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Effectiveness of Aquaponics System for Tilapia Culture (*Oreochromis niloticus*) with Recirculation System

Efektifitas Sistem Akuaponik Untuk Budidaya Ikan Nila (*Oreochromis niloticus*) Dengan Sistem Resirkulasi

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ABSTRACT

Tilapia is a leading commodity in Indonesia, in its cultivation the availability of water is one of the obstacles for cultivators, one of the efforts made is by cultivating aquaponics and recirculation systems. This study aims to determine the effectiveness of the aquaponics system on the survival and growth of tilapia (*Oreochromis niloticus*) fry with a recirculation system. The research method used a completely randomized design (CRD) using four treatments and three replications, namely P1 (without plants) P2 (lettuce plants), P3 (caisim plants), P4 (kangkung plants) then further tests were carried out using Analysis of Variance (ANOVA). Research parameters include absolute weight (BM), absolute length (PM), specific growth rate (SGR), survival rate (SR) and water quality. The results of this study indicate that the aquaponics system for tilapia cultivation with a recirculation system has a significant effect on the growth and survival of tilapia.

ABSTRAK

Ikan nila adalah komoditas unggulan di Indonesia, dalam budidayanya ketersediaan air adalah salah satu kendala pembudidaya, salah satu upaya yang dilakukan dengan melakukan budidaya sistem akuaponik dan resirkulasi. Penelitian ini bertujuan untuk mengetahui efektifitas sistem akuaponik terhadap kelangsungan hidup dan pertumbuhan benih ikan nila (*Oreochromis niloticus*) dengan sistem resirkulasi. Metode penelitian menggunakan Rancangan Acak Lengkap (RAL) dengan menggunakan empat perlakuan dan tiga kali ulanagan yaitu P1 (tanpa tanaman) P2 (tanaman selada), P3 (tanaman caisim), P4 (tanaman kangkung) kemudian dilakukan uji lanjut menggunakan *Analysis of Variance* (ANOVA). Parameter penelitian meliputi berat mutlak (BM) panjang mutlak (PM) laju pertubuhan spesifik (SGR), *survival rate* (SR) dan kualitas air. Hasil penelitian ini menunjukan bahwa sistem akuaponik untuk budidaya ikan nila dengan sistem resirkulasi memberikan pengaruh yang nyata terhadap pertumbuhan dan kelangsungan hidup ikan nila.

Kata Kunci	*Ikan Nila, Sistem Akuaponik, Sistem Resirkulasi*
Keywords	*Tilapia Fish, Aquaponics System, Recirculation System*

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INTRODUCTION

Tilapia (*Oreochromis niloticus*) is one of the leading commodities in freshwater aquaculture in Indonesia (Arifin, 2016). Tilapia fish has a fast growth and breeding rate, and also the need for tilapia fish continues to increase, under conditions of limited water sources and adequate cultivation land, requiring farmers to increase their production results by switching to intensive cultivation systems, so far, the use of recirculation systems in Limited water sources are considered very effective for implementation in tilapia cultivation (Islami et al., 2013). According to (Lesmana, 2004), recirculation (rotation) of water in fish keeping containers is very useful in helping to create biological balance in the water, maintaining temperature stability, oxygen distribution and can reduce the accumulation of metabolic products so that toxic levels in the water.

Even though the use of a recirculation system is considered effective in maintaining limited water sources, continuous use of the same water can reduce water quality conditions so that it can cause fish to become stressed quickly and various diseases easily attack the fish. Because in the cultivation system, water is not only a place for fish to live, but also an intermediary for pathogens (Darmayanti et al., 2018). According to (Djokosetiyanto et al., 2006), accumulation of organic material will cause the formation of compounds that are toxic to fish, mineralization of nutrients from organic material and high oxygen absorption can accelerate the decline in water quality.

Water management as a cultivation medium can be done through the implementation of a recirculation system. The filter used can be a plant as a biofilter/biological filter (Setijaningsih et al., 2015). The use of plant biofilters in a recirculation system can be categorized as an aquaponic system. The aquaponics system is a combination of aquaculture (fish cultivation) and hydroponic plant cultivation in one place. The basic principle of aquaponics is that it can be done at the same time by utilizing fish waste and fish food waste as a source of nutrition for the plants being cultivated. The hydroponic system will act as a biofilter through the plants used. It is hoped that these plants will be able to maintain the quality of cultivation water so that the cultivated fish can grow optimally (Pratiwi, 2010).

Food and Agriculture Organization/FAO of the United Nations (2014), explains that the selection of plant types in an aquaponic system is related to the ability of plants to absorb waste water from cultivation. This ability is the background to the aim of using plants as biofilters during the tilapia fish rearing period. The types of plants used in the aquaponics system are divided into three types of leaf vegetable plants, namely kale, lettuce and pak choy. Water spinach is a plant that can function as a phytoremediator (Effendi et al. 2015) while pak choy is thought to be a plant that can absorb organic material (Andreeilee et al. 2014). Due to the benefits of kale (*Ipomoea aquatica* Forsk), lettuce (*Lactuca sativa* L) and pak choy (*Brassica rapa* L), there are two categories, namely: leafy green crops and vegetable crops.

Due to these problems, it is necessary to have aquaculture engineering which must be implemented in intensive cultivation systems. One thing that can be done is to combine hydroponics with aquaculture which is called an aquaponic system.

METHODS

The biota used in this research was tilapia (*Oreochromis niloticus*) obtained from the Lenek fish seed center, East Lombok Regency. The rearing media used is 12 round buckets with a height of 23cm with a diameter of 55cm with a water volume of 40 L. In rearing the feed given by attation er, feed is given at 08.00, 13.00 and 17.00. The feed used in this research was PF – 1000 pellets.

The arrangement of treatments in this study was Treatment A (control), Treatment B (Lettuce Plants), Treatment C (Caisim Plants), and Treatment D (Kangkung Plants), this research was carried out for 45 days, then, the parameters observed were Length growth rate absolute, absolute weight growth, length growth and specific weight and survival.

RESULT

Absolute Length Growth

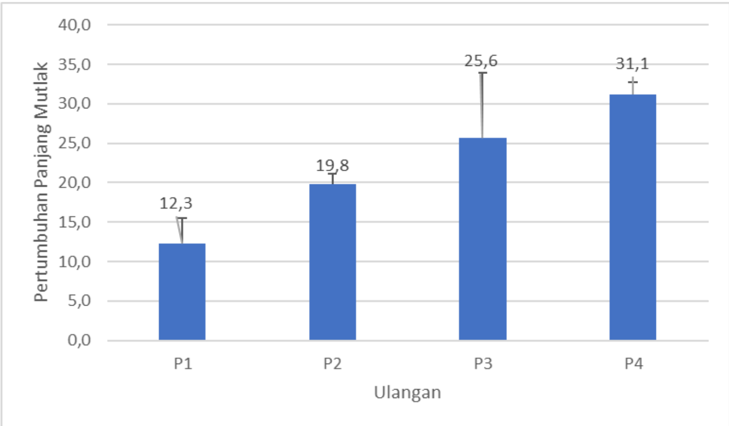

Figure 1. Absolute Length Growth

The results of analysis of variance (ANOVA) show that the effectiveness of the aquaponic system on the absolute length growth of tilapia gives significantly different results. ($P<0,05$).

Absolute Weight

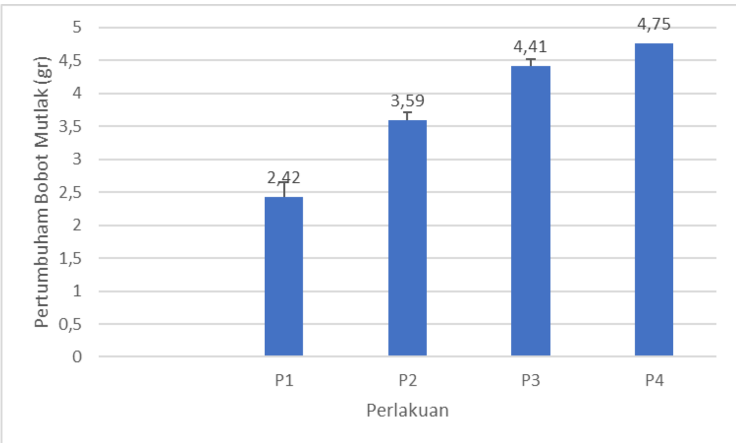

Figure 2. Absolute weight

The results of analysis of variance (ANOVA) show that the effectiveness of the aquaponics system on the absolute weight growth of tilapia gives significantly different results. (P<0,05).

Specific Length Growth

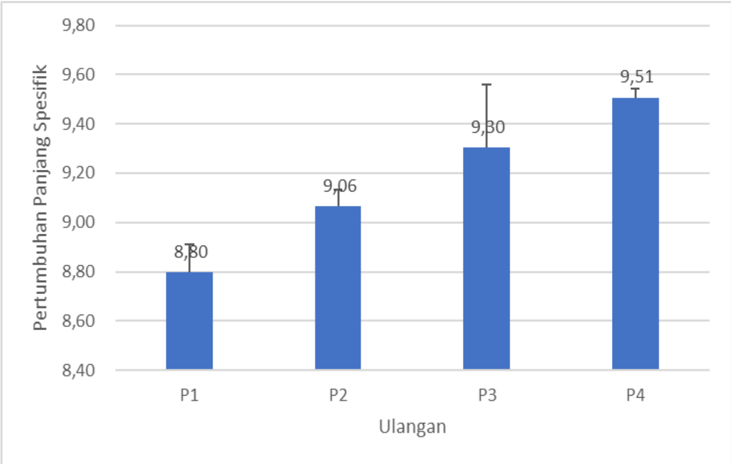

Figure 3. Specific length growth

The results of analysis of variance (ANOVA) show that the effectiveness of the aquaponic system on the specific length growth of tilapia gives significantly different results. (P<0,05).

Specific Weight Growth

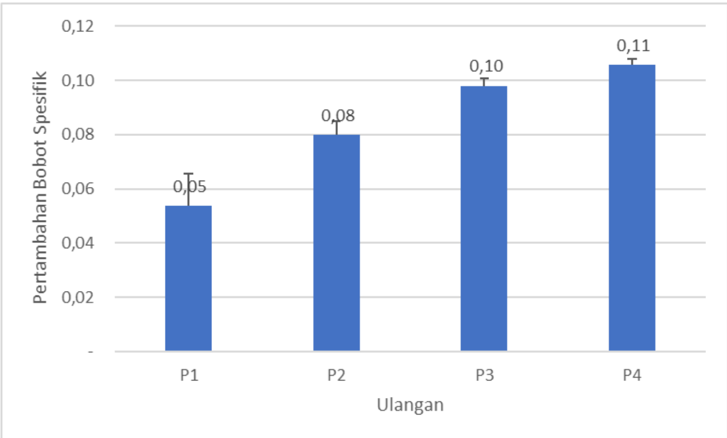

Figure 4. Specific weight growth

The results of analysis of variance (ANOVA) showed that the effectiveness of the aquaponics system on the growth of specific weight of tilapia gave significantly different results (P<0,05).

Survival Rate

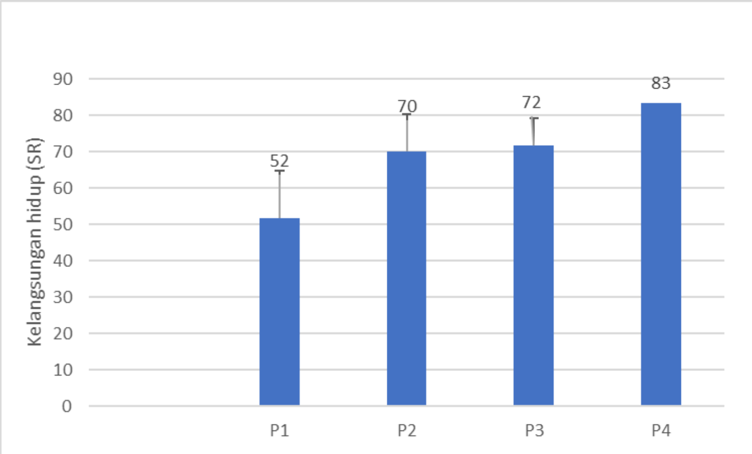

Figure 5. Survival

The results of analysis of variance (ANOVA) showed that the effectiveness of the aquaponics system on the growth of specific weight of tilapia gave significantly different results (P<0,05).

Table 1. Water Quality

No	Parameter	Treatment			
		Control	Lettuce	Caisim	Kangkong
1.	Temperature (°C)	25,8 – 30,5	26,1 – 30,3	26,1 – 30,1	26,2 – 30,3
2.	pH	7,6 – 8,2	7,7 – 8,2	7,8 – 8,2	76– 8,2
3.	Dissolved Oxygen (ppm)	4,4 – 5,4	5,5 – 6,4	4,6 – 6,6	5,4 – 6,8
4.	Ammonia (NH_3)	1,0 – 1,5	0,5 – 1,0	0,5 – 1,0	0,5– 1,0

The water quality value of each treatment is within the optimum value for raising tilapia fish (*Orechromis niloticus*).

DISCUSSION

Testing the use of different types of plants on the effectiveness of the aquaponic system such as lettuce, caisim, and water spinach in raising tilapia fish that were kept for 45 days with a recirculation system gave different responses. Where the best value among all treatments on the growth and survival of tilapia during the rearing period was shown in the water spinach plant treatment compared to the caisim and lettuce plant treatment, according to (Prasad et al., 2008), stating that water spinach is more effective in utilizing nutrients originating from The water that flows from catfish farming and then the water that has undergone biofiltration will be accepted as a medium for raising tilapia.

Growth rate is one of the parameters observed in this research. The high influence of water spinach plants on growth rate compared to control (without plants) in tilapia fish farming is thought to be due to differences in water quality in the rearing media such as water pH value, temperature, dissolved oxygen levels, especially ammonia levels from waste food waste and feces produced. by fish. according to (Lasena et al., 2016), states that the increase in the amount of ammonia is caused by waste from fish farming activities such as food waste, feces and urine which are sources of water pollution. Furthermore (Khairuman & Amri, 2013), added that waste from food waste, feces and fish urine can very significantly worsen water quality because it can increase the total concentration of nitrogen, namely nitrite, nitrate, ammonia and other dissolved organic materials in the aquarium, while dissolved oxygen will experience a decline.

When raising tilapia using plants, the water that passes through the plants can be filtered by the plants and the quality of the water can be controlled when it passes through the plants for growth. Meanwhile, in the control (without plants), the water was only circulated without being filtered before being returned to the maintenance medium. This is thought to be the cause of the difference in growth rate between the control (without plants) and those using plants. Because according to (Astuti & Indriatmoko, 2018), their research states that good water quality will increase appetite and feed intake. Good water quality will also influence the metabolic rate and energy assimilation for growth (Alfia et al., 2013). In line with the research results obtained, namely that good water quality can increase growth through high conversion of feed into body biomass which overall affects the survival of farmed fish.

Measurement of water quality parameter values during the research period showed a normal and appropriate range for the survival and growth of tilapia fish. The average range of temperature and pH parameters in each treatment, starting from the control (without plants), kale plants, caisim plants and lettuce plants tended to be relatively the same, namely ranging from 25℃– 30℃ for temperature measurement values and 7.6 – 8.2 for the pH measurement value. According to (Aliyas et al., 2016), the optimal temperature for the growth of tilapia is between 25℃-30℃, while the optimal pH value for the growth of tilapia is between 7 -8.

Other water quality parameters are measured, namely dissolved oxygen content and ammonia levels. Based on the measurements that have been carried out, the range of dissolved oxygen produced in each treatment is different, namely control (plants) at 4.4 – 5.4 ppm, lettuce at 5.5 – 6.4 ppm, caisim plants at 4.6 – 6.6 ppm and kale plants at 5.4 – 6.4 ppm. This range of dissolved oxygen values can be said to meet the oxygen needs for raising tilapia. Because according to (Wijayanti et al., 2019), optimal growth of tilapia requires waters with an oxygen content of at least 3 ppm. According to the statement (Astuti & Indriatmoko, 2018), the function of aquatic plants is that aquatic plants are effective in increasing oxygen levels in water through the process of photosynthesis. Carbon dioxide in the photosynthesis process is absorbed and then oxygen is released into the water (Pratiwi, 2010). Meanwhile, the measurement of the value of ammonia levels produced by each treatment in raising tilapia fish, namely the control (without plants) was 1.5 mg/L, and lettuce plants, caisim plants and kale plants both had a value range of 1.0 mg/L. L. According to (Nasution et al., 2014), the value of ammonia levels in waters suitable for tilapia cultivation is >2 mg/L. This proves that the use of various different types of plants in the aquaponics system can play an effective role in reducing and controlling the levels of ammonia contained in water from 0.25 mg/L to 0.10 mg/L or a reduction of 0.15 mg/L. (Nugroho et al., 2013), in his research also stated that the aquaponics system can reduce ammonia by absorbing cultivation waste water or waste water using plant roots so that the absorbed ammonia undergoes an oxidation process with the help of oxygen and bacteria, then the ammonia is converted into nitrate.

The differences in water quality parameter values cannot be separated from the growth of the plants used as filters. Based on research results, water spinach plants have fast growth because they can be seen from the growth of leaf length and the number of leaflets more than the other two plants, namely caisim and lettuce, while plants that the lowest is caisim. According to (Effendi, 1997), kale plants have a faster initial growth rate, this condition supports the plants to grow and absorb nutrients quickly. The faster the plant grows, the more inorganic nitrogen will be absorbed and the less toxic it will be in the cultivation water.

CONCLUSSION AND SUGGESTION

Conclussion

The results of this research show that the aquaponics system for cultivating tilapia with a recirculation system has a real influence on the growth and survival of tilapia.

Suggestion

There is a need for further research on the effectiveness of acuponic systems with different quantities and ratios as well as further calculations on water quality, especially ammonia, nitrite and nitrate in more detail to determine their effect on the growth and survival of tilapia fry.

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