The Effect of Protein Source Containing Diet on Growth and Feed Efficiency of Tilapia (*Orechromis niloticus*)

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ABSTRACT
Nile tilapia is of high economic value and has the potential to be cultivated. The problem that often arises in tilapia cultivation is the lack of optimal use of the feed given. The purpose of this study was to find out growth performance, feed efficiency and health status of nile tilapia during culture period. The method used was a completely randomized design (CRD) with four treatments and every treatment with four replications. The combination of treatment protein content (25 and 35% dry matter basis) and source of protein (fish meal and non-fishmeal). The stocking density of the aquaria is 15 individuals with average weight of 15 g. During the cultured period of 30 days, fish fed by formula diet of 3% biomass per day. Sampling of fish per aquaria was conducted for 10-days for fish growth and feed adjusted accordingly, in the same time TAN, nitrite and nitrate were also measured. While for temperature, DO and pH were daily monitoring. The results showed that the growth rate and feed efficiency of fish with 35% protein from fishmeal gave better performance 30% than that of others feed ($P<0.05$).

Keywords: *"Diet formula", "fishmeal and non-fishmeal protein", "growth", "tilapia"*

1. INTRODUCTION

Tilapia (*Oreochromis niloticus*) is a high economic value and has potential to be cultivated. According to data from KKP, total fisheries production in 2022 will be 5.89 million tons. This value consists of catching fisheries of 1.90 million tons and cultivated fisheries of 2.72 tons supported by Kementrian Kelautan dan Perikanan (KPP) [1]. Tilapia production reached 1.12 million tons or 31.94% from freshwater cultivated fisheries total production in Indonesia supported by A. R. Niode, Nasriani, dan A.M [2]. Tilapia is one of the fish that people are interested in because it has low cholesterol level and high protein level of 17.7% and fat level of 1,3% supported by Amaliah S et al [3].
An Important factor and determines success in cultivation activities is feed supported by Mopangga et al [4]. Feed is important because feed is an energy source for growth support. The main factor to maximum production also comes from feed. Feed that is classified as good if the feed has high nutrition, can be obtained and processed easily, easily digested by fish and has a relatively cheap price, doesn't contain toxins and compete with human needs supported by Anggraeni NM et al [5].
Fish feed consists of two types, natural feed and artificial feed, supported by Niode et al [2]. Natural feed is usually used in live form, while artificial feed can be interpreted as feed derived from processed materials whose nutrients are in accordance with the needs of fish, for example, pellets supported by R. Zaenuri et al [6]. Artificial feed can also be defined as feed made with a certain formulation based on the balance of the manufacturer. Artificial feed has some benefits i.e, the nutrition or protein content can be adjusted based on the fish needed, more durable, and the shape or size can be adjusted with the fish mouth, supported by Niode et al [2].
Protein is the main nutrient in feed. Protein is closely related to fish growth. Protein is often used as an indicator of feed quality supported by E. Tahaptari et al [7]. If the protein in the feed is high, it will make the accumulation of protein in the body of the fish to be high as well supported by Wahyudi R et al [8]. The problem that often arises in tilapia cultivation is the lack of optimal use of the feed given. The addition of fish meal to artificial feed is expected to overcome problems in aquaculture, especially tilapia cultivation supported by Safia WO et al [9].
Providing nutrients in the feed will result in optimal growth and feed efficiency. Fish meal has 60% protein and the most common raw material in manufacture of fish feed and main protein source that has not been replaced by Lestari SF et

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al [10]. The purpose of this study was to find out growth performance and feed efficiency of tilapia during culture period.

2. MATERIAL AND METHODS

This research was conducted from May to June 2023, at the Aquaculture Laboratory, Faculty of Fisheries and Marine Science, Universitas Brawijaya.
The method used was a completely randomized design (CRD) with four treatments and every treatment with four replications. The treatments are described as follows:
A : Treatment with protein content 25%, fish meal source of protein
B : Treatment with protein content 25%, non-fishmeal source of protein
C : Treatment with protein content 35%, fish meal source of protein
D : Treatment with protein content 35%, non-fishmeal source of protein
This study used 240 Tilapia with an average weight of 15 g. The stocking density of the aquarium is 15 fish. Test feed in this study is the form of dry pellets consisting of a combination of treatment protein content (25 and 35% dry matter basis) and source of protein (fish meal and non-fishmeal). The pellet size is adjusted to the fish mouth opening of 3 mm. Composition of the ingredients in test feed is shown in Table 1.
The procedure of this research went through three stages, namely, preparation, manufacture of feed, and implementation. The process of making feed includes preparation of raw materials, grinding of coarse raw materials using a grinding machine to a flour texture, balancing raw materials, mixing, molding dough using a molding machine, and ovens with a temperature of 60^0C for 24 hours. After making the pellets, a proximate analysis is carried out to determine the nutrients contained in the feed that has been made.
During the cultured period of 30 days, fish fed by formula diet of 3% biomass per day. Sampling of fish per aquaria was conducted for 10-days for fish growth and feed adjusted accordingly, at the same time TAN, nitrite and nitrate were also measured using test-kit. While for temperature, DO and pH were daily monitoring.

2.1 Main Parameters

2.1.1 Weight Growth

Weight growth is the difference between the weight of the fish at the end and the weight of the fish at the start of the research. Weight growth can be calculated by the formula. Supported by N.L.A.G. Astriani et al [11]:

$$Wm = Wt - Wo \quad (1)$$

Description:
Wm : Absolute weight growth (g)
Wt : Average weight at the end of the research (g)
Wo : Average weight at the start of the research (g)

2.1.2 Specific Growth Rate

Specific growth rate is the percent (%) difference between final weight and initial weight, then divided by the length of time of maintenance. Specific growth rate can be calculated by the formula supported by Mulqan, M et al [12]:

$$SGR = \frac{Ln\,Wt - Ln\,Wo}{t} x\ 100\ \% SGR = \frac{Ln\,Wt - Ln\,Wo}{t} x\ 100\ \% \quad (2)$$

Description:
SGR : Specific growth rate (%)
Wt : Average weight at the end of the research (g)
Wo : Average weight at the start of the research (g)
t : Duration of research (day)

2.1.3 Feed Conversion Ratio

Feed conversion ratio is a measure that expresses the ratio of amount of feed required to produce 1 kg of fish meat. Feed conversion ratio can be calculated by the formula supported by Rohma, A et al [13]:

$$FCR = \frac{F}{(Wt + D) - Wo} \quad (3)$$

Description:
FCR : Feed conversion ratio
F : Total feed consumed (g)
Wt : Average weight at the end of the research (g)
Wo : Average weight at the start of the research (g)
D : Dead fish weight during the research (g)

2.1.4 Feed Efficiency

The ratio of weight gain to feed consumed and expressed in percent is feed efficiency. Feed efficiency can be calculated by the formula supported by Rohma, A et al [13]:

$$FE = \frac{(Wt + D) - Wo}{F} \; x \; 100\% \quad (4)$$

Description:
FE : Feed efficiency (%)
F : Total feed consumed (g)
Wt : Average weight at the end of the research (g)
Wo : Average weight at the start of the research (g)
D : Dead fish weight during the research (g)

Table 1. Feed Test Ingrediens

Ingredient Name	A (g)	B (g)	C (g)	D (g)
Corn Yellow	14.3	13.6	16.7	16.8
Rice Bran	20.0	20.0	2.29	1.84
SBM 46%	33.3	34.0	31.2	32.5
DDGS	5.0	5.0	5.0	5.0
Oil	1.14	1.12	3.5	3.5
Corn Gluten	30.0	6.0	20.0	20.0
Poultry	3.0	6.0	5.0	3.0
Pollard	10.0	10.0	0.98	0.11
Cassava	9.5	9.5	9.5	9.5
Fish Meal 60%	30.0	0	50.0	0
Vitamin	0.05	0.05	0.05	0.05
Mineral	0.1	0.1	0.1	0.1
CMC	0.5	0.5	0.5	0.5

2.1.5 Survival Rate

Survival rate is the percentage of living biota at the end of the research time. Survival rate can be calculated by the formula, supported by Niode et al [2]:

$$SR = \frac{N_t}{N_O} \; x \; 100\ \% \quad (5)$$

Description:
SR : Survival rate (%)
Nt : Number of fish survived at the end of the research
No : Whole number of the beginning

2.2 Support Parameters

The supporting parameters in this study were water quality, temperature, pH, dissolved oxygen (DO), ammonia, nitrite, and nitrate. Temperature, pH, and DO measurements were taken daily. While ammonia, nitrite, and nitrate were measured every ten days. The results of water quality measurements in the form of temperature, pH, DO, ammonia, nitrite, and nitrate were recorded for descriptive analysis.

2.3 Data Analysis

The data obtained from the research result were analyzed using IBM SPSS program ver. 26. The research data will be processed using the SPSS program with a confidence level of 95% or 0.05 to carry out the-F test, the results of which can be seen in the ANOVA table. After the-F test, if the test results show different effects, the data will be further analyzed with the Duncan's Multiple Range Test. The results of water quality measurements in the form of temperature, pH, DO, ammonia, nitrite, and nitrate were recorded for descriptive analysis.

3. RESULT

3.1 Main Parameters

3.1.1 Weight Growth

The combination of treatment protein content and source of protein had a significant effect on absolute weight growth ($P<0.05$). Treatment with protein content 35%, fish meal source of protein able to increase the absolute weight of tilapia. The highest result was aimed at treatment C with an average weight growth of 208.65 g. These results prove that increasing fish growth can be done by giving feed that can function as an energy supplier to enhance growth and maintain fish survival, supported by Rohma A et al [13]. The growth performance of experimental fish shown in Table 2.
The existence of increase in average individual weight shows that all the feed tested can be utilized by fish for growth. This is caused by the allocation of energy that comes from feed for growth after the energy needs for maintenance of fish meat, supported by Lestari SF et al [10]. Protein is the most important element in determining feed quality. Proteins contained in the form are needed to build the body and growth of fish. The main function of protein sources is as a source of energy that has a role in fish growth and plays an important role in replacing damaged body tissues supported by S.W Pawhestri et al [14].

3.1.2 Specific Growth Rate (SGR)

The combination of treatment protein content and source of protein had an effect on specific growth rate ($P<0.05$). Treatment with protein content 35%, fish meal source of protein able to increase the specific growth rate of tilapia. The highest result was aimed at treatment C with a specific growth rate of 0.91%.

Table 2. The Growth Performance of Experimental Fish (± standart deviation)

Treatments	Weight Growth (g)	SGR (% BW.day^{-1})	FCR	Feed Efficiency (%)	Survival Rate (%)
A (FM_25%)	179.18±0.57^{a}	0.81±0.02^{d}	1.6±0.03^{d}	75.4±0.03^{b}	100±0.00^{a}
B (NFM_25%	172.99±0.49^{c}	0.78±0.08^{b}	1.5±0.09^{c}	71.3±0.09^{a}	100±0.00^{a}
C (FM_35%)	208.65±0.44^{d}	0.91±0.06^{c}	1.3±0.08^{b}	82.5±0.08^{c}	100±0.00^{a}
D (NFM_35%)	192.86±0.74^{b}	0.86±0.03^{a}	1.4±0.07^{a}	74.9±0.07^{d}	100±0.00^{a}

Note: The different notation between the number indicated a significant difference ($P<0.05$)

The results showed that the average value of specific growth rate of tilapia each treatment has different results at each sampling. The acquisition of different specific growth rate results is caused by different levels and protein sources that can increase the specific growth rate of tilapia. Protein is an essential nutrient for sustaining life and increasing growth of fish. High protein can increase growth due to the availability of sufficient protein after the breakdown of existing proteins in body tissues to maintain the main functions and replace cells that have died, supported by Lestari SF et al [10].

3.1.3 Feed Conversion Ratio (FCR)

The combination of treatment protein content and source of protein had an effect on feed conversion ratio ($P<0.05$). Treatment with protein content 35%, fish meal source of protein able to increase the feed conversion ratio of tilapia. The highest result was aimed at treatment C with an average feed conversion ratio (FCR) of 1.3.
The results showed that the average value of feed conversion ratio of tilapia in each treatment had different results in each sampling. Different FCR results are caused by different levels and protein sources. A good feed conversion ratio for tilapia ranges from 0.8 – 1.6. If the FCR value is low, it means the quality of the feed given is good. Conversely, if the FCR value is high, it means the quality of the feed given is not good, supported by Irawati, D [15].

3.1.4 Feed Efficiency (FE)

The combination of treatment protein content and source of protein had an effect on feed efficiency (P<0.05). Treatment with protein content 35%, fish meal source of protein able to increase the feed efficiency of tilapia. The highest result was aimed at treatment C with an average feed efficiency of 82.5%.
The different feed efficiency values are due to the different levels and sources of protein in the feed given to tilapia. The greater the feed efficiency value, the more efficient the fish is to utilize the feed consumed for growth, supported by Iskandar, R et al [16]. Feed efficiency is also affected by the amount of feed given to the fish. The smaller the amount of feed, the more efficient it will be.
Feed efficiency is useful for comparing the value of feed that supports weight gain. Feed efficiency changes with feeding rate and fish size. Feed efficiency can be influenced by several factors including feed quality, feed quantity, fish species, fish size, and water quality of the fish supported by Amalia, R et al [17].

3.1.5 Survival Rate (SR)

This study shows that the results of the average value of survival of tilapia in each treatment have the same results. Different levels and sources of protein have no effect on survival in tilapia (P>0.05). The results obtained from the calculation of survival rate is 100%. This means, during the maintenance there was no death in the test fish (Tilapia). Percentage of survival rate in tilapia can be influenced by several factors including human handling, the ability of organisms to adapt, age, disease, density, and competitors, supported by Pawhestri et al [14].

3.2 Support Parameters

The temperature measurement results obtained the highest result of 24.8^{0}C and the lowest result of 24.6^{0}C. A good temperature range for keeping tilapia is 24 - 32^{0}C supported by Azhari, D et al [18]. The pH measurement results obtained the highest result of 7.73 and the lowest result of 7.70. pH that is too high (very alkaline) or too low (very acidic) can interfere with the life of tilapia. Tolerance of pH values in tilapia is 6-9, but for optimal growth and development is in the range of 7-8 supported by Sihombing, P et al [19]. Result of water quality measurement during the study shown in Table 3.
The results of dissolved oxygen (DO) measurements obtained the highest result of 5.81 mg/L and the lowest result of 5.74 mg/L. Tilapia can grow optimally if the tilapia is in the range of 4 - 7 mg/L dissolved oxygen, supported by Zhang, L et al [20]. Low DO levels can disrupt growth, metabolism, and disease resistance. Tilapia growth can be optimized if DO levels are more than 3 ppm. Low and persistent DO levels can cause fish to lack oxygen, leading to death supported

Table 3. Water Quality Measurement during The Study

Variable	A (FM_25%)	B (NFM_25%)	C (FM_35%)	D (NFM_35%)
Temperature (^{0}C)	24.8	24.6	24.6	24.5
pH	7.70	7.73	7.71	7.71
Dissolved Oxygen (mg/L)	5.79	5.74	5.81	5.76
Ammonia (mg/L)	0	0	0	0
Nitrite (mg/L)	0	0.05	0	0
Nitrate (mg/L)	0	1	0.05	0

by Yanuar, V [21].
The results of ammonia measurements taken using test-kit in this study obtained a result of 0 mg/L in each treatment. This value is considered a good value for the life of tilapia. This is because the flushing of the aquarium is done every day in the afternoon and the water in the aquarium is always changed. Ammonia levels can be toxic to tilapia when ammonia concentrations are above 1.5 mg/L supported by Wiriyapattanasub et al [22]. High ammonia levels can cause fish to experience hyperplasia or accumulation of mucus in the gills. So, the fish will have difficulty breathing which will then cause the fish to become stressed until death occurs supported by Siegers, W. H. et al [23].
The nitrite measurement taken using test-kit in this study obtained the highest result of 0.05 mg/L and the lowest result of 0 mg/L. The nitrite value in this study is classified as good. Nitrite levels of more than 0.05 mg/L can be toxic to the life of tilapia supported by Siegers, et al [24]. Nitrite levels that exceed the threshold value will be toxic to fish and cause fish suffocation. Fish suffocate because the fish are poisoned by nitrite.

The nitrate measurement taken using test-kit in this study obtained the highest result of 1 mg/L and the lowest result was 0 mg/L. The nitrate value in this study is classified as good. Nitrate has stable properties, is easily soluble in water, and is not toxic to aquatic organisms supported by Wahyuningsih, S et al [25]. Nitrate levels in this study can be tolerated by tilapia. The maximum level for fisheries purposes is 10 mg/L, but the optimum nitrate level for tilapia is less than 5 mg/L. Although nitrate is not toxic, nitrate levels have an influence on fish growth, as dissolved oxygen levels in the water are caused by high nitrate levels supported by Ombong, F [26].

4. CONCLUSIONS

The combination of treatment protein content (25 and 35% dry matter basis) and source of protein (fish meal and non-fishmeal) affect the growth and feed efficiency of tilapia. Treatment with protein content 35%, fish meal source of protein was the best treatment in this research.

AUTHORS' CONTRIBUTIONS

FO. Afifah, A. Yuniarti, IMD. Mahariawan, and AM. Hariati conceived of the presented idea. FO. Afifah developed the theory and performed the computations. A. Yuniarti, IMD. Mahariawan, and AM. Hariati verified the analytical methods. All authors discussed the results and contributed to the final manuscript.

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