GROWTH PERFORMANCE OF MUTIARA CATFISH (*Clarias gariepinnus*) FED A COMBINATION OF COMMERCIAL FEED AND *BLACK SOLDIER FLY MAGGOT* (*Hemetia illucens*)

ABSTRACT

The purpose of this research was to determine the appropriate combination of commercial feed and maggot to produce optimum growth, feed efficiency and food conversion ratio for catfish. This research used experimental method with Completely Randomized Design (CRD) consisting of four treatments and four replications. The study was conducted in the Ciparanje Land Fisheries Area, Faculty of Fisheries and Marine Sciences, Padjadjaran University. The research was carried out between January - July 2019. The treatments are combination of commercial feed and maggots consisting of A (control, 100% commercial feed), B (75% commercial feed + 25% maggot), C (50% commercial feed + 50% maggot) and D (25% commercial feed + 75% maggot). The parameters observed were survival rate, daily growth rate, length ratio, feed efficiency, food conversion ratio and water quality. The combination of commercial feed and maggots affected the daily growth rate, length ratio, feed efficiency and food conversion ratio of catfish. The survival rate of each treatment was 88.75, 92.50%. Treatment C showed the value of highest daily growth rate, length ratio, feed efficiency namely 1.86%, 1.40%, 65.09% respectively and the lowest feed conversion ratio 1.54%.

Keyword : Growth, mutiara catfish, *Clarias gariepinus*, Black Soldier Fly Maggot*, Hermetia illucens*

1. INTRODUCTION

Based on statistical data from the Central Bureau of Statistics (Badan Pusat statistik/BPS 2019), fish production in West Java increases every year. In 2014 fish production reached 1,006,017 tons including 312,027 tons of mutiara catfish production. In 2016, fish production increased 1,185,042 tons including mutiara catfish production as much as 532,410 tons.

Mutiara catfish is a new strain of African catfish. This type of fish is the result of breeding in Indonesia. Mutiara catfish produced through individual selection for three generations that focus on the character of growth (Fish Breeding and Research Centre, Balai Penelitian dan Pemuliaan Ikan/BPPI 2014).

In general, the fish cultivators use commercial feed to raise catfish. Commercial feed has formulated nutrients so that the fish can grow quickly, but it will cost a lot. The cost spent by the fish cultivators for commercial feed ranges from 50-60% (Abidin et al. 2015).

In addition to using commercial feed, there is other type of feed for catfish, like natural fish feed. Natural feed is used to reduce production cost. This natural feed must be easily found and cultivated. One example of natural food that is easily found and cultivated is *maggot*.

Maggots are larvae of flies that belong to the Diptera order. One of the maggots that has high nutrition is black soldier fly (BSF) *maggot*. The protein content in BSF *maggot* ranges from 40-50% and the fat content ranges from 29-32% (Bosch et al. 2014).

The combination of commercial feed and BSF maggot is expected to accelerate the growth of catfish thus accelerating the production cycle and reducing the use of commercial feed. It can be done because of the nature of catfish that like meat or referred to as carnivores. Therefore, it is necessary to do research on the combination of *maggot* and commercial feed to get the fastest growth of catfish fry.

2. MATERIALS AND METHODS

2.1 Time and place

This research was conducted during January - July 2019. Research activities included preparation of tools and materials, preliminary tests, rearing and analysis of research results. The study was conducted in the Ciparanje Land Fisheries Area, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

2.2 Materials

The tools used are biopond for containers to rearing BSF maggot, BSF cages to separate BSF broodstock, wood for BSF substrate laying eggs, plastic buckets for catfish fry containers when sampling, scoop fish to take catfish fry, heaters to stabilize temperatures, millimeter block to measure the length of catfish fry, hose to fill water in aquarium, analytical scales to measure the weight of catfish fry, blower to increase dissolved oxygen levels, dissolved oxygen meter to measure dissolved oxygen levels in the water, pH meter to measure the acidity level of the water, aquarium as a container for catfish fry and a thermometer to measure water temperature. The materials used are PF

500 feed, BSF maggot, organic waste, catfish fry (size 5-7 cm), chlorine for sterilization of fish containers and *test kits* to measure ammonia levels in water.

2.3 Research prosedure

2.3.1 Culture of black soldier fly maggot

Maggot culture activity begins with incubating BSF prepupa obtained from the BSF Bandung community at a price of Rp. 80,000/kg and obtained the maggot with the media in the rabbit cage of the animal husbandry faculty, Padjadjaran University. The prepupa is hatched in a cage while the BSF *maggot* and the media are stocked into fiber and maintained until it becomes a prepupa. According to (Dortmans et al. 2017), the BSF life cycle is as follows . Prepupa will hatch after 7-14 days and become an adult fly. The survival of adult flies is very fast which is 7-10 days and the life cycle of adult flies is only for one reproduction. Adult flies tend to lay eggs in a place close to their feed so that the larvae that hatch will get feed. Therefore BSF container must be designed by adding attractants in the form of organic waste that has a pungent odor and wood substrate added on top so that BSF *maggot* will lay eggs in the wood.

Move the wood that contained BSF eggs to new containers where organic waste has been added. It has function to facilitate the newly hatched BSF larvae to eat. The eggs will hatch after three days. The warmer the temperature at the containers, the eggs will hatch faster. Maggot larvae in containers were kept for five days.

After five days the *maggot* larvae are moved into a larger container made of fiber. *Maggot* will be reared for five days. Maggot rearing is done by adding organic waste every day. Giving the organic waste is done adlibitum. Within these five days *maggot* can be given to catfish fry.

Maggot that is given for fish feed is only 70% of the total *maggot* that is available, the remaining 30% is kept until it becomes a parent to produce eggs again.

Maggot culture process is done every three days so that *maggot is* always available for catfish fry. Eggs are obtained from the BSF in nature that lay eggs on the substrate that has been provided in biopond and from the BSF cage.

2.3.2 Fish container preparation

Preparation begins with sterilizing the aquarium with chlorine and cleaning the equipment to be used with clean water. The aquarium used is 60 x 30 x 30 cm filled with 40 liters of water. The aquarium used is 16 pieces. To maintain the temperature during the research, aquarium was given a heater and to increase dissolved oxygen, the aquarium was given aeration.

2.3.3 Preparation of catfish

Catfish size used was 5-7 cm obtained from the Cileunyi catfish breeder. The size of catfish was sampled using a sorting basin of 500 fishes, 240 fishes as given treatment and 260 fishes as stock. Before the catfish are stocked, acclimatization is carried out for three days by adding water regularly. Stocking catfish every aquarium is 1 fish / 2 liters.

2.3.4 Rearing fish

Catfish was reared for 30 days and every 10 day sampling is carried out to measure weight gain, length and determination of the amount of feed. Catfish are fed daily according to the treatment, namely by a combination of commercial feed and maggot. Feed is given as much as 3% of the biomass of catfish. Giving maggot 2.25 times more than commercial feed. Commercial feed given contains protein of 39-41% and the maggot given is 5-10 days old maggot with 44-61% protein.

2.4 Research design

The study design was carried out experimentally using a trial design that was completely randomized design (CRD) which consisted of four treatments and four replications in each treatment, which were treated in this study, namely:

Treatment A : Commercial feed 100%
Treatment B : Commercial feed 75% + *maggot* 25%
Treatment C : Commercial feed 50% + *maggot* 50%
Treatment D : Commercial feed 25% + *maggot* 75%

2.5 Observation parameter

2.5.1 Survival rate

Survival is observed every day by counting fish deaths. The dead fish is then taken to avoid increasing ammonia levels and weighing them. Survival rate is the number of biota that live at the end of a certain time (Effendie 1997). Survival calculations using the formula:

$$\text{Survival rate} = \frac{Nt}{No} \times 100\%$$

Where :

Nt : The number of final fry in the 30 day research
No : The number of fry at the beginning of research

2.5.2 Daily growth rate

weights were observed every 10 days by weighing six fish samples in each replication. Calculation of daily growth rate using the formula Effendi (1997):

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

Where :
DGR : Daily growth rate (%)
Wt : The average fish weight at the end of the research (g)
Wo : The average fish weight at the start of the research (g)
t : Research time (30 day)

2.5.3 Length Ratio

Observations on lengths were carried out every 10 days, using six fish samples in each replication. The measured length is total length using a millimeter block. According to Satyani (2010), length ratio can be expressed by the formula:

$$\text{Length Ratio} = \frac{LnLt - LnLo}{t} \times 100\%$$

Where :

Lt : The average length of fish at the end of the research (cm)
Lt : The average length of fish at the beginning of the research (cm)
t : Research time (30 day)

2.5.4 Feed efficiency

Calculation of feed efficiency using the formula Zonneveld et al. (1991) as follows.

$$FE = \frac{(Wt+D)-Wo}{F} \times 100\%$$

Where :
FE : Feed Efficiency (%)
Wt : Fish biomass at the end of the research(g)
Wo : Fish biomass at the beginning of the research (g)
D : The weight of the fish that died during research (g)
F : Amount of feed consumed (g)

2.5.5 Food conversion ratio

Food conversion ratio is calculated using the Tacon formula (1987) as follows.

$$FCR = \frac{F}{(Wt+D)-Wo} \times 100\%$$

Where :
FCR : *Food conversion ratio*
Wt : Fish biomass at the end of the research (g)
Wo : Fish biomass at the beginning of the research (g)
D : The weight of the fish that died during research (g)
F : Amount of feed consumed (g)

2.5.6 Water quality

Water quality parameters observed were temperature, pH, DO, and ammonia. This water quality measurement is carried out at daylight at 1:00 p.m. WIB. Observations were made four times, namely on day one, day ten, day twenty and day thirty.

3. RESULT

3.1 Survival rate

One of the factors that caused the high survival rate in this research was the quality during the maintenance process controlled in the optimum conditions for the survival of catfish . According to Indonesian Nasional Standard (Standar Nasional Indonesia/SNI 2014) the survival rate of catfish fry (size 5-7 cm) is in good catergory if the value is greater than 80%. Data on the survival rate of catfish given a combination of commercial feed and maggot can be seen in Table 1.

Table 1. Survival rate of catfish

Treatments	Survival Rate (%)
A	92.50[a]
B	92.50[a]
C	88.75[a]
D	92.50[a]

one of the causes of catfish mortality in this research is cannibalism. This is evident from the absence of fish carcasses in the aquarium. Cannibalism allegedly occurred in the night when catfish are active and there is no feed available in the aquarium. According to Fessehaye et al. (2005) cannibalism is strongly influenced by fish stock density, age of fish and weight ratio of predatory indiviuals. The Cannibalism will decrease if there are other feed as an alternative.

The results of this study indicate that the combination of maggot with commercial feed did not affect the survival of catfish. This is because giving maggot as feed does not affect the quality of water.

3.2 Daily growth rate

Growth is a change in form due to the increase in length, weight and volume in a given period (Effendie 1997). Based on the observation results, catfish fry were given the combination of commercial feed and *maggot* with 30 days of rearing resulted the growth of the catfish weight averages are different. The increase in weight average of catfish seed can be seen at Figure 1.

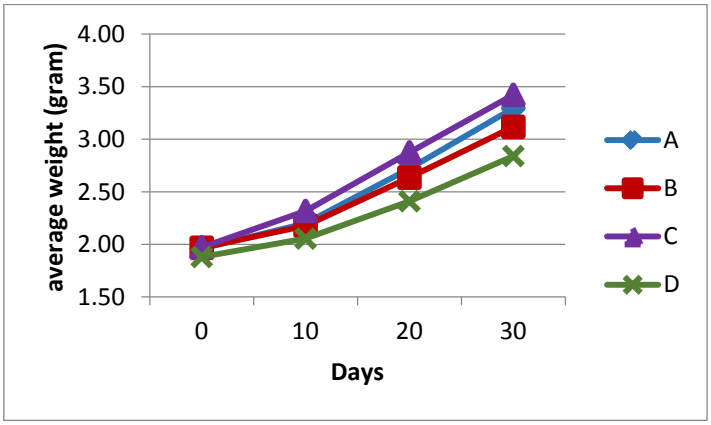

Figure 1. Graphic of average weight mutiara catfish

Average weight of catfish always increases every day. This is because the feed given is a combination of commercial feed and maggot responded well by catfish. Nutrient content affect the growth of catfish. According to Karim (2002) Growth will occur if there is an excess of energy and material in the feed consumed.

Table 2. Daily growth rate

Treatments	DGR(%)
A	1.74^{bc}
B	1.54^{ab}
C	1.86^{c}
D	1.37^{a}

Based on the data in Table 2, treatment C shows the highest daily growth rate which is 1,86%. This is in accordance with Murni (2013) statement which states that the combination of commercial feed and maggot given to tilapia with a concentration of 50% commercial feed + 50% maggot produces the highest daily growth rate because nutrition of the two feed complement each other so that the growth of tilapia becomes optimal.

Maggot fat contain of 5-10 days is in accordance with the nutritional needs of catfish fry because the fat content of maggot will increase with age. Maggots that are 5-10 days old have fat contain ranging from 13% -14% (Rachmawati et al. 2010). If the fat content in feed is less than the needs of fish, then some of the energy from the protein source will be used for fish activity and will inhibit growth. According to Fahmi (2009) The suitability of the needs of fat content in fish has an

impact on the high energy in fish feed so that fish can utilize energy from fat for their activities and maximize the function of protein for growth (energy sparing effect).

Maggot is a natural feed containing probiotic microbes as well as natural enzymes found in the digestion so that it can help the metabolic process of catfish. According to Awoniyi et al. (2004) found *Bacillus* sp. Bacteria. in the maggot digestive tract. *Bacillus* sp. is a probiotic bacteria that help increase growth and maintain fish health. *Bacillus* sp. in the intestine produces antibiotics to fight pathogenic microbes. *Bacillus* sp. is able to secrete enzymes that can simplify complex molecules into simple molecules so that fish more easily absorb nutrients in the feed given.

While in treatment D the value of the daily growth rate shows the lowest value when compared with other treatments which is 1.37%. This is because the content of chitin in maggot is hard to digest by catfish fish so that the feces released by catfish is still in the form of a maggot shell. This is suitable with the statement of Ediwarman et al. (2008) which states that the content of chitin in maggot is insoluble in strong acidic solutions, so it cannot be completely digested by the fish's body.

3.3 Length Ratio

Based on observations, the average length of fish given a combination of commercial feed and maggot was increased with a duration of 30 days. The graphic of the average length of catfish can be seen in Figure 2.

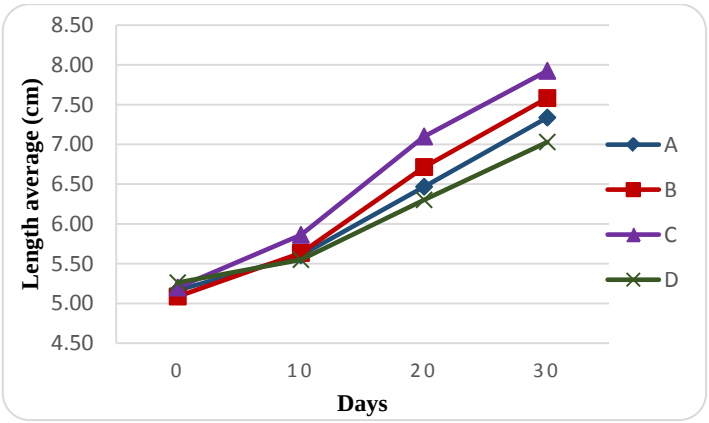

Figure 2. Graphic of average length catfish

Observation of the average length increase of fish fry is carried out every 10 days. The data obtained showed that the fish from each treatment had different length ratio. This is because the nutritional components in each feed are different.

Table 3. Length ratio of catfish

Treatments	Length ratio (%)
A	1.17^{b}
B	1.33^{c}
C	1.40^{c}
D	0.97^{a}

According to Dani (2005) to produce optimum fish growth there must be a balance of the components of the feed composition. The difference in composition of feed given will result in

differences in fish growth. The more complete composition in the feed will improve the quality of the feed and the growth of fish will be optimal.

The length increase in fish fry is influenced by the macro minerals needed in growth. Some macro minerals that function as a constituent of the body are calcium (Ca) and phosphor (P). The content of Ca and P is one of the macro minerals needed in large quantities by fish (Handjani and Widodo 2010).

Maggot has a calcium content of 5.36% and a phosphorus content of 0.88%. In the process of bone mineralization, Ca and P have an important role because about 80 - 90% of bone elements are composed of Ca, P and Mg (Zainuddin 2010). The percentage of length ratio in treatment B and treatment C is higher than treatment A.

Accordance to Handajani and Widodo (2010) statement, generally the P contain needed by fish in the body is 0.29-0.8%. Deficiency of Ca and P results in slow growth and low feed efficiency values (Steffens 1989). According to Zonneveld et al. (1991) which states that if fish lack phosphorus in the body it can result in inhibited growth and a disrupted bone formation process.

3.4 Feed Efficiency

The efficiency of catfish feed given a combination of commercial feed and maggot produced differences. Feed efficiency values can be seen in Table 4.

Table 4. Feed efficiency of catfish

Treatments	Feed efficiency (%)
A	64.50[b]
B	54.28[a]
C	65.09[b]
D	48.89[a]

Based on Duncan's multiple test, treatment C was not significantly different from treatment A, but treatment C showed the highest feed efficiency value of 65.09%. According to Craig and Helfrich (2002) the value of feed efficiency can be said to be good if the feed efficiency value is more than 50%. High efficiency values in treatment C because maggot contains animal protein so that it is easily digested by carnivorous fish. According to Zonneveld et al. (1991) animal protein is more digestible than vegetable protein. According to Kordi (2011), the higher value of feed efficiency shows the use of feed by fish is more efficient.

Treatment D showed the lowest feed efficiency value that is equal to 48.89%, this is presumed because maggot has a limiting factor which is chitin, if the gives is excessive of nutrients obtained from maggot cannot be fully converted into body weight but is used for metabolic processes and other needs. Djarijah (1995) states that the factors that determine the value of feed efficiency are the types of nutritional sources and the amount of each component of the nutrient source in the feed.

3.5 Food conversion ratio

Food conversion ratio (FCR) is a comparison between the amount of feed used and the amount of weight of fish produced. The low FCR value indicates that the feed given is in accordance with the nutritional needs of the fish. The low FCR value indicates that the addition a number of feeds can result in a greater proportion of fish weighting (Suwarta 2010).

Value of the food conversion ratio with the treatment combination of commercial feed and maggot showed significant differences. The food conversion ratio value of each treatment can be seen in table 5.

Table 5. Food conversion ratio of catfish

Treatments	FCR
A	1.56[a]
B	1.85[b]
C	1.54[a]
D	2.05[b]

The FCR value shows how much feed consumed will be biomass in the body of the fish. Based on Duncan's multiple test, treatment C shows the lowest FCR value of 1.54 but not significantly different from treatment A. This shows that giving a combination of commercial feed and maggot with the right ratio can be digested properly by catfish. Borrows and Hardy (2011) stated that the protein content in feed that was in accordance with the nutritional needs of fish would result in more efficient feeding and affect the FCR value.

Arief et al. (2014) states that feed quality is influenced by several factors including the ability of fish to absorb and digest feed, nutrient composition as a constituent of feed and the presence of probiotic microorganisms to help digestion of nutrients in the digestive tract of fish. Maggot is a natural feed that has probiotic bacteria in its intestine so that when catfish eat live maggot, probiotic bacteria in the maggot intestine will help the metabolic process in catfish.

Treatment D showed the highest FCR value that is equal to 2.05 This is because the process of absorption of feed is disturbed due to chitin. Priyadi et al. (2010) stated that maggot has the advantage of high nutritional value and complete but maggot has a limiting factor, namely chitin so that in it use as a substitute for commercial feed only in limited quantities.

3.6 Water quality

Water quality shows the value according to SNI (2014). Controlled water quality will redu length incrementce mortality in fish. Water quality data can be seen in Table 6.

Table 6. Water quality

Treatments	Observation			
	Temperature	pH	DO	Ammonia
A	27-30	7.1-8.15	6.3-6.9	0.003-0.03
B	27-29	7.35-8.3	6.4-6.9	0.003-0.03
C	27-29	7.24-8.24	6.2-6.9	0.003-0.03
D	27-29	7.14-8.17	6.4-6.9	0.003-0.03
Quality standards (SNI 2014)	25-30^{o}C	6.5-8	>3mg/L	<0.1 mg/L

The temperature of each treatment shows a range of 27-30^{o}C. Temperature in the aquarium is optimal range for catfish live. According to SNI (2014), catfish can live and grow well at a temperature range of 25-30^{o}C.

The degree of acidity (pH) of each treatment shows a range of 7.1-8.3. Growth and survival of catfish is influenced by pH. Inappropriate pH value can cause inhibits fish growth (Hermawan et al. 2012). According to SNI (2014), the optimal pH value for the survival and growth of catfish is 6.5-8.

Dissolved oxygen (DO) values in each treatment showed relatively the same values, namely 6.2-6.9. This is because aquarium are given aeration to increase DO. According to SNI (2014), catfish are able to live and grow optimally if the DO value is greater than 3 mg/L.

Ammonia is one of the factors that cause death in fish. Ammonia values in each treatment range 0.003-0.05 mg/L. This value is still in the optimal range for live catfish. Catfish are able to live in waters with ammonium levels of less than 0.1 mg/L (SNI 2014).

Feeding with combination of commercial feed and maggot does't affect water quality. This is indicated by the values of temperature, pH, DO and ammonia that are in accordance with SNI so that fish can keeping their survival and growth can be optimal.

4. CONCLUSION

The combination of commercial feed and maggot at the ratio of 50% + 50% gives the highest daily growth rate, length ratio, and feed efficiency namely 1.86%, 1.40%, 65.09% respectively and the lowest feed conversion ratio is 1.54.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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