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The Affection of Fine Bubbles (FBs) Application on Growth Siamese Catfish (*Pangasianodon hypophthalmus*) in Aquaponic System

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Authors' contributions

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

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ABSTRACT

This research aims was to determine the effective pressure on fine bubbles technology on the growth of Siamese catfish fry in the aquaponic system. This study uses a completely randomized design with four treatments and three replications. Treatment A (Control), Treatment B (FBs at a pressure of 4,5 atm), Treatment C (FBs at a pressure of 5 atm and treatment D (FBs at a pressure of 5,5 atm). The parameters observed were Specific Growth Rate, Survival Rate and water quality (Temperature, pH, DO, Ammonia) Data were analyzed using variance with the F test at a 95% confidence level. The best treatment for catfish growth was treatment D (5,5 atm pressure), which gave the highest SGR value of 7,24% and the highest SR value of 100%. The value of water quality parameters were in good condition for the growth and survival of catfish.

Keywords: Catfish; fine bubble; pressure; growth; survival.

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1. INTRODUCTION

Siamese catfish (*Pangasianodon hyphopthalmus*) is an economical special of freshwater fish that began to be cultivated by fish farmers for aquaculture. After the implementation of the catfish import protection policy in 2014, the Indonesian catfish industry showed significant development. In 2016 the national catfish production was 437,111 tons, a significant increase than the previous year which was 339,069 tons. In 2018, the Ministry of Maritime Affairs and Fisheries is targeting catfish production of 604,587 tons [1].

Problems often faced in aquaculture were limited land and water availability [2]. Another problem in aquaculture is residual waste such as ammonia which can pollute the waters. Although fish eat most of the feed given, the largest percentage is excreted into metabolic waste (nitrogen) [3]. Wasted food and fish feces were sources of water pollutants in the aquaculture area. One way to solve these problems the use of aquaponics technology [4].

Aquaponics technology can reduce nitrogenous wastes from fish metabolic waste through the integration of hydroponic vegetable production systems into aquaculture systems [5]. Aquaponics technology is a combination of cultivating plants and fish in one container. Almost all types of aquatic plants and some land plants can be used in the aquaponic system including water spinach (*Ipomoea aquatica* Forsk), ground water spinach (*Ipomoea reptans* Poir), and lettuce (*Lactuca sativa*). This plant as an alternative bio-filter can absorb nitrogen in the form of ammonium (NH_4^+) and nitrate (NO_3^-) so that nitrogen in the water will be reduced. The more large and large plants used in aquaponic cultivation, the more effective in reducing ammonia [4].

Oxygen demand in aquaponic aquaculture systems cannot be fulfilled only by natural diffusion. Therefore an artificial aeration system is absolutely necessary. Some research results state that the addition of aeration in the maintenance media environment is expected to increase the fish productivity of aquaponic system, one way to increase dissolved oxygen is to use the application of fine bubbles in aquaponic system aquaculture ponds [6].

Fine bubbles technology is a technology that ensures the availability of oxygen is very high and in a longer time. This technology is able to support fish production due to increased metabolic activity, making it more effective in utilizing feed for fish growth. Regulating FBs.

Usually uses pressure to get the bubble size and dissolved oxygen concentration values that were optimal for cultivation. FBs will control the rate of air flow into the generator mixing chamber so that the distribution of the size and number of bubbles will be controlled [7].

The purpose of this study is to determine the effective pressure on fine bubbles technology on the growth of Siamese catfish in aquaponic systems.

2. MATERIALS AND METHODS

2.1 Research Site

The study was conducted from September 18 to October 16, 2019 at the Ciparanje Green House, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jatinangor. Water quality testing was carried out at the Laboratory of Aquatic Resources, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

2.2 Sample Collection

The catfish fry retained for this experiment measure 2.95-3cm. They were obtained from catfish brood stock of Cijengkol-Subang BPBAT. A total of 5400 fish were used in this study, with a density of 450 fish / container. The vegetables used were 10-day-old water spinach after seeding. Husk charcoal is used as a planting medium for plants during the nursery and cultivation period. Catfish fry were fed using commercial feed (pellets).

2.3 Research Tools

Container measuring 70 cm x 70 cm x 70 cm as many as 12 tubs. Fine bubbles generator of 3 units with mixing pumps with a capacity of 150 watts. The pump is used to draw water from the container where the plant is being raised. Twelve pumps were used with a voltage of 220-240 volts, a frequency of 50/60 Hz, 70 watts of power, a total head of 3.2 m and an output of 3000 L / H. Seventy six plastic cups in each treatment that serves as a place to put plants. digital scales with an accuracy of 0.1 grams to measure the weight of fish Iron shelves measuring 3 mx 1 mx 2 m for laying PVC pipes.

The method used in this study namely the method: Experimental with a completely Randomized Design (CDR) consisting of 4 treatments and 3 replications. The research treatments given include:

Treatment A: control (without FBs)
Treatment B: FBs with a pressure of 4,5 atm
Treatment C: FBs with a pressure of 5 atm
Treatment D: with a pressure of 5,5 atm

2.4 Aquaponics System Installation

Preparations for aquaponics installation were carried out by making metal racks. Preparation of maintenance containers in the form of a square with a size of 70 x 70 x 70 cm totaling 16 units. 4 inch PVC pipe with a length of 4 m is used as a bio filter container. Before the 4-inch PVC is installed, a hole is made in 4-inch PVC using a drill to form 19 holes with a diameter of 6 cm, with a distance of 15 cm from the mouth of the pipe and 20 cm for each hole.

2.5 Fish Acclimatization

Acclimatization of fish is carried out so that Siamese catfish can adapt when the research process takes place. Besides acclimation aims to know health condition of fish fry. Newly purchased Siamese catfish were kept in an acclimatization container (like fiber) for 1 week so that the fish will not be stressed and reduce mortality. Feeding is done periodically a day (morning at 09.00 WIB and afternoon at 15.00 WIB) so that Siamese catfish still get food intake during the adaptation process.

2.6 Plant Seeding

The seeding process is carried out by planting seeds in the husk charcoal for 10 days. After the roots have grown, the plants were sorted into plastic cups and put in pipes hole.

2.7 Research Implementation

Maintenance is carried out for 28 days. Fish were fed twice a day using PF 1000 commercial feed. Feeding is carried out in the morning at 09.00 and in the afternoon at 15.00 WIB. Feeding is done by means of satiation with biomass of 5% of the total weight of the fish and adjusted to the weight of the fish each sampling. Observation of fish growth is done by measuring the weight and length of fish at the beginning of the study and measuring the parameters of growth and water quality is done every 7 days, with a sampling method. Meanwhile survival observation is done by observing fish that die every day. The number of fish taken as many as 10 fish at random or 5% of the total fish population. The fish were weighed and then measured in length.

2.8 Observation Parameters

Fish growth: Measurement of fish growth is done by measuring the weight and the total length of sample. Observation of fish growth rate (SGR) is calculated using the following method [8]:

Specific Growth Rate SGR =

$$\frac{(lnWt - lnWo)}{t} \times 100\%$$

Note: SGR = Specific Growth Rate (%),
Wo = initial weight of fish (g),
Wt = final weight of fish (g),
t = duration of cultivation (days).

Observation of fish survival (SR) can be calculated using the formula [9].

$$SR = \frac{Nt}{No} \times 100$$

Note: SR = survival rate (%),
Nt = amount of fish harvest (fish)
No = initial amount of fish stocking (fish)

Water quality: Observation of water quality in this study include measurement of concentration, ammonia, temperature, dissolved oxygen and pH. Measurement of water quality is important in this study, because good water quality can affect catfish growth.

2.9 Data Analysis

Research data on growth and survival of catfish seeds were analyzed using variance with F test at 95% confidence level. If there were significant differences between treatments, then the test is continued with Duncan's multiple range test with a confidence level of 95%.

3. RESULTS

The results of observations on the increase in weight of catfish fry in each treatment during 28 days of research showed that aquaponic and fine bubbles aquaculture systems with different pressures had different effects on the growth of catfish fry. The highest growth rate was at treatment D (5.5 atm pressure) 7.24 ± 0.5% (Fig. 1) and the survival rate did not differ significantly between treatments (P> 0.05) (Table 1).

Optimal water quality is one of the important requirements in aquaculture, especially in the cultivation of catfish fry. Water quality in aquaculture containers must be controlled so that it can produce optimal growth of catfish fry. Water quality parameters measured in this study include concentration, ammonia, temperature, dissolved oxygen and pH (Table 2).

Table 1. Survival growth rate and survival of siamese catfish fry

Treatment	Parameter	
	SGR (%)	SR (%)
A (Control)	3,75±0,03[a]	76,67 ±5,13[a]
B (FBs 4,5 atm)	6,06±0,9[bc]	100 ±0[b]
C (FBs 5 atm)	5,31 ±0,09[b]	98,2±1,53[b]
D (FBs 5,5 atm)	7,24±0,5[c]	100 ±0[b]

Note: Values followed by the same letter in the same column show no significant difference at the 5% test level

4. DISCUSSION

The growth rate of fish fry treatment a (control) was lower compared to other treatments (b, c and d), this was due to the role of fbs in treatments b, c and d. The administration of fbs could have an influence on the maintenance container among other things, fish is increasing the concentration of dissolved oxygen in maintenance containers so that it can accelerate blood flow and increase fish growth [10]. High dissolved oxygen can increase fish growth [11]. The statement is also supported by previous research which states that fbs can increase

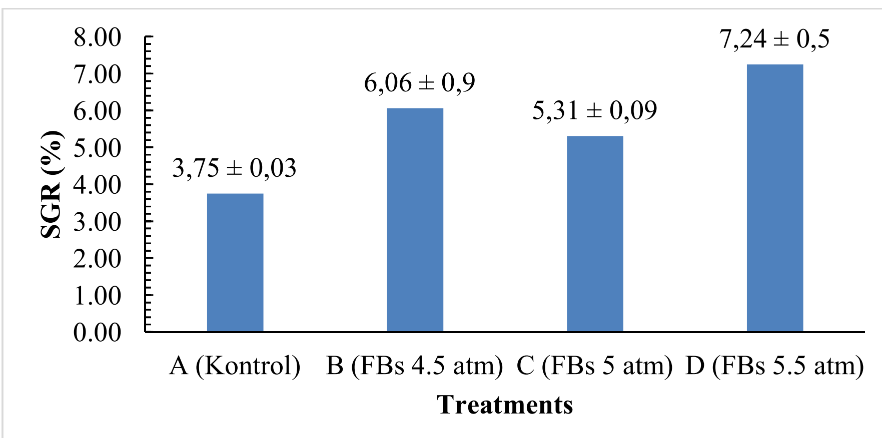

Fig. 1. Specific growth rate of siamese catfish fry

Table 2. Water quality parameters

Treatments	Water Quality Parameters							
	Dissolved Oxygen (mg/L)		Ammonia (mg/L)		Temperature°C		pH	
	Fish container	Water spinach	Fish container	Water spinach	Fish container	Water spinach	Fish container	Water spinach
A (Control)	7,5	7,5	0,025	0,0076	24	25	7,8	7,6
B (FBs 4,5 atm)	7,6	7,5	0,012	0,012	25	25	7,5	7,7
C (FBs 5 atm)	7,7	7,5	0,009	0,009	25	25	7,5	7,6
D (FBs 5,5 atm)	7,8	7,6	0,0056	0,009	25	25	7,4	7,7

the concentration of dissolved oxygen gas in water so that it has positive effects such as faster fish growth and water quality that is maintained even in closed ponds [12].

SGR values produced by treatments B, C and D were better than control treatments (A), whereas between treatments B, C and D, treatment C resulted in lower SGR values, this was because the treatment C was attacked by white spots which can affect the SGR of catfish fry. That is because the vitality of the catfish seeds is reduced because the energy obtained by the catfish seeds is used to defend the body against the white spot. increased ammonia content of metabolism can cause disorders that were physiological and trigger stress and cause disease [13].

SGR value of catfish fry ranged from 3.75-7.24%. The SGR is better than previous studies with the same density of 3 tails / L resulting in an SGR of 2.80% [14]. In this study there were additional components in the aquaponic installation, FBs. The addition of FBs will increase oxygen concentration so that it can maintain water quality that will support optimal growth. The ability of FBs in increasing dissolved oxygen concentration because FBs can produce nano-sized bubbles of oxygen (<100 nm) and have a longer residence time in water. Fine bubbles can provide higher oxygen solubility, which is an average of 7.8 mg / L. Improved water quality will affect the appetite of fish, when the water quality gets better, the appetite of fish will increase, the intake of food into the body of the fish also increases so that it has a good impact on fish growth [15].

Meanwhile, the survival rate of catfish fry in treatments b, c and d by using fbs showed higher results compared to treatment a (control). Fbs were able to maintain water quality by providing enough dissolved oxygen for fish. Dissolved oxygen is one of the limiting factors in water. Fish activities will be disrupted if the availability of dissolved oxygen is not sufficient to meet the needs of fish in aquaculture. Low levels of dissolved oxygen will inhibit the process of decomposition, reproduction and growth of fish will be hampered. Lack of dissolved oxygen will cause fish to lack appetite and the development of bacteria which will cause death in fish [16]. Fbs have a positive effect on fish survival which is able to form good environmental conditions which is able to increase oxygen concentration, reduce ammonia concentration so as to reduce stress levels in fish [17].

Fig. 2. Growth of catfish fry

Fig. 3. White spot on treatment c

Good survival rate for catfish fry according to SNI: 01-6483.4 (2000), ranges from 80-95%. Based on the survival rate category it can be said that the survival rate of catfish fry maintained during the study by FBs treatment is classified as a good survival rate. The survival rate in this study ranged from 76.67-100%, the results were better than the Ghofur et al. (2018) which results in a survival rate of catfish ranging from 43.64 to 84.68%.

Water quality in this study both dissolved oxygen, pH, temperature and ammonia were at optimal conditions for growth of catfish fry. Treatment D provides better water quality compared to other treatments. The value of dissolved oxygen concentration in treatment C is lower than the value of dissolved oxygen concentration in treatments B and D. This is because in treatment C, the fish population in the maintenance container is reduced because of the white spot, so the amount of oxygen concentration in the maintenance container is not utilized optimally. The concentration of dissolved oxygen in fish rearing containers ranges from 6.48 to 7.94 mg / L. This is better than previous aquaponics research, which states that dissolved oxygen in fish-rearing containers in aquaponic systems ranges from 3.4 to 5.8 mg / L [18]. This is due to the role of FBs as suppliers of dissolved oxygen in catfish rearing containers. The concentration of dissolved oxygen is still within the tolerance range for the growth of catfish fry. According to SNI: 01-6483.4 (2000) the concentration of dissolved oxygen for catfish culture activities> 3 mg / L. The statement was reinforced by Urbasa et al. (2015) which states that the minimum value of dissolved oxygen levels for fish culture is 3 ppm.

5. CONCLUSION

Based on the results of this study that the use of Fine Bubbles (FBs) with a pressure of 5.5 atm is effective in increasing growth and efficiency of catfish seed feed in the aquaponic system. The use of FBs with treatment D (5.5 atm pressure) gives the best results with the survival of catfish fry which is 100% and the Specific Growth Rate (SGR) of 7,24%. The best water quality found in treatment D (5.5 atm pressure) gives DO results ranging from 7.48 to 8.1 mg / L, pH ranges from 7.00 to 7.70, temperature ranges from 24-250C and ammonia around 0.002-0.014 mg / L.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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