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Utilization of Maggot Larvae (*Hermetia illucens*) for Processing Food Waste at the UIN Raden Intan Lampung Canteen

Ika Listiana[1,*], Marlina[2], Eko Kuswanto[3], Ade Lenty Hoya[4]
[1,4]Biology Department; Faculty of Tarbiyah and Teaching, UIN Raden Intan, Lampung
[2,3]Biology Education Department; Faculty of Tarbiyah and Teaching, UIN Raden Intan, Lampung
Jl. Letnan Kolonel H. Endro Suratmin Sukarame Lampung, Indonesia.

Corresponding author*
ikalistiana@radenintan.ac.id

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Abstract

Waste management using maggot larvae (*Hermetia illucens*) can be an innovative strategy for reducing organic waste. This study aims to determine the effectiveness of maggot larvae in processing organic waste at the UIN Raden Intan Lampung Canteen. The research used a Completely Randomized Design (CRD) technique with 3 treatments and 3 replications. The observed parameters were duration, residue, and maggot weight. The organic waste used included vegetables, fruits, rice, and bones. The results showed that for bone and rice waste, maggots were able to reduce waste by 80%, producing an average residue of 141.3 grams with a decomposition duration of 515 minutes and a final maggot weight of 320.67 grams. For fruit and vegetable waste, maggots reduced waste by 58%, producing an average residue of 293 grams with a decomposition duration of 395 minutes and a final maggot weight of 560.33 grams. For mixed waste, maggots reduced waste by 81% with a decomposition duration of 496.6 minutes and a final maggot weight of 430.3 grams.

Keywords: Waste; Maggot; Duration; Residue; Weight.

INTRODUCTION

Humans engage in various activities to enhance their well-being by producing goods from natural resources, which also generate waste materials that have the potential to become garbage (Winahyu et al., 2014). Waste has become a major problem in the environment and society, necessitating effective management solutions. Waste is closely related to daily life, so it must be managed and controlled properly (Sukerti et al., 2017). Waste management is an unresolved issue in both developed and developing countries. Poor waste management can increase risks such as flooding and contamination of water and soil. Waste disposal aims to avoid negative impacts on health and the environment. The success of a waste management system depends on the efficiency of waste disposal, which requires trained personnel, adequate land, and appropriate infrastructure (Kasih et al., 2018). In Indonesia, urban solid waste issues are of significant concern due to the substantial waste composition. About 70% of urban solid waste in Indonesia is organic waste, 28% is inorganic waste, and the remainder is hazardous waste that requires special handling (Prihandoko, 2022). One major issue is food waste, as Indonesia is known to be the second-largest contributor to food waste in the world, with an estimated 300 kilograms of food waste generated per person each year (Cahyani et al., 2022).

Food waste can arise from various processes, such as poor supply or distribution systems. Products still fit for consumption are often not arranged or rotated properly, leading to food waste (Annepu, 2012). If this issue continues to be ignored, its impact on the environment will become increasingly severe, such as air pollution from methane (CH_4) and ammonia (NH_3) gases produced from decomposing organic waste. These gases can harm health, reduce air quality, and damage the aesthetics and comfort of the environment (Puger, 2018). One way to address the problem of organic waste is to convert it into environmentally friendly resources. Accumulated organic waste must be utilized to reduce accumulation, for example, through bioconversion using maggot larvae (*Hermetia illucens*). The processing of organic waste with maggot larvae can be carried out in the campus environment of UIN Raden Intan Lampung to make the process faster and more efficient (Mufti, 2021).

The processing and cultivation of maggot larvae (*Hermetia illucens*) have become an increasingly recognized form of creative economy. These maggots act as bio-machines in the processing of organic waste. They are highly active in consuming various easily obtainable organic materials, such as vegetables, fruits, household waste, fishery waste, animal carcasses, and livestock

manure. This technology enables the decomposition of organic waste quickly, reduces odor, and is sustainable (Amandanisa & Suryadarma, 2020). Waste processing, especially food waste from canteens, is highly needed at UIN Raden Intan Lampung. Currently, the processing of food waste is not yet optimal, for example, the canteen at the Faculty of Ushuluddin produces a large amount of food waste daily. Based on observations and interviews conducted by researchers with the canteen management, the waste produced consists of vegetables, bones, rice, and fruit. A small portion of this waste is taken home by canteen owners with livestock, while the rest is disposed of in campus-provided facilities (Rahayu, 2023). Special or environmentally friendly management, such as using maggot larvae (*Hermetia illucens*), can be one solution to food waste.

This study aims to determine how maggot larvae (*Hermetia illucens*) can help in processing and decomposing organic waste at the UIN Raden Intan Lampung Canteen.

MATERIALS AND METHODS

Study area

The research was conducted in November 2023 at 2 locations. The first location involved collecting organic food waste from 24 canteen units at the Faculty of Ushuluddin, UIN Raden Intan Lampung. The second location was the maggot house (*Hermetia illucens*) at UIN Raden Intan Lampung.

Procedures

Approach and Type of Research

This research uses a quantitative approach that focuses on variables in human life and analyzes the relationships between these variables using statistical tools and objective theory (Hayre and Zheng, 2022). This experimental research uses a Completely Randomized Design (CRD) method with 3 treatments and 3 replications for each treatment. Each medium used weights 0.7 kg or 700 grams, and each therapy involves 300 grams of 12-day-old maggot larvae (*Hermetia illucens*). The treatments applied in this research are as follows: (P1) Bone and rice waste medium, (P2) Vegetable and fruit waste medium, (P3) Mixed vegetable, fruit, rice, and bone waste medium.

Observation Parameters

The research parameters observed in this study are the duration of maggot consumption, maggot residue, and maggot weight.

Tools and Materials

cThe tools used in this research include maggot bins (*Hermetia illucens*), jars, buckets, digital scales, gloves, masks, trash bags, maggot cages (*Hermetia illucens*), basins, plastic sieves, writing tools for recording observation results, and a mobile phone camera for documenting the research.

The materials used in this research include food waste such as vegetables, rice, bones, fruit, and 12-day-old maggot larvae (*Hermetia illucens*).

Data analysis

Data analysis is conducted to determine the time required for maggot (*Hermetia illucens*) to consume waste, the residue produced, and the weight of maggot (*Hermetia illucens*) in different media through quantitative data analysis. Quantitative data relates to numerical data, whether obtained from measurements, such as measurement or calculation results (Notoadmojo, 2010).

The data analysis process described in this paragraph includes a homogeneity test using SPSS 25 software. If the data is found to be homogeneous, a one-way ANOVA test is conducted. If the p-value is less than 0.05, a Duncan test is performed at a 5% significance level is performed to determine the differences between treatments. This statistical approach is important for assessing the significance of observed differences in the data, and ensuring the validity and reliability of the research findings (Zulias, 2013).

RESULTS AND DISCUSSION

Results

Duration, Residue, and Weight of Maggots

Observations on the duration of organic waste processing by maggots (*Hermetia illucens*), the residue produced, and the weight of maggots in each treatment show differences. The treatments consist of P1 (700 grams of rice and bone waste medium), P2 (700 grams of vegetable and fruit waste medium), and P3 (700 grams of a combination of vegetable, fruit, rice, and bone waste), as shown in figure 1 below:

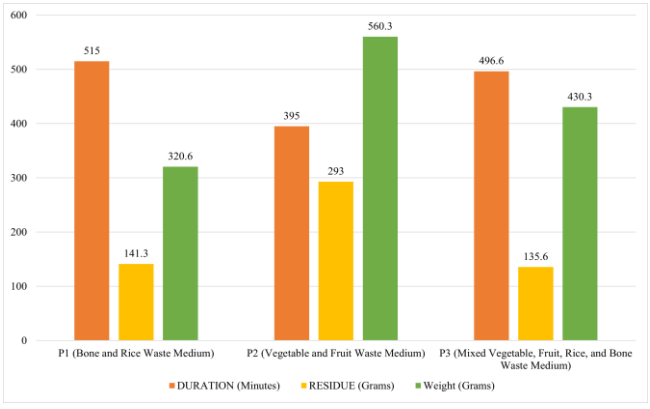

Figure 1. Research Data Results.

Durasi of Maggots (Hermetia illucens) in Decomposing Organic Waste

The duration of maggots (*Hermetia illucens*) in decomposing organic waste is the time maggots require to consume the organic waste. Observations show the average duration of decomposition varies for each treatment, as seen in Figure 2 below:

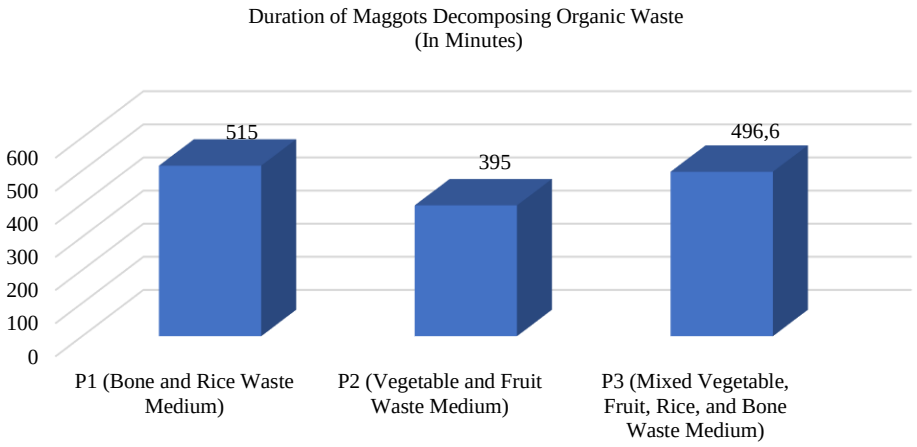

Figure 2. The average duration graph of *Hermetia illucens* maggots decomposing organic waste.

The Duncan test results can be seen in Table 1.

Table 1. Duncan Test Results for Maggot Duration (*Hermetia illucens*).

Treatment	Duration of Maggots *(Hermetia illucens)*
P1	515[b]
P2	395[a]
P3	496.6[b]

Residue Produced by Maggots (Hermetia illucens) in Processing Food Waste

Residue refers to the remains of waste decomposition by *Hermetia illucens* larvae. Observations on the residue produced by maggots in processing food waste from three different treatments show varying average results, as depicted in Figure 3 below:

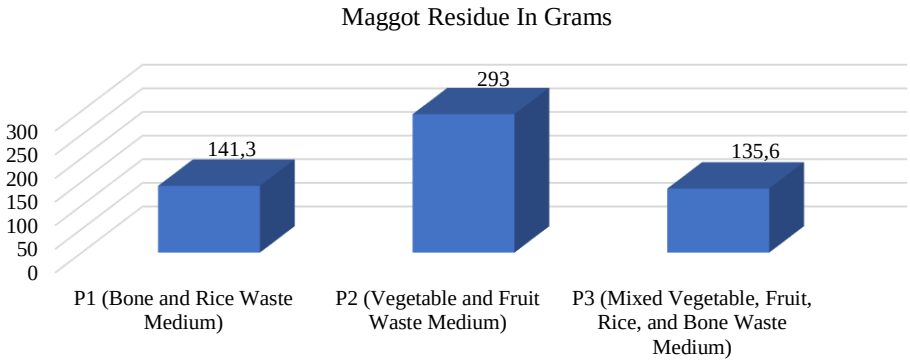

Figure 3. The Average Residue Graph of Maggots *(Hermetia illucens)*

The Results of the Duncan test can be seen in Table 2.

Table 2. Duncan Test Results for Maggot Residue *(Hermetia illucens)*

Treatment	Maggot Residue *(Hermetia illucens)*
P1	141.3[a]
P2	293[a]
P3	135.6[a]

Maggot Weight (Hermetia illucens)

Weight is the mass of an organism that has undergone growth (Azkaria and Herawati, 2021). Observation data on the weight of maggots (*Hermetia illucens*) from three different treatments can be seen in Figure 4 below:

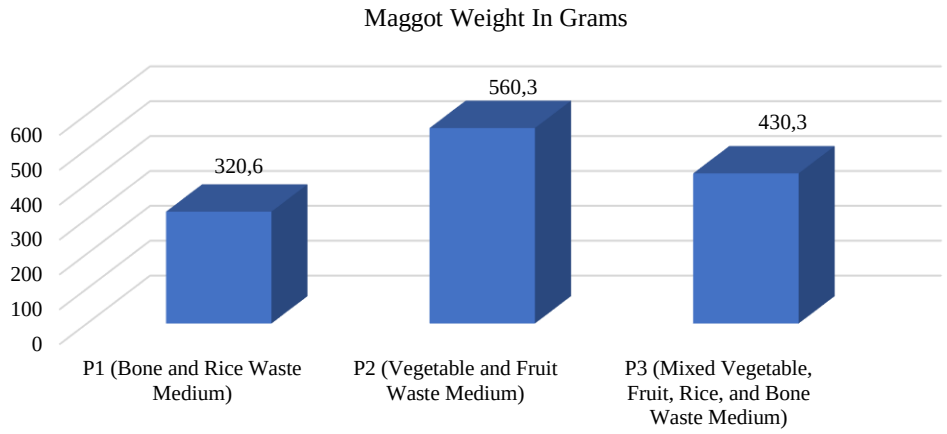

Figure 4. The Average Weight Graph of Maggots *(Hermetia illucens)*.

The Results of the Duncan test can be seen in Table 3.

Table 3. Duncan Test Results for Maggot Weight *(Hermetia illucens)*

Treatment	Maggot Weight *(Hermetia illucens)*
P1	320,67[a]
P2	560,33[b]
P3	430,33[b]

Discussion

Based on Figure 2, the average duration of maggots (*Hermetia illucens*) in decomposing organic waste varies. The fastest duration was found in P2 (fruit and vegetable waste medium), with an average of 395 minutes. This is due to the moist characteristics of the food with 60%-90% water content, as well as small or mashed pieces that facilitate nutrient absorption by maggots that lack chewing mouths (Dewi et al., 2021). Next, P3 (mixed waste medium of bones, rice, vegetables, and fruits) had an average duration of 496.6 minutes, slower than P2 because some media in P3 have a harder texture. The slowest duration was found in P1 (bone and rice waste medium) with an average of 515 minutes due to the hard texture of the bones, thus slowing down the decomposition by maggots (*Hermetia illucens*).

Based on Figure 3, maggot (*Hermetia illucens*) residue varies with different treatment media. The research shows that rice and bone waste is reduced by 80%, producing 141.3 grams of residue. Fruit and vegetable waste is reduced by 58%, with 293 grams of residue. Mixed waste of rice, bones, fruits, and vegetables is reduced by 81%, producing 135.6 grams of residue. The lowest residue is made from mixed waste (135.6 grams), while the highest residue is from fruit and vegetable waste (293 grams) because fruit seeds, fruit peels, and vegetable stems are difficult for maggots to reduce.

Based on Figure 4, P2 (vegetable and fruit waste) showed the highest weight with an average of 560.3 grams, followed by P3 (mixed bones, rice, vegetables, and fruits) with an average of 430.3 grams, and P1 (bones and rice) with the lowest weight of 320.6 grams. The weight in P1 is lower because its nutrients are sufficient to stimulate maggot (*Hermetia illucens*) growth, but the high organic content increases the number of bacteria and organic particles, affecting maggot weight.

The results related to the use of maggot larvae (*Hermetia illucens*) to decompose organic waste are simple methods that can be applied by the community, both at the household and industrial scales. Maggot larvae cultivation is easy to do at home because the process is simple and requires little capital. With proper management of the larvae life cycle, this method creates environmentally friendly waste processing. Maggot larvae do not produce additional waste, and the processing residue, known as frass, can be used as organic fertilizer (Raihan, 2022). This research uses waste and maggot larvae in a 2:1 ratio, namely 700 grams of waste (rice, bones, fruits, and vegetables) and 350 grams of 12-day-old maggot larvae per treatment. Twelve-day-old maggot larvae are chosen because at 12-18 days old, they are effective at consuming and reducing large amounts of organic waste. Additionally, maggots are easier to separate from the feed at this age, making it effective for observing residue parameters (Yuwita et al, 2022) (Bay et al, 2022).

Regarding the duration of maggots in decomposing organic waste based on analysis of variance (ANOVA), different waste media significantly affect the duration of maggots (*Hermetia illucens*) in decomposing organic waste. Maggots (*Hermetia illucens*) will remain in the medium if nutrients and water content are sufficient. Optimal water content is key to bioconversion; if water decreases, maggots will stop metabolism, harden, and die. Conversely, too much water makes maggots uncomfortable and tend to leave the food source (Fahmi, 2018). Differences in waste decomposition duration by maggots (*Hermetia illucens*) are due to feed characteristics. Effective feed should be moist enough

with 60%-90% water content, and high in protein and carbohydrates for maggot growth. The size of the waste also affects the decomposition speed; waste that is too large takes longer because maggots do not have mouths to chew. Therefore, large waste must be ground or chopped to maximize decomposition (Yulianingsih and Yani, 2023).

Maggots (*Hermetia illucens*) convert nutrients from organic waste into protein, fat, and other components, while the rest becomes residue from the decomposition process. The research results show that rice and bone waste is reduced by 80% with an average residue of 141.3 grams, fruit and vegetable waste is reduced by 58% with an average residue of 293 grams, and mixed waste of rice, bones, fruits, and vegetables is reduced by 81% with an average residue of 135.6 grams. Maggot larvae (*Hermetia illucens*) are most effective in decomposing mixed waste compared to fruit and vegetable waste, which has a residue that is difficult to decompose due to seeds, peels, and stems.

The growth of maggot larvae (*Hermetia illucens*) varies in each observation bin, with weight increasing as they grow. Observations in Figure 4. shows the highest maggot weight in P2 and the lowest in P1, because the feed medium affects maggot growth. Nutrients in the feed are crucial for maggot development, if the feed lacks sufficient nutrients, larva growth will be slower (Swastoko et al., 2023). P2 medium (fruit and vegetable waste) yields the highest maggot (*Hermetia illucens*) weight compared to other treatments because it contains nutrients and organic matter that support maggot growth. Fruit and vegetable waste provides a more complex source of nutrients, increasing the number of bacteria and organic particles from decomposition, which supports maggot growth (Faradila et al., 2023), (Neneng et al., 2023).

CONCLUSIONS

Maggots can reduce bone and rice waste by 80%, producing 141.3 grams of residue, with a decomposition duration of 515 minutes and a final weight of 320.67 grams. For fruit and vegetable waste, maggots reduce 58% of the waste, producing 293 grams of residue, with a decomposition duration of 395 minutes, and a final weight of 560.33 grams. For mixed waste, maggots were reduced by 81%, with a decomposition duration of 496.6 minutes and a final weight of 430.3 grams.

Based on the research results, the author recommends conducting further studies using different media and treatments to make the utilization of maggot larvae (*Hermetia illucens*) in decomposing organic waste more effective.

Competing Interests: All authors declare no competing interests.

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