Available online at www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 186 (2023) 27-39 EISSN 2392-2192

The Effect of Substituting Fish Meal with Maggot Meal in Artificial Feeding on the Growth and Survival of Dumbo Catfish - *Clarias gariepinus* (Burchell, 1822)

Indah Nurulliza*, Kiki Haetami, Izza Mahdiana Apriliani, Yuniar Mulyani

Faculty of Fisheries and Marine Sciences, Padjadjaran University,
Jl. Raya Bandung Sumedang KM 21, Jatinangor 45365, West Java, Indonesia

*E-mail address: Indah19007@mail.unpad.ac.id

ABSTRACT

This research aims to determine the effect of substituting fish meal with maggot meal on the growth and survival of catfish (*Clarias gariepinus*), as well as determining the best percentage of maggot meal as an alternative ingredient to replace fish meal. 300 catfish (*Clarias gariepinus*) with an average weight of 4.3 g were reared in 15 hapa units measuring (1m x 1 m x 1 m) with a stocking density of 20 fry kept for 40 days. The test feed used in this research was artificial feed with a protein content of 30% with a substitution percentage of fish meal with maggot meal according to the treatment. There are five maggot flour substitution treatments, namely treatment A (100%: 0%), B (75%: 25%), C (50%: 50%), D (25%: 75%) and E (0%: 100%). The research method used is an experimental method with an experimental design using a Completely Randomized Design (CRD). The research results showed that the addition of 50% maggot flour gave significant results ($P<0.05$) for catfish given maggot flour, with a specific growth rate of 3.1% and a survival rate with an average value of 95% - 100% . Treatment C, a combination of 50% fish meal and maggot meal, has an effect on the growth of African catfish. The addition of 100% maggot meal can replace fish meal and African catfish can be given maggot feed because the high fat content can replace some of the protein needed for energy.

***Keywords*:** Maggot, Alternative Feed, Growth, Survival, *Clarias gariepinus,* Aquaculture

(Received 28 September 2023; Accepted 20 October 2023; Date of Publication 22 October 2023)

1. INTRODUCTION

Dumbo catfish (*Clarias gariepinus*) is one of the aquaculture commodities that has economic value and is popular with the public. This catfish is a popular food fish and has the ability to withstand changes in the surrounding water environment, so it is widely cultivated by the public.

Feed is the most important aspect in the cultivation process which can support the growth rate and survival of fish. Feeding is one of several important aspects in cultivation activities. Feed costs reach 50-70% of the production costs that must be incurred. Use of fish meal as a basic ingredient to make pellets, the availability of which does not match the high price and is still imported. Based on data from the Freshwater Ornamental Fish Cultivation Research Workshop (LRBIHAT), fish meal imports to Indonesia reach US$ 200 million every year.

Moreover, there are production restrictions and the need for fish meal in the country which cannot be met by its own production. Therefore, it is necessary to look for alternative feed ingredients that are relatively cheap and contain good nutrition to reduce the use of fish meal. Quality feed contains nutrients such as protein, fat, carbohydrates, vitamins and minerals.

Maggot (*Hermetia illucens*) or larvae of the Black Soldier Fly grasshopper is an alternative feed that meets the requirements as a source of protein and is a type of natural feed that can increase the growth of catfish.

Maggots can be used as feed in fresh form or mixed with other raw materials such as bran to make pellet feed. According to Kardana (2012), the advantages of alternative feed include using natural flour, one of which is maggot flour. Maggot (*Hermetia illucens*) in the form of flour can be an option for providing feed as a source of animal protein because this fly is easy to find and breed. Maggot (*Hermetia illucens*) is considered a promising source of protein and lipids in animal feed, including fish.

Maggot flour contains 31.98% protein, 16.14% fat, 14.17% crude fiber, and 9.01% ash. The results of proximate analysis show that maggot flour contains 32.5% protein, 4.53% fat, 1.7% crude fiber, 8.44% ash, and 14.53% water content. Maggot flour has a high protein value so it has the potential to increase the growth rate of fish [1-24].

2. MATERIALS AND METHODS

This research will be carried out in June - August 2023 in the Cultivation Pond owned by Mr. Nurdin who lives in Cibodas, Sidamulih District, Pangandaran Regency.

2. 1. Tools and materials

The tools used in study are 15 waring within 1×1×1 m dimesion for fish cultivation, Do meter, thermometer, pH meter, ovens, filters, pellet printing tools, buckets, gas stoves, pans, digital scales, ruler.

2. 2. Research subject

The animal used for the test study is African catfish (*Clarias gariepinus*) within 8-10 cm in length, and weighing in 2-7 g wich collected from fish boster center Wonoharjo, Pangandaran.

Figure 1. Dumbo Catfish Seeds (*Clarias gariepinus* (Burchell, 1822))

2. 3. Feed Material

The feed used in this research used fish meal, maggot meal (*Hermetia illucens*), corn meal, shrimp meal, wheat flour, tapioca flour, bran, premix, fish oil.

2. 4. Working procedure

2. 4. 1. Tools and material preparation

The preparation starts by cleaning the tools that are going to be used. 300 seeds were used with a stocking density of 20 seeds/unit per container. The test fish, which came from fish seed sellers, were then acclimatized first in a pond that had been prepared for 3 days, this aimed to reduce the stress of the fish when they were moved from their place of origin to the research pond.

2. 4. 2. The feed formulation

Table 1. Analysis Proximate

	Water	Ash	Proteins	Fiber	Fat	KH	Energy
P1	14.89	9.07	32.49	3.66	12.23	42.55	4179
P2	12.7475	9.9625	31,465	5,175	12.8275	40.57	4275.75
P3	10,605	10,855	30.44	6.69	13,425	38.59	4372.5

P4	8.4625	11.7475	29,415	8,205	14.0225	36.61	4469.25
P5	6.32	12.64	28.39	9.72	14.62	34.63	4566

Laboratory Ruminant Animal Nutrition and Animal Food Chemistry, Padjadjaran University, 2023.

First of all, the raw materials are analyzed proximately and count the ration for e ach treatment based on every need of the raw materials' composition, the material is mixed from the heaviest to the lightest weight until they perfectly blend and add some water. The dough materials are moulded with 1-2 mm by using feed molder tools. After that, The feed is dried using an oven and ready to used.

2. 5. Method

The study uses experimental mode, and experiment design which is used in this research, a completely randomized design applies 5 treatments and 3 repetitions. The treatment using maggot flour was applied based on as following :

P0 : Fishmeal with maggot flour (100:0)
P1 : Fishmeal with maggot flour (75:25)
P2 : Fishmeal with maggot flour (50:50)
P3 : Fishmeal with maggot flour (25:75)
P4 : Fishmeal with maggot flour (0:100)

2. 6. Parameter

2. 6. 1. Spesific growth rate

Specific growth rate (SGR) is observed and then the results of research activities are calculated using the formula as follows:

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

Information:
SGR = Specific Growth Rate (% biomass/day)
Wt = Test animal weight at the end of the research (g)
Wo = Test animal weight at the start of the research (g).
t = Trial duration (days)

2. 6. 2. Survival Rate

Survival is a percentage of the number of living organisms at the end of a certain time.

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

Information :
SR : Survival rate (%)
Nt : Number of fish seeds at the end of the t-th research
No : Initial number of fish seeds

2. 6. 3. Water quality

Supporting parameters to be able to find out about water quality carried out in this research include:

1) Water Temperature Observation
   Observation to temperature Water is carried out by observing twice a day, namely in the morning and evening using a tool in the form of a thermometer.
2) Dissolved Oxygen Observations
   Dissolved oxygen observations are carried out by measuring observations carried out once a day, namely in the morning and evening using a tool in the form of a DO meter.
3) Degree of Acidity (pH)
   The degree of acidity or pH is carried out by measuring observations each time sampling using a pH meter.

2. 6. 4. Data analysis

Data analysis used analysis of variance (ANOVA) with a Completely Randomized Design (CRD) research design to determine treatment differences. If there are differences in treatments, a Duncan's distance test is carried out with a confidence level of 0.05 to determine the differences between all treatments and using SPSS software.

3. RESULT ND DISCUSSION

3. 1. Specific Growth Rate

Specific growth rate is the % of the difference between final weight and initial weight, divided by the length of time. Specific growth rate is the daily growth rate of fish or a percentage of the weight gain of fish per day. The specific growth rate value in the measurement is influenced by increasing weight. The higher the weight increase, the greater the specific growth rate value. Based on the results of observations made on African catfish that were treated for 40 days with five different treatments, it showed that the catfish experienced a decrease and increase in weight. Figure 2 shows the growth rate of catfish during maintenance.

Based on Figure 2 above, it can be seen that the growth rate of treatment C (50:50) has the highest value, followed by treatment D (25:75), then treatment E (0:100), treatment A (100:0) and B (75 :25) with the lowest results. Based on these results, it can be seen that the weight growth of African catfish in treatment C (50:50) was significantly different from treatment D and experienced a greater increase when compared with other treatments. This can happen because the nutritional content contained in maggot flour feed contains 28.39% protein, 14.62% fat, 9.72% crude fiber, 12.64% ash, and 6.32% water content. So the content obtained by the fish is relatively no different, resulting in values that are not significantly different. The weight of catfish increased every week, the highest increase was in treatment C (50:50) with an initial average weight of catfish from 4.4 g to 7.8 g.

The next treatment with an increase in the weight of catfish every week was treatment D (25:75), with the average initial weight of fish in treatment E being 4.2 g which increased to 7.7 g.

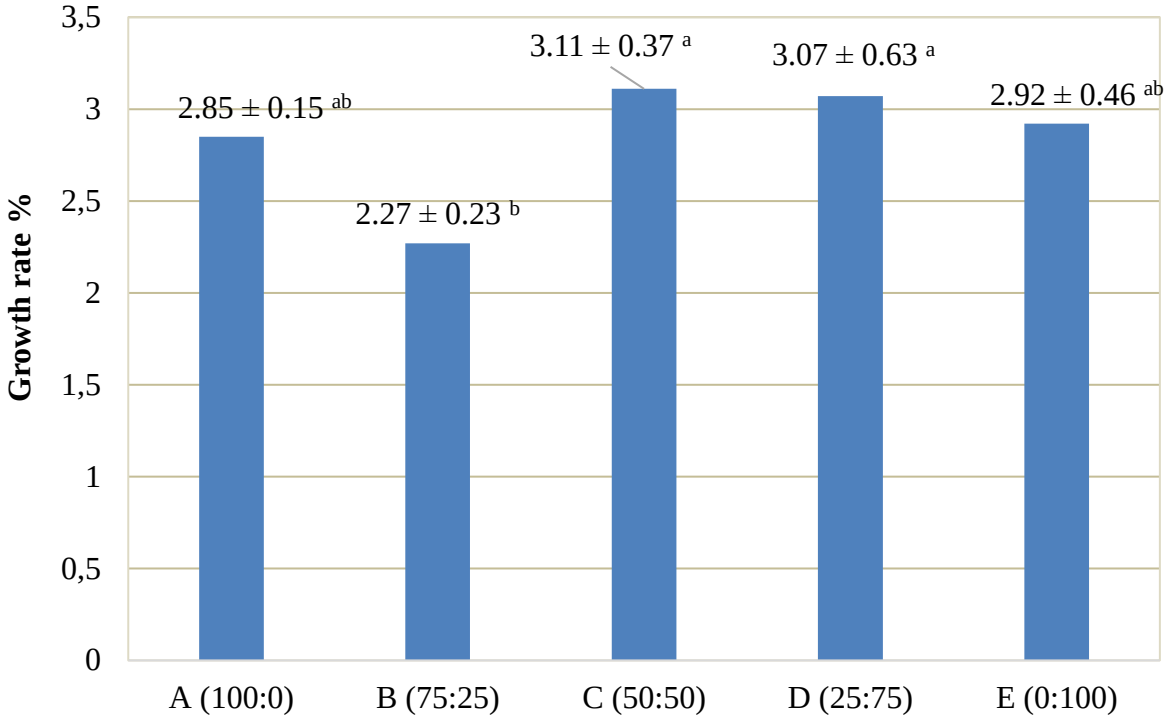

Figure 2. Growth Rate Chart

This increase is due to the nutrition provided in accordance with the optimal growth process in catfish, the nutritional content needed for African catfish measuring 4 cm^{-1} month requires a fat content of 4% and fiber 8%. Based on observations at the start of maintenance, the test fish had a low level of preference for the food provided. The level of preference for food in the middle to the last week of the rearing period began to increase, and it was seen that the catfish were able to adapt to fish meal and maggot meal. Treatment C (50:50) got the highest increase in weight compared to other treatments.

This increase in weight is due to the fact that the feed provided can be responded well by the fish and is used for metabolic and growth processes. One thing that influences growth is the balance of nutrients in the feed. This is in accordance with Fujiya (2004) statement that growth occurs if there is excess energy resulting from metabolism after being used for body activities and maintenance. The food consumed by fish will first be used to maintain the body and replace damaged cells and the rest will be used for growth. The treatment with the lowest results was treatment B (75:25), this was due to the fish's response to the feed provided and the level of adaptation to the feed was less.

The effect of the treatment results on the specific growth rate of catfish was analyzed using variance at a confidence level of 95% showing significantly different results. The following is a Table of 5 specific growth rates:

Table 2. Growth Rate Specific

Treatment (%)	Average Growth Rate (%)
A (100:0)	2.85 ± 0.15 ab
B (75:25)	2.27 ± 0.23 b
C (50:50)	3.11 ± 0.37 a
D (25:75)	3.07 ± 0.63 a
E (0:100)	2.92 ± 0.46 ab

Note : ab = notation letter similar means No There is difference real at the level of Duncan 's test 5% value

The results of the Duncan test showed that the growth rate of treatment C (50:50) was higher and significantly different from treatment D (25:75) but not significantly different from treatments E (0:100), A (100:0) and B (75:25). The growth rate of treatment A (100:0) of 2.85% had a growth rate that was not statistically different compared to treatment C (50:50) of 3.11%. However, treatment C (50:50) has a greater growth rate value so that maggot flour can be used to increase growth in catfish, to substitute fish meal up to 75%.

Treatments C (50:50) and D (25:75) were significantly different because the test fish, namely catfish, indicated that the treatment with additional maggot flour was still acceptable and had a significant effect on the growth of catfish, this was because maggot flour contained fat of 14.63%. According to Ghufran (2007), the nutritional needs of African catfish (*Clarias gariepinus*) are: 35-40% protein, 9.5-10% fat, 10-20% carbohydrates, 0.25-0.40% vitamins, and 10-20% minerals. 1.0%.

The results of the specific growth rate value in treatment C (50:50) with a fat content of 13.42% and energy of 4372.5 kcal with 25% maggot flour substitution which has the highest value compared to other treatments, this is thought to be due to the limiting effects of fat and chitin up to a percentage of 25% and the higher the fat content, the greater the energy source produced so that it can be used for fish activities, while the energy source that comes from protein is used to optimize growth. According to Sanjayasari (2010) Carbohydrates and fats can balance the use of most metabolic activities and the body's adjustments do not just rely on protein. The protein contained in feed can be used for growth. According to Lante (2010) Growth occurs when there is excess free energy which is then used for body maintenance, metabolism and activity. Energy comes from sufficient oil or fat, so the energy from protein is used to build new tissue so that growth, energy comes from sufficient oil or fat, so the energy from protein is used to build new tissue so that growth occurs.

The fastest growth rate was in treatment C (50:50) with an average of 3.11%, followed by treatment D (25:75), with an average growth of 3.07%, treatment E (0: 100), with an average growth of 2.92%, treatment A (100:0), an average of 2.85% and lastly held by treatment B (75:25), with an average growth of 2, 27%. Based on the values shown, it indicates that the fish feed provided is able to be digested well by the test fish so that the combination of magot and

fish meal (50:50) is a balanced combination and produces the greatest weight gain because magot is not only a source of protein, but also a source of fat and harvesting at before chitin hardens, it is easier to digest. Meanwhile, fish meal also contains good amino acids and fatty acids.

The growth rate of catfish is also influenced by feed. Fish can make good use of the feed provided because it is supported by the amount of fat that catfish needs for growth, so that with this amount the amount of protein in the feed will be used for growth, while the fat content in the artificial feed is used as a source of energy. In this way, optimal growth occurs, so that the weight gain will be greater.

This research, with a maintenance period of 40 days, showed that catfish treated with C (50:50) were the best. The treatment with the largest growth value after treatment C (50:50), namely treatment D (25:75), had growth that was not statistically different compared to treatment C (50:50), so maggot flour can be used to increase growth in catfish. , to substitute fish meal up to 75%. The growth value which was greater than the 100% fishmeal control in treatment C (50:50) was confirmed by research conducted by Prajayati et al. (2020) that a combination of 50% fish meal and maggot meal can provide the best results for the growth of Nirvana breed tilapia.

Fish growth will occur if the feed consumed by fish has the right protein content and protein-energy balance. Growth in fish is due to the presence of energy after the needs for the body and for fish metabolism are met. Growth in fish will continue to increase if the feed consumed has the right protein levels and protein-energy balance so that protein is used as building blocks for the body for growth, while fats and carbohydrates, including non-protein energy, are used as energy sources. One of the factors that influence fish to grow optimally is the amount of feed the fish can consume each day and the level of daily food consumption.

The ingredients in feed other than carbohydrates and fat are protein. Protein is the main energy source in fish feed supplies. This is because the digestive system in fish generally digests 80-90% protein while carbohydrates (starch) 30-50% and cellulose 5-15%. Carbohydrates are generally produced by plants through the process of photosynthesis. Fish's need for carbohydrates really depends on the type of fish. Carnivorous fish require approximately 9% carbohydrates, omnivorous fish require up to 18.6% carbohydrates, and herbivorous fish require even more carbohydrates, reaching 61%.

Adequate nutrition in feed is not only able to provide energy for the fish's metabolic activities, but is also able to meet the fish's needs 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. Other factors that cause the growth of catfish are internal factors and external factors.

External factors relate to the environment in which fish live, such as the physical and chemical properties of water, space for movement, and the availability of food both in terms of quality and quantity. Internal factors have an important role in fish growth. One of the main internal factors is the condition of the fish's body. Fish with good body condition can digest food well, thus supporting their growth.

At the seed stage, the digestive process in fish is not optimal, this is caused by the enzymes produced and the digestive capacity of the fish itself. According to Mahardikha et al. (2017) Large fish already have more perfect digestive organs compared to small fish or fish that are still at a certain stage, so their enzyme activity is higher.

Based on research that has been carried out, feeding with P2 treatment (89% commercial feed + 10% maggot flour + 1% tapioca flour) provides the best value of crude protein content for catfish (Clarias sp.) at a substitution dose of 10% fermented maggot flour with protein content. rough 20.3250a ± 0.042. The results obtained in this research are different from the results of research carried out by Meitiyani et al. (2020) A percentage of 30% maggot and 70% fish meal provides increased growth and good survival for sangkuriang catfish.

3. 2. Survival Rate

Survival Survival rate is the percentage ratio of the number of fish that are alive at the end of the rearing period to the number of fish that are alive at the beginning of the rearing period. Survival or also known as survival rate (SR) is the percentage of test fish that are alive at the end of rearing from the number of test fish stocked during rearing in a container. The survival of catfish is largely determined by food and environmental conditions.

The following is a survival graph based on research.

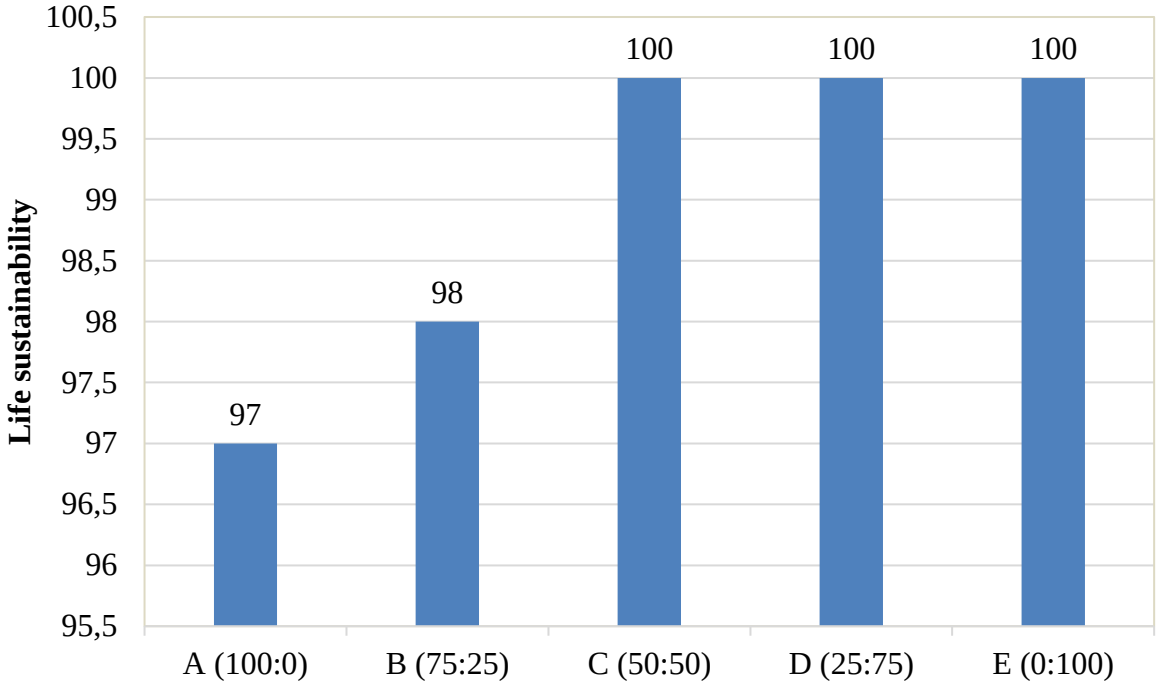

Figure 3. Chart Survival

Based on the data above, it shows that the highest survival rate was in treatment C (50:50), D (25:75), and treatment E (0:100) with the respective results being 100% followed by treatment B (75: 25) with a value of 98%, and the lowest survival rate was occupied by treatment A (100:0) with the results obtained being 97%.

Survival in all treatments was above 70%, this was due to the fact that the catfish had been able to adapt to their environment so that the death rate in these treatments was low. Apart from fish being able to adapt, many fish are also active. The survival of fish also depends greatly on the type of food given and the water conditions in their environment. Providing fish with

good quality and sufficient quantity of feed as well as good water environmental conditions will greatly support the survival of catfish.

According to the Ministry of Agriculture (1999), the average survival rate for fish is 63.5% -86%. According to Murjani (2011), the survival rate of fish ranges from 68.89% - 75.56%. Research that has been carried out by researchers on the survival of catfish has results with an average value of 95% - 100%, which can be said to be good for the survival rate of fish during cultivation and research.

3. 3. Water Quality

Water quality data consists of temperature, pH and DO levels. The quality of the water used during the experiment was measured at the optimum scale in cultivating Dumbo catfish. Water quality plays an important role in cultivation activities for the sustainability of fish. The water quality parameters observed in this research include temperature, dissolved oxygen, and pH. The results of water quality measurements obtained during the experiment generally show that the water quality is still within a good range to support the maintenance of catfish seeds.

The following is water quality data obtained during research.

Table 3. Catfish Rearing Water Quality

Treatment	Parameter		
	Temperature (°C)	DO (mg/L)	pH
A (100:0)	2 7	4.5	7, 3
B (75:25)	2 7	4.5	6.5
C (50:50)	2 7	5.5	7.5
D (25:75)	2 7	3,4	6.5
E (0:100)	2 7	5.3	7, 3
Standard	28-30*	>5*	6.5-8.5*

The temperature level is around 25–29 °C, pH 6.53-7.39 and DO 3.40-5.30 mg/L. Water quality is supporting data in this research which is important because water quality affects fish survival and growth. Water quality parameters consist of temperature and pH levels. The results of water quality testing showed that the temperature level during the experiment was 25-29 °C. The temperature level was still in acceptable conditions where catfish could grow to optimum size. In line with Hikmawan research (2011), he stated that a good temperature level for catfish growth is around 25-30 °C.

Furthermore, the pH numbers during the experiment showed 6.53 – 7.39. The results of the pH level are still acceptable, according to research by Hikmawan (2011) which states that the acceptable pH level for catfish is around 6.5–9. pH levels contribute to a decrease in fish growth rate, and in some cases can reduce fish metabolic function and can cause fish death. Dissolved oxygen examination during the experiment was 3.40-5.30 mg/L. African catfish can still tolerate this amount. In line with research by Nasrudin (2010) states that catfish need at least 3 mg/L to survive.

4. CONCLUSIONS

Research results showed that the addition of 50% maggot flour gave significant results (P<0.05) for catfish given maggot flour, with a specific growth rate of 3.1%, absolute weight growth of 10.93 g, and survival rate of the average value is 95% - 100%. Treatment C, a combination of 50% fish meal and maggot meal, has an effect on the growth of African catfish. The addition of 100% maggot meal can replace fish meal and African catfish can be given maggot feed because the high fat content can replace some of the protein needed for energy.

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