Open Science and Technology
Vol. 03 No. 01, (39-54)
ISSN (Print) :2776-169X
ISSN (Online) :2776-1681

The Effect of Using a Mixture of Maggot (*Hermetia illucens*) and Wolffia (*Wolffia arrhiza*) Flour on the Growth of Tilapia (*Oreochromis niloticus*)

Pengaruh Penggunaan Campuran Tepung Belatung (*Hermetia illucens*) dan Wolffia (*Wolffia arrhiza*) terhadap Pertumbuhan Ikan Nila (*Oreochromis niloticus*)

Budi Prasetyo[1,2*], Anisa Risqi Romadhona[2], Marlina Kamelia[2], Mahmud Rudini[2]
[1]Program Pascasarjana Pendidikan Biologi Universitas Muhammadiyah Metro, Indonesia
[2]Program Studi Pendidikan Biologi, Universitas Islam Negeri Raden Intan Lampung, Indonesia

*email: budiprasetyo558@gmail.com

Submitted:10 September 2023 Accepted: 12 October 2023 Published: 14 October 2023

ABSTRAK
Nila merupakan salah satu komoditas ikan air tawar yang banyak digemari oleh masyarakat, dikarenakan ikan ini memiliki tekstur daging yang tebal serta rasa yang lezat. Dalam usaha budidaya ikan nila, pakan merupakan salah satu hal yang kerap menjadi permasalahan, dikarenakan harga pakan yang terus mengalami peningkatan yang disebabkan oleh terus meningkatnya harga tepung ikan sebagai sumber protein utama. Belatung dan wolffia merupakan salah satu bahan alam yang dapat dijadikan alternatif pengganti tepung ikan karena keduanya memiliki kandungan protein cukup tinggi. Penelitian ini dilaksanakan pada Januari 2021 selama 30 hari di Desa Batu Raja, Kecamatan Sungkai Utara, Kabupaten Lampung Utara. Penelitian ini menggunakan rancangan acak lengkap dengan 4 perlakuan dan 4 pengulangan. Populasi dalam penelitian ini berupa 160 ekor ikan nila dengan parameter pengamatan meliputi pertumbuhan bobot mutlak, laju pertumbuhan spesifik (SGR), panjang mutlak, nilai konversi pakan (FCR), suhu air, dan pH air. Data dianalisis dengan uji ANOVA, dilanjutkan dengan uji BNT. Hasil penelitian menyatakan bahwa perlakukan P3 (70% tepung belatung dan 30% tepung wolffia) memberikan hasil terbaik, yaitu rerata pertumbuhan bobot mutlak 8,75 gr, nilai SGR 29,25%, rerata pertumbuhan panjang mutlak 4,1 cm, dan nilai FCR 3,6. Parameter kualitas air menunjukkan rerata suhu 28 °C dan pH 6,77.

Kata kunci: Magot, Ikan Nila, Pertumbuhan, Wolffia

ABSTRACT
Tilapia is one of the most popular freshwater fish commodities, owing to its thick meat texture and delicious taste. Rations procurement becomes one of the problematic things in tilapia farming business, because the rations price is continuously increase due to the increasing price of fish meal as the main source of protein. Maggot and wolffia are natural ingredients that can be used as an alternative to fish meal because both contain high protein. This study was conducted in January 2021 for 30 days in Batu Raja Village, North Sungkai Subdistrict, North Lampung. This study employed complete randomized design with 4 treatments and 4 replications. The observed population were 160 tilapia with observation parameters consisted of absolute weight growth, specific growth rate (SGR), absolute length growth, feed conversion value (FCR), water temperature, and water pH. Data were analyzed using ANOVA test, followed by LSD test. The best results were achieved by P3 treatment (70% maggot flour and 30% wolffia flour), which has generated the average absolute weight growth of 8.75 gr, SGR value of 29.25%, average absolute length growth of 4.1 cm, and FCR value of 3.6. Water quality parameters showed the average temperature of 28°C and pH of 6.77.

Keywords: *Growth, Maggot, Tilapia, Wolffia.*

INTRODUCTION

Nowadays, fish farming has increasingly being conducted, both intensively and extensively. Freshwater fish farming is an agribusiness activity that is inseparable from the fish rations industry. One of freshwater fishes favoured by farmers and consumers is tilapia (*Oreochromis niloticus*). Efforts to increase aquaculture production can be achieved by accelerating the growth of reared fish (Rangga et al., 2016). Aquaculture activities comprise various closely related factors, namely intensive water management, seed selection, rations management, also pest and disease control. Among those, the most economically decisive factor is rations management (Arsyadana et al., 2017). Fish meal is the main choice of protein source in fish rations formulations because fish meal has good digestibility and palatability (Rahmawati & Samidjan, 2013).

The increasing price of fish rations has resulted in a decrease in income earned by farmers, because it causes the increase in production costs. Rations procurement generally consumes the highest cost, namely 60–70% of the total production cost. Due to the continuously increasing price of fish rations, alternative rations are expected in order to overcome this problem. To date, fish meal is still the main source of protein in formulating fish rations (Ula & Eka, 2018). Despite this, one of the factors supporting the long-term success of fish farming is the availability of natural and artificial rations, two of which are maggot and wolffia (Azir et al., 2017).

A local natural ingredient that can be utilized as a source of animal-based protein in rations is maggot. Maggot flour is an alternative natural ingredient that exhibit almost the same nutritional value as fish meal. Maggot is a flower fly larva of the species *Hermetia illucens* (Black Soldier Fly larva) that is produced through a bioconversion process. As an alternative ingredient for rations, maggot exhibits various advantages, namely easy to obtain due to its wide availability, can tolerate high pH, does not carry or become a disease agent, and to obtain it does not require high technology (Kardana et al., 2012). Utilizing maggot to formulate rations can also reduce organic waste that can potentially pollute the environment (Amandanisa & Suryadarma, 2020). Maggot also contains antimicrobial and anti-fungal compounds, thus fish that consume it will be more resistant to diseases caused by bacteria and fungi (Azir et al., 2017).

In addition to maggot, the natural ingredient that can be used as an alternative to fish meal is wolffia as a source of plant-based protein. The advantages of wolffia are that it is easy to cultivate, does not require high costs, and contain higher nutritional value than other aquatic plants. *Wolffia arrhiza* plants possess a great opportunity as an alternative food ingredient (Arsyadana et al., 2017). Wolffia or catfish eyes can reproduce very quickly and can cover the entire water surface. Its productivity can reach 10–30 tonnes of dry weight per hectare (Gumiri, 2014). A comparison of the nutritional content of maggot flour, wolffia flour, and fish meal is presented in Table 1.

Table 1. Nutrient content comparison of maggot flour (Rahmawati & Samidjan, 2013), wolffia flour (Arsyadana et al., 2017), and fish meal (Jayadi & Rahman, 2018).

Maggot Flour	Wolffia Flour	Fish meal
10.79% water content	-	4.3% water content
43.42% protein content	34–45% protein content	60.1% protein content
17.24% fat content	5–7% fat content	6.5% fat content
8.70% ash content	-	6.7% ash content

18.82% coarse fiber content	10–11% coarse fiber content	-
-	Amino acid content: 2,7% metionine and cysteine; 7.7% phenilalanine and threonine; 4.8% lysine, leucine, valine, and isoleucine	22.4% carbohydrate content

Tilapia (*Oreochromis niloticus*) is one of the fishery commodities favoured by the community in fulfilling animal-based protein needs owing to its thick meat texture and good taste (Aliyas & Raihana, 2016). Tilapia can grow faster even though they are only given rations containing 20%–25% protein, while goldfish only grow well when the protein content in rations ranges from 30%–45% (Rina & Iskandar, 2015). In providing rations, it is necessary to pay attention to the amount of sufficient rations, timeliness, and nutritional content in accordance with the needs of fish. These nutrients include protein, fat, carbohydrates, vitamins, and minerals. Sources of nutrients can come both from natural and artificial rations. Artificial rations is one of the important supporting factors in improving the quality, growth, and survival of tilapia.

Indonesian national standards (SNI) had established quality requirements for tilapia rations in intensive rearing, namely rations must contain 12% moisture content for breeding and enlargement, 12% ash content for breeding and enlargement, 30% protein content for breeding and 25% for enlargement, 5% fat content for breeding and enlargement, 6% coarse fiber content for breeding and 8% for enlargement, a maximum of 0.20% free nitrogen content for breeding and enlargement, a maximum of 2 mm rations diameter for breeding and 2–5 mm for enlargement, the stability in water for floating rations is minimum 85%/15 minutes and for sinking rations is minimum 85%/15 minutes, a maximum of 20 µg/kg microbial content of aflatoxin B1 and 20 µg/gr *Salmonella* negative, a maximum of 1.2% total phosphorus content for breeding and enlargement (BSN, 2006).

This study was conducted as an attempt to explore the rations made from local natural ingredients as an alternative of fish meal in tilapia rearing. Therefore, this study aimed to determine the effect of using a mixture of maggot (*Hermetia illucens*) and wolffia (*Wolffia arrhiza*) flour on the growth of tilapia (*Oreochromis niloticus*).

METHODS

This study was conducted in Batu Raja Village, North Sungkai Subdistrict, North Lampung Regency for 30 days in January 2021. This study was experimental by means of quantitative approach. Quantitative method can be interpreted as a research method based on the philosophy of positivism, used to examine certain populations or samples. The sampling technique was carried out randomly. Data collection used research instruments. Data were analyzed quantitatively and statistically with aim to test the predetermined hypotheses. Method was conducted through experiments and direct observations by proving something that was researched or studied independently. The data were analyzed using complete randomized design.

Table 2. Treatment formula of tilapia rations (Nurhayati, 2019).

Ingredient (gr)	P0 (Control)	P1	P2	P3
Commercial rations	1,000	-	-	-
Maffia flour (a mixture of maggot and wolffia)	-	500	500	500
Corn flour	-	200	200	200
Soybean flour	-	200	200	200
Tapioca flour	-	50	50	50
Premix	-	40	40	40
Fish oil	-	10	10	10
Total (gr)	**1,000**	**1,000**	**1,000**	**1,000**

Description: P0: commercial rations, P1: use of 90% maggot flour and 10% wolffia flour, P2: use of 80% maggot flour and 20% wolffia flour, P3: use of 70% maggot flour and 30% wolffia flour (SNI, 2018).

The mixing of maggot flour and wolffia flour was conducted according to the following composition:

P1 = 90% maggot and 10% wolffia = 450 gr maggot flour and 50 gr wolffia flour
P2 = 80% maggot and 20% wolffia = 400 gr maggot flour and 100 gr wolffia flour
P3 = 70% maggot and 30% wolffia = 350 gr maggot flour and 150 gr wolffia flour

The observed population in this study were 160 tilapia (Fahrizal & Nasir, 2017). The research data observed included absolute weight growth, specific growth rate (SGR), absolute length growth, feed conversion value (FCR), and water quality parameters (temperature and pH). The data collection on absolute weight growth, SGR, absolute length growth, and FCR was conducted every 10 days, and water quality parameters (temperature and pH) were measured once a day during experiment (Sabrina et al., 2018).

Absolute Weight Growth

Absolute weight growth was calculated using the following equation (Fahrizal & Nasir, 2017):

$$W = Wt - Wo$$

Where W is absolute weight growth, Wt is the final weight of the fish (gr), and Wo is the initial weight of the fish (gr)

Specific Growth Rate (SGR)

Specific growth rate was measured from the first week to the final week of the study. Specific growth rate was calculated using the SGR equation as follows (Fahrizal & Nasir, 2017):

$$SGR = \frac{Wt - Wo}{t} \times 100\%$$

Where Wt is the final weight of the fish (gr), Wo is the initial weight of the fish (gr) and t is the weighing time (day).

Absolute Length Growth

Absolute length growth was calculated using the following equation (Jaya et al., 2013):

$$Lm = TLi - TLo$$

Where TLo is the total body length at the beginning of rearing (cm), TLi is the total body length at the end of rearing (cm), and Lm is the absolute length growth (cm).

Feed Conversion Ratio (FCR)

FCR was calculated using the following equation (Fahrizal & Nasir, 2017):

$$FCR = \frac{F}{Wt - Wo} \times 100\%$$

Where F is the amount of rations consumed during rearing (kg), Wt is the final weight of the fish (gr), and Wo is the initial weight of the fish (gr).

Parameters of Water Quality

Temperature

Temperature was measured using a thermometer by inserting the tip of the rod approximately 5 cm into the pond water, then reading the temperature alteration on the device and waiting until the value was stable. The quality standard of aquaculture water temperature based on SNI is 25–30^{o}C. The results were then recorded in the observation table. This procedure was conducted at 16.00 WIB every day during the experiment.

Acidity (pH)

pH was measured using a pH meter by inserting the device’s electrode into the pond water, then waiting until the value on the pH meter was stable. The quality standard of aquacultured water pH on SNI is 6.5–8.5. The results were then recorded in the observation table. This procedure was conducted at 16.00 WIB every day during the experiment.

Preparation of Rearing Ponds, Rations Preparation, Seed Preparation, Acclimatization, and Tilapia Rearing

Tilapia rearing ponds used for this study were made with dimension of 50 cm x 35 cm x 30 cm (p x l x t), then water was filled into it until reached 20 cm of height (Bagus, 2019). The allotment of experimental treatments is presented in Table 3.

Table 3. Schematic of complete randomized design (CRD) in rearing ponds.

P0 U1	P3 U3	P0 U4	P3 U2
P0 U3	P1 U3	P1 U4	P3 U1
P2 U1	P1 U4	P0 U3	P2 U2
P2 U2	P3 U1	P2 U4	P1 U4

Description: P0: Control treatment; P1: Treatment 1; P2: Treatment 2; P3: Treatment 3; U1: Replication 1; U2: Replication 2; U3: Replication 3; U4: Replication 4;

The rations were made by preparing the necessary ingredients in advance, namely maggot flour, wolffia flour, corn flour, soya flour, tapioca flour, premix, and fish oil (Nurhayati, 2019). After all ingredients were prepared, they were then mixed and stirred until evenly distributed, then the rations mixture was moulded using a feed moulding tool, then was dried up in direct sunlight until completely dry. Next, tilapia seeds were prepared with a total of 10 seeds in each container (Fahrizal & Nasir, 2017), with an average body length of 5 cm and average body weight of 3 g (Sari & Yulisman, 2017). The seeds were obtained from a fish farm in North Sungkai Subdistrict.

Acclimatization was conducted for one week. Feeding during acclimatization was conducted twice a day (morning and evening) with the portion used was 5% of the fish weight. The rations used were commercial rations (Djunaedi *et al.*, 2016). Tilapia rearing was conducted for 30 days using 16 ponds with a water level of 20 cm (Bagus, 2019). Each pond was filled with 10 tilapia (Fahrizal & Nasir, 2017).

Rations feeding was conducted in the morning and evening, namely at 08.00–12.30 WIB and 16.30–17.00 WIB (Fahrizal & Nasir, 2017). Tilapia rations requirement was calculated by determining the weight of one fish (A), determining the number of fish population in one pond (B), and calculating B × A × C. In the calculation, for example, 5 x 10 x 5% = 5.5 gr.

Temperature and pH were measured as water quality parameters. pH was measured in the afternoon at 16.00–16.30 WIB using a universal pH meter, and temperature was measured using a temperature thermometer. Throughout the process of tilapia rearing, pond water was replaced periodically. The purpose of this was to prevent disease infection in fish.

The hypothesis test used in this study was the ANOVA test. If the results of the hypothesis test indicate that there is a significance difference between each treatment, it then be continued with Least Significant Difference (LSD) test using a significant level of 5% to determine the differences among the treatments. Prerequisite analysis and hypothesis testing were conducted using SPSS 22 software.

RESULTS AND DISCUSSION

Measurement Results

This study aimed to determine the effect of using of a mixture of maggot flour and wolffia flour on the growth of tilapia, which was conducted for 30 days using 4 treatments and 4 replications along with parameters measurement (absolute weight, absolute length, SGR, FCR, temperature, and pH). The results are presented as follows:

Table 4. Measurement results of growth, SGR, dan FCR of tilapia.

Treatment	Replication	Absolute Weight (gr)	SGR (%)	Absolute Length (cm)	FCR
PO	1	9	30	5	2.5
	2	10	33	5.2	2.24
	3	10	33	5.4	2.25
	4	9.5	32	5.4	2.38
Average		9.625	32	5.25	2.34
P1	1	5.5	18	3	3.58
	2	5.3	18	3.2	3.72
	3	6	20	2.3	3.28
	4	5	17	3.1	3.92

Average		5.45	18.25	2.9	3.62
P2	1	6	20	3.5	3.29
	2	6.2	21	3.8	3.17
	3	5.3	18	3.1	3.71
	4	5	17	2.9	3.94
Average		5.625	19	3.325	3.5
P3	1	9	30	4	2.28
	2	8	27	4.2	2.56
	3	10	33	4.5	2.04
	4	8	27	3.7	2.56
Average		8.75	29.25	4.1	2.36

Absolute Weight Growth

Table 5. Results of LSD test on absolute weight growth of tilapia.

Treatment	Average value ± Standard deviation
P0	9.63 ± 0.47^a
P1	5.45 ± 0.42^b
P2	5.62 ± 0.56^b
P3	8.75 ± 0.95^a

Description: Numbers followed by the same letter in one column mean not significantly different

Based on Table 5, positive control (P0) is significantly different from P1 and P2, but not significantly different from P3. P1 is significantly different from P0 and P3, but not significantly different from P2. P3 is significantly different from P1 and P2, but not significantly different from P0.

Specific Growth Rate (SGR)

Table 6. Results of LSD test on specific growth rate of tilapia.

Treatment	Average value ± Standar deviation
P0	32 ± 1.41^a
P1	18 ± 1.25^b
P2	19 ± 1.82^b
P3	29 ± 2.87^a

Description: Numbers followed by the same letter in one column mean not significantly different

Based on Table 6, positive control (P0) is significantly different from P1 and P2, but not significantly different from P3. P1 is significantly different from P0 and P3, but not significantly different from P2. P2 is significantly different from P0 and P3, but not significantly different from P1. P3 is significantly different from P1 and P2, but not significantly different from P0.

Absolute Length Growth

Table 7. Results of LSD test on absolute length growth of tilapia.

Treatment	Average value ± Standard deviation

Open Science and Technology
Vol. 03 No. 01, (39-54)
ISSN (Print) :2776-169X
ISSN (Online) :2776-1681

P0	5.33 ± 0.19[a]
P1	2.9 ± 0.40[b]
P2	3.32 ± 0.40[b]
P3	4.1 ± 0.33[c]

Description: Numbers followed by the same letter in one column mean not significantly different

Based on Table 7, positive control (P0) is significantly different from all other treatments. P1 is significantly different from P0 and P3, but not significantly different from P2. P3 is significantly different from all other treatments.

Feed Conversion Ratio (FCR)

Table 8. Results of LSD test on feed conversion ratio of tilapia.

Treatment	Average value ± Standard deviation
P0	2.34 ± 0.12[a]
P1	3.63 ± 0.26[b]
P2	3.53 ± 0.35[b]
P3	2.36 ± 0.25[a]

Description: Numbers followed by the same letter in one column mean not significantly different

Based on Table 8, P0 (control) is significantly different from P1 and P2, but not significantly different from P3. P1 is significantly different from P0 and P3, but not significantly different from P2. P2 is significantly different from P0 and P3, but not significantly different from P1. P3 is significantly different from P1 and P2, but not significantly different from P0.

Water Quality Parameters

The measurement of water quality (temperature and pH) during the study has generated the following results:

Temperature

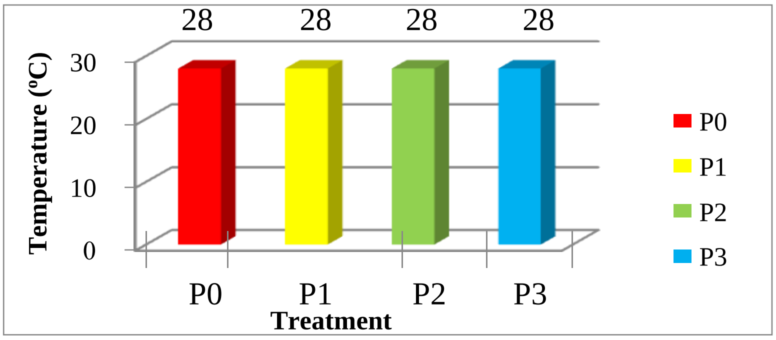

Figure 1. Results of water temperature measurement.

Based on Figure 1, it is known that the water in the tilapia rearing ponds during the study has generated the same temperature, namely 28°C.

Acidity (pH)

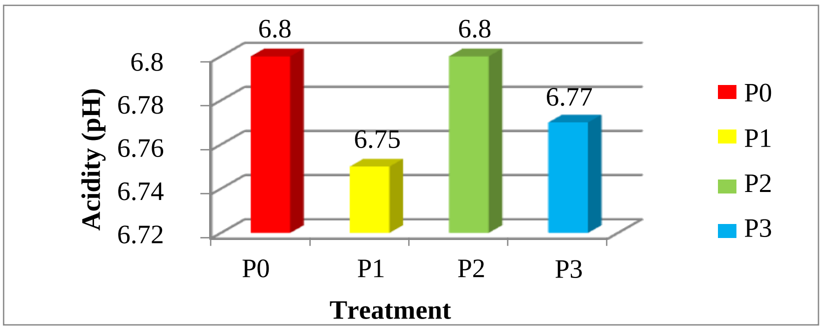

Figure 2. Results of water pH measurement.

Based on Figure 2, it is known that the water in the tilapia rearing ponds during the study has generated a relatively similar water acidity level, namely at range of 6.75–6.8.

Absolute Weight Growth and Specific Growth Rate (SGR)

The observation on the growth of tilapia for 30 days indicates that the use of a mixture of maggot flour and wolffia flour has affected the growth of tilapia, proven through the measurement results of absolute weight growth and specific growth rate (SGR).

The highest average absolute weight growth was resulted by positive control treatment (P0) with a weight of 9.65 gr, followed by P3 treatment with a weight of 8.75 gr, followed by P2 treatment with a weight of 5.625 gr, and the lowest average absolute weight growth was resulted by P1 treatment with a weight of 5.45 gr. Based on LSD test results on absolute weight growth, the positive control (P0) is significantly different from P1 and P2, but not significantly different from P3. P1 is significantly different from P0 and P3, but not significantly different from P2. P3 is significantly different from P1 and P2, but not significantly different from P0.

P0 treatment has generated the highest specific growth rate (SGR) value of 32%, followed by P3 treatment with a value of 29.25%, followed by P2 treatment with a value of 19%, and the lowest SGR value was resulted by P1 treatment, namely 18.25%. Based on LSD test results on SGR value of tilapia, P0 is significantly different from P1 and P2, but not significantly different from P3. P1 is significantly different from the control P0 and P3, but not significantly difference with P2. P2 is significantly different from P0 and P3, but not significantly different from P1. P3 is significantly different from P1 and P2, but not significantly different from P0.

The results obtained related to absolute weight growth and specific growth rate (SGR) of tilapia are in accordance with study by Rina & Iskandar (2015), that tilapia can grow faster even though they are only fed with rations containing 20%–25% protein. SNI (1999) listed the quality requirements for tilapia rations in intensive rearing, which are 8–12 cm and 15 cm of body length at the end of the study. Maggot flour contains high protein of 43.42%, 17.24% fat content, 8.70% ash content, 18.82% coarse fiber content, and 10.79% water content (Rahmawati & Samidjan, 2013). Wolffia flour also contains high protein of 34–45%, 5–7% fat content, 10–11% coarse fiber content, and amino acids (2.7% methionine and cysteine; 7.7% phenylalanine and threonine; 4.8% lysine, leucine, valine, and isoleucine) (Arsyadana et al., 2017).

The best results were achieved by P3 treatment with the use of 70% maggot flour and 30% wolffia flour, generating an average absolute weight of 8.75 gr and an average final weight of 11.75 gr. These results are in accordance with SNI quality standards on tilapia rearing, because the artificial rations in this study contained sufficient protein for tilapia growth. This is in accordance with Rina & Iskandar (2015) who stated that tilapia is an omnivore so it is easy to give additional rations. Intensive rearing requires additional rations feeding. Results from P3 treatment, with the use of 70% maggot flour and 30% wolffia flour, are almost the same as P0, which used 100% commercial rations, compared to other treatments. This is occurred due to high protein content from the formulation of a mixture of maggot flour and wolffia flour in rations that affects the growth of tilapia. This high protein content is one of the essential factors that support growth. The animal-based protein content in maggot and plant-based protein content in wolffia can complement each other to create a balance of nutrients needed by fish for growth. Other nutrients include protein, fat, carbohydrates, vitamins, and minerals, with fat is also a high source of energy for fish growth. Nutrient sources can be obtained both from natural and artificial rations (Usman et al., 2010).

Meanwhile, the lowest growth was achieved by P1 treatment, with the use of 90% maggot flour and 10% wolffia, resulting in an average absolute weight of 5.45 gr and an average final weight of 8.45 gr. The weight of tilapia that has not increased enough as expected is probably due to several internal metabolic factors that occur in the fish body. The low weight and SGR resulted by P1 treatment is thought to be caused by nutritional content in P1 not meeting the nutritional requirements of the fish. Furthermore, it is thought that the use of 90% maggot and 10% wolffia has hampered the optimal fish growth due to the high chitin content in maggot, which caused nutrients to can not be optimally absorbed by the fish.

According to Setiawan (2009), if the amount of rations given is more than enough but the rations are not all eaten, it automatically means that the rations consumed are not enough to generate optimal growth. Protein is a source of essential amino acids needed by fish to support optimal growth, as well as a source of energy for fish (Usman et al., 2010). Another factor that can affect fish's weight growth is the completeness of the organ, in this case the fish stomach. The digestive process that occurs in the stomach must be assisted by enzymes. If there is a disturbance, the fish cannot absorb nutrients sufficiently, thus reducing its growth rate (Nurfitasari et al., 2020).

In this study, the best results for absolute weight growth and SGR values were achieved by P0, but P3 treatment is considered positive because according to the results, P3 has generated the best data compared to other treatments. The lowest value was resulted by P1 treatment, while the result of P2 is not much different from P1. Based on these results, the authors assume that the nutrient content in the rations has affected the growth rate of tilapia. Wolffia is high in phenylalanine and lysine content. It was stated that antimicrobial content in *Wolffia arrhiza* extract plays a role in supporting plant resistance (Arsyadana et al., 2017). Maggot also contains high anti-microbials compounds for consumption by fish to support fish's resistance to disease (Azir et al., 2017). However, the chitin content in maggot can cause nutrients to not be absorbed optimally, which can reduce the growth rate of tilapia.

This study has achieved better results than previous study by Arsyadana et al. (2017), which applied a mixture of commercial rations and wolffia flour treatment to eel fish, resulting in a weight decrease by 10.4 g–6 g. This study has also achieved better results than previous study by Zahra (2022), which applied a mixture of 80% commercial rations and 20% fresh wolffia treatment to tilapia, resulting in an average final weight of 9.2 g. The differences that occured in these two studies are thought to be caused by differences in the types of fish used, the weight at the beginning of the study, the combination of each different treatment, as well as the daily rations given. In the process of rations digestion, the presence of enzymes in the stomach organ is also influential because enzymes allow food to be more digestible, making it easier for the intestines to absorb food and channel them as the energy source (Nurfitasari et al., 2020).

Absolute Length Growth

The observation on the growth of tilapia for 30 days indicates that the use of a mixture of maggot flour and wolffia flour has affected the growth of tilapia, proven through the measurement results of absolute length growth.

The observation results show that the highest average absolute length growth was resulted by positive control treatment (P0) with a length of 5.3 cm, followed by P3 treatment with a length of 4.1 cm, then followed by P2 treatment with a length of 3.325 cm. The lowest average absolute length growth was resulted by P1 treatment, namely 2.9 cm. The LSD test results show that the absolute length growth of tilapia in P0 is significantly different from all other treatments. P1 is significantly different from P0, and P3 is not significantly different from P2. P3 is significantly different from all other treatments.

The highest values in absolute length growth were resulted by positive control treatment (P0) of 5.3 cm and final length of 10.25 cm, followed by P3 treatment with a length of 4.1 cm and final length of 8.925 cm as the result of using a mixture of 70% maggot and 30% wolffia. SNI (1999) lists the quality requirements for tilapia rations in intensive rearing with a length of 8–12 cm and 15 cm at the end of the study. In P3 treatment, the feeding responded better than the other treatments so that P3 treatment generated the highest length growth. The results show that the lowest length growth was achieved by P1 (90% maggot and 10% wolffia), which statistically is not much different with P2 (80% maggot and 20% wolffia). The differences found in each treatment are assumed by the author to be caused by physiological factors and fish behavior in absorbing nutrients in the composition of rations in each different treatment. This is because length growth, besides being determined by growth protein, is also influenced by the adequacy of calcium (Ca) and phosphorus (P) intake (Anita et al., 2020). Calcium and phosphorus are essential minerals needed by fish for maintaining the growth of skin, scales, bones, and skeleton in fish body. The quality requirements by SNI mentioned that tilapia rations must contain calcium and phosphorus to fulfill the nutrients need, because if the calcium and phosphorus intake are not adequately fulfilled, the growth of tilapia will be inhibited. It is stated that maggot contains 7.56% calcium and 0.90% phosphorus (Tran et al., 2015), while wolffia contains 1.1% calcium and 0.5% phosphorus (Banerjee & Matai, 1990).

Several things need to be considered in rations feeding, such as sufficient amount of rations, timeliness, and suitability of nutrient content to fish needs, because nutritional deficiencies in rations can inhibit fish's growth (Usman et al., 2010). Protein, is both a source of essential amino acids and source of energy needed by fish to support optimum growth. The main source of energy for fish growth is protein, because the largest body composition after water is protein (Aliyas & Raihana, 2016). Fats and carbohydrates are also high energy sources for tilapia growth. Other components that are required in small amounts in fish rations are vitamins and minerals, but their presence in rations is also important because they are needed by the fish body to support its growth (Anggriani & Iskandar, 2012).

This study has achieved better results than previous study by Arsyadana et al. (2017), which applied 60% commercial rations and 40% wolffia treatment to eel fish, resulting in a length growth of 0.6 cm. This study has also achieved better results than previous study by Zahra (2022), which applied 80% commercial feed and 20% fresh wolffia treatment to tilapia, resulting in a length growth of 3.4 cm. This study has managed to generate a length growth of 4.1 cm through a mixture of 70% maggot and 30% wolffia treatment.

Feed Conversion Ratio (FCR)

Feed conversion ratio and feed efficiency are indicators to determine feed effectiveness. Feed conversion can be defined as the ability of an aquaculture species to convert rations into meat, while feed efficiency is the wet weight of fish meat obtained per unit dry weight of rations fed. Feed conversion values can indicate the extent to which rations are utilized efficiently by reared fish.

The LSD test results on FCR values show that P0 is significantly different from P1 and P2, but not significantly different from P3. P1 is significantly different from P0 and P3 and not significantly different from P2. P2 is significantly different from P0 and P3, but not significantly different from P1. P3 is significantly different from P1 and P2, but not significantly different from P0. The results state that the use of maggot and wolffia in rations has affected the FCR value of tilapia. The calculation results show that the lowest FCR value was resulted by positive control (P0) with an average FCR value of 2.34, followed by P3 treatment with an average FCR value of 2.36, followed by P2 treatment with an average FCR value of 3.5, then followed by P1 treatment with an average FCR value of 3.62. Good rations quality is indicated by a low FCR value, which is less than or equal to one, which means that every 1 kg of rations should able to generate 1 kg of meat. If the resulted amount of meat do not met this condition, then the rations quality is considered poor.

The best FCR value, namely 2.36, was resulted by P3 treatment, which used 70% maggot and 30% wolffia. This result is almost the same as the P0, namely 2.34, which used 100% commercial rations. P0 has generated the lowest FCR value among all treatments. Meanwhile, P1 treatment is considered generating the worst FCR value, namely 3.63. The high FCR value in P1 indicates a poor feed conversion value (Arifin & Rumondang, 2017), because the higher the FCR value, the worse the rations quality. Nonetheless, the best FCR value resulted in this study still has not met the quality requirement by SNI (2018) regarding good FCR value for fish's growth, namely 1.5. A low FCR value will positively impact the water quality because the waste generated from rations consumption will be smaller, then the nutrients contained in the rations will not be wasted. Basically, the feed conversion value is related to many factors, including rations quality. This can occur due to differences in treatment in each feeding. In this study, the feed conversion value is higher from the use of 90% maggot flour and 10% wolffia, instead of the use of 70% maggot flour and 30% wolffia. The cause of this is thought to be maggot, which inherently contains high chitin content. Chitin can hamper fish's growth because it is difficult to be digested by fish and can reduce growth. Chitin can rapidly empty the intestines and inhibit digestibility. Chitin can also cause less than optimal absorption of nutrients in the rations, because chitin contains substances that can inhibit the growth and absorption of metabolism in the fish body (Stamer et al., 2014). Chitin compounds are crystalline and insoluble in strong acid solutions, thus it causes incomplete absorption of nutrients by fish (Marno & Aryani, 2017).

According to Isnawati et al. (2015), rations eaten by fish will be processed in the fish body, and nutritional elements will be absorbed to be utilized in building tissues so that growth occurs. According to Setiawati et al. (2013), the ideal measurement of FCR value is not only determined by the amount of rations given, but also by several other factors, such as density, weight of each individual, age of the animal group, water temperature, and feeding method. The smaller the volume of the fish stomach, the fewer rations the stomach can hold, thus the feeding is required to be more frequent. This is related to stomach emptying and stomach capacity. The smaller the stomach, the faster the emptying that occurs in the stomach, thus the rations feeding is required to be more frequent. Furthermore, it is also mentioned that after a reduction in stomach contents, the appetite of several fishes will increase again if rations are available again (Mulyadi et al., 2010).

Temperature

The measurement on water temperature parameters for 30 days has showed feasible results for fish rearing. During tilapia rearing, temperature was measured once per day. An increase in water temperature can increase the speed of metabolism in reared organisms, which in turn increases the production of carbon dioxide and ammonia content (Karimah et al., 2018). Based on measurement results, tilapia rearing ponds during the experiment showed the same water temperature in all treatments, namely 28^{o}C. The temperature shown has met the range requirements of SNI (2009), namely 25–30^{o}C. Hot water temperature (more than 32^{o}C), will cause a decrease in dissolved oxygen content in water, which can cause death to fish, otherwise cold water temperature (less than 25^{o}C) will cause a decrease in fish appetite and fish activity.

Acidity (pH)

The measurable on the acidity parameter (pH) of water for 30 days has showed feasible results for fish rearing. During tilapia rearing, pH was measured once per day. pH is one of the factors that can affect the growth of tilapia. Based on measurement results, tilapia rearing ponds during the experiment showed relatively the same water acidity level, namely at the range of 6.75–6.8. The pH shown has met the range requirements of SNI, namely 6.5–8.5. Water pH less than 4 will cause death to fish, and water pH more than 11 will also cause death to fish (Athirah et al., 2013). A pH range of less than 6.5 and more than 9.5 will disrupt the growth and reproduction if it occurs for a long time. In conclusion, tilapia can grow and develop well in aquatic environments with low or neutral alkalinity (Karimah et al., 2018).

CONCLUSIONS

The following conclusions can be drawn from the results of this study: The use of a mixture of maggot (*Hermetia illucens*) and wolffia (*Wolffia arrhiza*) flour on the growth of tilapia (*Oreochromis niloticus*), of which the rearing has been conducted for 30 days in January 2021, has affected the growth of tilapia through the results of growth parameters (absolute weight, absolute length, SGR, FCR), and water quality parameters (temperature and pH). The best results were achieved by P3 treatment (70% maggot flour and 30% wolffia flour), which has generated the average absolute weight growth of 8.75 g, SGR value of 29.25%, average absolute length growth of 4.1 cm, and FCR value of 3.6. Water quality parameters showed the average temperature of 28^{o}C and pH of 6.77.

REFERENCES

Aliyas, N. S., & Raihana, Z. Y. (2016). Pertumbuhan dan kelangsungan hidup ikan nila (*Oreochromis* sp.) yang dipelihara pada media bersalinitas. *Jurnal Sains dan Teknologi Tandulako*, *5*(1), 45–63.

Amandanisa, A., & Suryadarma, P. (2020). Kajian nutrisi dan budi daya maggot (*Hermentia illuciens* L.) sebagai alternatif pakan ikan di RT 02 Desa Purwasari, Kecamatan Dramaga, Kabupaten Bogor. *Jurnal Pusat Inovasi Masyarakat*, *2*(5), 56–63.

Anggriani, R., & Iskandar, A. T. (2012). Efektivitas penambahan *Bacillus* sp. hasil isolasi dari saluran pencernaan ikan patin pada pakan komersial terhadap kelangsungan hidup dan pertumbuhan benih ikan nila merah (*Oreochromis niloticus*). *Jurnal Saintek*, *5*(1), 78–85.

Anita L., Irawawadi G., & Ricky, D. (2020). Rasio kalsium fosfor, glukosa darah, dan kinerja pertumbuhan ikan betok (*Anabus testudies*) yang diberi prebiotik inulin. *Jurnal Ilmu Hewani Tropika*, *9*(1).

Arifin, Z, & Rumondang. (2017, April 18). Pengaruh pemberian suplemen madu pada pakan terhadap pertumbuhan dan FCR ikan lele dumbo (*Clarias gariepinus*). *Fisherina : Jurnal Penelitian Budidaya Perairan*, *1*(1). https://www.jurnal.una.ac.id/index.php/fisherina/article/view/176

Arsyadana, Budiraharjo. A., & Pangastuti, A. (2017). *Aktivitas pertumbuhan dan kelangsungan hidup ikan sidat (*Anguilla bicolor*) dengan pakan* Wolffia arrhiza. Seminar Nasional Pendidikan Sains, 286–291.

Athirah, A., Mustofa. A., & Rimmer, M. A. (2013). *Perubahan kualitas air pada budidaya ikan nila* (Oreochromis niloticus) *di tambak Kabupaten Pangkep, Provinsi Sulawesi Selatan*. Prosiding Forum Inovasi Teknologi Akuakultur, 1065–1075.

Azir, A., Harris, H., & Bayu, R. K. H. (2017). Produksidan kandungan nutrisi maggot (*Chrysomya megacephala*) menggunakan komposisi media kultur berbeda. *Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan*, *12*(1), 67–72.

BSN. (2006). *Pakan buatan untuk ikan nila (*Oreochromis *spp.) pada budidaya intensif*. Jakarta: National Standardization Agency.

Badan Standardisasi Nasional Indonesia (BSNI). 2009. *Produksi benih ikan nila hitam* (Oreochromis niloticus) *kelas benih sebar*. SNI: 6141. Jakarta.

Banerjee, A. & Matai. (1990). Composition of India aquaric plants in relation to utilization an animal forage. *Journal of Aquatic Plants Management, 28*, 69–73.

Jaya, B., Agustriani, F., & Isnaini. (2013). Laju pertumbuhan dan tingkat kelangsungan hidup benih kakap putih (*Lates calcarifer* Bloch) dengan pemberian pakan yang berbeda. *Maspari Journal*, *5*(1), 56–63.

Djunaedi, A., Pribadi, R., Hartati, R., Redjeki, S., Astuti, R. W., & Septiarani, B. (2016). Pertumbuhan ikan nila larasati (*Oreochoromis niloticus*) di tambak dengan pemberian ransum pakan dan padat penebaran yang berbeda. Jurnal Kelautan Tropis, *19*(2), 131–142. https://doi.org/10.14710/jkt.v19i2.840

Fahrizal, A. & Nasir, M. (2017). Pengaruh penambahan probiotik dengan dosis berbeda pada pakan terhadap pertumbuhan dan rasio konversi pakan (FCR) ikan nila (*Oreochromis niloticus*). *Jurnal Median*, *9*(1).

Gumiri, S. (2014). *Sistem akuaponik produksi ikan nila* (Oreochromis niloticus) *berkelanjutan di lahan perkarangan dengan pakan duckweed (Lemnaceae).* Prosiding Seminar NasionalPerikanan dan Kelautan, 14–22.

Isnawati, N., Sidik, R., & Mahasri, G. (2015). Potensi serbuk daun pepaya untuk meningkatkan efisiensi pemanfaatan pakan, rasio efisiensi protein, dan laju pertumbuhan pada budidaya ikan nila (*Oreochromis niloticus*). *Jurnal Ilmiah Perikanan dan Kelautan*, *7*(2), 121–124.

Jayadi, Y. I., & Rahman, A. (2018). Analisis kandungan gizi makro pada ikan dua (penja) hitam dan putih sebagai pangan lokal Kota Palu. *Jurnal Gizi dan Kesehatan*, *2*(1), 31–38. http://jurnal.untad.ac.id/jurnal/index.php/ghidza.

Kardana, D., Haetami, K., & Subhan, U. (2012). Efektifitas penambahan tepung maggot dalam pakan komersiil terhadap pertumbuhan benih ikan bawal air tawar (*Collossoma macropomum*). *Jurnal Perikanan dan Kelautan*, *3*(4), 101–116.

Karimah, U., Samidjan, I., & Pinandoyo. (2018). Performa pertumbuhan dan kelulushidupan ikan nila gift (*Oreochromis niloticus*) yang diberi jumlah pakan berbeda. *Journal of Aquaculture Management and Techonology*, *7*(1), 128–135. http://ejournal-s1.undip.ac.id/index.php/jamt

Marno, A., & Aryani, N. (2017). Utilization of flour maggot (*Hermetia illucens*) as a substitute fish meal for growth of selais fish (*Ompok hyphoptalmus*) seed. *Jurnal Ilmiah Perikanan dan Kelautan*, *7*(2), 121–124.

Mulyadi., Usman M. T., & Suryani. (2010). Pengaruh frekuensi pemberian pakan terhadap pertumbuhan kelulushidupan benih ikan silais (*Ompok hypopythalmus*). *Berkala Perikanan Terumbuk*, *38*(2), 117-124.

Nurfitasari, I., Palupi, I. F., Sari, C. O., Munawaroh, S., Yuniarti, N. N., & Ujilestari, T. (2020), Respons daya cerna ikan nila terhadap berbagai jenis pakan. *Nectar: Jurnal Pendidikan Biologi*, *1*(2), 21–28.

Nurhayati, S. N. (2019). Aplikasi tepung daun gamal (*Gliricidia sepium*) yang difermentasi sebagai penyusun ransum pakan terhadap laju pertumbuhan ikan nila (*Oreochromis niloticus*). *Jurnal Ilmiah*, *3*(1).

Rahmawati, D., & Samidjan, I. (2013). Efektivitas substitusi tepung ikan dengan tepung maggot dalam pakan buatan terhadap pertumbuhan dan kelulushidupan ikan patin (*Pangasius pangasius*). *Jurnal Saintek Perikanan*, *9*(1), 60–65.

Akhmad Azir, Helmi Harris, Rangga K.H. (2017). Produksi dan Kandungan Nutrisi Maggot (*Chrysomaya megacaphala*) Menggunakan Komposisi Media Kultur yang Berbeda. *Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan, 12(1).*

SNI. (1999). *Benih ikan nila hitam* (Oreochromis niloticus *Bleeker*) *kelas benih sebar*. SNI 6141:1999, 1–10.

SNI. (2018). *Pakan buatan untuk ikan nila* (Oreochromis niloticus). SNI 7242:2018,12.

Sabrina, S., Ndobe, M. Tis‟I, & Tobigo, D. T. (2018). Pertumbuhan benih ikan mas (*Cyprinus carpio*) pada media biofilter berbeda. *Jurnal Penyuluhan Perikanan dan Kelautan*, *12*(3), 215–224.

Sari, I. P., &, Yulisman, M. (2017). Laju pertumbuhan dan efisiensi pakan ikan nila (*Oreochromis niloticus*) yang dipelihara dalam kolam terpal yang dipuaskan secara periodik. *Jurnal Akuakultur Rawa Indonesia*, *5*(1), 45–55.

Setiawan, B. (2009). *Pengaruh padat penebaran 1, 2, dan 3 ekor/l terhadap kelangsungan hidup dan pertumbuhan benih ikan maanvis* (Pterophyllum scalare). Undergraduate Thesis. Aquaculture Technology and Management Study Program. Depertemen of Waters Cultivation. Faculty of Fishery and Maritime Science. IPB University. Bogor.

Setiawati, J. E. T., Adipura, Y. T., & Hudaidah, T. (2013). Pengaruh penambahan probiotik pada pakan dengan dosis berbeda terhadap pertumbuhan, kelulushidupan, efisiensi pakan, dan retensi protein ikan patin. *E-Journal Rekayasa dan Teknologi Budidaya Perairan*, *1*(2), 151–162.

Stamer, A., Wessels, S., Neidigk, R., & Hoerstgen-Schwark, G. (2014). *Black soldier fly* (Hermetia illucens) *larvae-meal as an example for a new feed ingredients class in aquaculture diets*. Proceedings of the 4th ISOFAR Scientific Conference, *4*, 1043–1046.

Tran, G., Heuzé, V., & Makkar, H. P. S. (2015, April 1). Insects in fish diets. *Animal Frontiers*, *5*(2), 37–44. https://doi.org/10.2527/af.2015-0018

Ula, R. A. F., & Eka, N. S. (2018). Analisis usaha budidaya maggot sebagai alternatif pakan lele. *Industrial: Jurnal Teknologi dan Manajemen Agroindustri 7*(1), 51–54.

Usman, N., Neltje, P, Kamarrudin, M., & Rachmansyah. (2010). Pengaruh kandungan protein dan lemak pakan terhadap pertumbuhan dan komposisi badan ikan kerapu macan (*Eponephelus fuscoguttatus*). *Jurnal Riset Akuakultur*, *5*(2).

Zahra, Z. I. (2022). *Formulasi wolffia* (Wolffia arrhiza) *dan ransum komersiil pf 500 terhadap pertumbuhan ikan nila* (Oreochromis niloticus). Undergraduate Thesis. Raden Intan Islamic State University. Lampung.