

ECO-ENZYME PRODUCTION TRAINING FOR ORGANIC WASTE MANAGEMENT IN THE COASTAL COMMUNITY

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Abstract. Household organic waste management remains an environmental challenge in coastal communities, including Sungsang IV Village, Banyuasin Regency, South Sumatra, Indonesia. The availability of organic waste and mangrove litter that has not been optimally utilized indicates the need to improve community knowledge and skills in locally based waste management. This community engagement activity aimed to improve community understanding of organic waste utilization through eco-enzyme production and to encourage sustainable and environmentally friendly waste management practices. The activity was conducted on 23 May 2026 using a participatory approach consisting of educational sessions, an eco-enzyme production demonstration, interactive discussion, and pre- and post-training questionnaire evaluation. The evaluation results showed improvements across all measured indicators. Understanding of eco-enzyme increased from 25% to 80%, understanding of the production procedure increased from 40% to 90%, and understanding of eco-enzyme functions in agriculture and household activities increased from 37% to 85%. Participants' expectations regarding program sustainability also increased from 50% to 88%. Overall, the average evaluation score increased from 38.0% before the training to 85.75% after the training, representing an increase of 47.75 percentage points. These findings indicate that demonstration- and discussion-based training has potential as a community empowerment approach for improving understanding of organic waste utilization. Further assistance and the development of community-based organic waste management groups are recommended to support sustained implementation of the practice.

Keywords: coastal community, community empowerment, eco-enzyme, organic waste

Abstrak. Pengelolaan sampah organik rumah tangga masih menjadi tantangan lingkungan di wilayah pesisir, termasuk Desa Sungsang IV, Kabupaten Banyuasin, Sumatera Selatan. Ketersediaan sampah organik dan serasah mangrove yang belum dimanfaatkan secara optimal menunjukkan perlunya peningkatan pengetahuan dan keterampilan masyarakat dalam pengelolaan limbah berbasis sumber daya lokal. Kegiatan pengabdian kepada masyarakat ini bertujuan meningkatkan pemahaman masyarakat mengenai pemanfaatan sampah organik melalui pembuatan eco-enzyme serta mendorong keberlanjutan praktik pengelolaan sampah secara ramah lingkungan. Kegiatan dilaksanakan pada 23 Mei 2026 melalui pendekatan partisipatif yang meliputi penyampaian materi, demonstrasi pembuatan eco-enzyme, diskusi dan tanya jawab, serta evaluasi menggunakan kuesioner sebelum dan sesudah pelatihan. Hasil evaluasi menunjukkan peningkatan pada seluruh indikator yang diukur. Pemahaman mengenai eco-enzyme meningkat dari 25% menjadi 80%, pemahaman mengenai cara pembuatannya meningkat dari 40% menjadi 90%, dan pemahaman mengenai fungsi eco-enzyme dalam pertanian serta kehidupan rumah tangga meningkat dari 37% menjadi 85%. Harapan terhadap keberlanjutan program juga meningkat dari 50% menjadi 88%. Secara keseluruhan, rata-rata hasil evaluasi meningkat dari 38,0% sebelum pelatihan menjadi 85,75% setelah pelatihan, dengan peningkatan sebesar 47,75 poin persentase. Kegiatan ini menunjukkan bahwa pelatihan berbasis demonstrasi dan diskusi dapat menjadi pendekatan yang potensial untuk meningkatkan pemahaman masyarakat mengenai pemanfaatan sampah organik. Tindak lanjut berupa pendampingan dan pembentukan kelompok pengelola sampah organik diperlukan untuk mendukung penerapan secara berkelanjutan.

Kata Kunci: eco-enzyme, masyarakat pesisir, pemberdayaan masyarakat, sampah organik

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INTRODUCTION

Household waste management remains one of the environmental challenges that requires direct community involvement, particularly at the source or household level. Waste management



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approaches that focus solely on collection and disposal are insufficient to promote sustainable waste reduction. Studies on household waste management in Indonesia have shown that knowledge, environmental awareness, community participation, and institutional support are important factors in developing sustainable waste management practices. Community-based approaches also allow waste management practices to be adapted to local social and economic conditions as well as available local resources (Al Zahra & Shohibuddin, 2025; Ferdinan et al., 2022).

Organic waste constitutes an important component of this issue because it originates from daily household activities and is relatively easy to decompose. When not properly managed, the accumulation of organic materials can generate unpleasant odors, reduce environmental quality, and increase the potential for health problems and pollution (Nasution et al., 2026; Wahyuni et al., 2024). Conversely, the biodegradable nature of organic waste provides an opportunity to convert it into useful products through reuse and source-based processing approaches (Wainaina et al., 2020). Various community-based approaches in Indonesia have demonstrated that improving community knowledge and skills is an important component in promoting the sorting and processing of organic waste at the household level (Alam et al., 2024; Wahyuni et al., 2024).

This condition is also relevant to Sungsang IV Village, Banyuasin Regency, South Sumatra, which is a coastal area characterized by the presence of mangrove ecosystems and communities closely connected to coastal resources. Based on the conditions identified during the community engagement activity, household organic waste and locally available organic materials, including mangrove litter, have not been optimally utilized as useful resources. This condition indicates a gap between the availability of organic materials within the community's environment and the community's capacity to process them into usable products.

The utilization of organic waste to produce eco-enzyme is one simple alternative that can be introduced to the community. Eco-enzyme is a liquid product resulting from the fermentation of organic materials, such as fruit and vegetable residues, with sugar and water. This product has been widely introduced as a form of household-scale organic waste utilization and has potential applications in various activities, including as a cleaning agent and in agricultural applications. Studies on the utilization of household organic waste have demonstrated that fermentation of organic materials into eco-enzyme can serve as an alternative approach to household-level waste processing, while experimental studies have also evaluated its applications in agriculture and environmental management (Nangoi et al., 2022; Purba et al., 2024).

A training approach is important because the success of community-based waste management depends not only on the availability of appropriate technology but also on the community's ability to understand, apply, and sustain the practice. Eco-enzyme training and mentoring activities conducted in various regions of Indonesia have demonstrated that socialization, demonstrations, hands-on practice, and discussion can be used to improve community capacity in utilizing organic waste. Participatory training also provides opportunities for communities to connect the knowledge they acquire with environmental problems encountered in their daily lives (Palmasari et al., 2022; Supriana et al., 2026; Tuhumury et al., 2024).

The Sungsang IV community also has previous experience in utilizing organic waste to produce eco-enzyme. A socialization and training activity on organic waste processing in Sungsang IV Village resulted in the production of eco-enzyme and its derivative products (Meidalima et al., 2023). This finding indicates that organic waste utilization through eco-enzyme production is relevant to the needs of the local community. However, sustaining this approach requires strengthening community capacity and evaluating changes in participants' understanding following the training. Therefore, the present community engagement activity was designed not only to introduce eco-enzyme production but also to improve community understanding through a combination of educational sessions, demonstrations, discussions, and pre- and post-training evaluation. Similar community empowerment activities have shown that pre-post evaluation can be used to describe changes in participants' knowledge following educational interventions on organic waste processing (Palmasari et al., 2022; Supriana et al., 2026).

Based on these conditions, this community engagement activity aimed to improve the understanding of the Sungsang IV community regarding organic waste utilization through eco-enzyme production and encourage community readiness to implement sustainable organic waste management practices at the household level. The evaluation was conducted by comparing participants' understanding before and after the training, allowing changes in understanding to be used as a basis for assessing the achievement of the activity and formulating follow-up community empowerment strategies.

METHOD OF IMPLEMENTATION

Location and Participants

The community engagement activity was conducted on 23 May 2026 in Sungsang IV Village, Banyuasin Regency, South Sumatra, Indonesia. The activity targeted members of the local community, particularly residents involved in household activities and local community groups. The activity was designed as a participatory community training program aimed at improving participants' understanding of organic waste utilization through eco-enzyme production. The initial target was approximately 20–25 participants. Community participation was emphasized throughout the activity to facilitate interaction between the facilitators and participants and to enable participants to relate the training materials to their existing household waste management practices.

Preparation Stage

The preparation stage consisted of coordination with village authorities and local community members, administrative and permission arrangements, preparation of equipment and materials, and preparation of the training venue. The facilitators also prepared an eco-enzyme sample to be used as a demonstration model during the training. These preparatory activities were conducted to ensure the availability of the materials and facilities required for the training and to facilitate the implementation of the demonstration and discussion sessions.

Participatory Training Approach

The training employed a participatory community education approach consisting of educational delivery, interactive discussion, demonstration, and practical explanation of eco-enzyme production. The educational session introduced the concept of eco-enzyme, household organic waste management, the basic principles of fermentation, required materials and equipment, production procedures, and potential household and agricultural applications. The presentation was delivered using language adapted to the participants' background and local context. Participants were encouraged to share their experiences and existing practices in managing household organic waste. This approach was selected because participatory and experiential training allows community members to actively engage with the learning process rather than merely receive information. Similar eco-enzyme community engagement programs have successfully applied combinations of socialization, discussion, demonstration, and hands-on practice to strengthen participants' knowledge and interest in organic waste utilization (Ernawati et al., 2026; Sitorus et al., 2026; Wibowo et al., 2025).

Eco-Enzyme Production Demonstration

The demonstration focused on the production of eco-enzyme using locally accessible organic materials. The materials consisted of fruit peels and vegetable residues, brown sugar or molasses, clean water, and a plastic fermentation container. The formulation used a 1:3:10 ratio, consisting of one-part brown sugar or molasses, three parts organic waste, and ten parts water. The procedure began with cleaning the fermentation container to remove any residual soap or chemical substances. Water was then added to the container, followed by the addition of sugar and organic waste. The mixture was stirred according to the fermentation maintenance procedure introduced during the training, and the container was subsequently labeled with the production date and planned harvesting date. Participants were also informed about the general

characteristics of successful fermentation and the importance of maintaining the fermentation container throughout the process.

The use of the 1:3:10 formulation was maintained as a practical training protocol because this ratio is also reported in recent eco-enzyme training activities. For example, a 1:3:10 formulation of brown sugar, organic waste, and water in a training program combining socialization, demonstration, hands-on practice, and pretest-posttest evaluation. Thus, the formulation provided to participants represented a simple and reproducible procedure suitable for household-level application (Siregar et al., 2025).

Interactive Discussion and Community Engagement

Following the demonstration, an interactive discussion and question-and-answer session was conducted. This stage was intended to reinforce participants' understanding and identify their practical needs and concerns regarding organic waste management. Discussion topics included the types of organic materials suitable for eco-enzyme production, fermentation duration, handling of unsuccessful fermentation, potential applications for plants, household cleaning applications, and opportunities for developing eco-enzyme as a value-added community product. The discussion was conducted as a two-way communication process, allowing participants to connect the information provided by the facilitators with their own household and environmental conditions. The activity report indicated that most participants had not previously produced eco-enzyme but expressed strong interest in trying the process after the training.

Evaluation Design

The achievement of the training was evaluated using a one-group pretest-posttest design. A questionnaire was administered before and after the training to assess changes in participants' understanding following the intervention. Four evaluation indicators were used: (1) understanding of eco-enzyme, (2) understanding of the eco-enzyme production procedure, (3) understanding of eco-enzyme functions in agriculture and household activities, and (4) expectations regarding program sustainability. The pretest was administered before the core training activities, whereas the posttest was administered after completion of the training sequence. The evaluation also collected participants' expectations regarding the continuation of the program and provided feedback for planning subsequent community empowerment activities.

The use of a pretest-posttest evaluation is consistent with recent community-based eco-enzyme training programs. Applied a one-group pretest-posttest design to evaluate changes in community knowledge following participatory eco-enzyme training and analyzed the results descriptively. Similar approaches have also been used in eco-enzyme education programs to compare participants' understanding before and after training (Sy. et al., 2025; Wahyuningsih et al., 2024).

Data Analysis

The evaluation data were analyzed using descriptive quantitative analysis. For each indicator, the percentage of participants demonstrating the expected level of understanding was calculated for the pretest and posttest. The change in each indicator was calculated as the difference between the posttest and pretest percentages and expressed as percentage points. The overall change was also calculated by comparing the mean percentage across the four evaluation indicators before and after the training.

Descriptive analysis was selected because the available activity records contained aggregated percentages for each evaluation indicator rather than individual participant-level scores. Therefore, the analysis was intended to describe changes in participants' understanding following the training rather than to establish statistical significance or causal effects. This analytical approach is consistent with community engagement studies in which pretest-posttest results are summarized descriptively to assess changes in knowledge following educational interventions (Lu et al., 2025; Vélez-López et al., 2025).

Follow-Up Strategy

The follow-up strategy was formulated based on the participants' responses and the limitations identified during the activity. Because the training session could not directly monitor the complete fermentation process until harvesting, continued assistance is needed to support participants in independently applying the production procedure. Follow-up activities are therefore directed toward household-level implementation, monitoring of the fermentation process, troubleshooting, and the development of community-based organic waste management groups. This approach is consistent with community empowerment programs that combine training with mentoring and continued assistance to strengthen the sustainability of organic waste management practices (Hilmansyah et al., 2024; Zakiyyah Putri et al., 2026).

RESULTS AND DISCUSSION

Implementation of Eco-Enzyme Production Training

The community engagement activity was conducted on 23 May 2026 in Sungsang IV Village, Banyuasin Regency, South Sumatra, Indonesia. The activity was implemented through a participatory training approach consisting of an opening session, educational material delivery, eco-enzyme production demonstration, interactive discussion, and pre- and post-training evaluation. The training was designed to introduce a simple approach to organic waste utilization that could potentially be applied at the household level using locally available organic materials.

The activity began with an opening session and delivery of educational materials concerning household organic waste management and eco-enzyme. The materials covered the basic concept of eco-enzyme, the environmental problems associated with unmanaged organic waste, fermentation principles, required materials and equipment, production procedures, and potential household and agricultural applications. Participants were also encouraged to share their experiences and existing practices in managing household organic waste.



Figure 1. *Opening session and delivery of training materials to the Sungsang IV community.*

The use of educational sessions as an initial stage is consistent with recent community-based eco-enzyme programs, in which participants are first introduced to the relationship between organic waste management and eco-enzyme production before proceeding to practical activities. Supriana et al. (2026), for example, implemented community empowerment through a participatory sequence involving socialization, discussion, demonstration, and hands-on practice. This sequence is relevant because it provides participants with conceptual information before they are introduced to the technical aspects of production.

The training subsequently moved from knowledge transfer to practical demonstration. This transition was important because the objective was not merely to inform participants about eco-enzyme but to introduce a reproducible household-level processing procedure.

Demonstration of Eco-Enzyme Production

The demonstration constituted the main practical component of the activity. The facilitators introduced fruit and vegetable residues, brown sugar or molasses, clean water, and a plastic fermentation container as the main materials. The production procedure followed a 1:3:10 ratio, consisting of one-part brown sugar or molasses, three parts organic waste, and ten parts waters. Participants were shown how to prepare the container, combine the materials, and maintain the fermentation process.



Figure 2. *Demonstration of eco-enzyme production by the community engagement team*

The demonstration provided participants with direct visualization of the production sequence. This approach is particularly relevant for procedures involving several sequential steps because participants can observe the relationship between materials, proportions, mixing, container preparation, and subsequent fermentation. Recent community training programs have similarly used demonstrations and hands-on practice as core components of eco-enzyme education. Siregar et al. (2025) reported an active-learning approach involving socialization, demonstration, hands-on practice, and pre-post evaluation, while the same study used the 1:3:10 formulation for eco-enzyme production.

The practical orientation of the present training is also supported by recent community empowerment research. Nugraha et al. (2025) reported that participatory training involving lectures, demonstrations, group practice, discussion, and reflection enabled participants to understand the ingredients, production process, fermentation period, and potential applications of eco-enzyme. Thus, the demonstration in Sungsang IV was not merely a complementary activity but functioned as an important mechanism for translating conceptual information into a practical procedure that could potentially be reproduced at the household level. During the demonstration, participants also received information regarding general indicators of successful fermentation, including the development of a dark-brown color and a characteristic fermentation odor without an unpleasant rotten smell. Because the training period did not extend to the harvesting stage, however, the activity did not evaluate the actual success of the fermentation process among participants.

Community Participation and Interactive Discussion

Following the demonstration, participants engaged in an interactive discussion and question-and-answer session. The questions raised during the discussion concerned the types of organic waste that could be used, fermentation duration, handling of unsuccessful fermentation, applications for plants, household cleaning applications, and opportunities for developing eco-enzyme as a value-added community product. The range of questions suggests that participants' interest extended beyond the basic definition of eco-enzyme toward its practical application. Questions concerning fermentation failure and application indicate that participants were beginning to consider the operational aspects of implementing the technique independently. The activity report further indicated that most participants had not previously produced eco-enzyme but expressed interest in trying the process following the training.



Figure 3. *Interactive discussion and question-and-answer session with training participants*

This finding is consistent with recent community empowerment programs. Supriana et al. (2026) emphasized the use of discussion alongside demonstration and hands-on practice to strengthen participant engagement during eco-enzyme training. Similarly, recent training in household organic waste processing reported that participatory activities involving explanation, demonstration, and practical engagement could improve participants' understanding and willingness to apply eco-enzyme production independently. Therefore, the discussion session served two functions: reinforcing technical understanding and identifying community concerns that may need to be addressed during subsequent mentoring. This is particularly important for community-based environmental interventions because technical knowledge alone does not guarantee successful implementation.

Changes in Participants' Understanding Following the Training

Evaluation was conducted using questionnaires administered before and after the training. Four indicators were assessed: understanding of eco-enzyme, understanding of the production procedure, understanding of eco-enzyme functions in agriculture and household activities, and expectations regarding program sustainability.



Figure 4. *Post-training questionnaire completion by the participants.*

The results demonstrated improvement across all four indicators. Understanding of eco-enzyme increased from 25% before the training to 80% after the training, representing an increase of 55 percentage points. Understanding of the production procedure increased from 40% to 90%, corresponding to an increase of 50 percentage points. Understanding of eco-enzyme functions increased from 37% to 85%, representing an increase of 48 percentage points, while

expectations regarding program sustainability increased from 50% to 88%, representing an increase of 38 percentage points.

Table 1. *Changes in participants' understanding before and after eco-enzyme production training*

Evaluation indicator	Before training (%)	After training (%)	Change (percentage points)
Understanding of eco-enzyme	25	80	+55
Understanding of production procedure	40	90	+50
Understanding of eco-enzyme functions	37	85	+48
Expectation of program sustainability	50	88	+38
Average	38.00	85.75	+47.75

Overall, the mean percentage across the four indicators increased from 38.00% before the training to 85.75% after the training, representing an increase of 47.75 percentage points.

The magnitude of the observed increase is consistent with findings from recent eco-enzyme community training programs. Supriana et al. (2026), using a one-group pretest–posttest approach, reported an improvement in participants' understanding following participatory training involving socialization, discussion, demonstration, and hands-on practice. Similarly, a 2026 community education program in Kampung Buatan I reported an increase in average understanding from 53.61% in the pretest to 96.14% in the posttest following education and eco-enzyme production demonstration. These findings support the interpretation that combining conceptual education with practical demonstration can improve immediate participant understanding.

The largest increase in the present activity was observed in the understanding of eco-enzyme itself, which increased by 55 percentage points. This result is plausible because the pre-training level was relatively low, suggesting that many participants had limited prior familiarity with eco-enzyme. The increase in understanding of the production procedure was also substantial, reaching 90% after the training. This result is particularly relevant because the demonstration directly addressed the procedural knowledge required for household production.

The increase in understanding of eco-enzyme functions from 37% to 85% further indicates that the training expanded participants' knowledge beyond the production process. This finding corresponds with the discussion, in which participants asked about agricultural and household applications. Recent community programs similarly report increased awareness of potential household and environmental uses following eco-enzyme education and practical training. Importantly, these findings should be interpreted as evidence of immediate improvement in measured understanding, rather than evidence of long-term behavioral change. Because the evaluation was conducted immediately after the intervention and the available data were aggregated, the results cannot establish whether participants subsequently adopted eco-enzyme production or changed their household waste-management behavior.

Sustainability Potential of the Community Program

Participants' expectations regarding program sustainability increased from 50% before training to 88% after training, representing an increase of 38 percentage points. This result indicates a stronger positive response toward the continuation of the program after participants had been exposed to the concept and practical process of eco-enzyme production. However, an increase in expectations should not be interpreted as direct evidence of program sustainability. Sustainability requires continued implementation, technical support, institutional commitment, and community ownership. The present activity therefore represents an initial capacity-building intervention rather than a complete long-term waste-management program.

This interpretation is supported by recent community engagement studies that combine training with continued mentoring. A 2026 program in Denpasar, for example, combined observation, socialization, technical training, direct demonstration, and ongoing assistance, while

evaluating participant understanding through pre- and post-tests. Such an approach is particularly relevant to the present activity because eco-enzyme production involves a fermentation period that extends beyond the duration of the training itself (Naryndra Pradnyana et al., 2026; Ni Wayan et al., 2026). The need for follow-up is also evident from the implementation constraints in Sungsang IV. The activity could not directly monitor the fermentation process through the harvesting stage, and continued assistance was identified as necessary to support independent application by the community. Therefore, future activities should include technical mentoring, monitoring of household fermentation, troubleshooting, and development of a community-based organic waste management group.

Contribution, Limitations, and Future Development

The principal contribution of the activity was the establishment of an initial learning platform through which community members could connect household organic waste with a practical utilization strategy. The combination of educational delivery, demonstration, interactive discussion, and pre-post evaluation created an integrated intervention addressing both conceptual understanding and practical awareness. The increase from 38.00% to 85.75% across the four indicators demonstrates that the immediate educational objective was achieved. Nevertheless, several limitations need to be acknowledged. First, the evaluation measured short-term changes in understanding, not long-term behavior or household adoption. Second, the fermentation process was not monitored until the harvesting stage. Third, the available results were aggregated percentages rather than individual participant-level data, preventing statistical testing of individual changes. Fourth, although the demonstration was intended to develop practical understanding, participants' actual production skills were not assessed using an objective competency instrument.

These limitations are important because recent community programs increasingly combine knowledge evaluation with direct observation of participants' ability to perform the production procedure. For example, the 2026 Denpasar program assessed both knowledge through pre-post tests and practical ability through observation of participants' implementation of the production stages (Naryndra Pradnyana et al., 2026; Ni Wayan et al., 2026). Similarly, Nugraha et al. (2025) incorporated group practice and observation as part of the empowerment process. Accordingly, future implementation in Sungsang IV should strengthen the evaluation framework by incorporating individual-level pre-post scores, objective practical-skill assessment, fermentation monitoring until harvesting, and follow-up assessment of household adoption. This would allow subsequent programs to determine whether the increase in immediate understanding is translated into sustained changes in organic waste management practices.

CONCLUSION

The eco-enzyme production training provided an appropriate initial community empowerment approach for introducing household organic waste utilization in Sungsang IV Village, Banyuasin, South Sumatra. The combination of educational delivery, practical demonstration, interactive discussion, and pre- and post-training evaluation enabled participants to develop a better understanding of eco-enzyme, its production procedure, and its potential applications in household and agricultural activities. The activity also strengthened participants' positive expectations toward the continuation of community-based organic waste management. Thus, the training achieved its immediate objective of strengthening community understanding and establishing an initial foundation for the utilization of organic waste as a potentially useful resource at the household level. Further activities should focus on continuous mentoring rather than one-time training. Follow-up programs are recommended to monitor the fermentation process until harvesting, assist participants in addressing technical problems during production, and assess the extent to which participants independently apply eco-enzyme production at the household level. The development of a community-based organic waste management group should also be considered to facilitate collective waste collection, production, knowledge sharing, and continued technical assistance. Future evaluations should incorporate individual participant-level pre-post data, objective assessment of practical skills, and follow-up measurements several

months after training to determine whether the immediate improvement in understanding is translated into sustained household waste-management practices.

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