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Evaluating the Effect of Maggot Flour Protein as a Substitute for Fishmeal on the Growth Performance and Survival Rate of Common Carp (*Cyprinus carpio*)

Aldila Putra [a*], Subandiyono Subandiyono [a*] and Diana Chilmawati [a]

[a] Department of Aquaculture, Diponegoro University Jl. Prof. Soedarto S.H., Semarang 50275, Central Java, Indonesia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This research aims to know the role of maggot flour protein as a fishmeal protein source replacement on growth performance and survival of common carp (*Cyprinus carpio*) and the optimum dose from artificial maggot flour feed. This research take a place at Aquaculture Laboratorium of Diponegoro University in 23 January – 6 March 2023. The experimental method using complete randomized design (RAL) consisting of 4 treatments 3 repetitions. The treatment is applied with percentage maggot flour substitution 0%, 10%, 20%, and 30% per gram of feed. The

**Corresponding author: E-mail: sby.subandiyono@gmail.com;*

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substitution set according to carp protein sufficient (30 – 35%), so that carp does not having excess protein that can effect on growth performance. The test fish used was common carp with an average size of 4.54 ± 0.23 cm with an average weight of 0.75 ± 0.03 gr/head. The experimental containers using a aquarium tank with size of 45cm x 30cm x 22.5cm. Stocking density per aquarium is 0.5 fish/liter with a maintenance period of 42 days. The experimental using feeding methods 5% of biomass with a frequency 3 times/day. The experimental results showing that substitution of artificial maggot flour feed for common carp is significantly influential (P<0.05) on specific growth rate (SGR), feed conversion ratio (FCR), and survival rate (SR) of common carp. Based on experimental, the best dose substitution artificial maggot flour feed has been shown in treatments C (20%) and D (30%). Treatment C produced SGR 1.93 ± 0.04 and FCR 2.41 ± 0.07 and treatment D produced SGR 1.97 ± 0.09% and FCR 2.34 ± 0.12. The results of observations during the research showed that common carp fed with the experimental feed (substitution of maggot flour for artificial feed 0%, 10%, 20%, 30%) had a high survival rate with an average survival rate above 90%.

Keywords: Cyprinus carpio; maggot flour; growth; survival rate.

1. INTRODUCTION

Various types of freshwater fish are widely cultivated in Indonesia, both consumption fish as well as ornamental fish. Market demand in particular on fish consumption is in high demand because fish is one of the popular sources of animal protein which is liked by society[1]. Based on data from the KKP (2022), common carp is one of the superior commodity fish that is have high consumption based on market demand reaching 531.23 tons per year. The high market demand is due to carp (*Cyprinus carpio*) which has a delicious and savory taste, thick meat and contain high protein [2].

The fish cultivation business was rely on the availability of feed. Feed has the important role in growth and sustainability of live fish. The feed given must be high quality, nutritious and available in a way to keep going continuously, so that optimal growth can be achieved [3]. According to Andini et al. [4] feed is one of the important aspects with the largest costs (expenses) in the cultivation sector, around 60 – 70% of production costs. The great cost of feed causing high optimize utilization of feed so that it can give more profits. Fish flour as source of animal conventional protein material still depends on imports but the prices increase every year [5]. Management and alternative material for standard fish feed is necessary to get efficiency from production costs. Alternative raw materials in feed production have a critical attention because it can affect the nutritional content and sustainable availability of feed.

Maggot flour can be used as a raw material for making feed to replace fish flour. Now many cultivators of maggot use it to standard material as a replacement for fish flour. Therefore, maggot flour has its own potential as a source of animal protein fish feed because it contains sufficient high protein around 41-42% and contains essential amino acids [6]. Maggot protein content is higher than the content of commercial feed which is in the range between 25–30% [7]. Therefore need a more study about the role of maggot flour protein as a substitute for fish meal artificial feed on growth performance and survival of carp (*Cyprinus carpio*).

The purpose of this research is to review protein substitute in maggot flour artificial feed on growth performance and survival of carp (*Cyprinus carpio*) also know the best percentage of maggot flour protein substitute that provides carp (*Cyprinus carpio*) growth and survival performance. This study aiming to provide information to fish farmers and studies to fish meal producers regarding the role of maggot protein as a substitute for protein sources in artificial feed for growth and survival.

2. MATERIALS AND METHODS

This research uses tools that include aquarium with size 45x30x22.5cm as much as 12 pieces, fresh water, digital scale, millimeter block, fishnet, hose and aerator, hose siphon, water quality checker (WQC), oven, feed grinder machine, carp seeds with size of 4.54 ± 0.23 cm and weight 0.75 ± 0.03g derived from the Freshwater Fish Seed Center Sawangan, Magelang, Central Java. Stocked densely maintained is 0.5 head/liter. The optimal stocking density for carp cultivation is 15-20 fish / 30 liters because it gives real influence to life level continuity and growth (Sihite et al., 2020).

The feed used in this experiment is artificial feed in the form of pellets. The feed is adjustable to the needs of crap, wich is omnivorous fish. This experiment feed protein used fish flour and maggot flour that are substitute for fish flour and soybeans flour as source of vegetable protein. Maggot flour used as a replacement for fish flour, with appropriate dose treatment. Feed formulation from each treatment presented in Table 1. Result of proximate analysis for raw material compiler the experiment feed has been carried out at the Sidomulyo Drug and Feed Testing Laboratory, Ungaran, Semarang, Central Java presented in Table 2. and the contribution of protein is presented in Table 3.

Table 1. Feed Formulation For Carp (*C. carpio*) with Different Dose of Maggot Flour For 42 Days

MaterialType	Feed Composition (%/100 g Feed)			
Compiler Feeds	**A**	**B**	**C**	**D**
Maggot flour	0.00	5.20	10.40	15.60
Fish flour	52.00	46.80	41.60	36.40
Pack soybeans flour	39.20	38.83	38.40	38.09
Corn flour	0.80	0.92	1.25	1.27
Wheat flour	0.90	0.95	1.10	1.10
Rice bran flour	0.70	0.90	0.85	1.14
Fish oil	1.20	1.20	1.20	1.20
Corn oil	1.20	1.20	1.20	1.20
Vit-Min mix	3.00	3.00	3.00	3.00
CMC	1.00	1.00	1.00	1.00
TOTAL (%)	100.00	100.00	100.00	100.00
Protein (%)*	30.01	30.01	30.01	30.01
BETN (%)* *	17.04	18.85	20.82	22.56
Fat (%)	11.22	11.27	11.31	11.37
En. (kcal / g)* **	238.49	243.43	248.71	253.54
Ratio E/P****	7.95	8.11	8.29	8.45

Information :

**Protein for omnivorous fish around 27-35% (Mose and Saselah, 2021)*

*** BETN = material extract without nitrogen <40%*

****Optimal E/P ratio ranges from 8-10* [8]

*****Protein = 3.5 kcal /g; BETN = 2.5 kcal / gram; Fat = 8.1 kcal /g (National Research Council, 1993)*

Table 2. Proximate analysis of raw materials for preparing feed for research on carp for 42 days

MaterialType	Components (%)						Total
	Water	**Proteins**	**BETN**	**Fat**	**SK**	**Ash**	**(%)**
Maggot flour	0.00	37.44	34.22	10.22	5.88	12.24	100.00
Fish flour	0.00	36.01	0.63	8.68	8.68	46.01	100.00
Pack soybeans flour	0.00	28.22	38.39	10.83	15.56	7.00	100.00
Corn flour	0.00	9.04	82.77	3.43	3.37	1.39	100.00
Wheat flour	0.00	13.23	84.03	1.14	1.08	0.52	100.00
Rice bran flour	0.00	5.09	35.02	3.00	39.72	17.18	100.00

Table 3. Protein Content of Raw Feed Research Materials on Carp for 42 Days

Ingredients feed	Protein Content (%)			
	A	**B**	**C**	**D**
Maggot flour	0	1.95	3.89	5.84
Fish flour	18.72	16.85	14.98	13.11
Pack soybeans flour	11.06	10.96	10.84	10.75
Flour corn	0.07	0.08	0.11	0.11
Rice bran flour	0.04	0.05	0.04	0.06
Wheat flour	0.12	0.13	0.15	0.15
Total (%)	30.01	30.01	30.01	30.01

Maintenance performed for 42 days in the aquarium tank filled with 30 liters of water with feeding frequency 3 times a day at 08.00 morning, 12.00 noon, and 16.00 afternoon. Amount of feed use fixed feeding as much as 5% of the experiment carp biomass. Support of water quality in the form of an aerator in each aquarium and done siphon around 30-50% water volume each a week for reduces turbidity levels and cleans feces at the bottom of the aquarium tank. Besides that, measuring water quality each day in the morning before giving feed. The water quality parameter measured include pH, temperature and dissolved oxygen using WQC (water quality checker).

3. METHODOLOGY

The method used in this research is experimental method with complete randomized design (CRD) with 4 treatments with 3 repetitions in each treatment. Experimental method is implementing method that planned attempt to disclose new facts or strengthen theory and criticism results from existing research. There is treatment during research such as following:

Treatment A : Substitute feed maggot flour 0%
Treatment B : Substitute feed maggot flour 10%
Treatment C : Substitute feed maggot flour 20%
Treatment D : Substitute feed maggot flour 30%

3.1 Research Variable

A. Feed Intake (FI)

According to Pereira et al. [9] total feed intake (FI) is calculated using the following formula:

$$FI = F1 - F2$$

where:

TKP = Feed consumption levels
F1 = Amount of initial feed (g)
F2 = Amount of remaining feed (g)

B. Feed Efficiency (FE)

The efficiency of feed utilization can be determined using the Tacon formula [10] as follows:

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

Where:

EPP = Efficiency feed utilization (%)
Wt= Total weight of fish at the end of the study (g)
Wo= Total weight of fish at the end of the study (g)
F= Amount of feed consumed during research (g)

C. Feed Conversion Ratio (FCR)

The feed conversion ratio is the amount of feed given to produce 1 kg of meat. According to Tacon [10], the Feed Conversion Ratio (FCR) is calculated using the formula:

$$FCR = \frac{F}{(Wt + D) - W0}$$

where:

FCR= Feed Conversion Ratio
F= Amount of feed consumed (g)
Wt= Fish biomass at the end of the study (g)
D= Fish biomass weight at the end of the study (grams)
Wo= Fish biomass weight at the beginning of the study (g)

D. Protein Efficiency Ratio (PER)

Protein Efficiency Ratio (PER) is one method used to evaluate the quality of protein in feed. Calculation of the protein efficiency ratio (PER) value using the formula [11]

$$PER = \frac{Wt - Wo}{Pi} \times 100\%$$

where:

PER= *Protein Efficiency Ratio* (%)
Wt= biomass of test fish at the end of the study (g)
Wo= biomass of initial research test fish (g)
Pi= weight of feed protein consumed (g)

E. Specific Growth Rate (SGR)

According to Fagbenro et al., [12], specific growth rate (SGR) of fish is calculated using the formula:

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

where:

SGR =Specific Growth Rate (% per day)

Wt=Total weight of test fish at the end of rearing (g)
Wo= Total weight of test fish at the beginning of maintenance (g)
t=Maintenance time (days)

F. Survival Rate (SR)

Calculation of survival can be done using a formula. According to Effendie [13] the survival rate (SR) is calculated using the formula:

$$SR = \frac{Nt}{No} X\ 100\%$$

where:

SR= Survival rate (%)
Nt= Number of fish alive at the end of rearing (head)
No= Number of fish at the start of rearing (head)

G. Water Quality

Water quality data collection was measured using WQC (Water Quality Checker) with the observed water quality parameters consisting of temperature, pH and DO. Water quality measurements are carried out once a day, in the morning (07.00 WIB) before feeding time.

3.2 Data Analysis

Data obtained namely relative growth rate (RGR) and survival rate (SR). These data were analyzed using analysis variance (ANOVA) at level 95% confidence to see the affect of treatment. Data analysis was carried out using SPSS 25. If the analysis variation obtained the effect was very significant (P<0.05) then a double area test was carried out Duncan to know the difference between treatments. Water quality data is analyzed in a descriptive way and compared with optimum value of water quality in carp cultivation.

4. RESULTS AND DISCUSSION

4.1 Results

Based on the results obtained during research regarding the substitution of maggot flour in artificial feed for common carp which was carried out for 42 days, data was obtained which was displayed in a histogram. The results of the research indicate that the total feed consumption values obtained from the analysis showed that there was no effect of the treatment doses on the total feed intake in *C. carpio*. The total feed intake values were as follows: treatment A (0% substitution) 32.98±0.16g, treatment B (10% substitution) 33.61±1.74g, treatment C (20% substitution) 32.58±1.42g, and for treatment D (30% substitution) 33.18±2.65g. The histogram of total feed intake values is presented in Fig. 1.

The results of the research indicate that the feed efficiency values obtained showed no differences across the treatment doses for *C.carpio*. The results regarding feed utilization efficiency during the study were as follows: for treatment A (0% substitution) 36.33±1.51%, for treatment B (10% substitution) 35.32±4.58%, for treatment C (20% substitution) 37.50±4.75%, and for treatment D (30% substitution) 41.31±1.25%. Histogram values of feed efficiency are presented in Fig. 2.

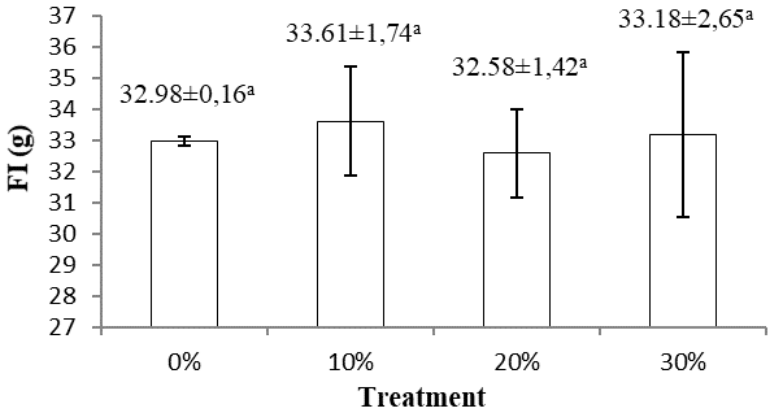

Fig. 1. Total feed intake of common carp fed with different maggot feed substitution doses for 42 Days

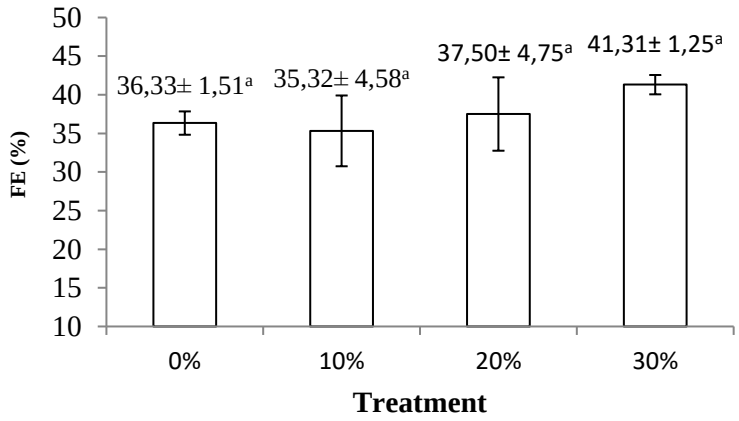

Fig. 2. Feed efficiency value of common carp fed with different doses of maggot feed substitution for 42 Days

The results of the research indicate that the feed conversion ratio values obtained were different between treatments C and D compared to treatments A and B. The best feed conversion ratio values were achieved in treatments C and D, with the values for treatment C (20% substitution) being 2.41±0.07 and for treatment D (30% substitution) being 2.34±0.12. Meanwhile, the feed conversion ratio values for treatments A and B were as follows: treatment A (0% substitution) at 2.60±0.08 and treatment B (10% substitution) at 2.62±0.05. Histogram of feed conversion ratio values are presented in Fig. 3.

The results of the research indicate that the protein efficiency ratio values did not show any differences. The protein efficiency ratio (PER) obtained during the study was as follows: for treatment A (0% substitution) 1.33±0.05%, for treatment B (10% substitution) 1.41±0.03%, for treatment C (20% substitution) 1.39±0.04%, and for treatment D (30% substitution) 1.40±0.07%. Histogram values of the protein efficiency ratio is presented in Fig. 4.

The results of the research indicate that there was an effect of each treatment dose on the specific growth rate of *C. carpio*. Based on the Duncan test, there were differences between treatments C and D and treatments A and B, with the results as follows: for treatment D (30% substitution) at 1.97±0.09% per day, and for treatment C (20% substitution) at 1.93±0.04% per day. Meanwhile, for treatment B (10% substitution) at 1.79±0.04% per day, and for treatment A (0% substitution) at 1.80±0.06% per day. The histogram of Specific Growth Rate values is presented in Fig. 5.

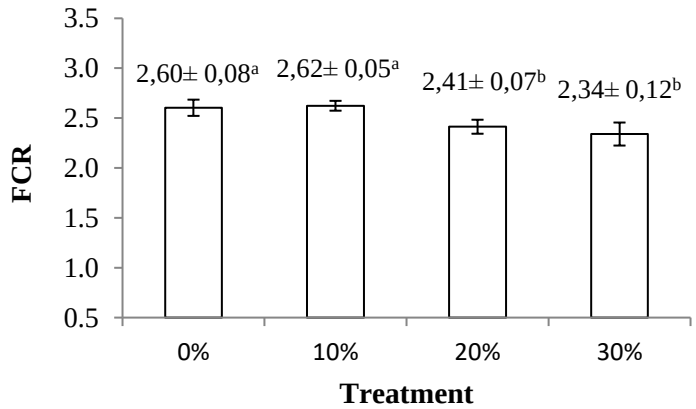

Fig. 3. Feed Conversion Ratio (FCR) Values of Common Carp Fed with Different Maggot Feed Substitution Doses for 42 Days

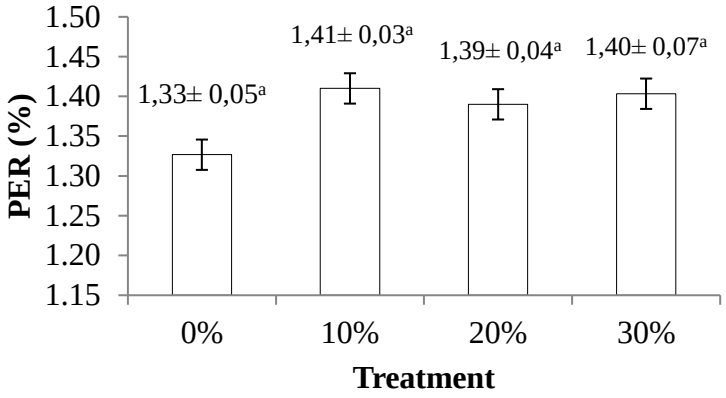

Fig. 4. Protein Efficiency Ratio (PER) Values in Common Carp Fed with Different Doses of Maggot Feed Substitution for 42 Days

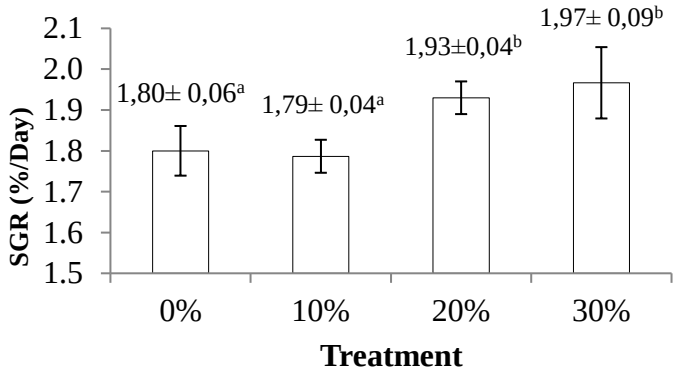

Fig. 5. Specific Growth Rate (SGR) Values of Common Carp Fed with Different Doses of Maggot Feed Substitution for 42 Days

The results of the research indicate that the survival rate of *C.carpio* fed with different doses of maggot feed substitution over 42 days did not show significant differences. The survival rates of the tested carp obtained during the study for each treatment were as follows: for treatment A (0% substitution) 95.55±3.85%, for treatment B (10% substitution) 95.55±7.70%, for treatment C (20% substitution) 93.33±6.67%, and for treatment D (30% substitution) 97.78±3.85%. The Survival Rate histogram can be seen in Fig. 6.

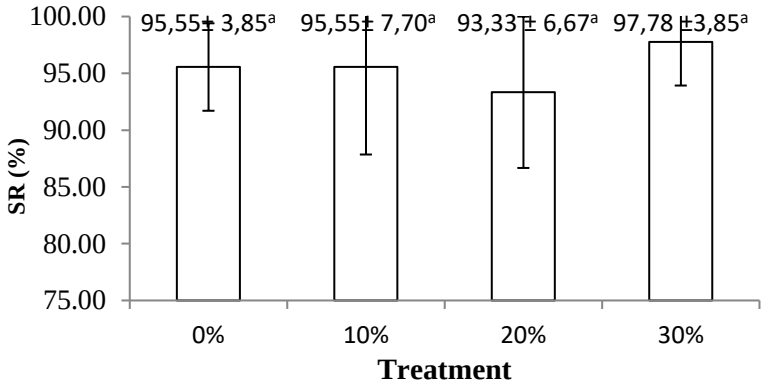

Fig. 6. Survival Rate (SR) of common carp fed with different doses of maggot feed substitution for 42 days

Table 4. Data on water quality values: research on common carp fed with different dosages of maggot feed substitution for 42 days

NO	Variable	Unit	Results (Range)	Appropriateness
1	DO	Mg/L	5.5 – 7.2	>4*
2	pH	-	7.88 – 8.56	6.5-8.5*
3	Temperature	°C	25.2 – 27	25-30*

**SNI 01-6133 – 1999* [14]

The results of measurements of several water quality variable that measured during research such as temperature, dissolved oxygen (DO) and pH. The results of water quality measurements in common carp rearing media during the research are presented in Table 4.

4.2 Discussion

4.2.1 Feed intake

The amount of feed consumed in this study with the substitution of maggot feed based in the artificial feed is in accordance with Fig. 1. Feeding with the substitution of maggot feed at different doses in the artificial feed in the study had a total feed intake value (FI) that was not significantly different. The substitution of fish meal for maggot feed in each treatment was different. This shows that the use of maggot flour as a raw material for artificial feed does not have a bad effect or does not reduce the level of feed consumption in common carp. Factors that influence the level of feed consumption are palatability, average fish weight and mortality. This was confirmed by Putra et al. [15], that the factors that influence feed consumption are age, fish weight, fish health, stomach capacity, nutrition, feed palatability and water temperature. According to Yuliyanto et al. [16]. The feed provided must have good buoyancy, the fish feed must be homogeneous, not soft, and not break easily so that it can be utilized optimally by the fish and in accordance with the preferences of the fish being farmed so as to produce optimal growth. This is reinforced by Subandiyono and Hastuti (2021) who state that palatability can be related to texture (soft or hard feed), and can also be related to nutritional components. The results obtained during the research showed that the use of maggot meal was no different from that of a person who completely used fish meal. This shows that the fish respond no differently to feed that uses maggot flour related to attractants. The attractiveness of the food is very necessary and important so that the fish immediately swim towards the food provided. (Subandiyono and Hastuti., 2021)

4.2.2 Feed efficiency

The value of feed efficiency during the study was not significantly different. The result value can be seen in Fig. 2. The efficiency value of good feed efficiency is close to 100%. The higher the feed efficiency value, the better the quality of the feed provided. The value of feed efficiency rate is affected by several factors, including the nutritional content of the feed, especially protein, carbohydrates and fats, and water quality.

Feed formulations that contain high amounts of crude fiber will cause the feed to pass through the intestines quickly, resulting in reduced nutrients being absorbed and ultimately resulting in low levels of protein being absorbed, the feed not being utilized optimally [17]. The efficiency value in this study was not significantly different with an average of below 50%. The value of feed efficiency shows that the feed provided is utilized well and according to the needs of the culture being cultivated or not. Protein and non-protein content needs to be considered, by selecting quality raw materials for feed formulations. The raw materials for making feed, especially the animal protein source maggot flour which substitutes for fish meal in this research treatment, contain 37.44% and 36.01% protein respectively. Feed, especially macro nutrients, is used for activity and growth, so that the more efficient the use of feed, the more optimal growth will be. according to Putranti et al. [8] stated that fish's need for energy is mostly met by non-protein nutrients such as fat and carbohydrates. However, the energy derived from non-protein nutrients is not yet fulfilled, so protein will be used as an energy source so that the function of protein for growth is less than optimal. Feed efficiency is influenced by many factors, such as feed quality. This was confirmed by Isnawati et al. [18], the food consumed will be processed in the body and the nutritional elements will be absorbed to be used to build tissue so that growth occurs. With raw materials with good content, especially protein, carbohydrates and fat, it is possible to continue growth and feed efficiency better, so it can also reduce costs [18].

4.2.3 Feed Conversion Ratio (FCR)

The results of the feed conversion ratio (FCR) values for common carp during the research showed results that had a real effect. The best feed conversion ratio results were obtained in treatments C (20% substitution) and D (30% substitution) with lower feed conversion ratio values compared to treatments A (0% substitution) and B (10% substitution). The ratio of feed conversion results obtained in the best treatment is treatment C was 2.41 ± 0.07 and in treatment D was 2.34 ± 0.12. It can be seen that differences in the percentage of maggot flour substitution in artificial feed with different doses produce different FCR values. The FCR value is directly proportional to the feed efficiency. The more efficient the feed consumed by the fish, the lower the FCR value and so the lower the FCR value the better in fisheries cultivation activities, in this case common carp cultivation. This was confirmed by Setiawati et al. [19], The lower the feed conversion value, the higher the feed efficiency value so that fish growth is more optimal. The lower the feed conversion ratio value, the better the quality of the feed provided, however, if the feed conversion ratio value is high, the feed provided is of lower quality, and increases cultivation costs [20]

There are many factors for the high and low FCR values, where the main factors are mortality and cultivation environmental conditions, especially temperature. The feed conversion value ratio in this study can be said to be bad because it has an FCR value of 2.34. In general, for common carp, the ideal FCR value is approximately between 1.5 and 2 [21]. The high FCR value is thought to be because protein requirements for growth in cultivated crops have not been met, which is related to the quality of raw macronutrients. Overall fish growth is closely related to the fish's needs and ability to utilize macro and micro nutrients in feed (Supandiyono and Hastuti 2021).

4.2.4 Protein Efficiency Ratio (PER)

The results of the protein efficiency ratio (PER) calculation value showed that the results did not have a significant effect on each treatment on the growth of common carp. The low protein efficiency ratio is thought to be caused by maggot flour as a raw material having poor quality so that the nutritional content is not good, especially the essential amino acid content so that the protein is not utilized optimally. Apart from that, the raw material source of protein is not utilized optimally because it affects the imbalance of other macronutrients in the feed such as fat and carbohydrates. (Lemba et al., 2022). The sparing effect of protein is the ability of fish to utilize protein optimally for growth and balance of fats and carbohydrates [22].

The low protein efficiency ratio is also thought to be because the protein content in the feed did not meet the common carp needs during the research, so the protein could not be utilized for growth. Previously there was a growth in energy needs for maintenance which had to be met even more so beforehand. This is confirmed by Putranti et al. [8] stated that the occurrence of growth in fish shows that the feed energy provided has fulfilled its own needs for maintenance so that the rest is for growth.

4.2.5 Specific Growth Rate (SGR)

Feeding common carp with maggot meal as a substitute showed that treatments C and D had a significant effect on treatment A and B on specific growth rate (SGR). The specific growth rate (SGR) value in treatment C was 1.93 ± 0.04%/day and in treatment D it was 1.97 ± 0.09%/ day. The results of the specific growth rate in this study were higher than the study by Naria et al. [21], the SGR value for carp was obtained at 1.53%/day. Maggot flour has nutritional content which has the potential to be a source of nutrition as common carp feed, especially as a source of animal protein. This is in accordance with the statement of Azizah et al. [23] states that growth depends on the feed given, because feed provides the nutrients and energy that are needed for growth. Fish growth can occur if the amount of feed nutrients digested and absorbed by the fish is greater than the amount needed to maintain its body. It is necessary to pay attention to the nutritional content of maggot flour used as raw material for fish feed. High quality ingredients produce quality feed. In this study, maggot flour had a protein content of 37.44%. So it is felt that better raw materials and formulations will also increase the specific growth rate.

Increasing protein feed does not always lead to increased growth. Increasing protein feed without a balance with non-protein energy sources such as carbohydrates and fat will cause protein to be used as an energy source. The raw materials in feed formulations have different qualities and contents, including protein, carbohydrate and fat

content. According to Arifin et al. [24] which states that maggot flour contains essential amino acids, namely *leucine, arginine, isoleucine, phenylalanine, valine, threonine, lysine and histidine*, where the essential amino acids lysine and leucine play an important role in increasing the growth of common carp. *Lysine* is an essential amino acid that can optimize the utilization of other amino acids, thus affecting the amount of protein utilized for daily growth rate.

4.2.6 Survival Rate (SR)

The results of various analyzes show that the fish meal with maggot feed substitute does not have a significant effect on the survival value of common carp. The results of observations during the research showed that common carp fed with the experimental feed (substitution of maggot flour for artificial feed 0%, 10%, 20%, 30%) had a high survival rate with an average survival rate above 90%. According to Winarti et al. [25] stated that a good sustainable survival rate for carp is at least 70%. The survival of fish is influenced by various factors. The main factors that influence the sustainable survival rate of common carp include water quality and the availability of sufficient and high-quality food. The high survival rate of common carp obtained in this study is thought to be due to the water quality during controlled rearing and being in a suitable condition for common carp cultivation activities. Apart from that, the quantity of test feed provided is sufficient for maintaining common carp. This was confirmed by Zakaria et al. [26] who stated that the high survival rate in the cultivation process shows that the quality and quantity of feed provided is sufficient to meet the basic nutritional needs of fish.

4.2.7 Water quality

The water quality results during the research for each parameter did not appear to be significantly different for each treatment. Based on Table 4, the water quality values during the research were still in the normal range or still included in the appropriate category for common carp growth. The DO value during this research is approximately between 5.5–7.2 ppm. The optimal DO value range for common carp growth according to SNI 0 6133 [14] regarding common carp seed production is >5 ppm. The optimal DO value during the research was due to the presence of research equipment in each aquarium in the form of aeration which could be adjusted using the aerator valve stop so that the DO value could be met according to common carp maintenance needs. Apart from that, the research was carried out indoors in a closed laboratory so it was more controlled. Meanwhile, the water temperature and pH during the study were still within the normal range. The temperature during the study was approximately between 25.2 – 27ºC. According to SNI 0 6133 [14] regarding the production of common carp (*Cyprinus carpio*) seeds, the optimal temperature range for common carp growth is approximately between 25-30ºC. Meanwhile the pH value during the study also showed normal results. According to SNI 0 6133 [14] regarding carp seed production, the optimal pH value for carp is 6.5–8.5. The water quality was decent during the research due to aeration for oxygen supply, the research was carried out in a closed laboratory and also routine maintenance in the form of siphoning. Siphoning is carried out to maintain good water quality to remove feces and reduce turbidity in the cultivation media.

Drastic changes in temperature can reduce appetite and can affect the body's immune system [27]. Temperatures that are too low result in most of the energy stored in the fish's body being used to adapt to an environment that is less supportive, so that it can damage the metabolic system or exchange of substances, which can disrupt fish growth due to disruption of the digestive system. This is confirmed by Kelabora [28] stating that water temperature has a big influence on the growth and level of feed consumption in fish [29,30].

5. CONCLUSION

The conclusion obtained from this research is that the protein substitution of Maggot Flour in Artificial Feed for common carp has a real influence on the specific growth rate (SGR) and feed conversion ratio (FCR) in common carp. Based on research that has been carried out, the best dosage for using maggot flour is in treatments C and D with maggot flour substitution of 20% and 30% respectively. Treatment C produces SGR 1.93 ± 0.04, FCR 2.41 ± 0.07 and treatment D produced SGR 1.97 ± 0.09 and FCR 2.34 ± 0.12. The results of observations during the research showed that common carp fed with the experimental feed (substitution of maggot flour for artificial feed (0%, 10%, 20%, 30%) had a high survival rate with an average survival rate above 90%.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Putri AI, Hastuti S, Sarjito S. The Effect of Using Tea Tree Oil (*Melaeuca Alternifolia*) as an Anesthetic in the Transportation System on the Profile and Survival Rate of Goldfish (Cyprinus Carpio). Tropical Aquaculture Science: Indonesian Journal of Tropical Aquaculture. 2022;6(1): 54-64.
2. Saparinto C, Susiana R. Complete Guide to Fish and Vegetable Cultivation with Aquaponic System. Andi Publisher; 2024.
3. Fitriana N, Handayani L, Nurhayati N. Addition of Oyster Shell Nanocalcium (*Crassostrea gigas*) to Feed with Different Doses on the Growth of Giant Freshwater Prawns (*Macrobachium Rosenbergii*). Aquatica: Journal of Aquatic Sciences. 2019;6(2):80-85.
4. Andini GD, Haetami K, Andriani Y. Giving Lemna sp. Still Against the Growth and Feed Efficiency of Tilapia (Oreochromis Niloticus). Journal of Fish Nutrition. 2021;1(1):1-9.
5. Sofia A, Nugroho BEL, Maulana MA, Silviawati PA, Ramadhan S, Sari Y. Application of Biotechnology in Making Trash Fish Silage through Lactic Acid Bacteria Fermentation. Journal of Aquaculture, Teuku Umar University. 2021; 5(1):10-16.
6. Sumiati S, Purnamasari DK, Erwan E, Syamsuhaidi S, Wiryawan KG, Rizki ANA, Isnaini M. Use of Maggots (*Hermetia illucens*) in Laying Hen Feed: Use of Black Soldier Pamphlet (*Hermetia illucens*) as Laying Hen Larvae Feed. Journal of Science, Technology & Environment. 2022; 8(1):87-96.
7. Muntafiah I. Feed Analysis in Catfish (Clarias Sp.) Cultivation in Mranggen. JRST (Journal of Science and Technology Research). 2020;4(1):35-39.
8. Putranti GP. The Effect of Different Protein and Energy in Artificial Feed on Feed Utilization Efficiency and Growth of Carp (Cyprinus Carpio). Journal of Aquaculture Management and Technology. 2015;4(3): 38-45.
9. Pereira L, Riquelme T, Hosokawa H. Effect of Photoperiodic Regime on Growth and Mortality of Japanese Abalone (*Haliotis discus hanaino*). Kochi University, Department of Aquaculture, Laboratory of Fish Nutrition, Japan. 2007;26:763-767.
10. Tacon AG. Nutrition and Feeding of Cultured Fish and Shrimp-A Annual Training. FAO UN, Brazil. 1987;106–109.
11. Zonneveld N, Huisman EA, Boon JH. Principles of Fish Cultivation. PT. Gramedia Pustaka Utama. Jakarta. 1991;318.
12. Fagbenro OA, Balogun AM, Anyanwu CN. Optimal dietary protein content for Heterobranchus bidorsalis fingerlings fed compound feed. Nigerian Journal of Fisheries & Applied Hydrobiology. 1992;1: 41-45.
13. Effendie MI. Fisheries Biology Methods. Nusantara Library Foundation, Yogyakarta. 1997;258.
14. BSN National Standardization Agency. SNI. 01-6133-1999. Production of Carp Seeds (*Cyprinus carpio Linneaus*) Majalaya Filter Seed Class Spread. National Standardization Agency: Jakarta; 1999.
15. Putra AN, Ristiani S, Musfiroh and MB Syamsunarso . Utilization of Water Hyacinth (*Eichornia crassipes*) as Tilapia Fish Feed: Effects on Growth and Feed Digestibility. Local Security Journal. 2020; 1(2):77-82
16. Yuliyanto R, Sinuraya and D. Kusunawati. Utilization of Solid Waste from Palm Kernel Cake as an Alternative Feed for Tilapia Fish (*Oreochromis niloticus* sp.) Citra Widya Education Journal. 2021;13(3):281-290.
17. Iskandar GD, Andini K, Haetami Y. Andriani. Giving Fresh Lemna Sp. for Growth and Feed Efficiency of Tilapia (*Oreochromis niloticus*). Unram Journal. 2021;1-9.
18. Isnawati N, Sidik R, Mahasri G. Potential of Papaya Leaf Powder to Increase Feed Utilization Efficiency, Protein Efficiency Ratio and Relative Growth Rate in Tilapia (Oreochromis niloticus) Cultivation. Scientific Journal of

Fisheries and Marine Sciences. 2015;7(2): 121-124.
19. Setiawati JE, Tarsim YT, Adipura S. Hudaidah. Effect of Additional Probiotics in Feed with Different Doses on Growth, Survival, Feed Efficiency and Protein Retention of Catfish (*Pangasius hypophthalmus*). Journal of Aquaculture Engineering and Technology. 2013;1(2): 151-162.
20. Simamora EK, Mulyani C, Isma MF. The Effect of Different Feeding on the Growth and Survival of Koi Carp (*Cyprinus carpio*) Seeds. Scientific Journal of Aquatic Oceans. 2021;5(1):9-16.
21. Naria, DK, Lumbessy SY, Lestari DP. Utilization of Young Moringa Leaf Flour (Moringa oleifera) as Raw Material for Artificial Feed in Goldfish (*Cyprinus carpio*) Cultivation. Unram Journal. 2022;2(1):37-48.
22. Welengane E, Sado RY, Bicudo Á, JDA Effect of Protein Sparing Due to Increased Dietary Lipids on Juvenile Tambatinga Hybrid Fish (Colossoma Makropomum Piaractus Brakipomus). Aquaculture Nutrition. 2019;25(6):1272-1280.
23. Azizah AA, AW Ekawati, H. Nursyam. Potential Protein Source from Black Soldier Fly (*Hermetia illucens*) Larvae as Fish Meal Substitute in Carp (*Cyprinus carpio*) Feed Formulation. International Journal of Scientific Research and Technology. 2019;8(11):1497-1501.
24. Arifin MZ, Widodo A, Fauziah A, Aonullah1 AA, AM Halim., and AB Cahyanurani. The Effect of Maggot Flour Substitution (Hermetia Illucens) on the Growth and Health Status of Fish (Oreochromis niloticus). Chano Chano Journal. 2020;18 (2):83-91.
25. Winarti W, Subandiyono S, Sudaryono A. Utilization of Lemna sp. Flour Fermentation in Artificial Feed on the Growth of Goldfish (*Cyprinus carpio*). Journal of Aquaculture Science and Technology. 2017;1(2):88-94.
26. Zakaria HM, Samidjan I. The Effect of Additional Probiotics in Feed Utilizing Protein Sources from Retired Chicken Egg Flour on the Growth and Survival of Tilapia (*Oreochromisniloticus*). Journal of Aquaculture Management and Technology. 2018;7(1):71-79.
27. Yanuar V. The Effect of Giving Different Types of Feed on the Growth Rate of Tilapia Seeds (*Oreochiomis niloticus*) and Water Quality in Maintenance Aquariums. Ziraa'ah Scientific Journal of Agriculture. 2017;42(2):91-99.
28. Kelabora DM. The Effect of Temperature on the Survival and Growth of Goldfish (*Cyprinus carpio*) Larvae. Terrestrial Fisheries Periodical. 2010;38(1).
29. Karimah U, Samidjan I, Pinandoyo. Growth Performance and Survival Rate of Tilapia (*Oreochromis niloticus*) with Different Amounts of Feeding. Journal of Aquaculture Management and Technology. 2018;7(1):128-135.
30. Subandiyono S, Hastuti S. Application of Broodstock Feeding Management in Catfish (*Clarias Gariepinus*) Seeding. Publisher Tigamedia Pratama, Semarang; 2021.

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