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Utilization of waste into eco-enzyme as organic fertilizer in Tanjung Jati Village, Muara Enim Regency

Tuty Emilia Agustina[1], Muhammad Faizal[1], Elda Melwita[1], Enggal Nurisman[1], Rabecha Maros Framita[2], Muhammad Taufik[3]

[1]Department of Chemical Engineering, Faculty of Engineering, Universitas Sriwijaya
Jl. Palembang Prabumulih Km 32, Indralaya, Ogan Ilir, South Sumatra, 30662, Indonesia
[2]Department of Agribusiness, Faculty of Science and Technology, [3]Department of Management, Faculty of Economic and Law, Universitas Serasan
Jl. H. Pangeran Danal No.142, Muara Enim, South Sumatra, 31311, Indonesia

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ABSTRACT

Tanjung Jati Village, Muara Enim Regency, faces the problem of suboptimal management of household and agricultural organic waste. Organic waste such as fruit peels and vegetable scraps is generally thrown away without processing, thus polluting the environment and causing an unpleasant odor. To overcome this, training and mentoring were conducted on processing organic waste into eco-enzymes as liquid organic fertilizer (POC). This activity aims to improve community knowledge and skills in utilizing organic waste independently and sustainably. The training involved 30 participants from farmers, village officials, and residents, using lecture, discussion, and direct practice methods. The evaluation results showed an increase in participant knowledge of 84 percent, with an average pre-test score of 20.23 to 37.23 in the post-test. A total of 9 kg of organic waste was successfully processed into 30 liters of eco-enzyme, then dissolved into POC with a dose of 20 ml eco-enzyme: 1000 ml water, then applied to kale plants. The treatment plants showed an average increase in height of 26 percent and the number of leaves of 32 percent compared to the control. This activity has proven effective in supporting organic waste management, increasing household agricultural yields, and strengthening public awareness of environmentally friendly agriculture.

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1. INTRODUCTION

Tanjung Jati Village, located in Muara Enim Regency, is a rural area where the majority of the population relies on agriculture as their primary livelihood. The farming community in this village routinely produces organic waste from both household and agricultural activities, including vegetable scraps, fruit residues, and crop harvest waste. This abundant organic waste potential has not yet been optimally utilized. Based on initial observations by the service team, most of the organic waste is merely discarded in the yard or burned, with no further effort toward utilization. With approximately 800 households, the majority of whom are actively engaged in farming and gardening, it is estimated

✉ Corresponding Author: **Tuty Emilia Agustina**: Tel. +62 711 580303 | E-mail: tuty_agustina@unsri.ac.id

that the volume of organic waste generated reaches 2–3 liters per household per week, which could potentially be processed into liquid organic fertilizer through the application of appropriate technology (AT) based on fermentation.

The main problem faced by the community groups in Tanjung Jati Village is the lack of knowledge and skills in organic waste management. Limited outreach and access to environmentally friendly technology have led to poor waste handling, which in turn results in environmental impacts such as water pollution, unpleasant odors, and potential health hazards due to waste decomposition. According to data from the Ministry of Environment and Forestry (MoEF) in 2023, more than 50 percent of the national waste composition consists of organic waste, most of which remains unmanaged. Findings by Hasani et al. (2024) also reinforce that in rural areas, inadequate infrastructure and education are the primary barriers to sustainable organic waste management.

The service team proposes a solution through the implementation of appropriate technology in the form of training and mentoring on organic waste processing into eco-enzyme. Eco-enzyme is a fermented liquid made from household organic waste such as fruit and vegetable peels, combined with brown sugar and water, which can be utilized as liquid organic fertilizer (LOF) (Sinaga et al., 2023). This innovation was chosen because the production process is relatively simple, does not require specialized equipment, and can be independently adopted by the community. Training participants are directly taught to produce eco-enzyme, which, after a fermentation process of 100 days, transforms into a dark brown solution with a distinctive fermented aroma and contains active microorganisms beneficial for plants. This solution is expected not only to address waste problems but also to offer economic benefits by reducing dependence on chemical fertilizers (Sholihah & Trisnaningtyas, 2023).

The effectiveness of using eco-enzyme as a liquid organic fertilizer has been demonstrated in various studies. Nangoi et al. (2022) showed that the enzyme content, organic acids, and nutrients such as nitrogen (N) and potassium (K) in eco-enzyme can improve soil fertility and accelerate the decomposition of organic materials. Aryesam (2024) confirmed that eco-enzyme has a low C/N ratio, which is ideal for accelerating nutrient mobilization in the soil and can significantly increase horticultural crop yields. Practical results from this activity demonstrated that participants successfully produced eco-enzyme that was fully formed after a 100-day fermentation process. The resulting product was then used by residents to water vegetable plants in their yards, with an average usage of 1 liter per household per week. This indicates a tangible quantitative impact in terms of transforming waste into functional products that support household agriculture.

Based on this background, the objective of this activity is to enhance the capacity of the Tanjung Jati Village community in organic waste management through the application of appropriate technology in the form of training and mentoring on the production of eco-enzyme as a liquid organic fertilizer (LOF). This activity specifically aims to improve participants' knowledge and skills in processing household and agricultural organic waste into useful products, reduce the volume of unmanaged organic waste, produce LOF that can be directly used for household agriculture, and promote the use of organic fertilizers as an alternative to chemical fertilizers. Additionally, this activity seeks to foster community awareness and independence in applying the principles of sustainable agriculture based on a circular economy in the village environment (Ronny & Ihsan, 2022).

2. METHODS

Activity Plan

This community service program was carried out in Tanjung Jati Village, Muara Enim Subdistrict, Muara Enim Regency, involving two main partners: the Agricultural Machinery Service Provider Unit

(UPJA) Cahaya Bintang and the local farmer group. A total of 30 participants took part, consisting of representatives of active farmers, farming households, and village officials. The activity focused on the application of appropriate technology (AT) in the form of training on the production of liquid organic fertilizer (eco-enzyme) and its use in horticultural cultivation as an effort to independently and sustainably manage household and agricultural organic waste (Qorib, 2024).

The activity design referred to the concept of learning by doing using a participatory approach (Jelita, 2022). Technically, participants were trained to produce liquid organic fertilizer by fermenting organic waste (fruit/vegetable peels) using a solution of brown sugar and water in a 1:3:10 ratio. The resulting product was fermented for 100 days until the eco-enzyme was fully formed and ready for use (Zultaqawa & Firdaus, 2023). The liquid organic fertilizer was then used for watering plants (tested on water spinach) at a dosage of 20 ml of eco-enzyme solution per 1 liter of water, applied every two days for two weeks. This process aimed not only to enhance participants' understanding but also to demonstrate the practical effectiveness of using LOF in supporting plant growth and reducing dependence on chemical fertilizers.

Method of Program Implementation

Structured training

The training activities were conducted in both classical and practical formats using a combination of lecture, discussion, and hands-on demonstration methods. The materials delivered included an introduction to organic waste management, basic principles of fermentation, techniques for producing eco-enzyme, and the benefits of its use in supporting sustainable agriculture (Rangkuti et al., 2023). The training materials can be accessed by participants and relevant stakeholders through the following Google Drive link: https://docs.google.com/presentation/d/1Y5drgnTbm5ItLHRfmhmm6oDqinMP55Nq/edit?usp=sharing&ouid=102648653064257225666&rtpof=true&sd=true.

Participants were divided into three groups and guided to directly practice the process of producing liquid organic fertilizer (LOF) based on eco-enzyme. The materials used consisted of household organic waste such as vegetable scraps and fruit peels, brown sugar, and clean water, with a mixing ratio of 3:1:10 (waste:sugar:water). The tools used in this practice included a digital scale for precise measurement, a cutting board and knife for chopping the organic waste, and a sealed container (a plastic bucket with a tight lid) as the fermentation medium for 100 days. A contextual learning approach was applied to align the methods and delivery of materials with the background of the participants, most of whom were farmers and household agricultural practitioners (Supriyanto et al., 2023). Through this method, participants not only understood the theory but also gained practical skills that could be immediately applied to independently manage organic waste.

Practical assistance

After the training session, the service team provided direct assistance to each group during the eco-enzyme fermentation process. The team ensured that participants understood the procedures for storage, periodic stirring, and indicators of successful fermentation. The assistance also included guidance on the use of liquid organic fertilizer on the test plants (water spinach), covering application methods, time intervals, and observation of plant growth results.

Quantitative-based program evaluation

Evaluation was conducted using three main quantitative indicators: participants' knowledge level, the volume of organic waste successfully processed, and the amount of liquid organic fertilizer

(LOF) produced. The increase in participants' knowledge was measured through pre-test and post-test using a closed-ended questionnaire instrument and analyzed using a paired t-test with SPSS software. The volume of organic waste processed was calculated based on the total amount of organic material fermented per group (an average of 3 kg/group), resulting in a total of 9 kg of waste being processed. The amount of eco-enzyme produced was measured after the 100-day fermentation process, with an average final yield of 10 liters of eco-enzyme per group, or a total of approximately 500 liters of LOF per group that can be produced using a dilution ratio of 20 ml eco-enzyme to 1000 ml water. Additional evaluation was conducted through a participant satisfaction questionnaire and a focus group discussion (FGD) to assess the effectiveness of the implementation and the potential for future program replication (Maulida et al., 2023).

Schedule and Stages of Program Implementation

The program was implemented for three months, from May to July 2024, with three main stages as in Table 1.

Table 1. Stages of implementation

Stages	Activities	Descriptions	Goals	Timeline
Stage 1	Initial survey and coordination	- Conducting field surveys to identify the characteristics and readiness of the target community. - Coordinating with UPJA and local farmer groups regarding location, participant selection, and activity scheduling.	Ensure the readiness of facilities, participants, and identify the potential of organic waste available for the manufacture of eco-enzymes.	First to third week of May 2024
Stage 2	Training on making eco-enzymes	- Delivering material on waste management and fermentation principles. - Demonstration of the eco-enzyme manufacturing process. - Participants making eco-enzymes using local organic waste.	Participants understand the process of making eco-enzymes and are able to apply them independently.	Fourth week of May 2024
Stage 3	Guidance during fermentation	- Guiding the fermentation process for 100 days. - Monitoring storage, signs of fermentation, and answering participant questions.	Ensure the fermentation process runs optimally until eco-enzymes are formed with the expected quality.	June – August 2024
Stage 4	Utilization of eco-enzymes and monitoring	- Testing eco-enzymes on short vegetable plants (e.g., spinach). - Application of solutions and observation of plant growth. - Collecting data on plant growth and health results.	Prove the effectiveness of eco-enzymes as liquid organic fertilizers and encourage adoption in daily agricultural practices.	September 2024
Stage 5	Evaluation and feedback	- Analyzing post-test and pre-test results. - Collecting participant feedback through discussions and questionnaires. - Compiling recommendations for program development.	Evaluate the effectiveness of the program, increase knowledge, and potential for replication to other areas.	First and second week of October 2024

Through this structured method, the community service activity not only enhanced participants' knowledge but also produced a direct impact in the form of liquid organic fertilizer products that can be sustainably used by the community. The success of this program is expected to serve as a replication model for other villages facing similar issues related to organic waste management.

3. RESULTS AND DISCUSSION

Results

Structured training results

The training on processing organic waste into eco-enzyme was conducted using a participatory approach and active learning methods consisting of three main strategies: lectures, interactive discussions, and hands-on practice (learning by doing). The lecture method was used in the initial training session to systematically deliver foundational material related to the concept of organic waste, fermentation principles, and the benefits of eco-enzyme liquid organic fertilizer in sustainable agriculture. The delivery of material was carried out in a communicative manner and tailored to the background of the participants, most of whom were farmers and household agricultural practitioners.

The interactive discussion method was applied to provide space for questions, clarifications, and the exchange of experiences between participants and the resource persons. This discussion aimed to explore participants' understanding, address technical concerns, and adapt the technology application to local conditions in Tanjung Jati Village. Participants were given the opportunity to express challenges and potential adaptations within their respective environments. The delivery of material by the team can be seen in Figure 1.

Figure 1. Delivery of material by the community service team
Figure 2. Implementation of eco-enzyme manufacturing practices

The hands-on practice method was the main component of this training (Figure 2). Participants were divided into three groups and facilitated to independently prepare eco-enzyme solutions using locally sourced materials, including organic waste such as vegetable scraps and fruit peels, brown sugar, and clean water. The ratio of materials used was 3 kg of organic waste, 1 kg of brown sugar, and 10 liters of water. Participants were guided through the processes of weighing the materials, mixing, transferring them into fermentation containers, and applying proper storage techniques. This hands-on approach provided practical experience and reinforced participants' understanding in a concrete manner.

To measure the effectiveness of the training, an evaluation was conducted using pre-test and post-test assessments. The measurement results in Table 2 indicate a significant increase in knowledge. The participants' average pre-test score was 20.23 with a standard deviation of 8.73, while the average

post-test score increased to 37.23 with a standard deviation of 6.10. The 84 percent increase in the average score demonstrates substantial progress in participants' understanding. The results of the paired sample t-test show a t-value of -14.90 with a significance level (p-value) of 0.000 ($p < 0.05$), indicating that the difference between pre-test and post-test scores is statistically significant (Table 4). A correlation of 0.698 between pre-test and post-test scores also suggests that the improvement occurred evenly across participants (Table 3). Thus, the training methods applied were proven effective in enhancing participants' knowledge of organic waste processing technology into eco-enzyme.

Table 2. Respondent pre-test and post-test results

Respondents	Mean	N	Std. Deviation	Std. Error Mean
Pre-test	20.233	30	8.728	1.593
Post-test	37.233	30	6.095	1.112

Table 3. Correlation test results

Respondents	N	Correlation	Sig.
Pre-test & Post-test	30	0.698	0.000

Table 4. Paired t-test results

Respondents	Mean	Std. Deviation	Std. Error Mean	95 percent Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pre-test - Post-test	17.00	6.25	1.14	-19.33	-14.66	-14.90	29	0.00

Practical assistance results

Participants were directly assisted throughout the 100-day eco-enzyme production process. Each participant processed household organic waste, such as fruit peels and vegetables, with brown sugar and water using a 3:1:10 ratio. The assistance was provided to ensure that the fermentation process proceeded optimally in accordance with established procedures.

Figure 3. Results of the eco-enzyme fermentation process after 100 days

From this activity, each group successfully processed an average of 3 kg of organic waste and produced approximately 10 liters of eco-enzyme, which can be used to create 500 liters of liquid organic fertilizer. The total organic waste processed by the three groups reached 9 kg, resulting in 30 liters of eco-enzyme ready to be converted into LOF. All produced solutions exhibited the characteristics of

successful eco-enzyme: brown color, a distinctive fermentation aroma that was neither pungent nor foul, and free from harmful gas or mold (Figure 3). These results indicate that all participants were able to independently and effectively apply the acquired skills to produce liquid organic fertilizer using appropriate technology.

Program evaluation results

After the fermentation process was completed, participants utilized the resulting eco-enzyme LOF to water water spinach plants in their home gardens. The application was carried out at a dosage of 20 ml of solution per 1 liter of water, sprayed twice a week. Observations showed that plants treated with eco-enzyme exhibited better growth compared to the untreated control group. Quantitatively, there was a 26 percent increase in plant height and a 32 percent increase in the number of leaves. The leaves also appeared greener and fresher, indicating optimal photosynthesis, as shown in Figure 4. These findings demonstrate that eco-enzyme LOF functions effectively as a liquid organic fertilizer and serves as a viable alternative to chemical fertilizers in household farming (Annisa et al., 2024).

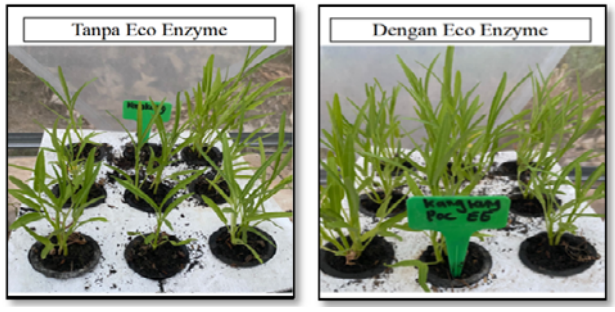
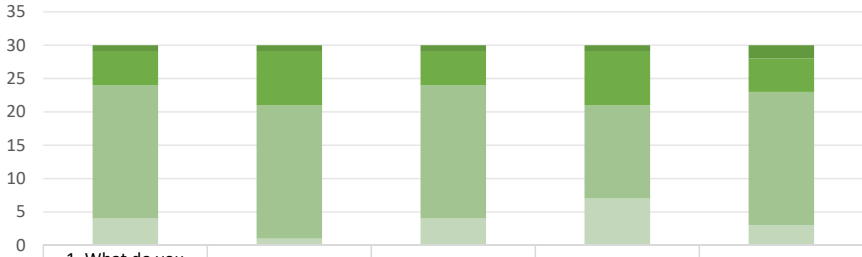


Figure 4. Comparison of the growth of spinach plants with the addition of eco-enzyme and without the addition of eco-enzyme



	1. What do you think about the clarity of the delivery of the material on making Ecoenzyme as a POC?	2. How relevant is the material presented to your needs?	3. Is the material easy for you to understand?	4. Are the extension methods used effective?	5. How confident are you that you can make your own Ecoenzyme after following this training?
1					
2	1	1	1	1	2
3	5	8	5	8	5
4	20	20	20	14	20
5	4	1	4	7	3

Figure 5. Participant assessment results regarding material delivery

In addition to technical observations, participants' perceptions of the program implementation were evaluated through a questionnaire. The evaluation results presented in Figure 5 show that 67 percent of participants gave a score of 4 for material clarity, and 13 percent gave a score of 5. Regarding material relevance, 67 percent rated it as very relevant (score 4), and 27 percent as fairly relevant (score 3). Ease of understanding the material was also rated highly by 67 percent of participants (score 4) and 13 percent (score 5). The effectiveness of the extension method was considered effective by 47 percent of participants (score 4) and very effective by 23 percent (score 5). As for participants' confidence in independently producing eco-enzyme, 67 percent stated they were confident (score 4), and 10 percent were very confident (score 5). Although a small portion of participants (around 23 percent) gave scores below 4 regarding self-confidence, these results indicate the need for follow-up support in the form of continued mentoring or the establishment of local facilitators.

Quantitative impact of implementation of appropriate technology

The implementation of Appropriate Technology (AT) through training and the production of eco-enzyme-based liquid organic fertilizer has demonstrated tangible quantitative impacts. Overall, the program successfully processed 9 kg of household organic waste, produced 30 liters of eco-enzyme, and diluted it into 1,500 liters of liquid organic fertilizer (LOF). It increased the average height of water spinach plants by 26 percent, enhanced the number of leaves by 32 percent, and reduced the use of chemical fertilizers in household-scale crop cultivation. These impacts reflect not only an improvement in participants' knowledge but also enhanced agricultural productivity and efficiency. Therefore, this activity is considered successful in providing a practical solution to organic waste issues while promoting environmentally friendly agriculture.

Discussion

Comparison with previous research

The results of this community service activity align with previous studies demonstrating that intensive training and active mentoring can enhance public knowledge and skills in various areas, including organic waste management. Research by Syahfitri et al. (2023) at SDIT Ashabul Kahfi showed that organic waste processing training significantly improved participants' understanding of organic waste management.

A study by Ramadani et al. (2019) on the application of eco-enzyme in pineapple peel waste management found that training on eco-enzyme production not only increased participants' knowledge but also encouraged behavioral changes regarding the reduction of harmful chemical use in households. These findings support this program's results, where improved participant understanding opens the possibility for everyday adoption of eco-enzyme practices.

Research by Kartika and Bakti (2022), focusing on organic waste management assistance in urban communities, also showed a positive impact from training and education. Their findings emphasized the need for ongoing mentoring to ensure long-term sustainability in both knowledge and behavioral changes. Accordingly, the post-training assistance in Tanjung Jati Village must continue to help participants consistently implement the knowledge they have gained.

The community service activities conducted in Tanjung Jati Village, Muara Enim Regency, proved successful in increasing community knowledge by 84 percent—from an average pre-test score of 20.23 to a post-test score of 37.23—and in processing 9 kg of organic waste into 30 liters of eco-enzyme,

which was formulated into liquid organic fertilizer (LOF). Application of this LOF to water spinach plants resulted in an average growth increase of 26 percent in height and 32 percent in leaf count compared to the control group.

These findings align with a study by Juwita et al. (2024) in Malangsuko Village, Malang Regency, where a PKK women's group was trained to process vegetable waste into liquid organic fertilizer (LOF) using fermentation techniques. The training resulted in a 55 percent increase in participants' skills and enabled them to process up to 50 kg of vegetable waste per day, producing approximately 250 liters of LOF daily. A notable strength of this program was its large-scale processing capacity supported by laboratory testing of the nutrient content in the resulting LOF.

Similarly, Agustinur et al. (2024) reported community engagement efforts in Drien Rampak Village, West Aceh, where participants were trained to produce eco-enzyme from fruit and vegetable waste. The program successfully produced 100 liters of eco-enzyme from 30 kg of organic waste and resulted in substantial improvements in participants' attitudes, skills, and knowledge, by 16.84, 13.11, and 5.49 points respectively. These outcomes demonstrate a meaningful behavioral impact on household waste management.

Community service activities by Manalu et al. (2024) in the POKBAPER community in Jayapura also explored organic waste utilization by converting fish waste into LOF using EM4 and molasses. The program improved participant understanding from 53 percent to 90 percent and processed 5 kg of fish waste into LOF after a 15-day fermentation period. This method shows that not only plant-based waste but also animal-based waste can be effectively processed into valuable agricultural inputs, with a relatively shorter fermentation time than eco-enzyme methods.

Challenges and solutions

The results of the community engagement program showed a significant increase in knowledge, yet several challenges may arise in implementing organic waste management into eco-enzyme production at the community level. First, some participants may face difficulties related to limited facilities and tools, which can hinder the application of the knowledge gained. A lack of basic equipment and raw materials remains a major obstacle in adopting waste processing practices in rural areas.

To address this issue, it is essential to improve access to necessary infrastructure, such as by establishing organic waste collection points or forming local working groups dedicated to eco-enzyme production. Involvement from local governments or private sector partners can also play a crucial role in supporting the program, both through funding and the provision of facilities.

Second, the success of the program heavily depends on continuity and ongoing support. Therefore, it is important for the training organizers in Tanjung Jati Village to ensure that monitoring programs or regular follow-up visits are conducted to track the community's progress in implementing eco-enzyme practices.

4. CONCLUSION AND RECOMMENDATIONS

The training and mentoring program on organic waste processing into eco-enzyme in Tanjung Jati Village, Muara Enim Regency, demonstrates a strong alignment between the community service objectives, namely enhancing public knowledge and skills in managing organic waste, and the measurable outcomes achieved. Quantitatively, the average knowledge score increased from 20.23 in the pre-test to

37.23 in the post-test, reflecting an 84 percent improvement that signifies the successful enhancement of participants' cognitive capacity. In terms of appropriate technology implementation, participants engaged in hands-on eco-enzyme production using household organic waste, brown sugar, and clean water in the prescribed ratio. After a 100-day fermentation process, the resulting solution transformed into eco-enzyme, characterized by a brown color, a strong but non-putrid fermented aroma, and the absence of mold or excessive gas, indicating a properly conducted process. A total of 9 kg of organic waste was successfully processed into 30 liters of eco-enzyme, which can be diluted to produce up to 1,500 liters of liquid organic fertilizer. These results highlight that the program not only improved participants' understanding but also produced tangible outputs in the form of eco-enzyme products that can be sustainably applied to household-scale agriculture.

Overall, the feedback evaluation results indicate that the materials presented were well received by participants, particularly in terms of clarity, relevance, ease of understanding, and the effectiveness of the extension methods used. However, the program still faces several limitations. These include the suboptimal adjustment of materials to the participants' diverse knowledge backgrounds, limited training duration that restricted some participants from fully engaging in hands-on practice, and the relatively low effectiveness of the material delivery methods. Based on these findings, the following recommendations are proposed for future community service initiatives: (1) Conduct initial assessments of participants' baseline knowledge levels prior to the training to better tailor the materials to their needs; (2) Extend the duration of the training or provide additional practical sessions to enhance participants' technical skills through more direct experience; (3) Implement post-training support, such as field visits or the formation of local learning groups, to strengthen participants' confidence and ensure the sustainability of eco-enzyme practices at the household level.

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