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Analysis of Earthworm (*Lumbricus rubellus*) Growth Due to the Addition of Fruit Waste Pulp to Feed

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Abstract: Earthworms are a group of animals that live in soil and have a segmented body, bilaterally symmetrical, and covered by a transparent cuticle, which protects from physical and chemical disturbances**.** One of the factors that influences the growth of earthworms is the availability of food substances in the media where they live. Research on the analysis of the increase in the number and total weight of earthworms (*Lumbricus rubellus*) due to the provision of fruit waste in feed has been carried out in 2023. This research aims to analyse the increase in the number and total weight of earthworms due to the application of fruit waste to the media where earthworms live. Research data was analysed using variance analysis. In this study, the results were obtained: (1) fruit waste pulp (papaya and banana) added to feed had a significant effect on increasing the number of earthworms, (2) fruit waste pulp added to the feed can increase the total weight of earthworms, (3) Giving 2 liters of fruit waste to the feed results in a higher number and total weight of earthworms than other levels of fruit waste pulp.

Keywords: Fruit waste pulp; Growth of earthworms.

Introduction

Earthworms are a group of animals that have a habitat in the soil and play a role in fertilizing the soil. Earthworms have a body that is segmented, bilaterally symmetrical, covered by a transparent cuticle, which functions as a protector from physical and chemical disturbances. In the cuticle, there are glandular sacs that can secrete fluid, which causes the earthworm's body to look shiny [1]. Earthworms are animals that are biparental hermaphrodites, meaning they have two genitals in one animal, namely the male and female genitals. When reproducing, an adult earthworm cannot mate alone but must mate with another adult worm. The characteristics of adult earthworms that are ready to mate are that they are more than 2.5 months old and have a clitellum formed on their body [2].

Three environmental factors determine the life of earthworms: humidity, pH, and temperature of the media in which they live. Media humidity affects the respiratory system and the health of earthworms. Good humidity for earthworms is 30% – 50%. If the media humidity is too low, earthworms will usually come out of the media. Temperature is an environmental factor that influences the metabolism, reproduction, growth, and respiration of earthworms. The normal temperature for the development of earthworms ranges from 15^{o}C – 25^{o}C. Furthermore, the normal temperature for earthworm reproduction is 21^{o}C – 29^{o}C [3].

Apart from environmental factors in the form of humidity. pH and temperature of the medium. The growth of earthworms is also influenced by the availability of food in the media. The living medium for earthworms is soil, which contains much organic material. The organic material in the soil comes from the remains of dead animals and plants. The results of research [4] show that the addition of cabbage waste, papaya fruit, and cow feces can increase the body weight of earthworms. Furthermore, the provision of sawdust from coconut tree trunks and Manila grass in living media had a significant effect on the growth of earthworms [5]. The addition of market organic waste to earthworm living media can increase the production of earthworm cocoons and biomass [6]

In Mataram City, there are many fruit traders. The types of fruit sold include mangoes, apples, papayas, bananas, avocados, pineapples, melons, and others. Sometimes, the fruit sold is not sold out; the rest rots and is thrown into rubbish dumps. Apart from that, people's fruit-eating activities produce waste in the form of fruit peels, which are also thrown into rubbish dumps. The waste in the form of fruit waste can be used as material for making earthworm food. Research on growth analysis of earthworms (Lumbricus rubellus) was carried out from July to October 2023. This research aims to analyze (1) the effect of adding fruit waste to feed on the total number of earthworms and (2) the effect of adding fruit waste to feed on the total weight of earthworms.

Research methods

Materials and tools

The materials used in this research are fruit waste (papaya and banana), well water, EM4, brown sugar, earthworm broodstock, cow feces, fresh banana stems,

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tin roofs, bamboo, iron nails, woven bamboo fence, iron wire, brick, cement, and *paranet*. Next, the tools used are machetes, shovels, push tools, plastic buckets, blenders, wooden stirring spoons, measuring cups, pH meters, hoes, and hammers.

Research Stages

This research was carried out in several stages: (1) constructing a building where earthworms are kept, (2) Making additional food for earthworms, namely in the form of fruit waste slurry (papaya and banana), which is fermented for 8 days, (3) rearing earthworms and (4) measurement of earthworm growth variables.

The building where earthworms are kept is made with dimensions of 5 meters x 8 meters. The basis of the building is land which is divided into 16 plots. Between one story and another plot, a brick block is separated, and the size of each plot is 35 cm x 40 cm. The walls of the building are made of woven bamboo fences and paranet. The top of the building is given a roof made of zinc. In this research, earthworms were given additional food in the form of fruit waste pulp (papaya and banana), which had been fermented for 8 days. The stages of making extra food for earthworms are (1) preparing the necessary materials and tools, (2) making fruit waste pulp (papaya and banana) using a blender, (3) mixing the fruit waste pulp with a solution of brown sugar and EM4, (4) put a mixture of fruit waste, brown sugar solution, and EM4 in a plastic bucket and ferment it for 8 days.

The number of earthworms kept at the start of the study was 60, with a total weight = 56 grams. Earthworm maintenance is carried out on basic media in the form of a mixture of 3 kg of soil, 3 liters of cow feces slurry, and 3 kg of fresh banana stem pieces. Furthermore, each experimental unit was given additional feed in the form of fermented fruit waste. The treatment doses are: B0 = 0 liters, B1 = 0.5 liters, B2 = 1 liter, B3 = 1.5 liters and B4 = 2 liters. Each fruit waste feed treatment was carried out with three repetitions. The environmental parameters measured are pH and media temperature. The earthworm growth parameters measured were the total number and total weight of all earthworms. The research data were analyzed using analysis of variance [7].

Results and Discussion

Total Number of Earthworms

The addition of fruit waste to the feed caused variations in the number of earthworms observed after 64 days of earthworm rearing. Data from observations of the number of earthworms in each experimental unit are presented in the following table.

The data in Table 1 shows that the highest number of Lumbricus rubellus was 144 found in treatment B4, namely the addition of 2 liters of fruit waste as feed. Furthermore, the number of Lumbricus rubellus decreased according to the decrease in vegetable waste feed given. The lowest number of Lumbricus rubellus was 114, observed in the treatment with the addition of 0 liters of vegetable waste. The results of the analysis of variance showed that the treatment of adding vegetable waste to the feed had a significant effect in increasing the total number of *Lumbricus rubellus.*

Table 1. Average number of earthworms Observed after 68 days of feeding.

Fruit waste dosage	Number of Earthworms
B0	114
B1	118
B2	126
B3	132
B4	144

A higher number of earthworms is possible because papaya waste contains the nutrients needed for the growth of earthworms. Papaya fruit contains fiber, minerals, vitamin A, vitamin B, vitamin C, and lycopene [8]. Papaya fruit contains saturated fat, unsaturated fat, cholesterol, sugar, protein, vitamin A, vitamin C, vitamin B6, vitamin B12, iron, fiber, calcium, and magnesium (Sugiarto, 2021). One hundred grams of papaya contains protein = 0.5 g, fat, carbohydrates = 12.2 g, vitamin A, vitamin B = 0.04 mg, vitamin C = 78 mg, calcium, iron, and phosphorus [9].

A number of researchers obtained results similar to this study. The addition of banana peel waste slurry to feed can increase the number of earthworms after 70 days of feeding. The addition of 1000 ml of banana peel waste slurry produced the highest total number and total weight of earthworms [10]. Variations in the carbohydrate content of feed made from tofu dregs (Glycine max), coconut dregs (Cocos nucifera), and rice bran (Oryza sativa) had a significant influence on increasing biomass and the number of earthworms (Lumbricus rubellus) with the most optimal level being 70.24% [11].

Giving cabbage vegetable waste (*Brassica oleracea*) to pig feces had a significant effect on the number of offspring, cocoon production, and the addition of Lumbricus rubellus biomass. The best comparison level for cabbage vegetable waste and pig feces is 30% cabbage vegetable waste mixed with 70% pig feces media [12]. Feeding the market organic waste can increase the number and weight of earthworms. Feeding 50 grams for 100 grams of earthworms gives the best results in increasing the number and weight of earthworms. The average final weight of earthworms = 111.75 grams from an initial weight of 100 grams. The final average number of individual earthworms = 192 from the initial number = 100 [13].

Total Weight of Earthworms

The total weight of earthworms showed variations due to the addition of fruit waste to the feed. The total number of earthworms after 64 days of feeding is presented in the following table.

Table 2 shows that the highest total weight of Lumbricus rubellus was 125 grams, found when 2 liters of fruit waste slurry were added to the feed (treatment B4). Furthermore, the amount of Lumbricus rubellus decreased according to the decrease in fruit waste feed

given. The lowest total weight of earthworms was 104 grams found in treatment B0. The results of variance analysis showed that adding fruit waste to feed could increase the total number of Lumbricus rubellus.

Table 2. Average Total Weight of Earthworms Observed After 68 Days of Feeding

Fruit waste dosage	Total Weight of Earthworms
B0	104
B1	107
B2	112
B3	119
B4	125

The higher total weight of earthworms due to the addition of fruit waste to feed is possible because the added banana and papaya fruit waste contains various kinds of nutrients. Bananas contain potassium, vitamin C, vitamin B6, vitamin A, fiber, glucose, and fructose [14]. Bananas contain carbohydrates, protein, vitamin B6, vitamin C, manganese, potassium, iron, fiber, magnesium, folate, niacin, and riboflavin [15]. Bananas contain phosphorus, folate, calcium, potassium, magnesium, iron, vitamin B, and vitamin C. Banana peels contain protein, fat, carbohydrates, vitamin B, vitamin C, and calcium [16].

The results of other research support the research results. The productivity of L. rubellus can be increased by adding feed in the form of mustard greens and papaya fruit waste. Feeding papaya fruit waste has the highest influence on increasing earthworms' body weight and length and can degrade more waste than other feed treatments [17] (Liberty et al., 2022). Media made from a mixture of manila grass waste and coconut sawdust can increase the growth of earthworms [18]. A media mixture consisting of palm frond waste, chicken feces, and vegetable waste can increase the growth of earthworms [19]. Water spinach waste and papaya fruit waste have a significant effect on the body weight and body length of earthworms (Lumbricus rubellus) [20]. Baglog mushroom waste feed can increase the number of earthworm cocoons. Chicken feces can increase the growth and number of earthworm cocoons. Feeding a combination of mushroom baglog waste and chicken feces has a significant effect on the growth and number of earthworm cocoons [21]. Feeding mustard greens and banana peel waste can increase the weight and body length of Lumbricus rubellus. The food that really influences the length growth of earthworms is mustard greens waste. The food that really affects the weight of Lumbricus rubellus is banana peel [22]. The addition of tofu dregs to feed has a significant effect on the body weight of earthworms [23].

Conditions of living media for earthworms

Earthworms can live and reproduce well if they are in media with environmental conditions that support their life. Abiotic environmental conditions that influence the life of earthworms are the pH and temperature of the media in which earthworms live. In this study, the pH and temperature of the media were measured once every 3 days. Data about the pH and temperature of earthworm living media can be seen in Table 3

Table 3. Average temperature and pH of the media where earthworms live

Fruit waste dosage	pH.	Temperature
B0	6.4	24^0C
B1	6.5	24^0C
B2	6.5	25^0C
B3	6.6	26^0C
B4	6.6	26^0C

In Table 3, it can be seen that the pH of the media used to breed earthworms ranges from 6.4 to 6.6. Furthermore, the temperature of the media used ranges from 24^0C to 26^0C. [24] explained that in order to live and reproduce well, earthworms require an environmental temperature of between 18^0C to 27^0C and a pH ranging from 6.8 to 7.2. Furthermore, [25] explained that earthworms can live well if they live in media with temperatures between 18^0C and 27^0C. Earthworms can live well in media that has a pH of 6 to 7 and a temperature between 23^0C to 27^0C [26]. Likewise, [27] reports that earthworms can grow well in media that has a temperature of 15^0C to 25^0C and a pH ranging from 6.0 to 7.2. Referring to the description above, it can be concluded that in this study, the pH and temperature conditions of the media used in breeding earthworms are the ideal pH and temperature for the life of earthworms.

Conclusion

In this study it can be concluded: (1) fruit waste pulp (papaya and banana) added to feed has a significant effect on increasing the number of earthworms, (2) fruit waste pulp added to feed can increase the total weight of earthworms, (2) fruit waste pulp added to feed can increase the total weight of earthworms, (3) Providing 2 liters of fruit waste in the feed produces a higher number and total weight of earthworms than other levels of fruit waste slurry.

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