The effect of giving corncob (Zea mays) on the growth of sludge worm (Tubifex sp.)

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Abstract. One of the best feed choices for aquaculture is sludge worms (Tubifex sp.). Sludge worms need enough protein for worm growth. Corncob is a waste that is not utilized in the environment. Corncob has protein content that can be used for sludge worm growth. Complex carbohydrates are broken down through fermentation. The purpose of this study was to optimize the development of sludge worm cultivation media based on corncobs. Sludge worms are cultured in a series of culture containers by recirculating watering. There are 3 variations of treatment, namely, treatment-I (10 %), treatment-II (20 %) and treatment-III (30 %). The parameters measured are water quality, dissolve oxygen, water flow rate, mass, number of individuals in the population, total organic matter. The results prove using corncob as a medium enrichment material provide good environmental results and is suitable for sludge worm. The range of temperature, pH and DO values are at the optimal conditions needed for the best fermentation process.

Keywords: Corncob; cultivation; fermentation; protein; sludge worm

1. Introduction

Indonesia as an archipelago with more than 1700 islands, has a large potential of fish resources. Until now, there has been an increase and development of fisheries culture both on a household scale and in large production. Based on data from the Indonesian Ministry of Maritime Affairs and Fisheries in 2018 there was an increase in aquaculture production from 7.93 million tons in 2011 to 16.68 million tons in 2016 [1]. The most important factor in the development of a fish cultivation business is the rearing larvae and fish enlargement. Natural food during rearing larvae is one of the important components. This natural food is given since the fish eggs are hatching until the fish is around 10 days old. The characteristics of natural food needed to support the growth and development of cultured fish are high in protein and small in size [2].

Sludge worms (Tubifex sp.) are pinkish-red aquatic invertebrate belonging to the class oligochaete that could be used as a natural live food for many commercial fish. Sludge worm is one type of natural feed that is favored by almost all type of freshwater fish with a high nutrient content consisting of 52.49 % protein and 13.3 % fat [2, 3]. The length of the sludge worm is 20–85 mm and 0.6–0.7 thick [4]. Apart from the high nutrient content, sludge worms are also easily obtained, have slow movements so that they are easily caught by fish, and have the ability to adapt in low oxygen content. Under hypoxic environmental conditions the sludge worms can survive for almost 48 hours [5, 6]. Sludge worms live in tropical region at a depth of 0–4 cm in the bottom of muddy waters that contain high organic content.
2. The fecundity and reproduction of sludge worms are influenced by several environmental variables consisting of temperature, substrate content, water flow and oxygen content. Temperature and oxygenated water will keep the habitat clean from solids and waste. Sludge worms will keep their bodies in contact with flowing water to obtain enough oxygen [7].

In line with the increase in the number of fish cultivation each year, the market demand for sludge worms as natural food has also increased. All this time, their availability in nature is used to fulfill the requirement of sludge worms as natural food in aquaculture so that the number and quality of sludge worms is unstable and not guaranteed. Another alternative that can be done to increase sludge worm production and quality is cultivating sludge worms. The media used in sludge worm cultivation is an important factor because it will affect the growth and nutritional content of sludge worms. The nutrient content of N, P and K in the medium is needed for growth and improve the quality of nutrients contained in sludge worms [8]. Enrichment of media nutrition with fermentation process is also expected to increase sludge worm populations and biomass [5]. One example of material that can be used to enrich the nutrition of a cultivation medium is corn cobs.

Maize (*Zea mays*) has been a crop plant in the last few decades. Maize is a good source of carbohydrate, protein, fiber, and vitamin. Increased maize production will be followed by an increase in waste such as corn cobs. In fact, as a component of waste product, corncob has enough of protein that can be used as a medium for sludge worm cultivation [9, 10]. The use of corn cobs waste as a medium for sludge worm cultivation has never been done until now. So this experiment is needed with the aim to determine the right concentration formula and know the effect of the use of fermented corn cobs to enrich the cultivation medium nutrition on the amount of biomass and the quality of sludge worms.

2. Materials and method

2.1. Location
The experiments were conducted in the Gudang 37, Kramat Jati, East Jakarta and Integrated Multidisciplinary Laboratory, Universitas Indonesia, Depok.

2.2. Preparation of unit culture
The worms were cultured indoor in plastic containers (52 cm x 38 cm x 15 cm) to protect them from rain and over light for 20 days. Twenty four culverts were used and arranged above ground level using flow-through water system to provide good drainage for best circulation of the worm. This was a 3 x 5 factorial experiment design conducted from April to December 2019. The difference lies in the concentration of corncobs in the treatment I, II and III. The media combination shown in table 1.

2.3. Collection of ingredients
The corncobs were collected from the Seed Center in Agronomy and Horticulture Department, Faculty of Agriculture, Institut Pertanian Bogor (IPB), Bogor. Corncobs are chopped into 0.5–1 cm cuts using a chopping machine (Honda GX 200). The process of copping corncobs into small pieces is done with the aim to facilitate the degradation process of corncob fibers by microorganisms. The mud is collected from the research location.

| Table 1. Media Combination |
|-----------------------------|
| Treatment | Mud (%) | Corncob (%) |
| Control | 100 | 0 |
| Treatment I | 90 | 10 |
| Treatment II | 80 | 20 |
| Treatment III | 70 | 30 |
2.4. Fermentation
The cultivation medium consists of 250 mL water, molasses, 1 kg corncob, and 15% probiotic treatment with Effective Microorganism (EM4). Before Probiotic EM4 is used, em4 must be activated using a mixture of molasses and water by mixing EM 4 and molasses solutions in a ratio of 1:1 [3]. Fermentation is a process to change organic components into simple forms using controlled microorganisms so that the final product can make chemical changes on an organic substrate.

2.5. Media preparation
Proximate composition of corncob was determined following the standard given by Wienhold et al. and Kanengoni et al. [9, 10]. The nutrient composition to enrich the cultivation medium is shown in table 2.

2.6. Collection of Tubifex spp.
Wild sludge worms were collected from fish farmer in Bumi Kependuan Sentul (BKS), Bogor, West Java, Indonesia. The sludge worms were cleaned for 24 hours before inoculation into the culverts by using continuous water flow.

2.7. Inoculation of sludge worms
Sludge worms were inoculated at the rate of 1.2c mg cm⁻² per container. The periodic supply of culture media was started from the 10th day with 10 days interval.

2.8. Water quality parameters in Situ Agathis and cultivation
Water flow rate was controlled by the stop cork of the PVP pipes with recirculating system using a water pump (DABAQUA Q 2007). Recirculation system is the process of reusing water that has been used by continuing to rotate water continuously through an intermediate filter into a container [11]. Water flow rate was measured once in every 10 days. Water quality parameters measured include temperature, pH, dissolved oxygen (DO), conducted every 10 days after sampling. Water temperature and pH of the culture was recorded with digital pH meter (IONIX+). Air temperature and coordinate was recorded by digital thermometer application (Xiaomi MI Play). Dissolved Oxygen (DO) and pH of water were determined with DO meters. The result shown in table 3 and table 4.

2.9. Adding new growth media regularly
The process of adding new growth medium is done every 10 days with the same concentration as the initial treatment for all containers. Giving a new medium on a regular basis is expected to increase population growth and biomass of Sludge worms [3].

2.10. Sampling
For each treatment, sample was taken at 10 days after inoculation of worms in the evening by glass tube and using filter. The worms were cleaned using running water and dried with tissue. Clean worms were weighed using an electric balance.

| Nutrient         | Concentrate (g/kg) |
|------------------|-------------------|
| Dry matter       | 908.3             |
| Crude protein    | 38.9              |
| Crude fiber      | 286.9             |
| Ash              | 76.7              |

Table 2. Nutrient composition of corncobs
3. Results and discussion

3.1. Water quality parameters

The results of the measurement of water quality parameters were observed throughout the experiment, shown in table 3 and table 4.

Water quality parameters that are measured in this study consisted of water temperature, pH and Dissolved Oxygen (DO). The water temperature in Situ Agathis (table 3) where sludge worms are also found range between 28.7–29.8 °C. Meanwhile, the water temperature during the cultivation (table 4) ranged from 27.4–28.2 °C. Based on research done by Adlan this range is suitable with the optimum temperature range for sludge worm growth media, which ranges between 24–32 °C [11]. Temperature is an important factor because an increase in temperature can cause an increase in metabolism and water respiration resulting in a decrease in gas solubility in water due to an increase in oxygen consumption by sludge worms. Oxygen consumption by aquatic organisms will increase 2–3 times equal to an increase in water temperature around 10 °C [5].

The second parameter is pH. Aquatic organisms are sensitive to pH because the changes will affect the biochemical processes. The pH in Situ Agathis UI as a representative environment of sludge worms in nature shows the pH ranges between 6.9–8.5. While the pH that have been obtained from cultivation (table 4) are range between 6.9–7.6. All this treatment are included in the optimum pH ranges between 5.5–8.0 [12]. The data (table 4) shows that the pH is neutral. This is a good result because a neutral pH provides an environment which is needed by bacteria that play a role in the process of degrading organic matter so it can be utilized by sludge worms [3, 5].

| Cordinate | Air temperature (°C) | Water temperature (°C) | pH | DO (ppm) |
|-----------|----------------------|----------------------|----|----------|
| 6°22’6” S 106°49’30” E | 31°C | 29.1°C | 7.1 | 6.8 |
| 6°22’11” S 106°49’26” T | 31°C | 29.8°C | 6.9 | 6.7 |
| 6°22.135’ S 106°49.493 E | 31°C | 28.7°C | 7.9 | 3.9 |
| 6°22’2” U 106°49’31” T | 31°C | 29.5°C | 8.0 | 9.6 |
| -6,3709742, 106.8258381 | 31°C | 29°C | 8.5 | 9.2 |

| Treatment | Air temperature (°C) | Water temperature (°C) | pH | DO (ppm) |
|-----------|----------------------|----------------------|----|----------|
| Control   | 30 ± 31              | 28.2                 | 7.6 | 5.8      |
| Treatment I | 30 ± 31              | 27.4                 | 6.9 | 4.2      |
| Treatment II | 30 ± 31              | 27.5                 | 7.1 | 2.4      |
| Treatment III | 30 ± 31              | 27.4                 | 7.0 | 2.4      |
The final water parameter used is Dissolved Oxygen (DO). Dissolved Oxygen is one of the parameters of water quality which is also affected by temperature and activation of fermentation bacteria.

The DO value obtained from cultivation (table 4) in the range of 2.4–5.8 is suitable with the optimum DO range to sludge worms reproduction which is around of 2.5–7.0 ppm [12]. Meanwhile, the DO in Situ Agathis UI range from 3.9–9.6. The difference in the value of DO between cultivation and nature is caused by the absence of the fermentation process. In all treatment during cultivation, fermentation is carried out so that more CO$_2$ is produced. The high CO$_2$ content in water makes DO values in cultivation relatively lower than those in nature [12].

4. Conclusion
The range of water temperature, pH, and DO obtained from each treatment were suitable with the optimal environmental condition that needed for sludge worm growth. This research proves that the use of corncob as a medium enrichment material can be used to increase the quality of fermentation process. The fermentation process is well aligned with the quality of the feed because it makes the feed easily digestible so that an energy source is quickly produced for tubifex growth. In future studies, trials of this feed directly to sludge worm will be conducted to observe the effect of feed with corncob on the mass and growth of sludge worm (Tubifex sp.).

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