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EFFECTIVENESS OF EARTHWORM (LUMBRICUSRUBELLUS) SUBSTITUTION FLOUR IN FEED FORMULATION ON SPECIFIC GROWTH RATE, FEED CONVERSION RATIO AND FEED EFFICIENCY OF NILE TILAPIA (OREOCHROMIS NILOTICUS)

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ABSTRACT

The production of Nile Tilapia (Oreochromis niloticus) is quite significant but the unstable quality of feed and the uncertain supply increase the demand of fish flour. The aim of this study is to find out the substitution of fish flour to earthworm (Lumbricusrubellus) flour on specific growth rate, feed conversion ratio and feed efficiency of Nile Tilapia. The study was experimental study using a completely randomized design (CRD) with five treatments and four replications. The concentration of worm flour was P0 (0%), P1 (30%), P2 (35%), P3 (40%), and P4 (45%). The parameters observed were specific growth rate, feed conversion ratio and feed efficiency. Data analysis used ANOVA. The results show that the addition of worm flour in feed formulations of Nile Tilapia for 45 days could increase specific growth rate, feed efficiency and could reduce feed conversion ratio. The fastest growth rate is in P4 treatment (mean = 2.31%) which was added of 45% worm flour. The lowest feed conversion ratio is in P4 treatment (1.26). The best feed efficiency is P4 treatment (79.06%). The substitution of fish flour into earthworm flour at a dose of 45% in fish rations can be used to increase the specific growth rate and feed efficiency and can reduce the feed conversion ratio.

Keywords: Earthworm *(Lumbricusrubellus),* Nile tilapia (*Oreochromis niloticus),* Specific growth rate, feed conversion ratio, Feed efficiency

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1. INTRODUCTION

Nile Tilapia (Oreochromis niloticus) is one of the potential freshwater fish species in aquaculture because it is classified as a fish that has a high tolerance to the environment (Mireku et al. 2018; Soegianto et al. 2017; Zainuddin et al. 2017) so it can be nurtured in brackish watery lowlands or plateau with low temperature. Production of Nile Tilapia is significant (Soto et al. 2011) specifically in Indonesia, as the largest fish producer in Southeast Asia(Matsuoka, Shizuka & Koike 2018) from 2010 - 2014 has increased by an average of 19.03%, with a mean of annual increase in production of 11.47%. In 2012 production of Nile Tilapia reached 695,000 tons, while in 2014 it reached 1,440,000 tons (Aquaculture 2014).

Feed is one of the most important elements in aquaculture activities which is aim to support the growth and survival of aquaculture fish, especially Nile Tilapia. This has an impact on the high interest in fulfilling fish feed needs. In Indonesia, fish feed needs for 5 years (2010-2014) are calculated as 6 million tons (Aquaculture 2014). Fish cultivation is strongly influenced by the availability of sufficient food in quantity and quality to support maximum quality. Feed factor determines production costs so it needs effective and efficient processing. The formulation of a fish feed must meet the nutritional needs of fish cultivated in terms of protein requirements (essential ammonia acid), fats (essential fatty acids), energy, vitamins and minerals (Watanabe, Ellis & Chaves 2001). So, feed formulation that can meet the nutrition needs for fish is needed., The problems in increasing food security for animal products are the provision of fish cultivation which are expensive and difficult to obtain. So far, the source of animal protein in the preparation of fish rations still comes from fish flour, mostly still imported from abroad. Feed in a cultivation process costs a considerable amount of total production costs (Anderson et al. 1997). The increasing demand of fish flour, unstable supply (Cook et al. 2000), erratic quality and quite expensive prices - compared to other protein sources causes in the need to find alternative protein sources as a substitute for fish flour.

One of alternative protein source substitutes for fish flour is earthworm flour. Earthworm (*Lumbricusrubellus)* can be used for alternative feed for fish flour (Jatmiko et al. 2018) because it is a protein source (Janković et al. 2015) with fairly complete source of amino acid. Earthworms are animals that have a potential to become feed source with high protein. Nutritional content of earthworms is BK 100%, crude protein 60-65%, fat 11%, ash 6%, fiber 0.19%, water 85.46% (Fadaee 2012).

The study therefore aims to determine the effect of substitution of fish flour with earthworm (*Lumbricus rubellus*) flour on the growth and survival of Nile Tilapia (*Oreochromis niloticus).*

2. MATERIALS AND EXPERIMENTAL PROCEDURES

2.1. Preparation of *Oreochromis Niloticus* and Rearing Conditions

The study was conducted in January 2018 until February 2018 and located in Faculty of Fisheries and Marine, Airlangga University, Surabaya,Indonesia. Proximate analysis of feed ingredients was carried out at the Feed Laboratory of Faculty of Veterinary Medicine, Airlangga University, Surabaya,Indonesia. The tools used in the study were 20 pieces of 50 x 30 x 20 cm^3 aquarium, blowers, aeration, aeration hoses, aeration, trays, mills, pellets, baking sheets, digital scales, seser, plastic, spoons, sipon tools , filter, ruler, oven. 5-7 cm of Nile Tilapia (Oreochromis niloticus) obtained from the Gunungsari fish market in Surabaya. There are 5 treatments and 4 replications, one aquarium was filled with 10 fish, so it takes 200 fish.

The materials of this study were earthworm flour, fish flour, fish oil, soybean meal flour, bran flour, corn flour, cmc and vitamin mix.

2.2. Experimental Diets

This study is experimental study using a completely randomized design (CRD). The independent variables in this study are doses of earthworm flour in feed that is 0%, 30%, 35%, 40%, 45%. The controlled variables in this study are 5-7cm fish size, temperature, pH, ammonia, and feed. The dependent variables in this study are specific growth rates, feed efficiency and feed conversion ratio. This study used 5 treatments, each treatment received 4 replications so there were 20 experimental units.. The treatments in this study are:

P0 : 100% fish flour + 0% worm flour

P1 : 70% fish flour + 30% worm flour

P2 : 65% fish flour + 35% worm flour

P3 : 60% fish flour + 40% worm flour

P4 : 55% fish flour + 45% worm flour

The protein content of feed is formed based on isoprotein. The content of feed protein made is 30%. Forming of treatment ration P0 to get 30% crude protein then requires 40% fish flour and 0% worm flour.

Earthworms (*Lumbricusrubellus*) are washed, steamed, and then drained. After that, put it in the oven. Feed ingredients (soybean meal flour, bran flour, fish oil, earthworm flour, corn flour, cmc, vitamin mix) were ground and sifted and then mixed into one. Materials in the form of flour were mixed from the smallest to the largest amount and so on. The half-finished pellets were dried at 30oC for 24 hours using an oven. Dry feed was carried out by proximate analysis.

2.3. Analytical Procedure of the Diets

Nile Tilapia was maintained in a 50 x 30 x 20 cm^3 aquarium. One aquarium was filled with 10 fish, fish were kept for 30 days. Feeding had done three times a day, in the morning, afternoon and evening. Pond cleaning was carried out in the morning during maintenance.

Specific growth rate of Nile Tilapia (Muchlisin ZA, A D, R F, Muhamaddar 2003):

$$SGR = \frac{In(Wt) - In(Wo)}{t} x100\%,$$

SGR= specific growth rate,

Wt= initial mean weight of fish

W_0 = final mean weight of fish

t = duration of experiment

Feed Efficiency (Tacon 1987):

$$FE = \frac{Wt - Wo}{F} \; X \; 100\%$$

FE = Feed Efficiency (%)

Wt = final biomass (gram)

W_0 = initial biomass (gram)

F = feed (gram).

Feed Conversion Ratio:

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

FCR= Feed Conversion Ration
F = feed fed (gram)
Wt. = final biomass (gram)
D = dead fish weight (gram)
W_0 = initial biomass (gram).

2.4. Statistical Analysis

Data of Specific Growth Rate, Feed Conversion Ratio, and Feed Efficiency of Nile Tilapia were analyzed by *Analysis of Variance* (ANOVA). If the results of the statistical analysis show that the effect is significantly different or very different, it is followed by Duncan's Multiple Distance Test.

3. RESULT AND DISCUSSIONS

The results of specific growth rate, feed conversion ratio and feed efficiency of nile tilapia for 45 days can be seen in table and graph 1.

Table 1 The Mean of Specific Growth Rate, Feed Conversion Ratio, and Feed Efficiency of Nile Tilapia.

Treatments	Specific Growth Ratio (%) ± SD	Feed Conversion Ratio ± SD	Feed Efficiency (%) ± SD
P0	$2,1093^{a} \pm 0,11141$	$1,50^{a} \pm 0,04435$	$66,48^{a} \pm 1,197527$
P1	$2,1030^{a} \pm 0,08163$	$1,45^{b} \pm 0,02630$	$68,62^{b} \pm 1,25704$
P2	$2,1860^{a} \pm 0,01117$	$1,38^{c} \pm 0,01414$	$72,46^{c} \pm 0,74011$
P3	$2,2145^{ab} \pm 0,02367$	$1,33^{d} \pm 0,01708$	$74,76^{d} \pm 0,95105$
P4	$2,3133^{b} \pm 0,09040$	$1,26^{e} \pm 0,02380$	$79,06^{e} \pm 1,49062$

* P0 (0% worm flour), P1 (30% worm flour), P2 (35% worm flour), P3 (40% worm flour), P4 (45% worm flour). Different superscripts show significant differences (p<0, 05).

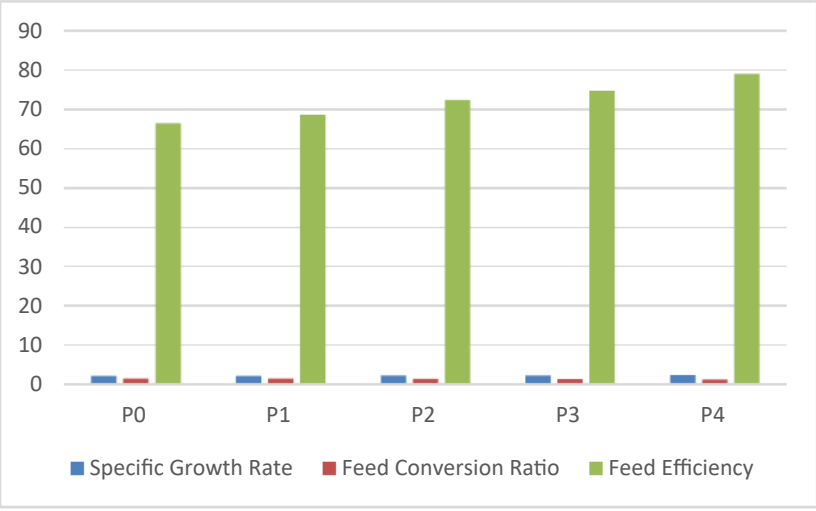

Figure 1. The Mean of Specific Growth Rate, Feed Conversion Ratio, and Feed Efficiency of Nile Tilapia

Data shows the specific growth of tilapia for 45 days in P0, P1, P3 treatments significantly different with P4 treatment.

Result of ANOVA test shows that the substitution of fish flour with worm flour showed a difference ($p < 0.01$) on the feed conversion ratio of Nile Tilapia, so it was continued to Duncan's Multiple Range test. Table 1 show that all treatment was significant difference and P4 treatment is the best treatment with 45% worm flour. The result of Duncan's Multiple Distance Test show that the best feed conversion ratio value was P4 treatment (mean = 1.26) and the highest feed conversion ratio value was P0 treatment (mean = 1.50). Feed Efficiency showed significance differences to all treatments (P0, P1, P2, P3, and P4) and P4 treatment was the best treatment with 45% worm flour.

Data of water quality of Nile Tilapia maintenance can be seen in Table 2.

Table 2 Range of water quality in 45 days of Nile Tilapia maintenance

Parameters	Range
Temperature (^{0}C)	26-30
pH	7-8
DO (mg/l)	4-6
Ammonia (mg/l)	0-0,5

The water quality parameters observed were temperature, pH, DO and ammonia levels in tilapia for 45 days. The results showed that temperatures ranged from 26-300C, pH (degree of security) ranged from 7-8, DO (dissolved oxygen levels) ranged from 4-6 mg / l and ammonia ranged from 0-0.5 mg / l.

Specific growth rate is very important to observed because it is related to the percentage of weight of Nile Tilapia per day (Hopkins 1992). Specific growth rate is closely related to feed. Feeds that meet high nutritional requirements can affect the fish growth (Rosenlund et al. 2004; Slawski et al. 2011), for example earthworm (Lumbricusrubellus) flour. Based on statistical calculations, it can be seen that the mean value of specific growth rates for all treatments in Nile Tilapia ranges from 2.10% -2.31%. The highest specific growth rate was obtained in P4 treatment (mean = 2.31%) which was added of 45% worm flour. The lowest specific growth rate was obtained in P0 treatment (mean=2.09%) which was added of 0% worm flour.

Substitution from fish flour to worm flour is best obtained in P4 treatment with 45% worm flour. This is because the worm flour contains lysine. The need of lysine for herbivore and omnivore fish is 2.07% (FAO 2014). Worm flour used as feed ingredients contains 2.92% lysine so the need of lysine for Nile Tilapia is sufficient. The feed which was used contains the same protein so that the use of 45% worm flour can increase the specific growth rate of Nile Tilapia because the worm flour contains a lot of lysine. Addition of worm flour with different doses will reduce protein levels and increase energy in each treatment. The lowest of decrease in protein was in P4 treatment (33.67%) while the energy produced was 3258.53 kcal / kg. High energy can reduce feed consumption levels, but this decreasing is followed by an increasing specific growth rate so it can reduce FCR. The low protein value in P4 treatment can increase specific growth rate because it contains high lysine.

The right amount of energy and protein will produce good growth and feed conversion ratio. The use of feed with suitable protein will cause fish growth and increase feed ratio (Goddard 1996; Jobling 1994). The smaller Feed Conversion Ratio indicate the higher level of feed utilization. Conversely, if the growth value is decrease, then the feed conversion ratio

will increase (Hung et al. 1989; Storebakken & Austreng 1987). So, the higher feed conversion ratio had shows that the feed given is more ineffective for Nile Tilapia. The results of statistical tests show that the value of the feed conversion ratio for all treatments is ranging from 1.26 to 1.5. The highest feed conversion ratio (1, 5) was obtained in P0 treatment with the addition of 0% worm flour or without the addition of worm flour. This means that to produce 1kg of tilapia requires around 1.5kg of feed. The higher FCR value, the more feed needed to produce 1kg of fish flour (Effendie 1997). Feed conversion ratio in P0 (1.5), P1 (1.45), P2 (1.38), P3 (1.33) was higher than P4 (1.26). This is because the feed provided in P4 was well utilized by Nile Tilapia so the nutrients can be absorbed properly and the growth rate obtained is high. In P4 treatment, energy in feed is high so the level of feed consumption is low. However, the use of 45% worm flour which contains high lysine can increase the Specific Growth Rate and reduce the Feed Conversion Ratio.

Feed Efficiency shows the quality of feed that can be digested properly by fish. Feed Efficiency values are related to the rate of growth of fish because the higher value of feed Efficiency, the better response of fish to feed as indicated by rapid fish growth(Thodesen et al. 2001). The results of statistical calculations show that feed efficiency for all treatments in Nile Tilapia is ranged from 66.48 to 79.06%. The highest feed efficiency (79.06&) was obtained in P4 treatment with 45% worm flour. The lowest feed efficiency (66.48%) was obtained in P0 treatment with 0% earthworm flour or without addition of worm flour.

Water quality affects the success of fish cultivation. Water quality can be defined as the water suitability for the fish survival and fish growth which is generally determined by several water quality parameters (Albert K. Imsland et al. 2007; Albert Kjartansson Imsland et al. 2007; Karås & Klingsheim 1997). Water quality parameters include temperature, pH, dissolved oxygen and ammonia. Temperature measurements had carried out every day. The temperature range of maintenance media during the study was between 26^{o}C-30^{o}C considering the optimal water temperature needed for nile tilapia ranged from 25-30^{o}C (Al-Asgah & Ali 1997). The water temperature in maintaining tilapia for 45 days was still in a condition that meets the requirements. The degree of acidity (pH) of water during the study ranged from 7-9 in accordance with the pH range required by tilapia ranging from 7-9 (Ross 2000). Thus pH at maintenance was still in good condition. Factor which affects the growth of stunted fish is pH. The degree of acidity (pH) which is too low or too high can cause fish to become stressed so its growth becomes hampered. Important parameter of other water quality is oxygen, considering oxygen is needed for respiratory and fish metabolism. Dissolved oxygen (DO) in water media during the study ranged from 4-7 mg / l. The range of DO during the maintenance period was still in a good range for nile tilapia (Makori et al. 2017).

4. CONCLUSION

The results of study which conduct the substitution of fish flour to earthworm (Lumbricusrubellus) flour can be concluded that the substitution of fish flour to earthworm (Lumbricusrubellus) flour until 45% of the total use of fish flour in Nile Tilapia ration can increase Specific Growth Rate, Feed Efficiency and can reduce Feed Conversion Ratio.

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