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CONSUMPTION FISH POLYCULTURE USING AQUAPONIC (POLYPONIC) SYSTEM AT UPR MANDIRI ABADI PALEMBANG CITY

Polikultur Ikan Konsumsi dengan Sistem Aquaponik (POLIPONIK) di UPR Mandiri Abadi Kota Palembang

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ABSTRACT

Stunting, known as short toddlers, is a long-term nutritional problem caused by low food intake over a long period of time. Stunting can occur when the fetus is in the womb and only becomes visible when the child is two years old. One of the initiatives promoted by the government is the fish eating movement and the program to increase aquaculture production, which contributes greatly to national food security, employment and the Indonesian economy. Fish is very rich in nutrients and beneficial for the body because it contains 18% protein consisting of EPA, essential amino acids, DHA, vitamins A, B1, B2, and D, as well as minerals. Polyculture is cultivation with 2 types of fish, where in 1 cultivation container you can raise each type of fish. Polyculture of betok fish and tilapia using an aquaponic system for 30 days with a stocking density of 40 m-2 betok fish and 40 m-2 tilapia fish resulted in a survival of betok fish of 95%, a length growth of 0.92 cm, a weight growth of 0 .76 g and the feed efficiency value is 27.2%, while the survival rate for tilapia is 97.5%, length growth is 1.75 cm, weight growth is 1.61 g. The height of lettuce varies between 9-11 cm with 2-3 leaves per plant. The quality of maintenance water, whether control or maintenance with treatment, is still within the optimum range for polyculture aquaponic systems.

Keywords: Aquaponics, Betok Fish, Polyculture, Tilapia

ABSTRAK

Stunting dikenal sebagai balita pendek, adalah masalah gizi jangka panjang yang disebabkan oleh asupan makanan yang rendah dalam waktu yang cukup lama. *Stunting* dapat terjadi sejak janin dalam kandungan dan baru terlihat saat anak berusia dua tahun. Salah satu inisiatif yang dipromosikan pemerintah adalah gerakan makan ikan dan program peningkatan produksi budidaya perikanan, yang berkontribusi besar pada ketahanan pangan nasional, lapangan kerja, dan perekonomian Indonesia. Ikan sangat kaya nutrisi dan bermanfaat bagi tubuh karena mengandung 18% protein yang terdiri dari EPA, asam amino esensial, DHA, vitamin A, B1, B2, dan D, serta mineral. Polikultur merupakan budidaya dengan 2 jenis ikan, dimana dalam 1 wadah budidaya dapat memelihara jenis ikan. Polikultur ikan betok dan ikan nila sistem akuaponik selama 30 hari dengan padat tebar 40 ekor m^{-2} ikan betok dan 40 ekor m^{-2} ikan nila menghasilkan kelangsungan hidup ikan betok sebesar 95%, pertumbuhan panjang sebesar 0,92 cm, pertumbuhan bobot sebesar 0,76 g dan nilai efesiensi pakan yakni 27,2%, sedangkan untuk kelangsungan hidup ikan nila sebesar 97,5%, pertumbuhan panjang sebesar 1,75 cm, pertumbuhan bobot sebesar 1,61 g. Pertumbuhan tinggi selada beragam antara 9-11 cm dengan daun 2-3 helai pertanaman. Kualitas air pemeliharaan baik kontrol ataupun pemeliharaan dengan perlakuan masih dalam kisaran optimum untuk polikultur sistem akuaponik.

Kata Kunci: Akuaponik, Ikan Betok, Ikan Nila, Polikultur

INTRODUCTION

Stunting is also known as short toddlers, a long-term nutritional problem caused by low food intake over a long period of time. Stunting can occur since the fetus is in the womb and is only seen when the child is two years old (KEMENKES RI, 2016). Stunting in children can inhibit their growth in the future (Rachmah et al., 2020). Currently, the issue of stunting is becoming a big one that requires proper handling. The Government of the Republic of Indonesia hopes that by 2024 the stunting figure graph can decrease to 14%.

One of the initiatives promoted by the government is the fish eating movement and the program to increase fisheries cultivation production, which contribute greatly to national food security, employment, and the Indonesian economy. Fish are very rich in nutrients and beneficial for the body because they contain 18% protein consisting of EPA, essential amino acids, DHA, vitamins A, B1, B2, and D, and minerals. So, consuming fish as a source of animal food can help overcome stunting problems (Arthatiani & Zulham, 2019).

Fish farming can be done by the wider community where current farming activities have also been carried out by the community in order to be able to raise fish independently. One idea to be able to meet the needs of animal protein in the daily lives of the community in carrying out fish farming activities with a polyculture system. Where the polyculture system is a fish farming system that uses more than one fish.

The term "Polyponics" is used to describe a system that combines vegetable crop development and polyculture cultivation. This system adopts the ecological system in nature, where fish and plants are symbiotic with each other (Sastro, 2016). There are several species of fish that can be cultivated in the aquaponic system, namely the catfish (*Anabas testudeneus*) and the tilapia (*Oreochromis niloticus*). The polyponic system was introduced as an effort to develop an economical and environmentally friendly cultivation system. These three polyponic products are related to the needs of basic food ingredients that can improve community nutrition in an effort to prevent stunting, especially in swamp communities, between each other (Sastro, 2016).

The purpose of this study is to utilize the polyponic system as an appropriate technology in developing swamp fish cultivation and as an effort to socialize the stunting prevention movement in the community. The polyponic system was introduced as an effort to develop a fish cultivation system and also to fulfill animal protein nutrition for the community, especially in Palembang City.

METHODS

Time and Place

This research was conducted in March-July 2024 at UPR Mandiri Abadi, Palembang City.

Tools and Materials

The tools used are tarpaulin pool, pH meter, DO meter, thermometer, ruler, digital scale, wire tie, scoopnet, plastic cup, styrofoam, bucket, aerator and cup. The materials used are catfish, tilapia, commercial pellets, rockwool, AB mix fertilizer and lettuce seeds.

Treatment and Experimental Design

The implementation of this study refers to the best treatment in the study by Cindy et al. (2023) as a control or P0, namely with a stocking density of 40 catfish/m^2 and 25 tilapia/m^2, while in the treatment with polyculture or P1, catfish and tilapia were stocked with the same amount, namely 40 fish/m^2. The aquatic plant used was lettuce (*Lactuca sativa*) which was planted on rockwool media in plastic cups as a substitute for netpots and placed on 45x30 cm^2 styrofoam that had been perforated and placed above the maintenance pond.

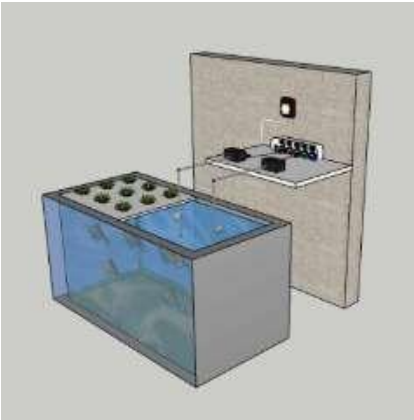

Figure 1. Design of Polyculture Containers in An Aquaponic System

Experimental Procedure

Preparation of Maintenance Container

The study began by preparing a container and water as a maintenance medium, lettuce plants, climbing perch and tilapia seeds. The container used was a tarpaulin pool measuring 100×50×50 cm^3 with a water height of 40 cm.

Preparation of Lettuce Plants (*Lactuca sativa*)

Lettuce seeds were sown using rockwool planting media that had been perforated with a sowing period of 5 days. Lettuce seeds were selected with the criteria of the same number of leaves, namely 2-3 strands. Furthermore, the lettuce seeds were transferred into a plastic cup containing charcoal at the bottom of the plastic cup, then the rockwool was placed on top of the charcoal. Each plastic cup was filled with 3 lettuce plants.

Distribution and Maintenance of Fish

The climbing perch used were 3-5 cm in size and the tilapia were 4-7 cm in size that had been acclimatized, sampled for length and body weight for initial data collection. The fish maintenance period is 30 days where every day the fish are fed PF100 pellets from Matahari Sakti with a protein content of 40% with a frequency of three times a day in the morning, afternoon and evening, as much as 5% of the fish's body weight. Sampling is carried out every 10 days by weighing and measuring the length of the fish. Fish that die during maintenance are weighed.

Harvesting

Harvesting is carried out after 30 days of maintenance, the total number of fish that are still alive is sampled by calculating and measuring the final weight to determine the survival and growth of tilapia and catfish. Lettuce plants are also harvested after being planted for 30 days (Irawati & Widodo, 2017). The lettuce plants that are harvested will have their leaves counted in number and size.

Parameters Observed

Fish Weight Growth

The calculation of weight growth values according to Effendie (1997), can be found using the following formula:

$$W = Wt - W_0$$

Description:
W = Weight growth (g)
Wt = Fish weight at the end of maintenance (g)
W0 = Fish weight at the beginning of maintenance (g)

Fish Length Growth

According to Effendie (1997), to determine the growth in fish length, the following formula can be used:

$$L = Lt - L_0$$

Description:
L = Length growth (cm)
Lt = Length at the end of maintenance (cm)
L0 = Length at the beginning of maintenance (cm)

Survival Rate

According to Effendi (1997), the survival rate during maintenance can be determined using the following:

$$SR = \frac{Nt}{N0} \, x \, 100\%$$

Description:
SR = Survival Rate (%)
Nt = Number of fish alive at the end of maintenance (tail)
N0 = Number of fish alive at the beginning of maintenance (tail)

Specific Growth Rate

According to Huisman (1976), the specific growth rate during maintenance can be determined using the following formula:

$$SGR = \frac{\ln Wt - \ln W0}{t} \, x \, 100\%$$

Description:
SGR = Specific growth rate (%/day)
W0 = Initial fish weight of maintenance (kg)
Wt = Final fish weight of maintenance (kg)
t = Time (days)

Feed Efficiency

Afrianto & Liviawaty (2005) stated that the feed efficiency value can be calculated using the following formula:

$$\text{Feed Efficiency (\%)} = \frac{(Wt + D) - Wo}{F} \times 100\%$$

Description:
Wt = Total weight of fish at the end of maintenance (g)
W0 = Total weight of fish at the beginning of maintenance (g)
D = Total weight of dead fish (g)
F = Amount of feed consumed (g)

Lettuce Plant Growth

Plant height was measured using a ruler from the base of the stem to the tip of the highest leaf. The number of leaves was calculated using a digital scale to calculate the weight of the plant, including leaves, stems, and roots (Novriani, 2014).

Physical and Chemical Quality of Water

The physical and chemical quality parameters of water measured included the degree of acidity, temperature and dissolved oxygen. Water temperature and pH were measured every day, namely in the morning and evening. Dissolved oxygen measurements were carried out every 10 days.

Data Analysis

Data were analyzed after collecting primary and secondary data from various literature studies and presented in the form of tables and figures and explained descriptively.

RESULT

Survival and Growth of Fish

The survival, growth, specific growth rate of betok fish and tilapia are presented in Table 1 below.

Table 1. Survival, Growth, Specific Growth Rate of Betok Fish and Tilapia

Code	Treatment	Stocking Density (fish/m^2)	SR (%)	Growth		SGR (%/day)
				Length (cm)	Weight (g)	
PO	Polyculture of betok	40	82.5	5.42	7.56	-
	Polyculture of tilapia	25	87.5	5.24	2.33	-
P1	Polyculture of betok	40	95	5.46	7.51	0.9
	Polyculture of tilapia	40	97.5	7.55	6.61	0.94

Feed Efficiency

The feed efficiency of catfish and tilapia is presented in Table 2 below:

Table 2. Feed Efficiency of Tilapia and Catfish

Code	Treatment	Stocking Density (fish/m^2)	Feed Efficiency (%)
P0	Polyculture of betok	40	24.9
	Polyculture of tilapia	25	
P1	Polyculture of betok	40	27.2
	Polyculture of tilapia	40	

Lettuce Plant Growth

The growth of lettuce plants is presented in Table 3 as follows:

Table 3. Lettuce Plant Growth After the Study

Treatment	Average growth	
	Plant height	Plant weight
Control	13.36	3.39
Treatment	14.56	5.59

Physical and Chemical Quality of Water

The physical and chemical quality values of water obtained during maintenance are presented in Table 4 as follows:

Table 4. Physical and Chemical Quality of Water

Treatment	Temperature (^{0}C)	pH	Dissolved oxygen (mg L^{-1})
Control	25.00-28.80	7.00-7.70	5.17-5.50
Treatment	26.80-27.11	7.00-8.5	4.91-5.47

DISCUSSION

Based on the results of the study, it was shown that polycultured climbing perch had a higher survival rate in P1 compared to P0. This is influenced by various factors, one of which is stocking density (Wibowo & Helmizuryani, 2015). Optimal stocking density is a condition where fish are stocked in high numbers, but competition in obtaining food and space to move can still be tolerated by the fish (Yusuf, 2014). The survival rate of P1 climbing perch is high because of the fish's tolerance to changes in environmental conditions, climbing perch that jump out of the maintenance container, and some fish that struggle to adapt to tilapia that are kept under the polyculture system. This is mostly due to the character of swamp fish that have instincts and the ability to detect the weather, so that fish can jump out of the maintenance container (Akbar, 2012). According to Syulfia et al. (2014), low stocking density gives fish more space to move, which makes them spend more energy from feed.

Based on the National Standardization Agency (2016), the survival rate for catfish production is >70% and the average survival rate for tilapia is 63.5–86.0. This shows that the survival rate of tilapia polyculture cultivation in both P0 and P1 is above 50%, which is considered a high survival rate percentage. In addition, feed and environmental conditions affect the survival of fish. The survival of fish that are kept will be increased with sufficient feed in quantity and quality, as well as good environmental conditions. On the other hand, lack of feed and poor environmental conditions will affect the health and survival of fish that are kept.

Based on Table 1, it is known that the highest growth in length of the betok fish is 5.46 cm at P1 while the lowest value is 5.42 cm at P0. The growth in length during the maintenance period of tilapia at P1 is higher by 7.55 cm and P1 by 5.24 cm. This indicates that there is an increase in the growth of the body length of the betok fish and tilapia. Based on Effendie's statement (2003), Growth is a gradual increase in the length or weight of fish, which can be influenced by feed, age, and size of the fish. Factors that can influence growth are dense fish distribution and good feed and water quality. Nutrition is another factor that greatly influences fish growth, the energy contained in the feed greatly influences fish growth (Sanjayasari, 2010).

The growth rate is influenced by many factors, including the amount of food given, space, temperature, and water depth. Fish food is primarily used to maintain the body and replace damaged equipment. The highest growth value of the weight of the climbing perch was 7.56 g in the P0 pond and the lowest was 7.55 g in the P1 pond, while in tilapia the weight growth value in P0 was smaller, namely 2.33 g and P1 was 6.61 g.

The results of the study for one month showed that the growth value of the climbing perch was quite low. Akbar (2012) stated that the main obstacle in cultivating climbing perch is the less specific growth in a short time. It takes a year or more for maintenance to reach a consumption size of 75 to 100 grams. In accordance with Djunaedi's statement (2016), that feed, physical activity, and water quality in the fish maintenance container can affect the absolute weight growth of the same fish as the absolute length growth. Providing more feed to this fish can result in greater growth (Karimah, 2018). Internal and external factors that affect growth to achieve optimal growth are that the cultivation environment must be managed optimally. The specific growth rate between climbing perch and tilapia is 0.9%/day for climbing perch and 0.94%/day for tilapia. This value indicates a relatively low specific growth rate.

The feed efficiency value of the climbing perch polycultured with tilapia gave different results. The feed efficiency in P1 was higher at 27.2% while in P0 the feed efficiency value was 24.9%. The values of these two treatments were less than optimal, because according to Craig & Helfrich (2017), the high feed efficiency value is more than 50%, therefore the low feed efficiency values of P1 and P0 can still increase the growth of climbing perch and tilapia but in low and insignificant amounts. The factors causing the low feed efficiency value are due to the high stocking density so that the available space for climbing perch makes the fish tend to move limitedly, there is competition between climbing perch and tilapia so that when feeding, tilapia consume more feed than climbing perch and there is also feed that is not eaten by the fish. As stated by Syulfia et al. (2014), climbing perch tend to move freely when fed because the low stocking density gives them plenty of room to move.

Based on Table 3, the results show that the maintenance of climbing perch polycultured with tilapia in an aquaponic system affects the growth of lettuce plants during 30 days of maintenance. The growth of lettuce plants during 30 days of maintenance shows that plant growth in the control was an average height growth of 13.36 cm and an average weight growth of 3.39 grams, while with the treatment, the average height growth of lettuce plants reached 14.56 cm and an average weight growth of 5.59 grams. Of course, the growth of this lettuce is different, because the seeds used for the control had an average height of 6.05 cm with an average weight of 1.18 grams, while in the treatment the height of lettuce seeds on the ninth day was 2.1 cm with a weight of 0.9 grams. Another cause according to Pratikel (2021), The more nutrients available from fish stocking density can increase plant growth and development, which means better results.

Based on the results of the study in Table 4, it shows that the temperature values obtained at P0 during maintenance ranged from 25.00-28.80˚C and during maintenance with P1 the temperature ranged from 26.80-27.11˚C. These temperature values indicate that the temperature is still tolerable for the survival and growth of betok fish and tilapia. According to Akbar (2014), the temperature range for the growth of betok fish ranges from 24-34˚C. However, the ideal temperature for raising class tilapia in still water ponds is between 25-32˚C (National Standardization Agency, 2009).

The acidity value obtained in maintenance without treatment ranged from 7.01 - 7.81 while maintenance with treatment the acidity value ranged from 7.00 - 8.4. Akbar (2014), stated that the range of good acidity for the growth of climbing perch is pH 4-8. The optimal pH for tilapia ranges from 6.5 - 8.5 (National Standardization Agency, 2009). According to Diansari et al. (2013), non-ideal pH values can cause fish stress, be more susceptible to disease, and decrease productivity and growth. The pH value shows that different stocking densities of climbing perch polycultured with tilapia for 30 days in an aquaponic system are still acceptable to climbing perch and tilapia.

Hasudungan et al. (2015) stated that fish activities such as swimming, growth, and survival will decrease if the dissolved oxygen content is insufficient to meet the needs of the fish. During 30 days of maintenance, the range of dissolved oxygen content without treatment was between 5.17 - 5.75 mg L^{-1} and maintenance with treatment containing dissolved oxygen ranged from 4.91-5.47 mg L^{-1}. Based on Lukman et al. (2019), the dissolved oxygen required by fish is at least 4 mg L^{-1}. Based on the measurement results, it shows that dissolved oxygen is in the range that can be tolerated by betok fish and tilapia. This dissolved oxygen value indicates the ideal level for the growth and survival of betok and tilapia fish in water with an oxygen content of 3-5 mg L^{-1}. However, according to Sucipto & Prihartono (2007), the dissolved oxygen content in water must be above 5 mg L^{-1} to increase fish productivity; if less than 3 mg L^{-1}, it can cause a decrease in fish productivity. In the maintenance container, the decomposition and growth processes are hampered due to low dissolved oxygen levels. Temperature, water movement on the surface, open surface area, and oxygen concentration are some of the factors that can affect dissolved oxygen. This is in line with the statement of Jumaidi et al. (2017) that temperature affects dissolved oxygen, increasing temperature will cause a decrease in the solubility of gases such as oxygen, CO_2, N, and others.

CONCLUSION

Polyculture of climbing perch and tilapia in aquaponic system for 30 days with a stocking density of 40 per m^2 climbing perch and 40 per m^2 tilapia resulted in 95% survival of climbing perch, 0.92 cm in length growth, 0.76 g in weight growth and 27.2% in feed efficiency, while tilapia survival was 97.5%, 1.75 cm in length growth and 1.61 g in weight growth. Lettuce height growth varied between 9-11 cm with 2-3 leaves per plant. The quality of maintenance water, both control and treatment, was still within the optimum range for aquaponic system polyculture.

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