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Production of Eco-enzyme as a Solution to Organic Waste Management

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Abstract

The waste in Indonesia, as recorded in the National Waste Management Information System by the Ministry of Environment and Forestry of the Republic of Indonesia in 2023, amounted to 38,315,969.64 tons per year, with around 42.60% of this waste being dominated by organic food waste. Al-Hikam Islamic Boarding School produces organic waste from leftover food left by the students, which is currently managed by either being used as animal feed or discarded in the trash. This issue has drawn the attention of the Community Service Team from the University of Trunojoyo Madura, who introduced eco-enzyme as an alternative method for organic waste management at Al-Hikam Islamic Boarding School in Kemayoran, Bangkalan. The aim was to enhance students' knowledge about the dangers of organic waste, waste management, and eco-enzymes. The method used in this activity was Service-Learning (SL). The results showed that the activity increased participants' knowledge and skills about eco enzymes, with an average pre-test score of 49.85 and a post-test score of 85.6. Thus, participants' understanding of this activity increased by 71.72%.

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INTRODUCTION

The waste problem in Indonesia is still difficult to overcome, both in terms of quantity and management. Waste generation in Indonesia is recorded in the National Waste Management Information System by the Ministry of Environment and Forestry of the Republic of Indonesia in 2023 at 38,315,969.64 tons per year. However, only 61.67% or 23,628,074.39 tons of waste have been managed annually. While the remaining 38.33% or 14,687,895.25 tons per year remains unmanaged. Based on the data, it is proven that waste management in Indonesia has not reached a satisfactory level. The waste composition is dominated by organic waste in the form of food scraps, at 42.60%. Organic waste is often underestimated and left to pile up because of the idea that organic waste is waste that can be easily decomposed by decomposing organisms (Marlianingrum et al., 2024; Marmi et al., 2023). Without realizing it, the decomposition process also takes time, so the piled-up waste will last for some time before decomposing.

Piles of organic waste can cause unpleasant odors that worsen environmental sanitation. This unpleasant odor will also attract insects or organisms that carry infectious diseases, such as flies, cockroaches, rats, and so on, which consider the piles of garbage as food fields (Fazri et al., 2023; Labib, 2022). Piles of garbage are attractive to germs and harmful bacteria, becoming a source of disease for the surrounding environment. In addition, piles of garbage serve as breeding grounds for mosquitoes, increasing the mosquito population, which is certainly very disturbing (Rosmala & Rosidah, 2019). Piles of rubbish will also produce methane gas, which can cause global warming because methane gas absorbs more heat than carbon dioxide. In addition, methane gas accumulates continuously and can explode because there is not enough oxygen (Ishak et al., 2019). Accumulated organic waste can also produce a dangerous liquid called leachate (Islami & Ratni, 2022). This liquid contains heavy metals, namely zinc (Zn) and mercury (Hg), so that the waste problem in Indonesia is still difficult to overcome, both in terms of quantity and management (Hardiyanti et al., 2020).

Al-Hikam Islamic Boarding School produces organic waste from food waste during the cooking process, such as fruit and vegetable peels. This organic waste only ends up in landfills or is used as animal feed. This happens because students lack knowledge about the dangers of organic waste and how to manage it. Through this activity, it is hoped that students' understanding of the dangers and management of organic waste will increase.

METHODS

Community service activities were carried out at the Al-Hikam Kemayoran Islamic Boarding School, Bangkalan, East Java. The method used in this activity is Service-Learning (SL). This method is very effective for applying knowledge gained from courses in the real world to the community. Service-Learning is a learning approach that emphasizes practical aspects, referring to the concept of experiential learning, namely knowledge gained from lectures in the community while interacting with the in which knowledge gained from lectures is applied in the community while interacting with the community and providing solutions to the problems faced by the community. It also allows students to actively implement their role in community service (Afandi et al., 2022). The participants involved in this community service activity were approximately 20 High School students, before the implementation began, participants were given pre-test questions and after that, they were given post-test questions with questions that were made by themselves as an evaluation of participants' understanding of eco enzymes before and after the activity was carried out. We targeted the activity's success to increase participants' understanding by at least 50%. The implementation was divided into three sessions: material delivery, questions and answers, and eco-enzyme practice.

RESULTS AND DISCUSSION

Community service activities were carried out on October 2, 2024. Twenty students participated. Before the implementation began, the participants were given pre-test questions. Afterward, they were given post-test questions to evaluate their understanding of eco-enzyme before and after the activity. The implementation was divided into three sessions: material delivery, questions and answers, and practicing the process of making eco-enzyme. Documentation of the activity can be seen in Figure 1.

Figure 1 Documentation after the activity

Eco enzyme production training

The tools and materials used in making eco enzyme included: 1 gallon of drinking water (1 piece), 3 kg of pineapple skin, 1 liter of molasses, and 10 litres of water. The manufacturing process began by placing 3 kg of pineapple skin into the gallon, adding 1 liter of molasses and 10 liters of water, stirring to mix the ingredients evenly, then closing with a gallon lid. Eco enzyme was fermented in conditions without oxygen for 3 months with maintenance of opening the bottle cap once a day in the first week of fermentation, opening the bottle cap 2-3 times/week in the following weeks, and opening the bottle cap 1 time/week in the following weeks. The production process can be seen in Figure 2.

Figure 2 Eco-enzyme manufacturing process

With the processing of organic waste into eco-enzyme, it is hoped that the amount of organic waste at Al-Hikam Islamic Boarding School will decrease. Mardiana et al. (2023) processed organic waste into eco-enzymes at Islamic boarding schools and stated that this could help maintain environmental sustainability while providing added economic value for students. Eco-enzyme has also been proven to reduce waste generation while producing useful products, as shown in research by Pranata et al. (2021). This demonstrates that eco-enzyme can be an effective alternative for processing organic waste (Viza et al., 2023).

Evaluations

The evaluation was carried out by administering pre-test questions before the delivery of the material, followed by post-test questions after the practice session. Several indicators were used to assess the increase in participants' understanding, including their knowledge about the dangers of organic waste, waste management, and eco-enzymes. These indicators were presented in questions that could be answered with "yes" or "no" options.

The results of the pre-test are shown in the graph in Figure 3. Figure 3 illustrates the results of participants' understanding based on their responses to the pre-test questions. A "yes" answer was considered a positive point, and a "no" answer was considered a negative point. Based on the graph, it was found that out of 20 participants, 20% understood the dangers of organic waste, 30% understood waste management, and only 10% understood eco-enzyme. Additionally, 40% of participants did not understand any of the indicators.

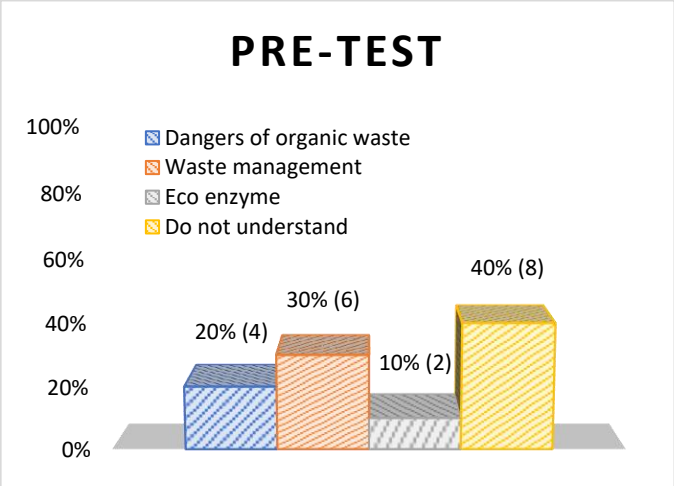

Figure 3 Results of the pre-test on the eco-enzyme introduction

According to research by Mananda et al. (2024), during the pre-test for high school students, some still did not know what an eco-enzyme was. Meanwhile, research by Handayani et al. (2024) stated that among housewives, most still did not know about eco enzyme, so it can be concluded that it is still unknown to most of the general public, including Islamic boarding school students. These results will be compared with the post-test results, as seen from the graph in Figure 4.

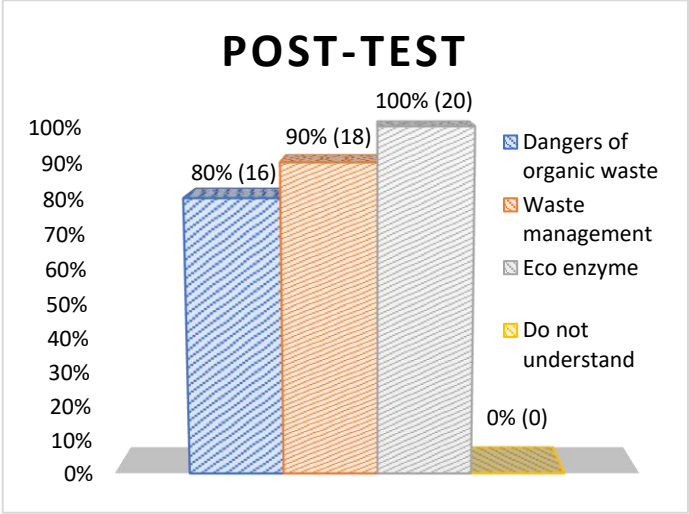

Figure 4 Post-test results of the eco-enzyme introduction

The graph shows participants' level of understanding after the post-test was carried out, which was used as an indicator of the activity's success. Based on the graph, it was

obtained that out of 20 participants, 80% of them had understood the dangers of organic waste, 90% had understood waste management, and 100% had known about eco enzymes. There was not a single participant who did not understand the entire material. The post-test was conducted to evaluate the results after the treatment (Setiawati et al., 2023). The following graph is presented to determine whether there is an increase in participants' understanding before and after the activity is carried out.

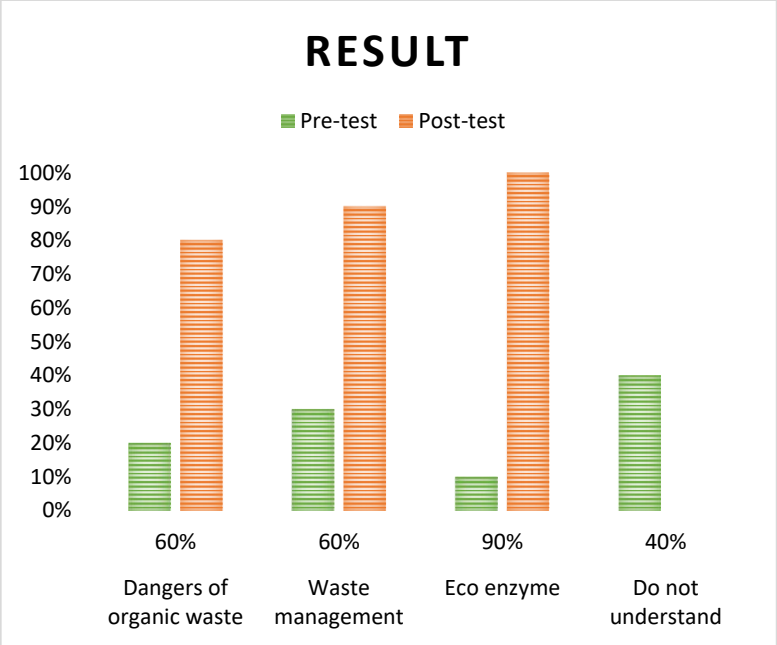

Figure 5 Pre-test and post-test results of the eco-enzyme introduction

Based on the graph above, it is clear that there was an increase in participants' understanding of the material presented, and the percentage of participants who did not understand the material decreased. The graph shows that the percentage of participants who understood the dangers of organic waste increased from 20% to 80%. Understanding of waste management increased from 30% to 90%. The most significant increase was observed in participants' understanding of eco-enzyme, which rose from 10% to 100%. This indicates that all participants had learned about the eco-enzyme. In the pre-test, 40% of participants still did not understand the material, but by the post-test, no participants were left who did not understand. Based on these results, it can be concluded that the introduction activity successfully increased participants' knowledge, with an average increase of 63%. Pranata et al. (2021) also conducted an introduction to eco-enzyme and found that the pre-test results were 51.8% (moderate) and 48.2% (less). However, after the post-test, the results showed that 100% of participants' knowledge fell into the good category.

The results of the paired t-test showed that there was a significant increase in the average value from pre-test to post-test. The intervention or treatment given succeeded in increasing the results with a significance value of 0.022 at a 95% confidence level ($p < 0.05$), which means that there was an increase in the understanding of students at the Al-Hikam Kemayoran Islamic Boarding School regarding the dangers of organic waste, how to manage organic waste. Eco enzymes were measured before and after the activity was held.

Zulfa et al. (2022) stated that their research at the Al-Mustaqim Islamic Boarding School succeeded in increasing students' awareness and skills in processing waste. Research conducted by Rochmah et al. (2024), which was conducted at the Al-Fatih

Islamic Boarding School in Jombang, also showed positive results and increased students' understanding of the benefits and advantages of processing organic waste.

CONCLUSION

Community service activities by the MBKM KKN Thematic Team of Trunojoyo University, Madura, introduced eco-enzyme as an alternative method for processing organic waste. The introduction was carried out in three sessions: material delivery, questions and answers, and practicing eco-enzyme production. Participants filled out pre-test and post-test evaluations, and the results showed an increase in participants' knowledge by 71.72%. The paired t-test results showed a significance value of 0.022 at a 95% confidence level ($p < 0.05$), indicating the activity's success. This demonstrates that we have enhanced students' knowledge and understanding of the eco-enzyme. Similar activities should be conducted in other educational institutions to improve knowledge and environmental sanitation.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

H, RRP, IWA, EY, and CLA contributed to the design and implementation of the community service program, the analysis of the results, and the writing of the manuscript.

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