Original Research Article

Growth of Juvenile Striped Catfish (*Pangasius hypophthalmus*) and Water Quality in Aquaponics System

Abstract

This study aims to determine the growth of striped catfish (*Pangasius hypophthalmus*) in aquaponic systems in different plants. The study was conducted at the Laboratory of Aquaculture, Ciparanje, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran from June to July 2017. The method used in this study was the experimental method using Completely Randomized Design (CRD) with 3 treatments and 4 times replication. Treatment A: Biofilter by treatment of water spinach plants, Treatment B: Biofilter by treatment of lettuce plants, Treatment C: Biofilter by treatment of scallions plants, and Treatment D: Control (unfiltered). The measured parameters in this study were fish growth and water quality which includes level of nitrate, ammonia and phosphate in the water. The results showed that the highest fish specific growth rate in treatment A 0.0395 ± 0.0039% with a survival rate of 93.125 ± 13.75% followed by treatments B and C, while the water quality parameters including nitrate, ammonia and phosphate concentrations ranged from 0.042 -1,806 mg / l; 0.003-0.084 mg / l; 0.036-2,342 mg / l.

Keywords: Aquaponics, Striped Catfish, Growth Rate, Survival Rate, Water Quality

Introduction

Striped catfish (*Pangasius hypophthalmus*) is a type of freshwater fish that has high economic value. Catfish has many advantages compared to other freshwater fish; its meat has a high calorie and protein content. Catfish is considered healthier because of low cholesterol levels compared to meat from livestock. Catfish contained 68.6% of protein, 5.8% of fat, 3.5% of ash, and 59.3% of water (Saparinto & Susiana, 2014).

The recent development of the aquaculture industry is still constrained by limited land and inadequate water quality. An effort is needed to optimize the available land and water. The success of a cultivation can be acquired when optimum environmental conditions is achieved. The high mortality of fish that is cultivated using aquaculture with intensive systems without water changes is an issue that needs attention. One way to overcome this problem is to utilize biofilters that can be used as an alternative to reduce pollution in aquaculture media. Biofilter in aquaponic systems is a cultivation technique that maintains water quality for a certain period without disturbing the growth of the fish which combined in the aquatic plant systems (Sagita et al. 2014).

Aquaponics is a combination of aquaculture and hydroponics that aims to cultivate fish and plants in one interconnected system. The interaction between fish and plants produces an ideal environment for fish and plant growth, so aquaponics system is considered to be more productive than conventional methods. Plants function as biofilter which will break down toxic substances into substances that are not harmful to fish, while also supplying oxygen to the water used for fish cultivation (Fathulloh, 2015). According to Rakocy et al. (1997) aquatic plants can effectively utilize nutrients. Several benefits of using aquatic plants are include efficient use of water and the reduction of water pollution which are produced from fish cultivation process. Plants that are often used in the aquaponic system includes water spinach, lettuce, and scallions. According Nugroho & Sutrisno (2008) water spinach is a fast growing plant, has lush roots and is not too strong and its cultivation requires continuous water. According to Rokhmah (2014), lettuce is a plant that is widely used in the aquaponic system, because it has a short life span and is relatively less problematic with pests compared to fruiting plants. Scallions are annual (short-lived) leafy vegetable plants with roots that can grow and develop well on loose, fertile and easy to absorb soil (Cahyono 2014). These three types of vegetable plants are very often used in aquaponic systems.

The purpose of this research is to determine the growth of striped catfish (*Pangasius hypophthalmus*) in the aquaponic system using different type of plants.

Material and Method

Research Site

The research was conducted from June to July 2017 at Ciparanje Green House, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran, Jatinangor, West Java, Indonesia.

Sample Collection

The juvenile catfish used in this experiment were 7-8 cm in size, which were obtained from the catfish brood stock originating from Cijengkol-Subang BPBAT.

There were 3200 fish used in this research, with a density of 200 fish/container. Vegetables used are water spinach, lettuce, and scallions aged 1 to 2 weeks from seeding. Husk charcoal were used as a growing medium for plants during seeding and cultivation period. The fries were fed using commercial feed (pellets).

Research Tools

Fiber tub measuring 70 cm x 70 cm x 70 cm as many as 12 tubs. Pump for drawing water from the cultivation container to the 4" PVC pipe. 12 pumps with the size of 90 watts (4 meters) and 25 watts (2 meters) were used. 12 heaters were installed to stabilize the temperature of the water. 4" and ½" PVC pipe to drain water or collect water for the plants. 4 mechanical filters for filtering water in the fiber control tub. 76 plastic cups in each treatment that serves as a place to put plants. Kenko digital scales with the accuracy of 0.1 gram to measure fish weights. Iron rack measuring 3m x 1m x 2m for laying PVC pipes.

Materials and Methods

The method used in this research was an experimental method by using Randomized Block Design (CRD) with 4 treatments, repeated 3 times :

A: Biofilter by treatment of water spinach plants

B: Biofilter by treatment of lettuce plants

C: Biofilter by treatment of scallions plants

D: Control (unfiltered)

Aquaponics System Installation

The containers used in this research were 12 fiber tubs with a dimension of 70 cm x 70 cm x 70 cm, which were filled with water 75% of the body volume, amounting to 257 L and 1 iron rack. A 4-inch PVC pipe with a length of 4 m was used as bio filter container. The 4-inch PVC pipe was perforated using a drill to form 19 holes with diameter of 6cm, with a distance of 15 cm from the mouth of the pipe and 20 cm for each hole. A small tub was put under the drain pipe to act as a water reservoir. The water in the reservoir was channeled back through the ½ -inch PVC pipe using a water pump, so that the water could go back up to the cultivation containers. The next process was activating the aquaponics system which had been assembled for one week, so that the water quality was stable.

Fish Acclimatization

Fish acclimatization were carried out for one week, because the fish came from an area that has different environmental conditions, so that the fish can adapt to the new environment, and adjust themselves during the research process.

Plant Seeding

The seeding process is carried out by planting the seeds in the charcoal husk for one to two weeks. After the roots have grown, the plants were sorted into plastic cups and inserted into the pipe holes.

Research Implementation

The study was conducted for 30 days. Feeding, management and measurement of water quality parameters (nitrate, ammonia, and phosphate) were done once every seven days, in the morning. The fish in this study was fed with commercial feed (pellets). The size of the pellet was adjusted so it fits with the opening of the fish mouth. the amount of feed given is 3% of fish biomass with a frequency of 2 times a day, in 10:00 and 15:00 WIB.

Observation Parameters

Fish Growth

Fish growth measurement is done by weighing the sample weight, then measuring the total length of the fish. Specific growth rates are calculated using the following formula (Ogunji et al. 2008):

Specific Growth Rate

$$\boldsymbol{SGR = \frac{(\ln Wt - \ln Wo)}{t}\ x\ 100\%}$$

Note : SGR = Specific Growth Rate (%), Wo = Initial weight of fish (g), Wt = Final weight of fish (g), t = Duration of cultivation (days).

The survival rate of catfish seedlings was calculated using the formula below (Effendie, 1997):

$$SR = \frac{Nt}{No} \, x \, 100$$

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

Water Quality

Water quality observations in this study were include measurements of levels of nitrate, ammonia and phosphate in the water. Measurement of water quality is an important part of research, because good water quality can affect the growth and survival of fish fries.

Data Analysis

Data analysis of growth and survival of catfish seedlings was carried out by analyzing variance (F test) with a confidence level of 95%. If the results of the analysis of variance showed significantly different results, then a further test was conducted with the Duncan test with a confidence level of 95%.

Results

Observation results of catfish seedlings cultivated in the aquaponics systems using different plants showed that the specific growth rate was not significantly different between treatments ($P > 0.05$), but the highest growth rate was in treatment A (water spinach) of 0.0395 ± 0,0039% (Fig.1) and survival rate were not significantly different between treatments ($P > 0.05$) (Table 1).

Optimal water quality is one of the important requirements in aquaculture, especially in cultivation of catfish juveniles. Water quality in the cultivation container must be controlled so that it can produce optimal growth of catfish seedlings. Water quality parameters measured in this study were nitrate, ammonia, and phosphate levels in the water (Table 2).

Table 1. Growth rate and survival rate of Striped catfish seedlings

Treatment	Parameter	
	SGR (%)	SR (%)
A (Water Spinach)	$0,0395 \pm 0,0039^{a}$	$93,125 \pm 13,75^{a}$
B (Lettuce)	$0,0388 \pm 0,0006^{a}$	100 ± 0^{a}
C (Scallions)	$0,0375 \pm 0,0014^{a}$	$95.000 \pm 9,35^{a}$
Control	$0,0365 \pm 0,0013^{a}$	$90,333 \pm 15,89^{a}$

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

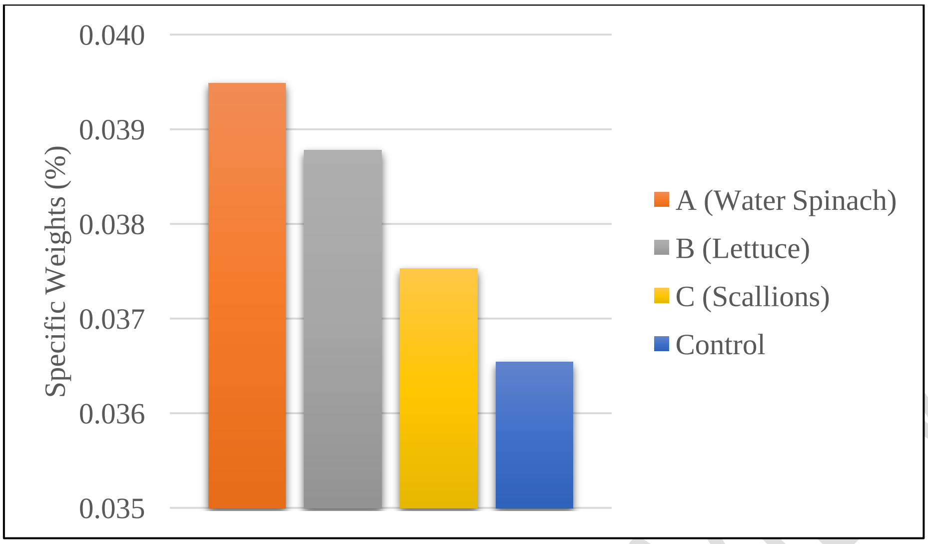

Fig 1. Graphic of Specific Growth Rate of Striped Catfish Seedlings.

Table 2. Water Quality Parameters during Research

Treatments	Water Quality Parameters					
	Ammonia (mg/L)		Nitrate (mg/L)		Phosphate (mg/L)	
	Container	Inlet	Container	Inlet	Container	Inlet
Water Spinach	0,012 – 0,069	0,013 – 0,084	0,835 – 1,609	0,825 – 1,806	0,360 – 2,342	0,392 – 2,390
Lettuce	0,013 – 0,028	0,016 – 0,033	0,748 – 3,577	0,937 – 2,382	0,367 – 1,382	0,390 – 1,197
Scallions	0,008 – 0,045	0,007 – 0,042	0,045 – 2,059	0,042 – 2,814	0,138 – 0,850	0,147 – 0,836
Control	0,003 – 0,048	–	0,905 – 2,232	–	0,036 – 1,628	–

Discussions

The weight of striped catfish fries during the study increased every week. In treatment A (water spinach) weight gain of catfish occurs due to optimal environmental conditions. Water spinach plants can filter out dirt particles carried by the flow of water so that it can improve the water quality in the cultivation container, therefore the appetite of striped catfish increases, and the utilization of feed is more optimal. According Djuariah (2007), spinach plants have fibrous roots that extend and spread so that they can absorb nutrients optimally from aquaculture container systems. Besides, water spinach roots are highly absorbent towards nutrients.

According to Setijaningsih & Suryaningrum (2009), water spinach is more effective in utilizing nutrients derived from water that flows from raising fish. In treatment B (lettuce) and C (scallions), the weight gain of striped catfish was lower than treatment A (water spinach). The roots in lettuce and scallion plants were not as long and dense as water spinach, so the filtration process is not optimal as shown in Fig.2.

Fig 2. Plant Roots: A (Water Spinach), B (Lettuce) and C (Scallions)

Shimoda et al. (2006) stated that the higher the density of roots, the more particles can be caught or attached, thus increasing the absorption of N and P. The reduction process is also influenced by the root system and physiological aspects of aquatic plants.

The survival rate of Striped catfish seedlings in every treatment were good enough because the survival rate was above 90%. According to SNI (2002), good survival rate for Striped catfish cultivation ranges from 80-95%. The death of catfish seedlings in each treatment was thought to be caused by the decrease in water quality, especially because of temperature fluctuations. According to Noerkhaerin (2015), an increase or decrease in temperature will result in changes in metabolic rate and energy needs of fish.

The survival rate of fish in the control group is the lowest. Besides the fluctuations of temperature, fish mortality is also caused by the deposition of organic and inorganic materials that accumulate at the bottom of the cultivation container. Due to the accumulation of the organic and inorganic materials, the concentration of ammonia in the cultivation media will increase, thus the water quality decreases and gradually becomes toxic to fish.

Water Quality

Ammonia

Ammonia concentration measurement results during the study fluctuated, ranging from 0.003 to 0.084 mg / L. An increase in ammonia concentration is caused by optimum nitrification process. According to Affandi (1992) through the nitrification process, ammonia will be oxidized by bacteria to nitrite and nitrate. Freshwater fish have tolerance towards ammonia up to 1.0 mg / L (Molleda 2007). Increased levels of ammonia caused by increasing the level of feed needs as increasing fish growth, resulting in the excretion of patin fish seed increase. According to Effendi (2003), increased feeding needs by fish can lead to an increased metabolite increase and then the build up of feces.

Nitrates

Based on the results of nitrate measurements during the study, the nitrates values showed a range between 0.042-1,806 mg / L. This condition is still within the tolerance limits for Striped catfish to grow. Based on the statement of Rakocy et al. (1997), the concentration of safe nitrate values in fish culture is not to exceed 10-20 mg / L. Nitrates at concentrations around 90 mg / L will not harm fish, but will be dangerous when the nitrate decreases and turns into nitrite (Effendi 2003). According to Saptarini (2010), an increase in nitrate occurs due to recirculation system that works well. Optimum recirculation process will promote balanced growth and activity between Nitrosomonas and Nitrobacter, so that ammonia will be broken down into nitrites and then converted into nitrates by Nitrobacter. The content of nitrate and phosphate is relatively high because the plant is less optimal in the process of absorption of nutrients, while the process of nitrification in the installation of aquaponic goes well.

Phosphates

Phosphate is a phosphorus compound needed by plants and is an essential element for higher plants and algae, that can affect the level of aquatic productivity (Barus 2008). The results of phosphate measurements during the study were 0.036-2,342 mg / L. The increase in phosphate concentration is due to the fish having a high appetite so that more metabolite waste discharged, and dissolved oxygen levels decreased, thus phosphate concentrations in the water increases. This is in accordance with the opinion of Effendi (2003), which stated that an increase in fish appetite can cause metabolite discharges to increase, which causes buildup of feces, and resulted in decreased dissolved oxygen, thus phosphate concentrations will also increase. According to Effendi (2003), the presence of excessive phosphate accompanied by the presence of nitrates can trigger algae blooms in water, where the algae can consume large amounts of oxygen and thus have an impact on decreasing dissolved oxygen levels. It is evident that the concentration of dissolved oxygen continues to decline each week (Fig 3).

Conclusions

The results showed that the water spinach (treatment A) was the best biological filter to support the growth of striped catfish in aquaponics system. The highest specific fish growth rate in treatment A was 0.0395 ± 0.0039% with a survival rate of 93.125 ± 13.75% followed by treatments B and C, while the water quality parameters including nitrate, ammonia and phosphate concentrations ranged from 0.042 -1,806 mg / l; 0.003-0.084 mg / l; 0.036-2,342 mg /l.

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