ECOLOGICAL CITIZENSHIP: BIOCONVERSION OF FOOD WASTAGE WITH MAGGOT BLACK SOLDIER FLY

Nastiti Mufidah[1*], Faninda Novika Pertiwi[2], Tirta Dimas Wahyu Negara[3], Nureeman Jehyeh[4]

[1), 2), 3)] Universitas Islam Negeri Kiai Ageng Muhammad Besari Ponorogo, Ponorogo, Indonesia
[4)] Thaksin University, Songkhla, Thailand

Author Correspondence Email: * nastiti@iainponorogo.ac.id

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ABSTRACT

This study aims to analyze the formation of ecological citizenship to overcome the problem of food wastage through the bioconversion of Black Soldier Fly maggots. The method used is a qualitative case study with observation, interview, and documentation data collection techniques, using triangulation analysis techniques. This study was conducted on three groups of informants: chicken noodle shops, fruit shops, and households in Ponorogo. The informants in this study were specifically informants who initially threw their waste directly into the trash and ended up in the Final Disposal Site, so that it became one with inorganic waste without further treatment. The results of the study show that the embodiment of the ecological citizenship model put forward by Dobson, namely anthropocentrism, is a reference for the analysis of ecological citizenship about the relationship between individuals who occupy the same ecological space determined by their ecological footprint, so that it can be an alternative if managed and used correctly with the proper handling techniques. The conclusion of this study shows that the obligation of ecological citizenship imposed on each individual can be realized through the processing of food waste produced by bioconversion using BSF maggots.

ABSTRAK

Penelitian ini bertujuan untuk menganalisis terbentuknya *ecological citizenship* guna mengatasi permasalahan *food wastage* melalui biokonversi maggot *Black Soldier Fly*. Metode yang digunakan kualitatif studi kasus dengan teknik pengambilan data observasi, wawancara dan dokumentasi melalui teknik analisis triangulasi. Penelitian ini dilakukan kepada tiga golongan informan yakni; kedai mie ayam, toko buah dan rumah tangga di Kabupaten Ponorogo. Penelitian ini di khususnya pada informan yang awalnya membuang sampahnya langsung ke tempat sampah dan berakhir di Tempat Pembuangan Akhir sehingga menjadi satu dengan sampah anorganik tanpa diberikan penanganan lebih lanjut. Hasil penelitian menunjukkan bahwa perwujudan dari model *ecological citizenship* yang dikemukan oleh Dobson yakni antropocentris menjadi rujukan analisis kewarganegaraan ekologis tentang hubungan individu yang menempati ruang ekologis yang sama ditentukan oleh jejak ekologis mereka. Sehingga mampu menjadi alternatif jika dikelola dan mengggunakan teknik penanganan yang tepat. Kesimpulan dari penelitian ini menyatakan bahwa kewajiban kewarganegaraan ekologis yang dibebankan kepada tiap individu dapat diwujudkan melalui pengolahan sampah *food wastage* yang dihasilkannya dengan biokonversi maggot BSF.

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INTRODUCTION

The concept of ecological citizenship is a thought that is closely related to the ethical and moral procedures of citizens towards their environment. It is manifested in responsible behavior in managing and preserving the environment. In this era of globalization, cultural and citizenship literacy is very important to face and maintain local culture, which is the nation's identity (Setyawati & Aulia, 2023). Although built from green political philosophy, the concept of ecological citizenship has then undergone deepening and expansion. Latta said that several scientists who developed the concept of ecological citizenship have their specialties (Latta & Wittman, 2014). Related to ecological citizenship, this aligns with utilizing waste or organic waste for various things that can bring benefits rather than problems (Bartkienė et al., 2018). We all know that in recent years, food and market waste have increasingly attracted the attention of local and national governments, international organizations, non-governmental organizations (NGOs), and academics from various disciplines. Concerns about food security and environmental impacts, such as resource depletion and greenhouse gas emissions caused by food and market waste, have drawn increased attention. Meanwhile, households are the primary source of food waste (Schanes et al., 2018). Given the large amount of food waste that occurs at the household level, preventing food waste early is the most crucial step to address (Parfitt et al., 2010).

Food is a fundamental component in fulfilling the energy needs for human activities. Not only as a hunger filler, but the type and form of food consumed by a person can also be used as a benchmark related to a person's ability to sort and choose the food to be consumed (Tanamal & Prasetiyo, 2023). It ensures that the food consumed is always good and nutritious for the body. So, it is common for you to go through various sorting or filtering to get a good quality product. This process causes products that are not suitable or of poor quality to be wasted without processing (Godfray et al., 2010). This selection process ultimately leads to the food wastage phenomenon or a person's behavior in throwing away food waste (Aamir et al., 2018).

Although many interpret food waste as a word that refers to all food waste globally, using this term can be considered inappropriate because food waste, if interpreted generally, is more appropriate for the term. The spike in waste, classified as food wastage, is often not only created because of the production process but also because of the stages of the processing process by consumers or the community. The United Nations (UN) agency that deals with food ingredients, the Food and Agriculture Organization (FAO), estimates that around 32% of the food that was produced in 2009 was wasted (Parfitt et al., 2010) . Several things often create the phenomenon of food wastage, one of which is excessive purchases that apply not only to ready-made food but also to semi-finished foods that are frequently not utilized optimally. The suboptimal utilization of ready-made food or semi-finished food ingredients often causes rot, making it unsuitable for consumption, thus creating increasingly uncontrolled food wastage. In this case, food wastage is one of the consequences for people who often do not think long about maximizing the utilization of ready-made and semi-finished food, so they immediately throw away the stale food in vain.

Globally, the annual food waste is no less than 1.3 billion tons. Based on this data, Indonesia is one of the three largest food waste-producing countries after the United States and Saudi Arabia. According to the Ministry of Environment and Forestry (Kementerian Lingkungan Hidup dan Kehutanan/KLHK), it has been recorded that the amount of waste produced by people in Indonesia reached 21.88 million tons in 202 (Permen KLHK No. 4 Tahun 2021). Based on sources collected by KLHK, household waste, which is mainly

classified as food waste, is the most significant contributor to national waste, at 42.23%. The next most crucial waste source is commerce, with a percentage of 19.11%. Markets contribute 15.26% to national waste. Then, waste from offices is 6.72%. Public facilities and areas contribute to waste in Indonesia at 6.71% and 6.42% respectively (Sari et al., 2022). Meanwhile, 3.55% of waste comes from other sources. So, it is necessary to have the best strategy to deal with the increase in waste, especially food waste, for the years to come (Mahdi, 2022).

In Ponorogo itself, the waste problem is also often a concern that needs to be addressed immediately. Therefore, in 2018, the Ponorogo government issued Ponorogo Regent Regulation Number 32 of 2018 concerning the Establishment of a Regional Technical Implementation Unit for Waste Management at the Ponorogo Environmental Service (Peraturan Bupati Ponorogo Nomor 32 Tahun 2018 tentang Pembentukan Unit Pelaksana Teknis Daerah Pengelolaan Sampah pada Dinas Lingkungan Hidup Ponorogo), which explicitly contains the implementation of the duties and functions of the Regional Technical Implementation Unit (Unit Pelaksana Teknis Daerah/UPTD) contained in the Ponorogo Regent Regulation in 2018 (Pemerintah Kabupaten Ponorogo, 2028). Although the regulations have been explained in detail regarding the duties and functions of the UPTD, without awareness from each individual or community, especially the people of Ponorogo, the accumulation of waste will continue to occur at various temporary waste disposal sites (Tempat Pembuangan Sampah/TPS), resulting in overload, as happened at the Final Disposal Site (Tempat Pembuangan Akhir/TPA), Ponorogo (Marhaban, 2022). The effects will be terrible if multiple types of waste, including organic and inorganic, are gathered together in one temporary waste disposal site (TPS). It will result in decay, which ultimately produces a foul odor and causes pollution in the form of odor and air pollution, leachate, and slurry, preventing airflow so that waste quickly turns anaerobic (Bindra et al., 2015).

Based on the above, a solution is needed to deal with the problem of food wastage. One way to deal with this waste problem is in line with research conducted by A Singh entitled An inclusive approach for organic waste treatment and valorization using Black Soldier Fly larvae (Singh & Kumari, 2019). His research concludes that using Black Soldier Fly in composting organic waste is a new, environmentally friendly approach with great potential, so it is very interesting for people worldwide. Furthermore, Singh, Marathe, and Kumari (2023) stated that Black Soldier Fly larvae waste processing is a cost-effective method that can be carried out independently to restore resources that produce value-added products. So that it can massively increase new economic value for the industrial sector and entrepreneurs in various developing countries. By referring to and complementing these studies, this research aims to strengthen ecological citizenship as one of the solutions researchers offer residents through waste processing using Black Soldier Fly maggot cultivation. The ability of maggots to eradicate waste problems was also emphasized in the initial interview that the researcher conducted with one of the maggot activists in Ponorogo, named Yusuf, who stated that, within one day (1x24 hours), one maggot biopond can reduce/decompose between 1 - 3.5 kg of waste from food wastage. So we can imagine that if one entrepreneur had more than 10 maggot bioponds in his captivity, then around 10 - 35 kilograms of food waste would have been reduced, and the waste could have been decomposed within 1 x 24 hours.

Therefore, this study aimed to determine the impact of Black Soldier Fly maggot cultivation on the environment and the effectiveness of maggots in overcoming waste problems, especially food waste, in Ponorogo. Waste management through policy is in line with research conducted by Thyberg entitled Drivers of Food Waste and Their Implications

for Sustainable Policy Development, in which this article states that the causes of food wastage can be influenced by the best policies that the government can provide in dealing with waste problems (Thyberg & Tonjes, 2016). According to research by Bila et al., character strengthening is significant for society to foster a much better moral attitude and not be easily carried away by negative currents (Bila et al., 2023). Increasing awareness of ecological citizenship in the community is expected to be proven by optimally utilizing food or household waste. The results of this study are also likely to be an initial pioneer in the partnership program between universities, especially Kiai Ageng Muhammad Besari University, with maggot activist stakeholders and the broader community regarding overcoming food waste problems in Ponorogo. In addition, researchers hope this activity will provide valuable information for every citizen and government in Ponorogo regarding implementing ecological citizenship as an alternative to increasing the economic value of food waste processing through the cultivation of Black Soldier Fly Maggots (BSF).

METHOD

This study uses a qualitative approach. Qualitative research is a study that aims to understand the phenomenon of what is experienced or happens to the research subject (Hasibuan & Simatupang, 2021). For example, behavior, perception, action, etc., are holistically described in words and language in a special natural context and utilizing natural methods (Moleong, 2010). This type of research is a case study. The use of case study research is because this research seeks to investigate and understand an event or problem by collecting various information, which is then processed to obtain a conclusion. Case studies enable researchers to get a complete and integrated understanding of a case. The case referred to in this study is related to the accumulation of food or organic waste.

The research data will be produced on the impact of BSF maggot cultivation and its effectiveness in overcoming existing problems in Ponorogo. Other supporting data related to BSF maggot cultivation, waste problems in the Ponorogo district, and the amount of organic waste produced daily in shop stalls and households are also available. This research data was obtained from data sources, namely food, fruit, or other merchandise traders, whose leftover sales are included in food waste. These traders are expected to be able to provide information regarding the amount of waste produced and what efforts they have made in disposing of or processing waste so far. Furthermore, data related to the technical aspects of Black Soldier Fly Maggot cultivation, the impact of maggot cultivation, and its effectiveness in decomposing waste were obtained from data sources, namely Black Soldier Fly Maggot entrepreneurs in Ponorogo.

This research was conducted within one year, with research subjects divided into three informant groups: chicken noodle shops, fruit shops, and households in Ponorogo. The informants' classification was done to make it easier for researchers to classify the types of waste and the amount of waste produced. Informants in this group came from six chicken noodle shops spread across four sub-districts, namely from Jenangan District, two shops, Babadan District, one shop, Mlarak District, and Jetis, one shop. The second group has eight households as informants. Moreover, the third group came from fruit shops, totaling six fruit shops.

The first observation was made using the data collection technique used in this study. Observation was carried out to see the waste management efforts or observations on the utilization of waste through the cultivation of Black Soldier Fly Maggots. Observations were also carried out to obtain data on the effectiveness of maggots in overcoming organic waste problems. Observations in this study were carried out from completing the maggot

cultivation process until they could finally decompose organic waste in the surrounding area. In addition to observation, interviews were conducted with chicken noodle traders and fruit and maggot activists (Kasmi et al., 2025). Documentation in this study was intended to obtain data on the cultivation and development of Black Soldier Fly Maggots from the egg stage to being used as an alternative to decomposing food waste.

The data analysis technique used in this study is interactive (Suyanto et al., 2015). Interactive techniques allow researchers to conduct data analysis after returning from the research location or while still at the research location. Qualitative data analysis used the analysis model from Miles, Huberman, and Saldaña (2013), including data collection, condensation, data presentation, and conclusion. The data collected in qualitative research is in the form of narratives and is descriptive or further elaborated on. Data condensation is summarizing and selecting the main points from the research results. Then, the data is presented as a description, which is divided into several sub-chapters; this is the display stage. The last step is to conclude the data that has been described. This conclusion is the stage of concluding all the data that has been presented.

RESULTS AND DISCUSSION

Food waste in Ponorogo often causes environmental and air pollution problems that have a destructive impact. So this study began with researchers showing the causal factors of waste production produced by three groups of informants, namely, chicken noodle shops, fruit shops, and households in Ponorogo. The informants' classification was done to make it easier for researchers to classify the types of waste and the amount of waste produced. The selection of informants in this study was specifically for informants who threw their waste directly into the trash and ended up in the Final Disposal Site (TPA), so that it became one with inorganic waste without further handling.

The first contributor to food wastage comes from the group of restaurants or chicken noodle shops that do not have a waste or garbage processing facility. Informants in this group came from six chicken noodle shops spread across four sub-districts, namely two shops from Jenangan Sub-district, one shop from Babadan Sub-district, one shop from Mlarak Sub-district, and one shop from Jetis. When various restaurants or shops do not have a waste processing facility, most business actors will dispose of it together with inorganic waste at the TPA directly or through waste collectors who are paid every month to deposit the waste at the nearest TPA. It can cause various environmental pollution and is dangerous to health where it has been explained that food waste is food that is ready to be consumed by humans but is thrown away and ends up piling up in the Final Disposal Site (TPA) or even several places that can produce or produce methane and carbon dioxide gases that are dangerous to health and the environment. The effects of the pile of waste cause gas to be carried into the atmosphere, ultimately damaging the ozone layer on Earth (Munesue & Masui, 2019).

Based on interviews with informants, data were also obtained that business actors directly disposed of waste because they did not have special storage for the waste. In addition, informants also stated that it was difficult to provide special land for the final disposal of food waste from their business results due to limited costs and land. One of the reasons is that some business actors also use land to sell at this time by renting. Furthermore, informants stated that until now, there has been no handling or service provided by the government to provide a solution for the organic waste produced from their business premises. This situation is further exacerbated by the increasing number of foods that are only partially eaten by consumers after buying food at the shop, so the rest is wasted. Food

wastage can also result from consumer actions, such as wanting to taste food without intending to finish it. Therefore, when we eat, we try to eat it all so that the rest does not become food wastage (Hazuchova et al., 2020). Based on data from the first group of informants, it can be concluded that the amount of food wastage produced by chicken noodle and meatball shops varies greatly. It depends on the number of customers at the shop each day. The more visitors to the shop, the more food wastage from the visitors' leftover food will increase.

In the second group, interviews and observations were conducted with eight household informants. These eight informants are located in four different sub-districts: the Jenangan Sub-district with two informants, the Babadan Sub-district with two informants, the Mlarak Sub-district with two informants, and Jetis with two informants. In addition, these eight informants also have different numbers of families, from two (husband and wife) to six family members (husband, wife, three children, and grandmother). The amount of food waste produced daily varies depending on the number of family members. Based on the interview results, it was found that the more family members there are, the more food that is cooked or needed will increase, so the amount of food wastage produced also tends to be greater.

Furthermore, based on the data obtained related to the amount of waste in this second group, it is also associated with the type of work done by the head or the housewife in the family. Suppose a family member has a job related to ready-to-eat food (for informants from Jenangan District who work as catering providers). In that case, the food waste produced also tends to be higher than that of families. In addition, environmental factors and the moments that occur are also the cause of the diversity of the amount of food waste produced in each household. Suppose a household in a housing or village environment does not have pets such as chickens, ducks, muscovy ducks, and other animals that can eat the remaining food waste each family produces daily. In that case, the food waste can be ascertained to be disposed of together with other inorganic waste at the Final Disposal Site (TPA).

Based on the observations and interviews conducted, it can be concluded that food waste produced by households fluctuates a lot daily. Differences in the amount of food waste in each household occur due to various factors, including the number of family members, the work of family members, environmental factors, and the moment when that happens. Second, suppose there is a household in a housing or village environment that does not have pets such as chickens, ducks, muscovy ducks, and other animals that can eat the food waste produced by each family daily. In that case, the food waste can be disposed of together with other inorganic waste, either in the landfill or in the landfill behind/around the house, which will cause various types of pollution.

This research was continued with the third group, namely, several fruit shops in the Ponorogo district. Informants in this group consisted of six fruit shops spread across four sub-districts, namely Jenangan District with two shops, Babadan District with one shop, Mlarak District with one shop, and Jetis District with one shop. Based on the results of observations and interviews conducted by the researcher, data were obtained that food wastage from fruit shops was primarily due to a decrease in quantity and quality, in the definition of food waste, describing or explaining a condition where the decrease is interpreted as a physical loss of food (weight). On the other hand, the definition of a decrease in the quality of food waste means a decrease caused or arising from a reduction in the value of food, such as a decrease in some nutritional content in food (for example, nutritional content, vitamins, minerals, etc. which can arise because the food or ingredients are dented

or the packaging has been opened). In addition, a decrease in quality can also result from a decrease in a food's economic value because the food does not comply with existing quality standards (Duroy, 2011; Munesue & Masui, 2019; Widjaja et al., 2021). In addition, storing food for too long can cause the food to rot, become moldy, and give off a bad smell.

Based on the data collection obtained from interviews, observations, and documentation on the third group of informants, it was concluded that the amount of food wastage produced by the six fruit shops also varied greatly. It was influenced by the amount of rotten fruit that day. Food wastage can also increase when new fruit shipments arrive from suppliers because, in some fruit storage boxes, sometimes there are some rotten fruits due to impact factors during the trip or other factors that cause the fruit to be unsaleable. In addition, food waste also often occurs in fruits that do not have a long storage period. Based on the interviews with informants, it was found that there are groups of fruits that do not have a long storage period, such as langsat, rambutan, avocado, mango, and other fruits that ripen and rot quickly. The other group is fruit that lasts a long time at room temperature, such as oranges, salak, watermelon, and other fruits that can last up to approximately one whole week without refrigeration. Like the waste produced by food stalls or chicken noodle shops, all fruit shops that were informants also produced food waste, which did not have a waste collection place willing to accommodate food waste from the business actors. So far, the waste produced by fruit shops will be thrown away together with other inorganic waste. The disposal is returned to the TPA or another nearby waste disposal site. It is perilous for the environment and health.

Before analyzing the formation of ecological citizenship, researchers discuss the effectiveness of handling food waste through the bioconversion of Black Soldier Fly maggots. Bioconversion is an effort to accelerate the process of decomposing organic materials, usually requiring bioconversion agents with the help of bacteria or fungi (Addo et al., 2022; Ameixa et al., 2023; Gao et al., 2019). However, recently, a bioconversion agent that is no less fast has been found using larvae from black soldier flies or BSF (Hermetia Illucens) (Cai et al., 2019; Gunawan et al., 2018; Kari et al., 2023; Parra Paz et al., 2015). In this study, data were obtained related to the amount of organic waste that maggots could decompose or eat from the beginning to harvest (maggots sold). Bioponds 1,4,3,6 contain maggots that feed on fruit waste. While in bioponds 2 and 5, they contain maggots fed on household waste and noodles.

Based on the research that has been done, the initial number of maggots, around 2000 grams in biopond one from July 22, 2023, to July 30, 2023, was able to consume 7000 grams of fruit waste. This waste was consumed for 9 days; then, on August 1, 2023, when the 700 grams of maggots were moved to Bio Pond 4, and the 1300 grams remained in Bio Pond 1, this was able to consume 35,600 grams of fruit waste in biopond 1. This waste was consumed in 29 days, from August 2, 2023, to August 30, 2023. In biopond 4, maggots could consume 20,584 grams of fruit waste. This waste was consumed for 22 days, from August 2, 2023, to August 23, 2023. In biopond 3, from July 22, 2023, to August 28, 2023, maggots could consume 45,168 grams of fruit waste. This waste was consumed for 37 days. In biopond 6, maggots could consume 34,911 grams of fruit waste from August 1, 2023, to August 30, 2023. This fruit waste was consumed within 30 days. Details can be seen in Table 1 below:

Table 1. Feeding Biopond 1 (Food Waste From the Fruit Shop)

No	Date	Food Waste Weight	Waste Type
1.	July 19, 2023 – July 22 (Hatching Phase)	1.500 gram	Bran + water

2.	July 22, 2023 (Enlargement Phase)	800 gram	chopped fruit
3.	July 24, 2023 (Enlargement Phase)	500 gram	chopped fruit
4.	July 25, 2023 (Enlargement Phase)	1.000 gram	household waste + grated coconut, so it is not muddy
5.	July 28, 2023 (Enlargement Phase)	1.100 gram	chopped fruit
6.	July 30, 2023 (Enlargement Phase)	2.100 gram	chopped fruits and vegetables
The amount of fruit waste used up over 6 days was 7,000 grams.			
7.	August 2, 2023	1.210 gram	fruit
8.	August 3, 2023	3.136 gram	Fruit
9.	August 4, 2023	400 gram	Fruit
10.	August 5, 2023	1.150 gram	Fruit
11.	August 8, 2023	3.232 gram	fruit
12.	August 10, 2023	3.947 gram	Fruit
13.	August 13, 2023	2.502 gram	Fruit
14.	August 15, 2023	2.850 gram	Fruit
15.	August 18, 2023	3.011 gram	Fruit
16.	August 20, 2023	2.751 gram	Fruit
17.	August 23, 2023	3.100 gram	Fruit
The amount of waste generated over 11 days was 27,289 grams.			
18.	August 25, 2023	2.520 gram	fruit
19.	August 28, 2023	2.901 gram	fruit
20.	August 30, 2023	2.890 gram	fruit
The amount of fruit waste consumed over 3 days was 8,311 grams.			

Source: Research Data, 2024

The data obtained with the initial number of maggots around 2000 grams in biopond one from July 22, 2023, to July 30, 2023, consumed 7000 grams of fruit waste. This waste was consumed for 9 days; then, on August 1, 2023, when the 700 grams of maggots were moved to biopond four, and the 1300 grams remained in biopond 1, this was able to consume 35,600 grams of fruit waste in biopond 1. This waste was consumed over 29 days, from August 2, 2023, to August 30, 2023. In biopond 4, maggots could consume 20,584 grams of fruit waste. This waste was consumed for 22 days, from August 2, 2023, to August 23, 2023. In biopond 3, from July 22, 2023, to August 28, 2023, maggots could consume 45,168 grams of fruit waste. This waste was consumed for 37 days. In biopond 6, maggots could consume 34,911 grams of fruit waste from August 1, 2023, to August 30, 2023. This fruit waste was consumed within 30 days.

Due to several factors, it is unknown how much fruit waste the BSF maggots can consume daily. Among them, the larger the size of the maggot, the greedier it eats, so the more days pass, the more waste the maggots can consume. In addition, the feed in the biopond cannot be used up 100% in one day because fruit waste often leaves behind skin and seeds, most of which cannot be decomposed by BSF maggots. Therefore, the researchers calculated from July 22, 2023, to August 30, 2023 (38 days). During that period, the food wastage from the fruit shop that had been consumed was 63,184 grams. On average, BSF maggots can consume 1,662 grams of fruit waste daily.

After describing the results of the food waste data carried out by BSF maggots fed fruit waste, Table 2 shows the details of the results of maggots fed household waste and noodles:

Table 2. Feeding Biopond 2 (Food Waste from Households and Noodle Shops)

No	Date	Food Waste Weight	Waste Type
Hatching phase			
1.	July 19, 2023 – July 22	1.500 gram	Bran + water
Enlargement phase			
2.	July 22, 2023	600 gram	household
3.	July 24, 2023	1.100 gram	noodle and meatball shop
4.	July 25, 2023	2.109 gram	household + grated coconut
5.	July 26, 2023	769 gram	household
6.	July 27, 2023	1.439 gram	noodle and meatball shop
7.	July 28, 2023	2.105 gram	noodle and meatball shop + household
8.	July 29, 2023	3.750 gram	noodle and meatball shop + household
9.	July 31, 2023	2.185 gram	noodle and meatball shop
The amount of waste generated over 8 days was 14,057 grams.			
10.	August 2, 2023	526 gram	household
11.	August 3, 2023	2.133 gram	noodle and meatball shop + household
12.	August 5, 2023	1.654 gram	household
13.	August 7, 2023	1.678 gram	noodle and meatball shop
14.	August 8, 2023	832 gram	household
15.	August 12, 2023	3.047 gram	noodle and meatball shop + household
16.	August 14, 2023	2.805 gram	noodle and meatball shop + household
17.	August 15, 2023	350 gram	household
18.	August 16, 2023	3.651 gram	noodle and meatball shop + household
The amount of waste generated over 9 days was 16,676 grams.			
19.	August 18, 2023	2.241 gram	noodle and meatball shop + household
20.	August 20, 2023	3.808 gram	noodle and meatball shop + household
The amount of waste spent over 2 days was 6,049 grams.			
The total household waste and noodles over 28 days was 36,782 grams.			

Source: Research Data, 2024

Table 3. Feeding Biopond 5 (Food Waste From Households and Noodle and Meatball Shops)

No	Date	Food Waste Weight	Waste Type
The enlargement phase began on August 1, 2023, with an initial maggot weight of 1,700 grams.			
1.	August 1, 2023	2.788 gram	household
2.	August 3, 2023	1.660 gram	noodle and meatball shop + household
3.	August 4, 2023	640 gram	household
4.	August 5, 2023	2.758 gram	noodle and meatball shop + household
5.	August 8, 2023	3.637 gram	noodle and meatball shop + household
6.	August 9, 2023	3.831 gram	noodle and meatball shop + household
7.	August 10, 2023	2.905 gram	household

The amount of waste generated over 7 days was 18,219 grams.			
8.	August 10, 2023	2.241 gram	noodle and meatball shop + household
The amount of waste produced in 1 day is 2,241 grams.			
The total household waste and noodles consumed by maggots from August 1, 2023, to August 12, 2023, was 20,460 grams.			

Source: Research Data, 2024

Based on the data, it appears that with an initial maggot count of around 2700 grams in biopond two from July 19, 2023, to July 31, 2023, before finally on August 1, 2023, there was a transfer of 1,700 grams of maggots to biopond 5. From July 22, 2023, to July 31, 2023, the maggots consumed 14,057 grams of household waste and noodles. Then, on August 1, 2023, 1,700 grams of maggots were transferred to biopond 5, and 1000 grams remained in biopond 2. In biopond 2, namely from August 2, 2023, to August 16, 2023, the maggots could consume 16,676 grams of fruit waste. Then, from August 18, 2023, to August 20, 2023, maggots could consume 6,049 grams of waste. The total waste consumed by maggots in biopond 2 was 36,782 grams of household waste and noodles. This waste was consumed for 30 days, from July 22, 2023, to August 20, 2023. In biopond five, from August 1, 2023, to August 10, 2023, maggots could consume 18,219 grams of household waste and noodles. Then, on August 12, 2023, maggots consumed 2,241 grams of waste. So, the total household waste and noodles consumed by maggots in biopond five from August 1, 2023, to August 12, 2023, was 20,460 grams. This waste was consumed for 12 days. The total waste consumed by maggots in bioponds 2 and 5 was 57,242 grams. It is unknown how much household waste and noodles can be used daily because the bigger the maggots get, the more they eat. So, the more days pass, the more waste the maggots can accumulate. If calculated in general, for 30 days, bioponds 2 and 5 could use up 57,242 grams of household waste and noodles. If calculated in general, then on average, the maggots could use up 1,908 grams of household waste and noodles in one day.

Based on the data that has been obtained, maggot cultivation is effective in overcoming existing waste problems. According to Godfray, short or long-term achievement manifests effectiveness (Godfray et al., 2010). According to Handayaningrat, effectiveness is the achievement of previously set targets and objectives. Suppose the targets and objectives are achieved according to those previously determined. In that case, the program is called effective, but conversely, if the previously set targets and goals are inappropriate, the program is said to be ineffective (Wiwit et al., 2020). According to Sutrisno, something is practical if it meets five indicators: 1). program understanding (program realization so the program can run smoothly), 2). target accuracy (the targets to be achieved must be appropriate), 3). timeliness (according to the time that has been determined or planned), 4). achievement of goals (the more benefits it provides, the more effective the program is), and 5). real change (the program offers fundamental changes to program targets) (Sutrisno, 2011).

The effectiveness of maggot cultivation in overcoming this waste problem can be seen from the first indicator, program understanding. Program understanding is needed so that the program runs well. The program, namely BSF maggot cultivation, is applied in this study. Maggot cultivation has been carried out in real terms, starting from the construction of BSF cages, where, in its construction, it has a specific purpose that is certainly well understood by researchers. For example, the form of the biopond building is divided into two: by dividing the biopond based on its purpose. The first goal is a biopond that is expected to be able to produce BSF maggots that are ready to be sold and meet consumer demand (as animal feed, fish, poultry, etc.), or it can also be said to produce BSF maggots that are ready to be sold

with an age range of 20-30 days. Based on this goal, the researcher built this biopond by dividing 10 boxes into five on the right side of the middle road and five on the left.

The second indicator is the accuracy of the target. In this study, the initial target was the landfill at the Mrican Ponorogo TPA and several other TPAs where the trash piles up and is mixed with organic and inorganic waste. This waste, especially organic food waste, has not been appropriately handled. Then, in several fruit shops, markets, chicken noodle shops, etc., the food waste is disposed of by being mixed with other waste, so a solution is needed for this mounting food waste. Based on this, the program is on target if implemented in Ponorogo, especially in the Jenangan sub-district, where TPAs, chicken noodle shops, and fruit shops exist. The third indicator is timeliness. This maggot cultivation research, from eggs to harvest, takes about 30 days; after 30 days, the benefits of maggot cultivation can be seen, as well as how the maggot sales results are carried out. In the maggot cultivation carried out on the six bioponds, all of them have been completed to the harvest stage, and the amount of waste that the maggots have consumed can be known from the enlargement phase to harvest. Therefore, it can be said that the program carried out, namely the cultivation of BSF maggots, was completed on time.

The fourth indicator is the achievement of the goal. The program is said to be effective if the results are as expected. The cultivation of BSF maggots has achieved its goal of overcoming existing problems. It can be proven from the data on cultivating maggots fed on fruit waste. The results showed that every 1 gram of maggot consumed 3.34 grams of fruit waste. In the cultivation of maggots fed with household waste and noodles, the results showed that every gram of maggot consumed 3.57 grams of household waste and noodles. In total, during this study, which was carried out for around 30-40 days, the fruit waste successfully consumed was 63,184 grams, and household waste and noodles were 57,242 grams. It can be imagined that if the number of cultivated maggots increases, more organic waste can be destroyed. Maggots that are successfully harvested can also be an additional income because, when harvested, maggots can be sold to farmers.

The last indicator is real change. In this study, fundamental changes were evident in the area around the researcher's residence; residents who initially did not care about the environment, namely throwing away all types of garbage into one, and then throwing it carelessly because they knew the impact of maggot cultivation was positive. Hence, the community gradually changed to become more environmentally conscious. The community is very enthusiastic about separating the waste when cooking and cleaning. Organic waste is separated and delivered to the maggot cultivation site, while inorganic waste is disposed of in a special inorganic waste place. The community feels that since this organic waste has been used as maggot food, there is no garbage at home, no foul smell, etc. So, maggot cultivation is quite effective in overcoming the existing waste problem. However, in the observations of this study, it is still small in scope. However, if this is done continuously and sustainably, one day, the waste problem in Ponorogo can be solved.

Referring to data related to the causal factors of food wastage waste production produced by the three groups of informants, namely chicken noodle shops, fruit shops, and households in Ponorogo, and the effectiveness of BSF maggots to become food wastage bioconversion, the researcher then conducted an analysis related to the formation of ecological citizenship to overcome the problem of food wastage through bioconversion of Black Soldier Fly maggots. One method for managing organic waste is the bioconversion process, utilizing maggots or Black Soldier Fly (BSF). The presence of maggots or BSF in waste management systems is highly beneficial because the larvae can degrade organic waste

and act as decomposers throughout their life cycle (Waste.refinery, 2020). This process is a promising alternative method for processing organic waste, as it solves the waste problem and produces value-added products, including animal feed, composted larvae, and biofuel.

The theory in the book entitled Citizenship and the Environment by Andrew Dobson, to date, is the most influential book in exploring the relationship between citizenship and the environment (Dobson, 2003). Dobson argues that there are five ecological citizenship models: Anthropocentric, Relationalist, Post-national, Intergenerational, and Asymmetric. Furthermore, referring to the theory of Michel Bourban (2023), ecological citizenship with an anthropocentric model concerns justice and relationships between people. More precisely, anthropocentric ecological citizenship is about the relationships shared by people who occupy the same ecological space, with each person's share of that space determined by their ecological footprint (Dobson & Bell, 2006). This anthropocentric theory is further strengthened by the opinion that defines the concept of ecological citizenship as a developing dimension of sustainable urbanism, emphasizing environmentally responsive lifestyles (Asilsoy & Oktay, 2018).

In this regard, it is necessary to strengthen ecological citizenship to change people's behavior and make them more environmentally conscious. Behavior related to waste management is a significant factor contributing to the current increase in waste piles in Ponorogo. If the waste management problem in this study focuses more on food waste and is not addressed immediately, it will exacerbate environmental issues caused by irresponsible human behavior. It is because ecological citizenship is the idea that being a citizen means not only obeying the law and being active in formal political processes, but also playing an active role in protecting and preserving the environment. An ecological citizen acts with the awareness that their daily choices in terms of consumption, waste disposal, and resource use will impact ecological conditions, both locally and globally, today and in the future.

One concrete manifestation of this ecological citizenship practice can be seen in managing household waste and waste from production at noodle shops and fruit shops through bioconversion using BSF maggots. Amidst the ever-increasing challenges of organic waste management, particularly in Ponorogo, BSF maggots offer an environmentally friendly, efficient solution with the potential to generate economic value. BSF maggots have the extraordinary ability to decompose organic waste such as food scraps and rotting vegetables in a short time (Febiola et al., 2024). Waste that was previously a burden and source of pollution can be converted into two main products: protein-rich larval Biomass for animal feed and frass, an organic residue that can be used as a natural fertilizer.

When residents process their household waste with BSF maggots, they truly practice the principle of ecological citizenship. They no longer passively respond to the waste they produce but take direct responsibility for minimizing its negative impacts. This choice demonstrates an awareness that waste is part of the life cycle that must be managed wisely, not simply discarded and forgotten. Furthermore, this practice also reflects a transformation in values and lifestyles. In a society accustomed to viewing waste as a burden or something disgusting, the courage to raise larvae and manage waste independently is a revolutionary step. It represents a shift in perspective: from a paradigm of consumption and disposal to one of utilization and recycling. From a linear mindset to a circular one.

On the other hand, maggot bioconversion also has a significant ecological impact. This process is far more energy-efficient and produces significantly lower carbon emissions than traditional waste incineration or landfill disposal methods. Furthermore, the conversion results replace the need for conventional feed, which is based on large-scale natural resource

extraction (Abduh et al., 2020). Thus, every kilogram of waste converted through maggots reduces waste and pressure on forests, land, and biodiversity. However, like all forms of ecological citizenship, BSF maggot management also faces challenges. Many people still view flies and larvae as symbols of uncleanliness. Many are also sceptical of its economic benefits or unsure how to start. Education, supportive policies, and cross-sector collaboration are crucial, so growing ecological awareness at the individual level can be systematically strengthened and disseminated.

Ultimately, waste management with BSF maggots is not just about technology or recycling methods, but also about moral commitment and social responsibility. It is a new form of citizenship that transcends administrative and legal boundaries, touches the ecological realm, and connects our daily lives to the planet's future. Amidst the Earth's vulnerability and environmental pressures, becoming an ecological citizen characterized by courage and concern for wise waste management is a small step with a significant impact. Therefore, the government's role is crucial in this regard, not only through education and outreach but also through providing facilities and solutions to raise public awareness of this ecological citizenship.

CONCLUSION

Based on the results and discussions, various factors are causing food wastage produced by the three groups of informants. Informants from the chicken noodle shop group can conclude that the amount of food waste produced depends on the number of customers in the shop daily. Furthermore, from the second group of informants, the difference in the amount of food waste in each household occurs due to various factors, including the number of family members, the work of family members, environmental factors, and the moment that happens at that time. Based on the third group of informants, namely fruit shops, it was concluded that the amount of food wastage produced by the six fruit shops also varies greatly. Furthermore, related to the effectiveness of BSF maggots in bioconverting food wastage, this study concluded that BSF maggots are very effective in overcoming food wastage. This conclusion was obtained based on the findings of the data, stating that in one day, BSF maggots can decompose around 1,662 grams of fruit waste and 1,908 grams of household and noodle waste. So, following the objectives of this study, the researcher can conclude that, based on the data obtained, it is very clear that BSF maggots can bioconvert food waste quickly without causing pollution or other contamination.

In this study, fundamental changes were evident in the area around the researcher's residence; residents who initially did not care about the environment, namely throwing away all types of garbage into one, and then throwing it carelessly because they knew the impact of maggot cultivation was positive. Hence, the community gradually changed to become more environmentally conscious. The community is very enthusiastic about separating the waste when cooking and cleaning. Organic waste is separated and delivered to the maggot cultivation site, while inorganic waste is disposed of in a special inorganic waste place. The community feels that since this organic waste has been used as maggot food, there is no garbage at home, no foul smell, etc. So, maggot cultivation is quite effective in overcoming the existing waste problem. However, in the observations of this study, it is still small in scope. However, if this is done continuously and sustainably, one day, the waste problem in Ponorogo can be solved. Through BSF maggot cultivation, the community is expected to be able to change their behavior and become more concerned and aware of their environment.

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