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Growth of Sangkuriang Catfish (*Clarias gariepenus*) in The Recirculation System

Pertumbuhan Ikan Lele Sangkuriang (*Clarias Gariepenus)* Pada Sistem Resirkulasi

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ABSTRACT

Catfish is one of the commodities with promising prospects for development, both in hatchery and grow-out activities. One of the challenges in catfish farming is the high mortality rate of intensively raised fish without water exchange. In order to increase production, the implementation of good cultivation technologies is necessary to maximize the results. One such technology that can be used is the Recirculating Aquaculture System (RAS). This study aims to analyze the effects of RAS using lettuce plants as biofilters on the growth and survival of Clarias gariepinus catfish. The test animals used in this study were *Clarias gariepinus* catfish sourced from Beta Fish Lingsar Farm, with seed size ranging from 7-8 cm. The study was conducted with three treatments (plots): pond 1 = RAS with lettuce biofilter at a stocking density of 1000 individuals, pond 2 = RAS with a stocking density of 1000 individuals, and pond 3 = RAS with a stocking density of 500 individuals. The results of the study showed that the use of the RAS system had an impact on the growth and survival of the fish. The RAS system with lettuce biofilter was able to increase the Specific Growth Rate (SGR) by 6.02% and reduce fish mortality rate with a Survival Rate (SR) value of 62.8%. Based on these findings, the use of RAS with plant biofilters can be further developed on a larger scale in aquaculture.

ABSTRAK

Lele merupakan salah satu komoditas yang mempunyai prospek yang cukup besar dalam pengembangannya baik pada kegiatan pembenihan maupun pembesaran. Salah satu masalah dalam kegiatan budidaya ikan lele adalah tingginya mortalitas ikan yang dipelihara dengan sistem intensif tanpa pergantian air. Dalam upaya peningkatan produksi budidaya diperlukan induksi teknologi budaya yang baik, dengan tujuan untuk memaksimalkan hasil produksi. Salah satu teknologi budidaya ikan yang dapat digunakan yaitu sistem resirkulasi akuakultur (Recirculating Aquaculture System). Penelitian ini bertujuan untuk menganalisa pengaruh sistem resirkulasi menggunakan tanaman selada sebagai biofilter terhadap pertumbuhan dan kelulus hidupan ikan lele sangkuriang (*Clarias gariepinus*). Hewan uji yang digunakan dalam penelitian ini adalah ikan lele sangkuriang yang berasal dari Farm Beta Fish Lingsar dengan ukuran benih 7-8 cm. peneliatian ini dilakukan dengan 3 perlakuan (plot) yaitu kolam 1 = Sistem Sistem Ras dengan biofilter selada air padat tebar 1000 ekor, kolam 2 = Sistem ras dengan padat tebar 1000 ekor, dan kolam 3 = Sistem ras dengan padat tebar 500 ekor. Hasil penelitian menunjukkan bahwa penggunaan sistem resirkulasi memiliki pengaruh terhadap pertumbuhan dan kelus hidupan ikan. Sistem resirkulasi dengan biofilter selada mampu meningkatkan SGR sebesar 6,02 % dan menekan tingkat kematian ikan dengan nilai SR 62,8 %. Berdasarkan hasil penelitian ini penggunaan sistem resirkulasi dengan biofiler tanaman dapat dikembagkan kesekala budidaya yang lebih besar.

Kata Kunci	*Ikan lele sangkuriang, sistem resirkulasi, biofilter tanaman selada*
Keywords	*Sangkuriang catfish, recirculation system, lettuce biofilter*
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INTRODUCTION

Catfish is a commodity that has quite large prospects for development, both in hatching and rearing activities. This fish originates from the African continent and was first imported to Indonesia in 1984. Catfish is one of the fish that is most easily accepted by the public because of its various advantages, namely fast growth, good adaptability to the environment, good taste, high nutritional content, and price. more affordable. The nutritional composition of catfish includes protein content (17.7%), fat (4.8%), minerals (1.2%), and water (76%) (Muhammad & Andriyanto, 2013). Apart from that, more than 10% of national fish farming production comes from catfish farming, with a growth rate of 17-18% every year. With a target of 38% of total fisheries production, catfish cultivation has become one of the main motors in national fish cultivation (Sayuti et al., 2022). in 2019 catfish production in NTB was 5,842,483 tonnes (Ministry of Maritime Affairs and Fisheries, 2019) and decreased in 2021 to 2,704,952 tonnes (Ministry of Maritime Affairs and Fisheries, 2021)

One of the problems in catfish farming activities is the high mortality of fish. The cause of high fish mortality in intensive systems without water changes is poor water quality. In catfish farming, fish growth and survival are the main factors that determine success. Ammonia, when under anaerobic conditions, has toxic properties that can interfere with the survival and growth of fish, which will affect the amount of production.

In an effort to increase cultivation production, good cultural technology induction is needed, with the aim of maximizing production results. In fish cultivation technology, one option that can be used is a recirculating aquaculture system (RAS). RAS is a sustainable aquaculture technology that allows controlling waste discharged into the environment and maintaining water quality in cultivation ponds. (Fauzia & Suseno, 2020). In principle, the basic principle of the RAS mechanism is that the ammonium content is converted into nitrite and into nitrate which is low in toxicity so that the water can be reused (Hapsari et al., 2020)

The RAS system with an aquaponic biofilter is used to maintain water quality and convert ammonia into compounds that are not harmful to the survival and growth of cultivated plants. Nitrosomonas bacteria oxidize ammonia to nitrite, which is then oxidized to nitrate by Nitrobacter bacteria under aerobic conditions. The nitrates produced are the main source of nutrition for plants, such as lettuce. (Wicaksana et al., 2015). Apart from that, lettuce plants also have quite high economic value and are much sought after by the public (Zidni et al., 2019).

In research conducted by Wicaksana et al. (2015) showed that the aquaponic biofilter system was proven to provide better results in raising catfish compared to conventional systems. This can be seen from the SGR (Specific Growth Rate) values of 4.21 ± 0.06% weight/day, SR (Survival Rate) of 92.71 ± 1.88%, feed consumption level of 36.17 ± 1 .52 kg, FCR (Feed Conversion Ratio) of 1.15 ± 0.02, and feed utilization efficiency of 81.07 ± 3.30%. Apart from that, the effectiveness of using an aquaponic biofilter system can also be seen in its ability to absorb ammonia, nitrite and nitrate up to the 8th week. Toxin content such as ammonia produced from fish farming can be reduced by up to 90% from its initial level. This shows that the aquaponic biofilter system is effective in reducing toxic levels and maintaining water quality in catfish cultivation. For this reason, this research needs to be carried out to find out the effect of a recirculation system using lettuce plants as a biofilter on the growth and survival of Sangkuriang catfish. (*Clarias gariepinus*).

METHODS

Research Preparation

Construction Model

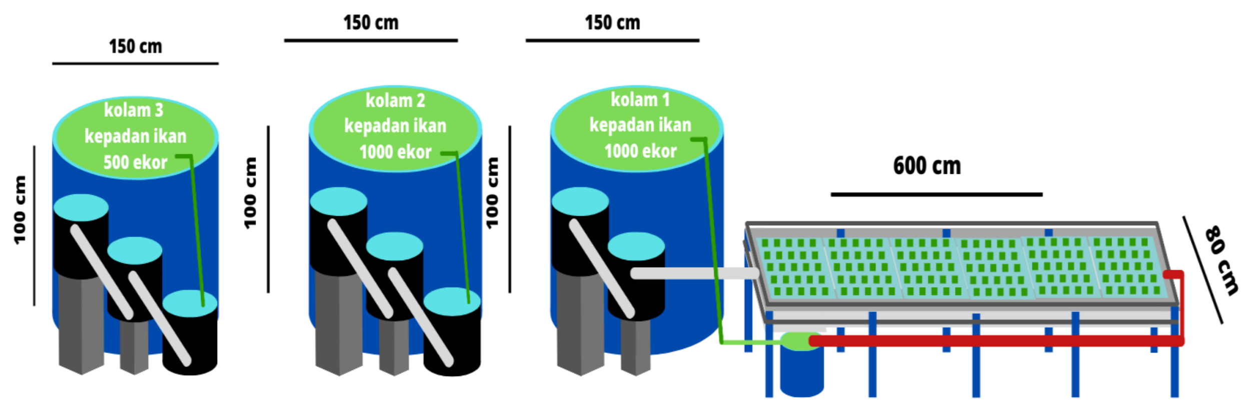

Figure 1. Cultivation Media Construction Model

The pool used is a round tarpaulin pool with a diameter of 1.5 m and a height of 1 meter with a volume of 1,766 liters. The pool walls use wire mesh with a thickness of 5 mm. The aquaponics rack is made using galvalum with a length of 6 m and a width of 0.8 m, the volume of water that can be held is 960 liters. The treatments in each pond were pond 1 = Race System with a watercress biofilter stocking density of 1000 heads, pond 2 = Race system with a stocking density of 1000 heads, and pond 3 = Race system with a stocking density of 500 heads. The filter materials used are sponge, pumice and ginger coral.

Pool Preparation and Filtration Installation

The tarpaulin pool is cleaned first using soap and a brush, then rinsed and dried for 24 hours. The dry tarpaulin pool is arranged according to the construction model that has been made. Then the filtration installation is installed. The filtration system uses a plastic tub with a volume of 80 liters, there are three parts, namely tub 1 is a physical filter in the form of an 8 layer sponge, tub 2 is a chemical and biological filter in the form of 4 pumice stones with a size of 30 cm2, tub 2 is a 4 layer ginger coral filter measuring 30 cm2 and tub 3 has a water pump.

Preparation of Cultivation Media

The water used is fresh water sourced from wells. The pool water was filled to a height of 80 cm in a pool with a diameter of 1.5 m so that the volume of water used was 1,413 L. The filled pool was added with starter bacteria in the form of Nitrogencycle containing 1 bottle cap of Nitrobacter sp and Nitrosomonas sp, the water was then left for 1 Sunday.

Plant Persians

The plant used as a biofilter is lettuce. Before being used as a biofilter, lettuce seeds are sown first in rokwooll media which has been cut to size 2 cm x 2 cm and placed in a tray. The minimum sowing time is 7 days or until there are at least 2 leaves and a height of 3-4 cm. Lettuce plants that are ready are separated into netpots and ready to be applied to the RAS system.

Preparation of test animals

The test animals used in this research were sangkuriang catfish which came from Farm Beta Fish Lingsar with seed size of 7-8 cm. The catfish which had been taken from the nursery pond were sorted according to size and counted in number, then put in plastic filled with water. Before, there were 4 bags of seeds, 2 bags containing 1000 seeds and 2 bags containing 500 seeds each. The test animals that have been counted are then given oxygen and tied up. Transportation of test animals was carried out by car with a travel time to the cultivation location of 2 hours. After arriving, acclimatization is then carried out.

Acclimatization

Acclimatization is carried out until the temperature in the seed bag is the same as the temperature in the pond water. The acclimatization process is carried out by placing a bag containing catfish seeds into the pond, leaving it for 15-20 minutes.

Test Animal Measurements

Fish Weight

This weight measurement is carried out to determine the initial biomass of fish at the time of stocking the fish. The sampling process was carried out by taking 10 catfish at random, putting them in a plastic container and weighing them. The scales used were scales with an accuracy of 1 g to 1 kg. Determining total fish biomass is done by calculating the average weight of 1 fish multiplied by the stocking number.

Fish Length

Fish length is measured by taking a test animal, then measuring it using a ruler on white paper. This aims to ensure that the length of the fish can be seen more clearly. The length measurement is carried out by measuring the total length of the fish, starting from the tip of the upper jaw to the base of the fish's tail. Furthermore, observations of body length and body weight of the fish were carried out every 7 days for 60 days of rearing.

Catfish maintenance

Catfish rearing is carried out for 60 days. Referring to research (Jubaedah et al., 2020), during maintenance catfish are given commercial feed with a protein content of 30%. The feed used in this research was commercial feed with the brands Hi-pro vit 781-1 and Hi-Pro vit 781-2. Feeding is carried out 3 times at 07.00, 13.00 and 19.00 WITA. The amount of feed given is done by calculating feed requirements based on body weight (ad libitum), namely on day of culture/DOC 1 to DOC 30 the feed given is 5% of the fish biomass and on DOC 31 to DOC 60 the feed given is 3% from fish biomass. Fish rearing for 60 days is expected to reach consumption size. According to (Muhammad & Andriyanto, 2013) the size of catfish consumed is 7-12, meaning that in 1 kg of fish there are 7 to 12 fish..

Research Parameters

Absolute Growth in Body Weight (WM)

The absolute growth in fish weight can be determined based on the fish biomass at the end of the study which is calculated using the formula according to Mubarok et al., (2020) as follows.

$$Wm = Wt - W0$$

Information :
Wm = Absolute growth of test biota (g)
Wt = Weight of test biota at the end of the study (g)
W0 = Weight of test biota at the start of the study (g)

Absolute Growth in Body Length

According to Mulqan et al., (2017), the absolute length is calculated using the formula:

$$Lm = Lt - Lo$$

Information:
Lm = Absolute length growth of test fish (cm)
Lt = Final length of test fish (cm)
Lo = Initial length of test fish (cm)

Specific Growth Rate (SGR)

Specific growth rate according to Mukhlis et al. (2017). can be calculated using the following formula:

$$SGR = ((Wt / W0)^{1/t} - 1) \times 100\%$$

Information :

SGR = Specific Growth Rate (% hari)
Wt = Average weight of test animals at the end of the study (g)
W0 = Average weight of test animals at the start of the study (g)
t = Length of observation period (hari)

Survival Rate (SR)

Survival rate (SR) can be interpreted as the number of living biota divided by the number of biota stocked during the research process. The survival rate (SR) value according to Muchlisin et al. (2016) can be expressed using the following formula.

$$SR = (N0-Nt)/N0 \times 100\%$$

Information :

SR = Survival rate (%)
Nt = Number of individuals at the end of the study (ekor)
N0 = Number of individuals at the end of the study (ekor)

Data Analysis

Data were analyzed descriptively using Mc. Excel is then presented in the form of pictures, tables and explanations of the data and supported by literature studies.

RESULT

Absolute Growth in Body Weight and Length

The results of observing the growth of catfish after rearing for 60 days in each pond with a different race system showed that absolute growth results in weight and body length were relatively different in each pond. Figure 4.1 shows that the recirculation system in pond 1 provided the highest absolute weight growth for catfish with a value of 55.07 g, while pond 2 was 43.47 g and pond 52.13 g. From the picture below, it can be seen that the absolute growth in body weight of fish in pond 3 is higher than in pond 2 but lower than in pond 1 with a difference of 2.94 g.

The absolute growth in body length of catfish as in Figure 4.1 shows that the recirculation system in pond 1 provides the highest growth in absolute length of catfish with a value of 15.5 cm, followed by pond 3 at 15.2 cm while in pond 2 it is 14.9 cm. From Figure 4.1, it can be seen that the absolute growth in body length of fish in pond 3 is higher than in pond 2 but lower than in pond 2.

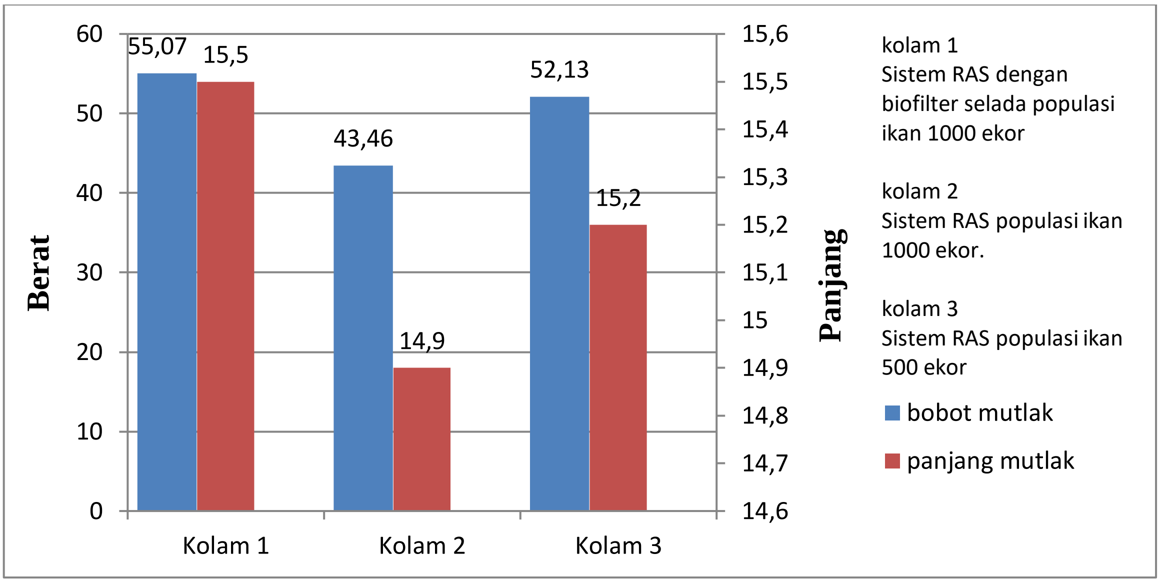

Figure 2. Absolute growth in weight and length of catfish (*Clarias gariepinus*)

Specific Growth Rate (SGR)

The results of observations of the growth of catfish (*Clarias gariepinus*) after maintenance for 60 days showed that there were differences in the specific growth rate of catfish in each pond with a different recirculation system. Figure 4.2 shows that the recirculation system in pond 1 provides the highest specific growth rate for catfish with a value of 6.021756%, followed by pond 3 at 5.927764% while in pond 2 it is 5.61836%. From Figure 4.2, it can be seen that the relative growth in body weight of fish in pond 3 is higher than in pond 2 but 0.1% lower than pond 1.

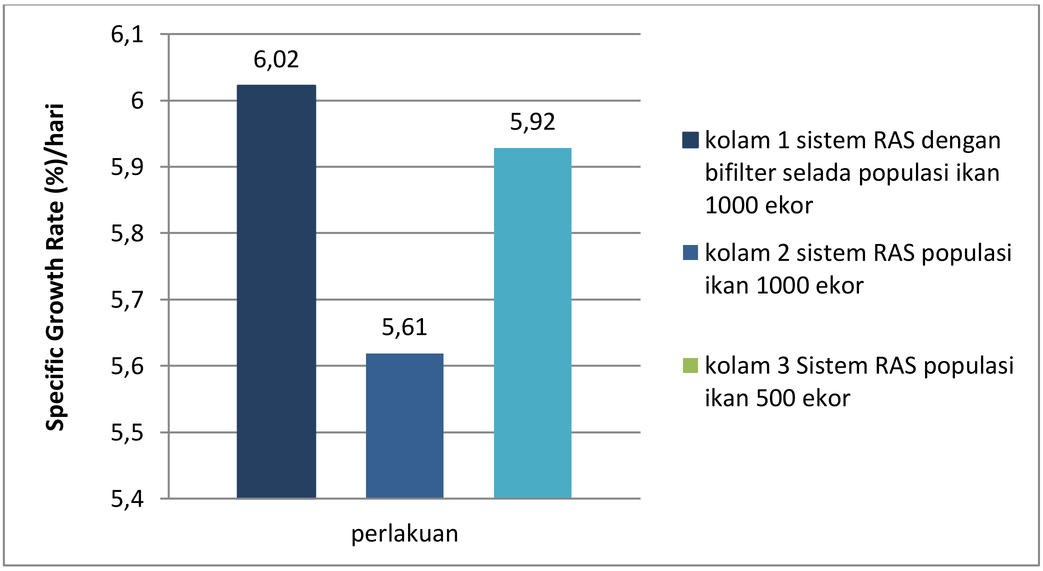

Figure 3. Catfish Specific Growth Rate (*Clarias gariepinus*)

Water Quality

The average results of water quality measurements including temperature, pH, DO and ammonia during 60 days of maintenance can be seen in table 1. From the results of water quality measurements during maintenance, it can be seen that the pH values obtained in each pond are different, it can be seen that there are pH fluctuations in the ponds. 1 and pool 3 are more stable than pool 2. The lowest pH obtained during the research in pool 1 was 6.7 and the highest was 7.8, pool 2 the lowest pH was 5.7 and the highest was 7.7. In pool 3 the lowest pH was 6.8 and the highest was 7.9. According to Kelana et al. (2021) optimal pH based on SNI 01-6484.5:2002 standards ranges from 6.5 – 8.5.

Table 4.1 shows that the average temperature change in each pool is not much different. The lowest temperature was obtained in pool 3 during the afternoon check with a temperature of 24 °C and the highest temperature was 27.6 °C, while in pool 2 in the afternoon it was 25.4 °C and the highest was in the afternoon with a temperature of 28.2 °C. In pool 1 it is not much different from pool 2 with the lowest temperature in the afternoon 25.2 °C and the highest 28 °C. Kelana et al. (2021) states that the optimal temperature based on the SNI 01-6484.5:2002 standard is between 25 – 30 °C. This shows that the temperature in each pool during maintenance is at an optimum condition.

Measurements of dissolved oxygen levels in ponds during 60 days of maintenance were found in ponds 1 and 2, the lowest DO values obtained were 3.0 pmm and the highest in ponds 1 and 2 were 6.8 ppm and 7.1 pmm respectively. DO fluctuations in ponds 1 and 2 were quite high, this was in line with the amount of stocking density used in each pond. In contrast to pool 3, the DO values obtained were relatively stable with the lowest value being 3.1 ppm and the highest being 5.9 ppm. According to Kelana et al. (2021) based on SNI standard 01-6484.5:2002 a good DO value is above 4 ppm.

Table 1. Temperature, pH and DO values

parameter	pool	Morning	Afternoon	Evening	range
pH	1	6,7 – 7,3	6,8 – 7,2	6,9 – 7,8	6,7 – 7,8
	2	6,8 – 7,2	5,7 – 6,8	6,9 – 7,7	5,7 – 7,7
	3	6,9 – 7,8	7,2 – 7,1	6,8- 7,9	6,8 – 7,9
Temperature	1	25,7 – 27,1	27.1 – 28,0	25,2 – 26,7	25,2 – 28
	2	26,2 – 27 6	28,0 – 28,2	25,4 – 26,1	25,4– 28,2
	3	25,1 – 27,0	26,7 – 27,6	24 – 25,5	24 – 27,6
DO	1	3.1 – 6.8	3.0 - 6,0	3,1 – 5,2	3 - 6
	2	3,0 – 7,1	3,0 – 5,3	3,1 – 5,2	3 – 7,1
	3	3,1 – 7,5	4,0 – 5,9	4,0 – 5,4	3,1 – 7,5

Amoniak

The ammonia content in each pond for 60 days by observing ammonia 5 times, it is known that there are differences in the ammonia content in each pond, as seen in Figure 5, it shows that the ammonia content continues to increase in line with the length of maintenance time. It can be seen that in the first 10 days the ammonia content of each pond was below 0.1 ppm and continued to increase until the 50th day. On the 20th day it was seen that there was a spike in ammonia levels in pond 1 and pond 2 with values of 0.491 ppm and 0.488 pmm while in pool 3 it is 0.024 pmm. The highest ammonia content during the study was in pool 2 and the lowest average in pools 1 and 3 can be seen in figure 4.4 above. According to Kelana et al. (2021) based on the SNI standard 01-6484.5:2002 a good ammonia level is less than 0.1 ppm

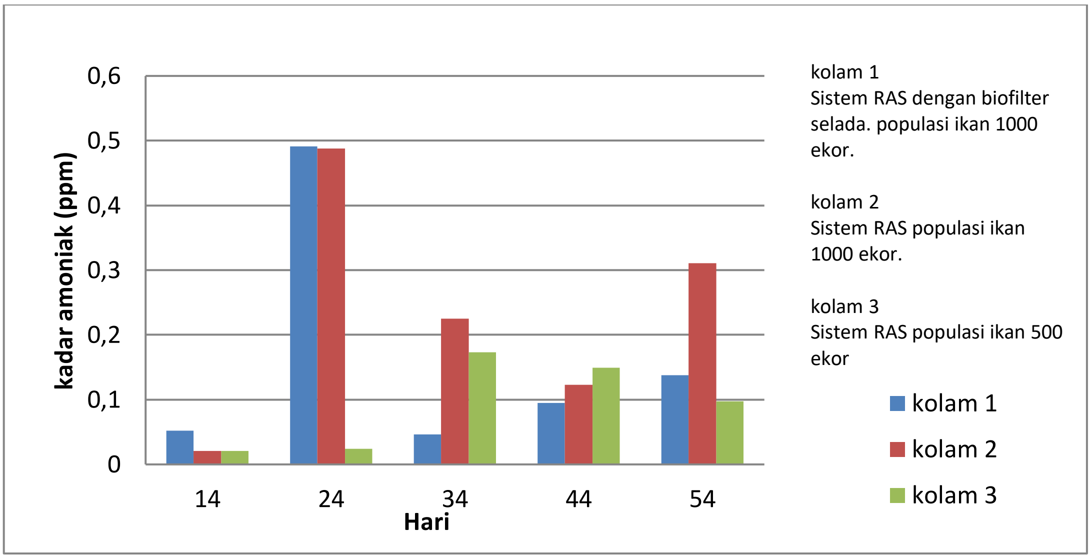

Figure 4. Ammonia Levels in Pools

Relationship between Ammonia and Growth of Test Animals

Based on the logarithmic regression analysis that has been carried out, it is known that there is an influence of ammonia concentration in the pond on the absolute growth of catfish body weight. Ammonia levels in ponds only affect absolute growth in body weight by 17% and the rest is influenced by other factors. Figure 4.5 shows that the ammonia concentration in the cultivation pond has a 24.5% effect on the absolute growth of catfish body length. Zidni et a., (2013) explained that there are internal and external factors that influence the growth of catfish. Internal factors are related to the fish itself, such as age and genetic characteristics which include heredity, ability to utilize food, and resistance to disease. Meanwhile, external factors relate to the environment where fish live, including the physical and chemical properties of water, space for movement, as well as the quality and quantity of food available.

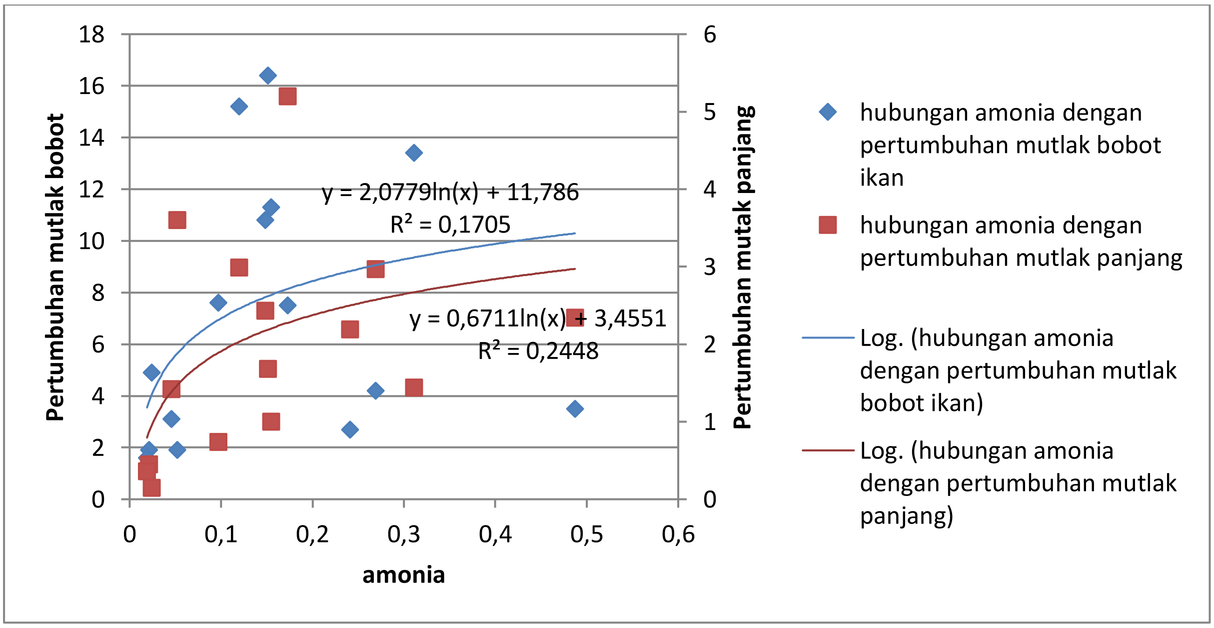

Figure 5. The relationship between ammonia and the growth of sangkuriang catfish (*Clarias gariepinus*)

DISCUSSION

Catfish Growth

The use of a recirculation system using lettuce plants as a biofilter (pool 1) has a significant influence on absolute weight growth, length growth and specific growth rate of fish when compared with the usual recirculation system in pond 2 and pond 3. The high growth of fish in pond 1 is thought to be due to the influence of the filtration system and biofilter of lettuce plants. Lettuce, which is a plant, absorbs excess nutrients in water in the form of ammonia which has been broken down into nitrates, which can improve the quality of water entering cultivation ponds. According to Susanti et al. (2021) the basic principle applied to this system is that leftover feed and manure from the cultivation system which has the potential to worsen water quality will be used as nutrients for plants. It is thought that the high growth of fish in pond 1 is also influenced by the fish's high appetite and is supported by optimal water quality. According to Martini (2017) good growth is supported by good water quality and nutritional conditions. The water recirculation system provides optimal water quality conditions for the fish, and is supported by providing feed with sufficient nutritional content for the fish, so this has a big influence on the growth of catfish. Furthermore, according to Lembang & Kuing (2021) the use of RAS technology can increase the carrying capacity of cultivation media, because the water used can be controlled well, is effective in water utilization and is more environmentally friendly for the life and growth of fish. The use of a water recirculation system using lettuce plants as a biofilter is the best system that can be applied on an industrial scale.

Based on observations during cultivation, the use of a water recirculation system can increase growth values. The growth values obtained by each pond are not much different as seen in Appendix 1. This shows that the use of a water recirculation system can increase fish growth optimally with high stocking densities, in pond 1 and pond 2 1 fish/L and pond 3 2 fish/L L. According to Yunus, et al. (2014) a good stocking density for catfish growth is 5 fish/10 liters of water. The existence of a filtration system helps improve water quality, by filtering the physical filter and the process of decomposing organic material in the form of food waste and fish feces in the biological filter by drainage bacteria. The type of bacteria added is Nitrosomonas sp. and Nirobacter sp. as well as lactobacillus. According to Fadillah, et al. (2022) Nitrosomonas sp. and Nirobacter sp. is a nitrifying bacteria that plays an important role in the process of breaking down ammonia into nitrites and nitrates, thus creating a more suitable and safe aquatic environment for fish. Bacteria such as Nitrosomonas and Nitrobacter have the ability to reduce ammonia levels and form simple compounds that can be utilized by other organisms for growth. Furthermore, according to Putri et al. (2015) the use of probiotics containing heterotrophic bacteria such as Lactobacillus casei can help maintain water quality and increase fish growth.

The recirculation system in pond 2 has a lower average growth compared to the recirculation system in pond 1. It is suspected that the filtration system in pond 2 is not working optimally due to the small filter capacity and high stocking density, the filter being unable to hold material. organic matter from leftover food and fish feces which increases with the length of time they are kept. Samsundari & Wirawan (2013) explained that because the area of the pool media is not balanced with the filter media, it causes the accumulation of organic material in the pool. Organic material that enters the cultivation pond without a filtering process and does not undergo a decomposition process in the filtration system, will worsen the water quality in the cultivation pond, as can be seen in Figure 4.9, pond two has the lowest water quality value with the highest average ammonia content. during observations, according to. Kelana et al. (2021) refers to the SNI standard 01-6484.5:2002, the ammonia level that is good for the life of catfish is less than 0.1 ppm. Martini (2017) continued to state that "good growth is supported by good water quality and nutritional conditions." So the water quality in cultivation ponds is very important to maintain at an optimal condition for fish.

Pond 3 had slightly higher growth than pond 2, this is thought to be due to low stocking density and low fish populations due to mass deaths that occurred in all ponds. according to Yunus, et al. (2014) a good stocking density for catfish growth is 5 fish/10 liters of water. The higher the stocking density, the higher the competition for space and food (Hermawan et.al., 2012). With a low fish population, dangerous organic matter from leftover feed and fish feces is also low, so that the filtration system runs normally, so the water in the cultivation pond is in optimal condition. Zidni et al. (2013) stated that factors that influence fish growth can be classified into two, namely internal and external factors. Internal factors are related to the characteristics of the fish itself, such as age, genetic characteristics, including heredity, ability to utilize food, and resistance to disease. Meanwhile, external factors are related to the environment where fish live, such as the physical and chemical properties of water, space for movement, and the availability of food both in terms of quality and quantity.

Survival Rate

Based on the results of research that has been carried out, the survival rate values for each pool are different, as can be seen in Figure 9, pool 1 shows the highest SR value, namely 62.8%, in pool 2 the SR value is 40.9% and in pool 3 19 %, this shows that the SR value in each pool is still relatively small. Irania et al. (2022) stated that the survival value of good fish is an average of 63.5 – 86.0%. Sarmada et al continued. (2016) explained that the survival rate for Sangkuriang catfish can reach 80% - 90%. Low survival caused by high fish population density can cause a decrease in water quality. Even though in this study the water quality was still in a fairly good range, this happened because of the recirculation system which kept the water quality stable. However, even though water quality is well maintained through a recirculation system, the water quality parameter values in this study show an increase in ammonia content and a decrease in oxygen solubility along with an increase in fish population density. Apart from that, interactions between fish are also another impact of the high fish population density.

The low survival rate value in each pond is due to mass deaths at the start of cultivation. This happens because most of the catfish jump out of the pond. Moreover, many of the deaths are thought to be due to poor transportation management, where the number of fish in each seed bag is too dense which causes the fish's body to be injured and the fish are easily stressed due to lack of oxygen. Situmorang (2016) explained that the relationship between oxygen content in the transportation of catfish seeds (Clarias gariepinus) is greatly influenced by factors such as fish density, the number of catfish seeds (Clarias gariepinus), and the duration of transportation. Fish that lack oxygen will cause the fish to become easily stressed and then spin around on the surface of the water, which will result in the fish fry dying. However, the use of a recirculation system with lettuce as a biofiter is able to reduce fish mortality rates, this can be seen from the fish survival value in pond 1 which reached 62.8% compared to pond 2, which obtained 40.9% with the same fish density.

CONCLUSSION

The use of a recirculation system affects the growth and survival of fish. The recirculation system with lettuce plants as a biofilter in pond 1 showed relatively higher growth results than the ordinary recirculation system in pond 2 and pond 3 with absolute weight = 55.07 g, absolute length = 15.55 cm, SGR = 6.02 % and SR 62.8%. The use of a recirculation system with lettuce as a biofilter is able to reduce fish death rates. Apart from that, using lettuce plants as a biofilter can reduce ammonia levels in cultivation ponds.

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