate fish. Stocking density, in addition to directly affecting the rate of growth, also indirectly affects water quality, such as the accumulation of organic material derived from fish metabolic waste discharges and food feed that is not consumed [6].

One alternative technology for the maintenance of Siamese catfish fry that can be applied is the cultivation of the recirculation system. The recirculation system is a cultivation technology innovation that can maintain water quality through the waste management process by reusing water that has been used by turning water continuously into the container. Based on the principle, when the water comes out of the fish container, the water is reused [7]. The recirculation system has the advantage of being implemented in a confined space and controlled environmental conditions. This will make Increased fish production in limited land and water.

This study aims to determine the best stocking density in the maintenance of Siamese catfish fry based on the influence given to the survival rate of Siamese catfish fry and improving water quality in the recirculation system. Maintenance of fry with optimal stocking density supported by maintained water quality conditions in a recirculation system is expected to increase the amount of fry production in the household scale hatchery of Siamese catfish.

2. MATERIALS AND METHODS

2.1 Time and Place

This research was conducted on August 7th, 2019 at the Ciparanje Green House, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran, Jatinangor. Water quality testing was carried out at the Laboratory of Aquatic Resources, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran.

2.2 Material

The equipment used was a fiber container as a fish-raising container and a reservoir. Fiber containers were used as many as 5 units with a size of 70 cm x 70 cm x 70 cm. There were 4 units of fiber tanks used for fish maintenance containers and 1 unit for reservoir containers. The PVC pipe sized 4 inch as a conduit and shelf brackets as a rack for laying a 4 inch PVC Pipe. The pump (Submersible Pump Sakkai Pro AA-105) was used to draw water from maintenance and reservoir containers. A 500 mL plastic sample bottle was useful as a water sample medium to be tested. Mercury thermometer with (accuracy 0.1) was useful to measure the temperature of water in fiber maintenance. The pH meter (Lutron brand) with an accuracy of 0.1 was useful for measuring the acidity of water in aquaculture media. The filter paper was useful as a filter for water samples. Measuring Cylinder merk Iwaki Pyrex 25 ml was useful as a container for measuring water samples. The spectrophotometer was used as a tool to measure the value of the concentration of ammonia. Siamese catfish fry is 1 inch in size with an average weight of 0.307 grams from the Cijengkol-Subang Northern Sea and Fisheries Service Office. The feed used was PF 1000 commercial feed with a size of 1.3 – 1.7 mm with the following nutritional content specifications crude protein: min. 39-41%, crude fat: min. 5%, crude fiber: max. 6%, ash: max. 16% and moisture: max. 10%.

2.3 Procedures

The stocking density that was experimented was 375 fry/fiber (treatment A); 450 fry/fiber (treatment B); 525 fry/fiber (treatment C); and 600 fry/fiber (treatment D). Preparations for the recirculation installation were done by making metal racks, installing 4-inch PVC, installing sock drat pipes, and installing pumps. Preparation and placement of maintenance containers were done randomly.

The acclimatization of fish was done in order to adapt to the new environment. Maintenance was done for seven days. Feeding was done at 09.00 WIB and 15.00 WIB. Water quality parameters measured consist of physical (temperature) and chemical parameters (pH and ammonia). Water samples for water quality testing were derived from water in each maintenance fiber. Everyday observations were made for the survival of fish by means of the number of dead fish recorded. During maintenance no water exchanges change of water or siphoning.

Survival Rate (SR) is the percentage of the number of fish that are still alive. Observation of fish survival can be calculated using the formula is [4]:

$$SR = \frac{Initialnumberoffishstocked - Numberoffishdied}{Initialnumberoffishstocked} X\ 100$$

2.4 Data Analysis

The analytical method used in this research was descriptive and the results of the survival rate fish and water quality parameters were compared to the Indonesian National Standard (SNI).

3. RESULTS AND DISCUSSION

3.1 Rate of Survival of Fish

The results showed that the highest survival rate of Siamese catfish fry was obtained in treatment D (600 fry/fiber) with 100%, and for the other treatments as follows treatment A was 93.87%, treatment B was 91.78%, and treatment C was 95.24%. The survival rate of Siamese catfish fry in each treatment is presented in Table 1.

The Survival Rate of Siamese catfish fry had a good survival rate because it had an SR value above 80%. The best survival rate of Siamese catfish fry for the cultivation ranges from 80-95% [8]. The stocking density of treatment B (450 fry/fiber) had the lowest survival rate. This could occur because fish that were kept at too low density tend to be less aggressive because there was no competition in gaining space and looking for food. The fry responses in maintenance fibers had different responses to the feed given. Not all fry in a container could use feed well and were less aggressive if fed while in low stocking conditions [9]. Feeding to support fish growth and survival was an external factor [10]. These factors would balance the state of the fish's body during maintenance media. The availability of feed had a big influence on the growth and survival of fish [11].

Table 1. Survival rate of Siamese catfish fry in recirculation system

Treatment	Survival rate (%)
A (375 fry/fiber)	91.78
B (450 fry/fiber)	93.87
C (525 fry/fiber)	95.24
D (600 fry/fiber)	100

The survival rate is one of the main parameters that shows success in maintaining fish. The survival rate of Siamese catfish fry with stocking density D (600 fry/fiber) was very good compared to other treatments. The survival rate of the 600 fry/fiber (4 fry/L) stocking density was still higher compared to previous studies by Amanda [12] who reported that the maintenance of Siamese catfish fry in a recirculation system with a stocking density of 1 fry/L resulted in a 90% survival rate. This could occur due to good and proper environmental conditions that affected the survival of fish during fish growth. Fish survival was influenced by environmental conditions, such as temperature, dissolved oxygen, pH, ammonia, parasites, and fish diseases [13]. In cultivation, mortality is a determinant of the success of the business.

The survival of catfish fry with high stocking densities (600 fry/fiber) showed that the optimal requisite for individual seedlings were met. Competition in the wiggle room, dissolved oxygen, and feed affected fish growth. Competition among catfish fry in conquering feed and space was higher in high fry stocking densities. Fish that were maintained in a high density would be more active to conquer feed and oxygen. Optimal space requirements for individual fish could support fish competition in utilizing feed and oxygen properly. High stocking densities of fish had competitiveness in utilizing food and space so that they would influence the growth rate of these fish [14].

3.2 Water Parameters

Based on observations during the study showed the temperature values in the four treatments were still in normal conditions with values that could still be tolerated by fish. According to SNI 01-6483.5-2002 [8], the optimum temperature range for Siamese catfish culture is25-30°C. The results of temperature measurements on stocking densities of 600 fry/fiber (4 fry/L) were still lower when compared with previous studies by Asis et al. [15] who reported that the maintenance of Siamese catfish fry in a recirculation system with a stocking density of 4 fry/L resulted in temperatures ranging from 28.7-31.1°C.High temperatures could cause a faster metabolic rate so fish growth was also expected to be higher. Optimal energy for fish growth came from effective digestion and metabolism through high feed consumption. At high temperatures, the process of digestion of food in fish took place quickly so that the metabolic rate also took place quickly [16]. Temperature values on day 0 and day 7 are presented in Fig. 1.

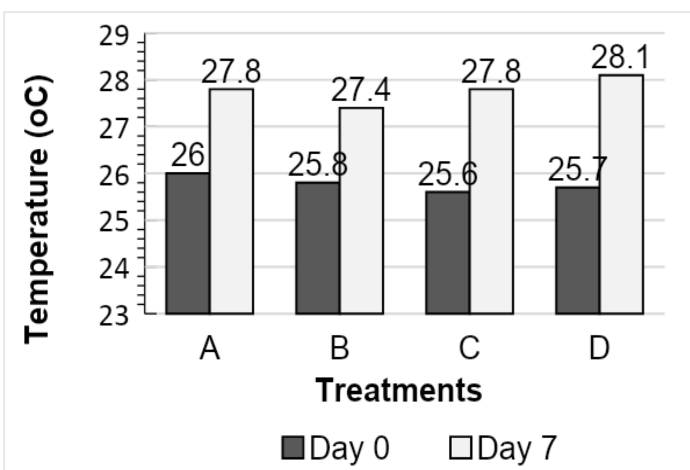

Fig. 1. Water temperatures during the study

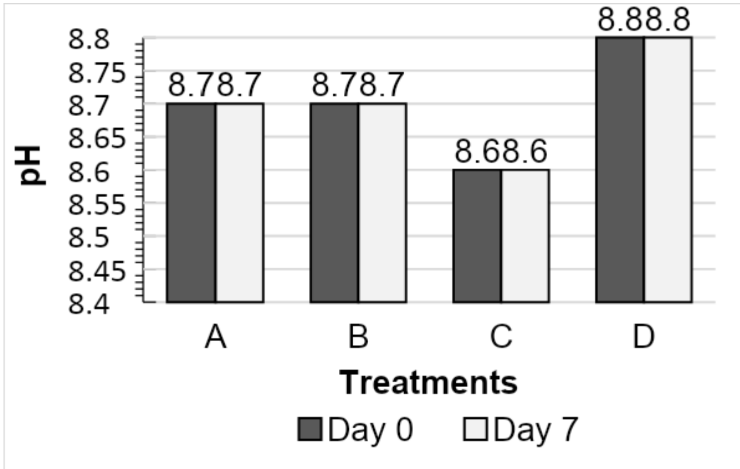

Fig. 2. pH value during the study

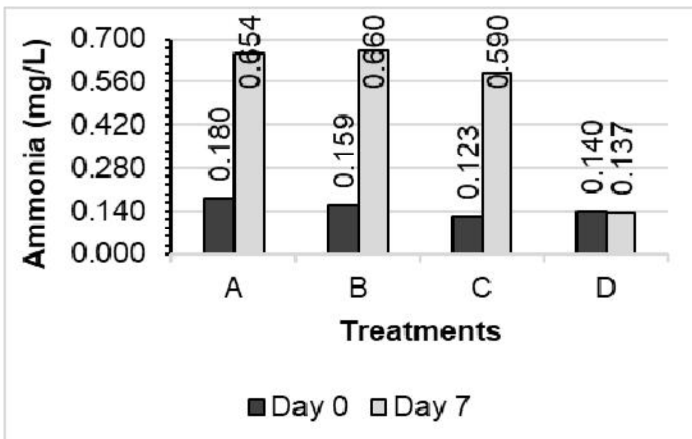

Fig. 3. Ammonia (NH_3) in water during the study

The results of the measurement of the acidity (pH) in each treatment showed that the pH value still did not meet the appropriate range for the maintenance of Siamese catfish fry which ranged from 6.5 to 8.5 (SNI 01-6483.4-2000) [17]. The high pH value at each treatment indicated the photosynthesis process of microalgae that produced O_2 so that the pH value of water in the maintenance container increased. The pH value could affect the metabolic rate and growth of fish during maintenance. The pH value could affect the toxicity of a chemical compound. High pH values in water caused ammonia which was not ionized and was toxic [18]. The pH values at day 0 and day 7 are presented in Fig. 2.

The pH value in water can affect the concentration of ammonia in the water. Changes in the pH value of water during the study in each treatment were stable until the seventh day. This showed that the release and uptake of carbon dioxide (CO_2) was still balanced by the organisms that existed in the maintenance media. Increasing pH value in water caused ammonia value to increase. The results of the pH value on the stocking densities were still higher when compared with previous studies by Dhewantara [19] who reported that the maintenance of catfish fry in a recirculation system with 20 fry/L stocking densities resulted in a pH range 7.44 - 8.11. The high pH value during the study showed the condition of the concentration of CO_2 in the water was low. Respiration process produced CO_2 gas which would then be hydrolyzed into hydrogen element where the element was an element of acid and bicarbonate (an alkali element), which caused pH to increase [20].

Ammonia concentration values (Fig. 3) in treatments A, B, and C increased on the seventh day with ammonia concentrations that exceeded the tolerance limits for the growth of Siamese catfish seeds. According to Effendie Research [4], the concentration of ammonia for the cultivation of Siamese catfish seeds is <0.1 mg/L. Treatment A, B, and C increased on the 7th day, whereas in treatment D decreased. The results of the ammonia value of 600 fry/fiber stocking (4 fry/L) stocking were still lower when compared with previous studies by Amanda [12] who reported that the maintenance of Siamese catfish fry in a recirculation system with a stocking density of 1 fry/L resulted in average value ammonia was 0.7380 mg/L.

The stocking density of treatment D (600 fry/fiber) had ammonia value at the beginning of maintenance was 0.140 mg/L and the end of maintenance decreased to 0.137 mg/L. Ammonia concentration in water could be influenced by the pH and temperature of the waters. The high value of ammonia on the seventh day was followed by the high pH value in water. Most forms of ammonia would form into NH_3 (unionized ammonia/ammonia) if the water conditions were in a maintenance container with a high pH. Ammonia in aquaculture ponds generally came from fish excretion (urine and feces) and the decomposition of organic matter. High temperatures and pH caused ammonia levels of NH_3 to increase in aquaculture ponds. High ammonia concentrations could be caused by water coming from fish maintenance containers that had been accumulated by metabolic waste and not from clean water [21].

4. CONCLUSION

From the results of this study, it can be concluded that the stocking density of Siamese catfish fry 375 fry/L- 600 fry/L produced different survival rates. The optimal stocking density for Siamese catfish fry production is 600 fry/fiber (4 fry/L) with a survival rate value 100%. The increase in stocking density of 600 fry/fiber (4 fry/L) resulted in a decrease in ammonia concentration at the beginning of 0.140 mg/L and the end of maintenance decreased to 0.137 mg/L. The use of the recirculation system in this study can still maintain water quality such as the temperature and pH value that still supports the survival rate of Siamese catfish fry with applicable standards.

CONSENT

As per international standard informed and written participant consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/59108