Effectiveness of Using Pakcoy (*Brassica rapa L.*) and Kailan (*Brassica oleracea*) Plants as Vegetable Media for Aquaponic Culture of Tilapia (*Oreochromis sp.*)

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Abstract
Aquaponic is one way to use a narrow area of land as a medium for fish cultivation and vegetables in one compartment. The types of commodities that are often cultivated using this system are tilapia fish, pakcoy vegetables, and kailan plants. The purpose of this study was to assess the effectiveness the use of pakcoy (Brassica rapa L.) and kailan (Brassica oleracea) on growth rates and feed conversion ratios by tilapia fish (Oreochromis sp.) cultivated in aquaponic aquaculture systems. The method used was an experimental design with a completely randomized using 3 treatments and 3 replications. The main parameters analyzed in this study were the specific growth rate (SGR) and the fish feed conversion ratio (FCR). Meanwhile, the supporting parameters measured include water quality variables such as temperature, pH, dissolved oxygen, ammonia, nitrite and nitrate. The results showed, during the maintenance of tilapia fish (Oreochromis sp.) with an aquaponic system, pakcoy (Brassica rapa L.) and kailan plants (Brassica oleracea) had an effect on increasing growth rate and feed conversion ratio by tilapia (Oreochromis sp.). In addition, during the maintenance period the water quality parameters also tend to be stabilized and comply with quality standards. The conclusion from this research is that the application of kalian plant (Brassica oleracea) use in the aquaponic system of tilapia commodities is more effective than pakcoy plants (Brassica rapa L.) with an effective SGR value at 3.15% and an FCR value at 1.21.
Keyword: Aquaponic, *Brassica oleracea, Brassica rapa L.*, *Oreochromis niloticus.*

Introduction

Tilapia fish (*Oreochromis niloticus*) is a fish commodity that has high economic value. Several things that are considered will be important for tilapia fish, including tilapia which has relatively high resistance to disease, has a wide tolerance for environmental conditions, has good growth ability, and can be cultivated with an intensive system (Isnawati et al., 2015).

Tilapia fish farming is economically very profitable and can support the fulfillment of nutrition for the community. Along with public awareness of consumption consumption, the need for fish consumption will also increase (Wullur et al., 2013). However, in aquaculture activities there are several environments such as water quality which is decreasing in status due to increasing feeding.

In closed aquaculture system, offering excess feed will have a negative impact, namely the accumulation of waste accumulation in the culture media in the form of N and P originating from fish waste and pollutant feed residue (Taufik et al., 2015). To solve this problem, it is necessary to have a solution. One solution that can be expected is the application of an aquaponic aquaculture system. Aquaponics has many advantages, such as: it can be done in limited land, does not need to use a lot of water, and there are variations in cultivation in its operations, namely vegetables and fish (Isnawati et al., 2015). The concept of acuponic aquaculture, we just need to feed the fish for growth, fish waste and food waste that is wasted will be absorbed by vegetables as natural fertilizer (Apriyanti and Rahimah, 2016).

Some of the vegetables that can be used in aquaponics include pakcoy (*Brassica rapa* L.) and kailan (*Brassica oleracea*). Both of these vegetable plants have nutritional formulations needed by the human body and are very beneficial for health if consumed regularly (Fahrudin, 2009; Apriyanti and Rahimah, 2016). Based on this description, the aim of this study was to assess the effectiveness of the use of pakcoy (*Brassica rapa L.*) and kailan (*Brassica oleracea*) on growth rates and feed conversion ratios for tilapia fish (*Oreochromis sp.*) cultivated in aquaponic aquaculture systems.

Materials and Methods

The study was conducted in June-July 2017 at the Hydrobiology Laboratory of the Fish Resources Division, Faculty of Fisheries and Marine Sciences, Brawijaya University, Malang.

Materials

The tools used in this study included 9 units of tank size 50 cm x 30 cm x 30 cm, 9 units of water pump, net scoop, aerator, 9 plastic tubs, styrofoam, L pipe, bioball, paranet, net pot, socket outlet. fish tank, sponge, ruler, DO meter, pH meter, analytical scale (accuracy 10^{-2} gr), thermometer, spectrophotometer, bottle sample, beaker glass, porcelain cup, spatula, hot plate, pipette, volume pipette, washing bottle, cuvet, test tube, test tube rack, suction ball, funnel, and pond tray.

The materials used in this study included tilapia seeds (*Oreochromis sp.*) 4-5 cm in size with an average weight of 1.83 grams, PF 800 type pellets with 30% protein content, 45 pakcoy plants (*Brassica rapa L.*), 45 kailan plants (*Brassica oleracea*), water, soap, pipe glue, filter paper, label paper, NED, sulfanilamide, nessler, NH_4OH, disulfonic phenol acid, aquadest.

Research methods

The research method used in this research is the experimental design with a completely randomized. This study used 3 different treatments, each of which was repeated 3 times. The following are the types of treatment in research:

A : Aquaponics with pakcoy plants
B : Aquaponics with kailan plants.
K : Control treatment

The main parameters in this study are the calculation Specific Growth Rate (SGR) and Feed Conversion Ratio (FCR). Also, supporting parameters are in the form of water quality variabels (temperature, pH, DO, ammonia, nitrite and nitrate).

Research procedure

The implementation of the research was started with the spread of tilapia seeds that had been acclimatized for 1 week as many as 3 fish/L in each unit where the plants were 2 weeks old in each treatment unit media with a distance of 10 cm per plant (Nugroho and Sutrisno, 2008). The aquaponic aquaculture period was carried out for 30 days of research. Fish in the culture medium are feeding 2 times a day with a total feed amount of 5% from the total biomass weight and sampling is done once a week. Water quality measurement variables including temperature, pH and DO were carried out every day in the morning and evening using the DO YSI550 and pH G77 tester, while ammonia, nitrite and nitrate were measured once a week using the spectrophotometry method. On the last day of the research, the final weight of tilapia fish (*Oreochromis sp.*) was weighed to obtain growth yields.

Measurement of the main parameters, consisting of the specific growth rate (SGR) and feed conversion ratio (FCR) is calculated using the following formula:

Specific Growth Rate (SGR)

The specific growth rate is a percentage of the difference in final weight and initial weight, divided by maintenance time. According to Elliott and Hurley (1995), the formula for calculating specific rate growth is as follows:

$$\%SGR = \frac{LnWt - LnWo}{T} \times 100\%$$

Information :
SGR : specific growth rate (%)
Wt : average body weight at time t (g)
Wo : initial average body weight (g)
T : time (days)

Feed Conversion Rate (FCR)

The calculation of feed conversion ratio was carried out using the formula from NRC (1977) which is as follows:

$$FCR = \frac{F}{(Wt + D) - Wo}$$

Information :
FCR : Feed Conversion Ratio
Wo : biomass weight of fish beginning (gr)
Wt : biomass weight of fish at the end (gr)
D : Total body weight of fish dead (gr)
F : amount of feeding given (gr)

Data analysis

The research data obtained was carried out by statistical analysis using analysis of diversity or the F test (ANOVA) with a 95% degree of confidence and notification between treatments.

Results and Discussions

Water Quality Parameters

The fluctuation of water quality parameters during the study can be seen in **Table 1.** The value of water quality parameters during the research period was still optimum enough for aquaponic aquaculture. On the parameters of nitrite and nitrate, the table shows that the upper limit value is quite high, namely 0.265 mg/L for nitrite and 0.977 mg/L for nitrate. High levels of nitrite and nitrate are derived from ammonia compounds which accumulate in the maintenance medium through from nitrification process (Siikavuopio and Saether, 2006). The fluctuating nitrite value in the maintenance medium will indirectly affect to organism growth rate (Ariadi et al, 2019). Meanwhile, the nitrate value is too high, indicating that there condition is nutrient contamination on the waters (Tatangindatu et al, 2013).

Table 1. Water Quality Parameters

Parameter	Nilai	Baku mutu
Suhu (^{0}C)	24-27.8	25-30
pH	6.52-8.66	7.0-8.5
Oksigen terlarut (mg/L)	5.32-9.14	> 4
Amonia (mg/L)	0.07-0.39	< 0.5
Nitrit (mg/L)	0.04-0.265	< 1
Nitrat (mg/L)	0.11-0.977	< 5

Sumber : Tatangindatu et al, (2013)

The concentration of dissolved oxygen parameters at the upper limit value was detected to be quite high, reaching 9.14 mg/L. Fluctuations in dissolved oxygen values in aquaculture ponds are influenced by the fluctuation of water temperature levels (Ariadi et al, 2019). Meanwhile, the pH water value at the upper limit is quite low, namely 6.52. This is because in the early days of acuponic systems the water was still clear and poor of trace elements, so that the pH waters tended to be slightly acidity.

Specific Growth Rate

From the results of research observations, the average number of specific growth rates was obtained in **Table 2.** The average specific growth rates for kailan and pakcoy were moderate. In numerical terms, the growth rate of the kailan plant has a downward trend.

Based on the data average number of specific growth rates in **Table 2,** the results of statistical analysis of specific growth rate variance (SGR) can be obtained as in **Table 3.** Variance analysis is used to determine the effect of the applicative use of the two plants on the fish specific growth rate. In addition, by conducting analysis of variance, the researcher can minimize error data during research repetition.

Table 2. Specific Growth Rate of Tilapia Fish (*Oreochromis niloticus*)

Treatment	Replicated			Total	Mean
	1	2	3		
A	2.77	2.87	2.63	8.27	2.76 ±0.12
B	3.26	3.1	3.1	9.46	3.15 ±0.09
K	2.43	2.57	2	7	2.33 ±0.30
Total				25	

Table 3. Statistical Analysis of Specific Growth Rate Variance

Diversity	Db	JK	KT	F test		
				F count	F 5%	F 1%
Treatment	2	1.009	0.5045	13.598**	5.14	10.92
Random	6	0.223	0.0371	-	-	-
Total	8	1.232	-	-	-	-

The F count from treatment at 13,598

Based on the analysis of variance, the calculated F value > F table 5% and > F table 1% with a value of 10.92. To determine the order of the effects of different treatments, the Least Significant Difference (LSD) test was performed. LSD test results can be seen in **Table 4** below:

Table 4. The Least Significant Difference (LSD) Test Results

Treatment average		K	A	B	Notation
		2.33	2.76	3.15	
K	2.33	-	-	-	a
A	2.76	0.43**	-	-	b
B	3.15	0.82**	0.03**	-	c

Description : (**) = very real different.

Furthermore, for the graph of the calculation by tilapia fish specific growth rate during the research period in aquaponics media can be seen in **Figure 1.** From **Figure 1.**, it can be seen that the specific growth rate value from the largest to the smallest, starting from treatment B (kailan plant) of 3 , 15%; then treatment A (pakcoy plant) was 2.76% and the smallest treatment K (control) was 2.33%. Treatment K (control) had the smallest specific growth rate. From these results it can be concluded that the best specific growth rate was in treatment B (kailan plant).

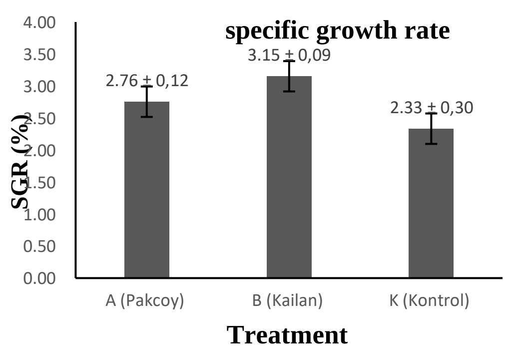

Figure 1. *O. niloticus* Specific Growth Rate

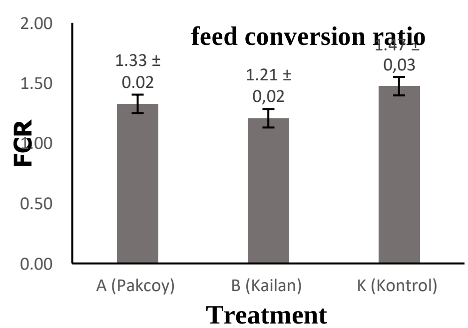

Figure 2. *O. niloticus* Feed Conversion Ratio

Feed Conversion Rate (FCR)

The feed conversion ratio is an important indicator that affects the level of operational costs that must be incurred during the aquaculture cycle (Ariadi et al, 2020). From the results of research observations, data on the average number of feed conversion ratio rates are presented in **Table 5.** Overall, the FCR value is still below 1.5, meaning that it is still in the good enough category for fish culture.

Table 5. Feed Conversion Ratio of Tilapia Fish (*Oreochromis niloticus)*

Treatment	Replicated			Total	Mean
	1	**2**	**3**		
A	1.32	1.31	1.35	3.98	1.33 ±0.02
B	1.19	1.21	1.22	3.62	1.21 ±0.02
K	1.46	1.45	1.51	4.42	1.47 ±0.33
Total				12	

Based on the data on the average feed conversion value in **Table 5**., the results of the analysis of the feed conversion value variance statistical analysis are presented in **Table 6.** Based on the variance test value, the calculated F-value is 94,431.

Table 6. Statistical Analysis of Feed Conversion Ratio Variance

Diversity	Db	JK	KT	F test		
				F count	**F 5%**	**F 1%**
Treatment	2	0.107	0.0535	94.431**	5.14	10.92
Random	6	0.003	0.0006	-	-	-
Total	8	0.110	-	-	-	-

The F count from treatment at 94.431

The results by variance analysis show that the value of F count > F table 5% is 5.14 and > F table 1% is 10.92. Furthermore, to determine the order of the effects of different treatments, the Least Significant Difference (LSD) test was performed. LSD test results presented in **Table 7.** below:

Table 7. The Least Significant Difference (LSD) Test Results

Treatment average		K	A	B	Notation
		1.21	**1.33**	**1.47**	
K	**1.21**	-	-	-	a
A	**1.33**	0.12**	-	-	b
B	**1.47**	0.26**	0.14**	-	c

Description : (**) = very real different.

Furthermore, for the graph by the calculation of tilapia feed conversion ratio rates during the research period in aquaponic media can be seen in **Figure 2.** From **Figure 2**., it can be seen that the feed conversion value from the largest to the smallest is starting from treatment K (control) of 1, 47; then treatment A (pakcoy plant) was 1.33 and the smallest treatment B (kailan plant) was 1.21. Treatment B (kailan plant) had the smallest feed conversion ratio value, thus the best feed conversion value was in that treatment. The value of the feed conversion ratio will determine the effectiveness of the feed and also the production costs used for cultivation (Ariadi et al, 2020). According to Zainuddin et al, (2014) states that feed conversion ratio value is influenced by several factors, namely the feed quality and quantity, fish size and water quality.

Analysis from the series of research data results, it is shown that the treatment using kalian plants is considered to have a better level of cultivation effectiveness on aquaponic media than treatment using pakcoy plants. Kalian are a type of aquatic plant that is very efficient when cultivated with a running water system. Kalian plants are usually cultivated with a verticulture system on narrow land cultivation (Hidayati et al, 2018). Aquaponic aquaculture media that uses kalian plants have the highest specific growth rate because you are a type of plant that very quickly absorbs nutrients complect such as nitrates and phosphates (Kushayadi et al, 2018). Thus, the condition of the aquatic environment becomes more stable and the fish can grow optimally. Like with the FCR value, with optimal fish growth, the value of the feed conversion rate becomes more efficient.

In addition, the growth rate and the FCR efficiency value are also influenced by the conditions of the culture water quality parameters. Water quality parameters such as temperature, salinity, and alkalinity are some of the parameters that have a direct influence on the FCR value of aquaculture systems (Ariadi et al, 2020). Meanwhile, water quality parameters such as nitrite, dissolved oxygen, temperature, organic matter (TOM), and density of vibrio bacteria are some of the parameters that affect the growth rate of organisme cultivated during the aquaculture periods (Ariadi et al, 2019). So that the effectiveness of Kalian plants in aquaponic aquaculture, a part from being influenced by the biological properties of the plants themselves, is generally also influenced by the water quality stability during the research period.

Conclusion

Based on the results of this study, the application of kalian plant use in the aquaponic system of tilapia culture is considered more effective than pakcoy with an effective SGR value at 3.15% and an FCR value at 1.21.

Future Research

Based on the research results, the best conclusion are obtained, namely the treatment of kailan plants, so it is more advisable to use kailan plants compared to pakcoy plants in the aquaponics system. In addition, further research is needed on the analysis of aquaponic business using kailan plants, as well as comparing with other plants, different types of fish, planting media and different aquaponic recirculation models.

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