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Regional Case Study

Organic Solid Waste Management by Producing Eco-Enzymes from Fruit Skin in Permata Tembalang

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Abstract

The Ministry of Environment and Forestry in 2020 estimates that waste dumps in Indonesia will be 67.8 million tons. However, organic waste management in Indonesia is still relatively low. The accumulation of organic waste in the landfill, which usually causes unpleasant odors and potentially cause an explosion due to the production of methane gas from natural decomposition processes, can be avoided by prioritizing waste management from the source. An alternative way to handle organic waste is make eco-enzymes because it is efficient, economical, and environmentally friendly. This is the focus of the community service team. The community service method is carried out in three stages, including the preparation stage, the implementation stage, and the final stage. The preparation stage consists of doing a module for sorting organic waste and its utilization (making eco-enzymes). The next phase consists of socialization, education, and training on sorting organic waste and making the right eco-enzymes. The final stage consists of evaluation and making a final report. The expected result after education, socialization, or training has been carried out by the community service team, the community members, especially RT 04 RW 05 Permata Tembalang, know better and understand the sorting and utilization of organic waste.

Keywords: Waste; organic; recycle; eco-enzyme

1. Introduction

Population growth and the increasing consumption patterns are the main factors that cause the waste production rate always continue to grow. In addition, industrial and technological developments also contribute to increasing the amount, volume, and diversity of waste characteristics (Dewi, 2021). The Ministry of Environment and Forestry in 2020 estimates that waste dumps in Indonesia will be 67.8 million tons. Based on its nature, waste is classified into two types: organic waste and inorganic waste. Organic waste, such as food scraps, dry leaves, and vegetables, can decompose. Meanwhile, inorganic waste, such as plastic bottles, used paper, cardboard, and used cans, are difficult to decompose and cannot be decomposed. The main problem of waste management in Indonesia is not following environmental insight management (Dewi, 2021). As evidence indicated by Indonesia's low level of organic waste management, because people prefer to burn waste rather than manage it. Due to less-than-optimal waste management, waste burning often occurs in developing countries. In addition, it is supported by the large surrounding suburbs that can be used as a waste burning area, an erratic and unsegregated waste collection system, a lack of public awareness about environmental health, waste

burning is the fastest and easiest way to clean up waste, as well as community habits (Ramadan et al., 2022). The smoke generated from the combustion can cause air pollution and interfere with health (Larasati et al., 2020). The number of households that burn waste reaches 66.8 percent. Meanwhile, the percentage that recycles household waste only reaches 1.2 percent (Badan Pusat Statistik, 2018).

The accumulation of organic waste in landfill usually causes an unpleasant odor. It can potentially cause an explosion due to methane gas production from natural decomposition processes. In addition, methane gas produced from the degradation process of organic waste is a greenhouse gas that can capture heat 30 times more effectively than carbon dioxide (Larasati et al., 2020). This can be avoided by prioritizing waste management at the source. The application of reduce, reuse, and recycle (3R) waste is one of the best efforts to preserve the environment by prioritizing waste management at its source (Nurhamidah et al., 2021). Processing organic waste at the source of the waste (especially the household), which is carried out consistently and continuously, is believed to solve the waste problem from an early age.

Some organic waste management has been carried out, including processing organic waste using maggot (Siswanto et al., 2022), utilizing organic waste as compost (Subandriyo et al., 2012), and eco enzyme (Sujarta & Simonapendi, 2021). Eco-enzyme is an extract derived from the fermentation of vegetable and fruit residues and glucose (Nurfajriah et al., 2021). The specialty of eco-enzyme is that it does not require a large area for fermentation as in the composting process. Making eco-enzymes is very economical in processing sites and can be applied at home. The production of eco-enzymes does not even require a composter with certain specifications. Containers such as bottles of mineral water or other products that are no longer used can be reused as eco-enzyme fermentation tanks.

The composition of main ingredients of eco-enzyme is agricultural waste or household waste and a solution resulting from the fermentation of household waste by adding water and brown sugar cane/palm sugar. Organic waste, such as the skin of apples, oranges, pears, or vegetables that do not have hard skins, is put into bottles or containers with lids. Before being put into the container, the waste can be chopped first to speed up the fermentation process, then add water and brown sugar. The fermentation process takes a long time of about three months and requires regular checks. The benefits of eco-enzymes are not only in agriculture but can also be useful for cleaning polluted water bodies (Penmatsa et al., 2019); anti-fungal, anti-bacterial, and insecticidal agents (Vama & Cherekar, 2020). This is because the eco enzyme can accelerate biochemical reactions inside to produce valuable enzymes such as amylase, lipase, and protease and have inhibitory power against E. coli and S. aureus bacteria (Farma et al., 2022). This encourages the community service team to increase public knowledge about using organic waste in eco-enzymes because this activity supports the concept of reuse in saving the environment. It is hope that after the community service team carries out education on the use of organic waste, processing organic waste at the source of the waste, which is carried out consistently and continuously, is believed to be able to solve waste problems from an early age. Enzymes from this "garbage" are one way of waste management that utilizes kitchen scraps to produce valuable liquids.

2. Methods

This community service is carried out through three stages: preparation, implementation, and final.

2.1. Preparation Phase

This stage includes collecting secondary, primary, and current materials and doing modules for sorting and utilizing organic waste. Secondary data includes a map of the location of RT 04 RW 05 Permata Tembalang and the number of families. While the primary data was obtained through a survey to obtain information about the condition of the resident's garbage dumps in RT 04 RW 05 Permata Tembalang. The material that also needs to be prepared at this stage is the latest information on the types of organic waste and how to use them.

2.2. Implementation Stage

This stage includes initial socialization, education, and training. The initial socialization activity aims to provide an understanding of the education program for the correct sorting and utilization of organic waste to residents of RT 04 RW 05 Permata Tembalang. Education and training activities are carried out through counseling on the importance of correctly sorting waste types and using organic waste. The tools and materials needed to produce eco-enzymes include: knives, mixing spoons, cuttings, fruit peelers, closed containers, basins, measuring cups, scales, fruit and vegetable waste, and molasses. The tools and materials can be seen in Figure 1 as follows. Making eco-enzymes is a fermentation process in which chemical changes occur in organic substrates that can survive due to biochemical catalysts and enzymes produced by certain living microbes (Sujarta et al., 2020). The minimum fermentation process is carried out for three months to release enzymes and other organic compounds in raw materials, which in this case is organic waste, can take place optimally (Susilowati et al., 2021). Molasses or sugar in the fermentation process will produce alcohol. However, basic materials containing organic compounds, especially glucose or starch, can be used as substrates to produce alcohol (Supriyani et al., 2020).

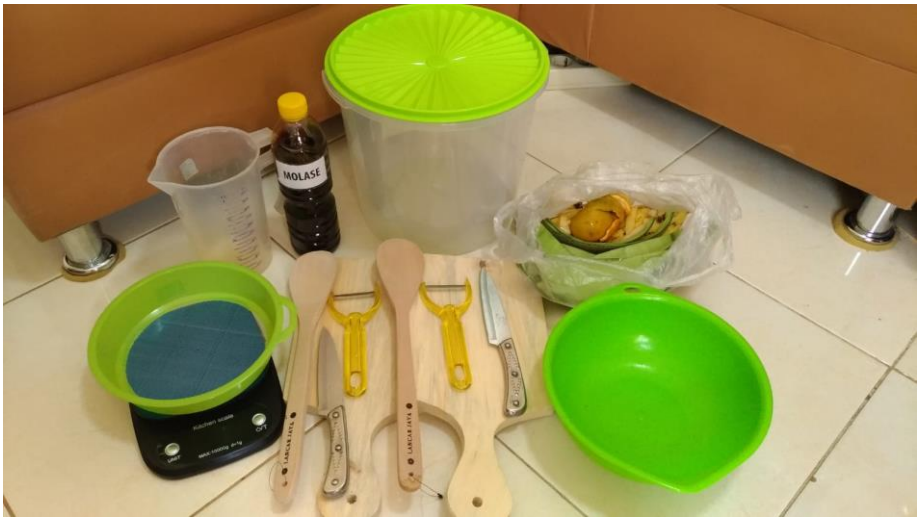

Figure 1. Eco-enzyme manufacturing tools and materials

2.3. Final Stage

This stage includes evaluation, making a final report, and publication. The evaluation was carried out in the final period of community service activities on the level of knowledge and awareness of residents in sorting waste and using it, as well as joint evaluation with the managers of RT 04 RW 05 Permata Tembalang, Kramas Village, Tembalang District. The final report is based on the results of education on the sorting and utilization of organic waste for residents.

3. Result and Discussion

3.1 Waste Problem Analysis

The city of Semarang has implemented waste management with the 3R concept starting in 1992 with the provision of the Jatibarang Final Processing Site (landfill). However, the efforts of the Semarang City Government have not been able to overcome the waste problem. The volume of waste in the Jatibarang landfill is increasing yearly but is not decreasing. It is increasing, and the percentage of waste composition in Semarang City is dominated by organic waste. The type of household organic waste is a source of waste with the most significant proportion of the total waste generated daily (Rambe, 2021).

To realize a clean, beautiful, and healthy city, the Semarang City Sanitation Service has several missions. First, improving the hygiene management system and mechanism from household and commercial waste sources to the Final Processing Site (landfill). Second, increasing greenery and city

gardening to realize the city's beauty, coolness, and shade. Third, increasing public participation and awareness of cleanliness and beauty in the surrounding environment to create a clean, beautiful and healthy city of Semarang. Fourth, improve the quality of human resources to provide excellent service to the community in the field of cleanliness and landscaping. Fifth is optimizing cleaning fee collection (Pramadianto & Widowati, 2016).

Technically, the Cleanliness and Parks Office (DKP) of Semarang City handles the waste problem by taking it, storing it in the Waste Collection Place (TPS), and throwing it into the Jatibarang landfill. With this pattern of handling, the city of Semarang will always face the problem of a lack of garbage collection sites and several problems due to the complexity of urban problems. To anticipate overloading at the Jatibarang landfill, the Semarang City Government, through the Semarang City DKP, implemented an integrated waste management system through the Integrated Waste Processing Site (TPST) in the sub-district area. Integrated waste management aims to reduce the volume of waste generated to be transported to the Jatibarang landfill, anticipate the increasingly limited use of landfill land, reduce the cost of transporting waste from TPS to landfill, increase community independence and increase the active role of the community in maintaining environmental cleanliness through friendly waste management. In general, the waste processing system has been carried out but is not well integrated, so waste processing products cannot be utilized optimally (Rambe, 2021).

Policies regarding waste management cannot run effectively due to the lack of discipline and commitment from the government and the community (Ramadan et al., 2022) and the low level of community participation in waste reduction and handling (Rambe, 2021). Several other aspects that can hinder the government's performance in waste management include limited budgets, lack of support for facilities and infrastructure, and the quality of human resources that are still less than optimal (Pramadianto & Widowati, 2016).

3.2. Organic Waste Management Socialization and Education

Socialization and education on processing organic waste from fruit peels into eco-enzymes held on Saturday, March 19, 2022. This socialization and education are expected to increase public knowledge and awareness of organic waste processing so that organic waste can be utilized optimally and with value. Thus, it can create a reliable community in overcoming waste problems (Dewi & Sutama, 2022). Making eco-enzymes is simple by utilizing simple ingredients that are readily available and easy to apply. Eco-enzymes can be produced at various scales, including small, community-based ones (Rambe, 2021). The resident's enthusiasm also showed active participation in facilitating socialization activities and their attendance at the time of the socialization was also extraordinary. Even during the pandemic, the attendance rate was excellent following the activity targets, and contributed actively to the discussions held during this socialization. Waste management is adjusted to the needs of the community. Because the adaptation of waste management will continue if its implementation is under its status and role, maintenance of waste management patterns will form a culture which, if supported by the availability of supporting facilities, will have an influence on the behavior of individuals and community groups (Nurpratiwiningsih et al., 2015) which is expected to increase the use of organic waste. The existence of community service activities regarding the manufacture of this eco-enzyme can fill the daily life of the local community with practical activities.

(a) (b)

Figure 2. (a) Eco-enzyme outreach material brochures & banners, (b) Community service team

The technical education on processing organic waste from fruit peels into eco enzymes delivered was:

- Sort household organic waste, namely skins, from various fruits. The results of this organic waste are then coarsely chopped before being poured into a holding container.
- Pour the coarsely chopped results into a container, prepare sugar or molasses, and dissolve it with water in the ratio of molasses: organic matter (fruit skin): water (1:3:10).
- Close the lid and store the container (jar) in a dry and cool place at room temperature.
- Label the date of manufacture and date of harvest. Leave it for three months.
- Open the container every first week to remove the gas produced.
- Stir on the 7th and 30th days.
- For the second month, open the container every 2-3 days, and for the third month, open the container once every week.
- After three months, filter the eco-enzyme using gauze or a filter, then store it in a sealed bottle or plastic.

The ratio of organic waste in the form of fruit and vegetable peels is 80% versus 20%. This is because the composition of more vegetables in the mixture can cause the eco-enzyme solution to have a less pleasant aroma. The duration of eco-enzyme fermentation is three months for tropical regions and six months for sub-tropical regions (Yuliani et al., 2022). The sugar has not been bleached, thus minimizing contamination of other chemical compounds in eco-enzyme products (Rambe, 2021). The products produced from the manufacture of eco-enzymes vary. Eco-enzyme will have a brown color if it comes from a mixture of vegetables and fruits and can be fermented again using molasses or brown sugar if the color is too dark. Eco-enzyme has a brighter color with a more specific odor from one type of organic waste. In the eco-enzyme fermentation container, it is necessary to provide space to accommodate the gas produced from the fermentation process. In addition, the residue from the remaining eco-enzyme fermentation can be reused to manufacture eco-enzymes (Harahap et al., 2021). The variety can measure the quality of eco-enzymes and the variety of materials used. The more diverse and varied, the more varied the quality of the eco enzyme produced (Maulana & Khumaeroh, 2021). O_3 (ozone) gas is released into the atmosphere during the eco-enzyme fermentation process. It helps absorb ultraviolet light radiation that is harmful to human, animal, and plant health (Susilowati et al., 2021).

In the conditions of the COVID-19 pandemic, a new habit has emerged for the community to always maintain cleanliness, thereby increasing public consumption of cleaning and anti-bacterial products such as hand sanitizers, soaps, and disinfectants (Harahap, 2021). Eco-Enzyme produced from fruit and vegetable peel's organic waste has many benefits. Namely, it can be used as a floor cleaner, toilets, drains, dishwashing liquid, laundry detergent, hand sanitizer, and organic fertilizer. Eco-enzymes can also relieve infections and allergies in children and heal wounds (Alkadri and Asmara, 2020). Eco-enzyme liquid fertilizer can be applied as a foliar or by watering the plant surface in the morning (G.Rosnina et al., 2022). Using eco enzymes as plant fertilizer can stimulate root growth and make leaves greener and fresher (Putri et al., 2022). In addition, eco-enzyme contains microflora, which can be used for organic fertilizer and as a soil ameliorant that can improve the characteristics of marginal land into land suitable for agriculture. Improvement in soil characteristics can be seen from the level of plant fertility on the land (G.Rosnina et al., 2022).

Eco-enzyme, in its utilization for wastewater treatment, shows a performance comparable to the performance of commercial enzymes. Eco-enzymes have high power to inhibit and reduce pathogens because the acidic nature produced by eco-enzymes helps extract extracellular enzymes from organic waste during fermentation. The acidic nature of the eco-enzyme comes from the fermentation of glucose which produces pyruvic acid. Under aerobic conditions, pyruvic acid will undergo decomposition by pyruvate decarboxylase into ethanol and carbon dioxide. Acetobacter will convert alcohol into acetaldehyde and water, producing acetic acid (Septiani et al., 2021). The acetic acid in the eco-enzyme can kill germs, viruses, and bacteria. Organic acids harm the metabolism of microorganisms. Acidic pH causes cell deformation of microorganisms and damages the enzymatic tissue, protein, and DNA structure of microorganisms causing damage to extracellular membranes. In addition, changes in pH in microorganism cells will suppress NADH oxidation which can affect the electron transport system and cause the death of microorganisms (Utami et al., 2020). Enzyme content in eco-enzyme include lipase, trypsin, and amylase, which can kill or prevent pathogenic bacteria. Also, nitrate (NO_3) and carbon trioxide (CO_3) in eco-enzymes are needed by soil as nutrients (Maulana & Khumaeroh, 2021).

The antimicrobial content of eco-enzymes can be used as vegetable preservatives. Research on the use of eco-enzymes as preservatives has been carried out by Utami et al. (2020) to preserve cherry tomatoes. Antimicrobials in eco enzymes inhibit the growth of microorganisms to inhibit spoilage in cherry tomatoes. Compared with formalin preservatives, eco-enzyme as a natural preservative is safer for consumption. Eco-enzymes as vegetable preservatives can be applied by spraying (Utami et al., 2020). In the study of Mahdia et al. (2022), eco-enzyme produced from citrus waste can inhibit the growth of Escherichia coli and Staphyloccocus aureus bacteria. The eco-enzyme is five times more effective in reducing the number of bacteria in the chicken coop compared to detergent for the same area (Mahdia et al., 2022).

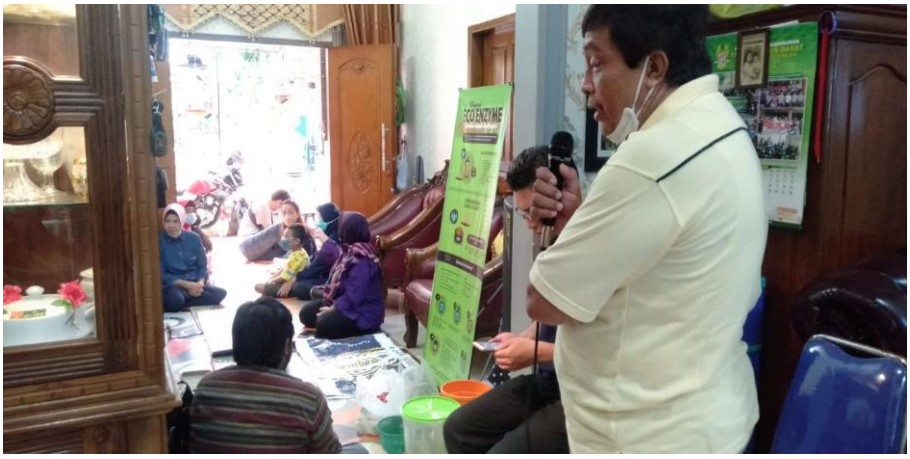

Figure 3. The enthusiasm of citizens in participating in educational activities

Figure 4. Tutorial on making eco-enzyme by community service team

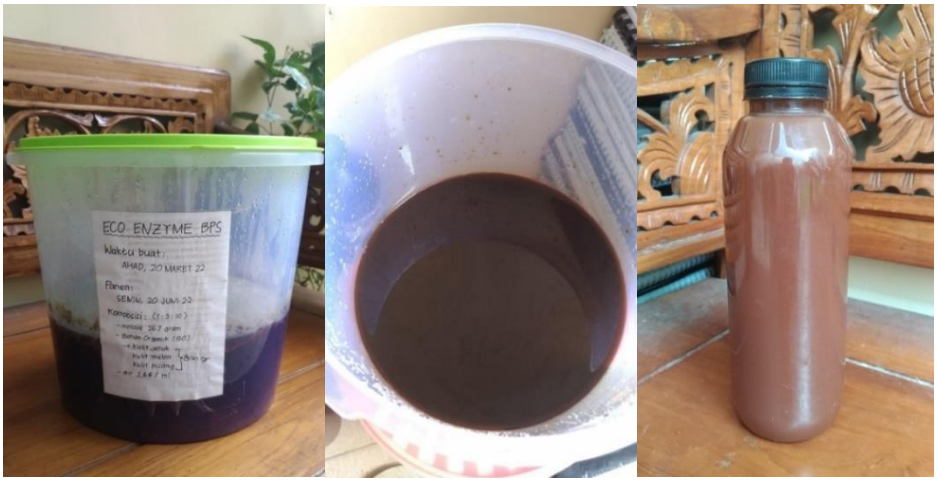

Figure 5. Final product of eco-enzyme

3.3. Monitoring and Evaluation

All stages of the implementation of this activity are expected to be the beginning of the realization of sustainable waste management and especially the processing of organic waste in the area of RT 04 RW 05 Permata Tembalang. This activity is also useful for increasing the volume of organic waste recycling towards zero waste status (Yuliani et al., 2022). The use of household waste is one of the environmental conservation efforts (Rohyani et al., 2022), where the benefits of eco-enzymes can be used as an alternative to synthetic products. In addition, the eco-enzyme products produced can be used alone to reduce expenses and be used as partners' economic opportunities (Fatimah et al., 2022). The sustainability of the waste management program through using organic waste in eco-enzymes is highly dependent on community participation. Community participation can be realized in the form of direct or indirect. Direct participation can be in material, labor, or expertise. Meanwhile, indirect community participation can be in the form of ideas or decisions in handling waste (Nurpratiwiningsih et al., 2015).

The waste management paradigm should change from waste management that relies on the final approach to a new paradigm that views waste as a resource of economic value that can be utilized. Creating eco-enzymes and using organic waste as a resource can also reduce the burden of managing organic waste. Waste management with a comprehensive approach from upstream, that is, before the production of products that have the potential to become waste, to downstream, when the product has become waste and is returned to the environmental media safely, should be cultivated (Septiani et al., 2021).

4. Conclusions

Based on the community service activities that have been carried out, it can be concluded that the processing of organic waste from fruit peels into Eco-Enzyme products for the residents of Anturium RT 04 RW 05 Permata Tembalang is on target and is running effectively. The activity of processing organic waste from fruit peels into Eco-Enzyme products can provide benefits, namely increasing community independence and increasing the community's active role in maintaining environmental cleanliness and contributing to dealing with waste problems.

After processing organic waste from fruit peels into Eco-Enzyme products correctly, to handle waste problems, a follow-up (action plan) can be carried out in the form of an implementation survey assignment for one head of family in RT 04 RW 05 Permata Tembalang. It is necessary to consider if the manufacture of Eco-Enzyme products has been running regularly in RT 04 RW 05 Permata Tembalang, it is necessary to provide education about similar things in other RT's, either from the community or the service community team.

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