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Community Empowerment through Eco-Enzyme Production Training for Organic Waste Management in Pematang Johar Village

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ABSTRACT

Pematang Johar Village generates organic waste from household and agricultural activities, including fruit and vegetable residues that have not yet been optimally utilized. This community service program aimed to improve community knowledge and strengthen participants' interest in managing organic waste through eco-enzyme production training. The activity was conducted on 14 May 2024 and involved 38 participants, consisting of housewives and farmers. A participatory approach was employed through socialization, discussion, demonstration, and hands-on practice. The activity was evaluated using a *one-group pretest–posttest* design, with questionnaires administered before and after the training, and the data were analyzed descriptively. The evaluation results showed that participants' knowledge of the definition and production process of eco-enzyme increased from 5.3–21.1% before the training to 100% after the training. Participants' interest in utilizing eco-enzyme, which was already relatively high at baseline, also increased from 86.8% to 100%. These findings indicate that the training reduced the technical knowledge gap and strengthened participants' interest in utilizing organic waste. The activity highlights that the application of simple, locally based technology, combined with a participatory approach, can support community empowerment and organic waste management at the source.
Keyword: Eco-enzyme, Enzyme, Organic Waste, Fermentation

ABSTRAK

Desa Pematang Johar menghasilkan sampah organik dari kegiatan rumah tangga dan pertanian berupa sisa buah dan sayuran yang belum dimanfaatkan secara optimal. Kegiatan pengabdian kepada masyarakat ini bertujuan meningkatkan pengetahuan dan memperkuat minat masyarakat dalam mengelola sampah organik melalui pelatihan pembuatan eco-enzyme. Kegiatan dilaksanakan pada 14 Mei 2024 dengan melibatkan 38 peserta yang terdiri atas ibu rumah tangga dan petani. Pelaksanaan kegiatan menggunakan pendekatan partisipatif melalui sosialisasi, diskusi, demonstrasi, dan praktik langsung. Evaluasi dilakukan menggunakan desain *one-group pretest–posttest* melalui kuesioner yang diberikan sebelum dan setelah pelatihan, kemudian dianalisis secara deskriptif. Hasil evaluasi menunjukkan peningkatan pengetahuan peserta mengenai pengertian dan cara pembuatan eco-enzyme dari 5,3–21,1% sebelum pelatihan menjadi 100% setelah pelatihan. Minat peserta dalam memanfaatkan eco-enzyme yang sejak awal sudah relatif tinggi juga meningkat dari 86,8% menjadi 100%. Peningkatan tersebut menunjukkan bahwa pelatihan mampu mengurangi kesenjangan pengetahuan teknis dan memperkuat minat peserta dalam memanfaatkan sampah organik. Kegiatan ini menegaskan bahwa penerapan teknologi sederhana berbasis sumber daya lokal yang dipadukan dengan pendekatan partisipatif dapat mendukung pemberdayaan masyarakat dan pengelolaan sampah organik dari sumbernya.
Keyword: Eco-enzyme, Enzim, Sampah Organik, Fermentasi

1. Introduction

Waste remains a major environmental issue that requires systematic and sustainable management. Converting waste into organic fertilizer is one approach to reducing waste accumulation while increasing the utility of materials that would otherwise be discarded [1]. Organic waste, particularly fruit and vegetable residues generated from household, market, and agricultural activities, decomposes rapidly if it is not promptly managed [2]. One potential use of this waste is as a raw material for eco-enzyme production [3]. Training in organic waste processing using the eco-enzyme method has also been implemented to improve community knowledge and participation in environmental management [4]. In addition to biological treatment, waste management innovations have been developed through the use of technology to support waste collection and sorting processes [5]. Reusing materials previously regarded as waste can increase their utility and create opportunities for producing more beneficial products for the community [6].

Eco-enzyme is a liquid produced through the fermentation of fruit and vegetable residues, brown sugar or molasses, and water. The fermented product typically has a brownish color and a characteristic acidic aroma. Organoleptic characteristics, such as color and aroma, can be used as preliminary indicators when assessing the eco-enzyme fermentation process [7]. The potential applications of eco-enzyme have been examined in various fields, including its use as an organic-based material to support the handling and storage of agricultural produce [8]. Eco-enzyme combined with other organic materials also has potential as a natural disinfectant [9]. In addition, eco-enzyme can be developed as a multipurpose liquid derived from household organic waste [10]. The accessibility of its raw materials and the relative simplicity of its production process make eco-enzyme a relevant alternative for community-based organic waste management.

Household and agricultural activities in Pematang Johar Village generate fruit and vegetable residues as part of the local organic waste stream. Based on preliminary observations and discussions with the partner organization, these organic materials had not been optimally utilized, while community knowledge of processing organic waste into eco-enzyme remained limited. This condition indicated a gap between the availability of organic raw materials and the community's capacity to process them into useful products. Housewives and farmers were selected as participants because both groups are directly involved in managing kitchen waste and organic residues generated from agricultural activities.

Previous community service initiatives have generally introduced the benefits and production process of eco-enzyme through community outreach and hands-on practice [11,12]. The program implemented in Pematang Johar Village combined educational sessions and practical training with the involvement of housewives and farmers, the provision of fermentation drums and supporting equipment, and evaluations conducted before and after the training. These evaluations were used to identify changes in participants' knowledge and interest as preliminary outcomes of technology transfer in organic waste management. This approach added value to the program because the training outcomes were assessed not only on the basis of program implementation but also through changes in participants' responses. Accordingly, this community service program aimed to improve the knowledge of housewives and farmers and strengthen their interest in processing organic waste through eco-enzyme production training. The program also aimed to introduce a simple, locally based waste-processing technology with the potential for sustainable application at both household and village levels

2. Methods

The community service activity employed a participatory approach and a *one-group pretest–posttest* design to compare participants' knowledge and interest before and after the training. The activity was conducted on 14 May 2024 from 9:00 a.m. to 3:00 p.m. in Pematang Johar Village, Labuhan Deli Subdistrict, Deli Serdang Regency, North Sumatra, with a total duration of six hours. A total of 38 participants, consisting of housewives and farmers, attended the activity. The participants were selected and coordinated by the Deli Serdang Regency Land Office, which served as the program's implementation partner.

2.1. Problem identification and activity preparation

The activity began with field observations, interviews, and coordination with the partner organization to identify existing organic waste management practices, the availability of fruit and vegetable residues, and community knowledge regarding the utilization of organic waste. The information obtained was used as the

basis for developing the training materials, determining the training methods, and preparing the required equipment and materials. The activity stages included observation, interviews, program introduction, participatory practice, training, and community assistance.

2.2. Socialization and training

The training was delivered through lectures, discussions, question-and-answer sessions, demonstrations, and hands-on practice. The materials covered organic waste management, the definition and benefits of eco-enzyme, the selection of equipment and materials, ingredient composition, fermentation, storage, harvesting, indicators of successful fermentation, and the utilization of eco-enzyme liquid and residue.

2.3. Equipment and materials

The eco-enzyme production practice used a large plastic drum with a tightly fitted lid as the fermentation container. The supporting equipment consisted of a weighing scale, knives, cutting boards, collection containers, measuring cups, stirrers, a strainer or gauze cloth, and droppers. The organic materials included discarded or overripe papaya without signs of mold, orange peels, and other fruit and vegetable residues available during the activity. The additional ingredients consisted of brown sugar or molasses and clean water. Cooked, moldy, worm-infested, oily, or inorganic-contaminated materials were not used.

2.4. Eco-enzyme production practice

The ingredients were prepared using a ratio of 1:3:10, consisting of one part brown sugar or molasses, three parts organic material, and ten parts water. The water volume was limited to a maximum of 60% of the drum capacity to provide sufficient space for the organic materials and gases produced during fermentation. The organic materials were sorted, washed, drained, cut into smaller pieces, and weighed according to the predetermined composition. Water was first poured into the drum, after which the brown sugar or molasses was added and stirred until completely dissolved. The organic materials were then added gradually and stirred until evenly mixed. After mixing, the drum was tightly closed and labeled with the production date and estimated harvesting date.

2.5. Fermentation and harvesting

Participants were instructed to store the fermentation drum for 90 days, or three months, in a shaded and well-ventilated area protected from direct sunlight, contamination sources, and chemicals. After the fermentation period, the liquid was harvested by filtering and separating it from the solid residue, after which it was stored in a closed container. A dropper was used to collect liquid samples for product-characteristic observations. Participants were informed that successful fermentation would produce a brownish liquid with a fresh, acidic fermentation aroma and a pH below 4.0.

2.6. Activity evaluation

The activity was evaluated through program monitoring and the administration of pretests and posttests to all participants. Monitoring was conducted after the training to observe the continuity of the eco-enzyme fermentation process and identify constraints encountered by the community. The pretest and posttest were used to evaluate changes in participants' knowledge and interest. The evaluation instrument consisted of three "Yes" or "No" questions assessing participants' knowledge of the definition of eco-enzyme, knowledge of its production process, and interest in utilizing eco-enzyme. The pretest was administered before the training materials were delivered, whereas the posttest was administered after all training and practical activities had been completed. The same questions were used in both tests to allow participants' responses to be compared.

2.7. Data analysis

Participants' responses were tabulated according to the frequency of "Yes" and "No" answers and were subsequently analyzed descriptively using percentages. The percentage for each response category was calculated by dividing the number of participants in that category by the total number of participants and multiplying the result by 100%. The analysis was used to describe changes in participants' knowledge and interest before and after the training.

3. Results and Discussion

The eco-enzyme production training was conducted on 14 May 2024 in Pematang Johar Village and involved 38 participants consisting of housewives and farmers. Before the training materials were delivered, participants completed a pretest to assess their initial knowledge of eco-enzyme and their interest in utilizing it. A posttest containing the same questions was administered after all training and hands-on activities had been completed. The pretest and posttest results are presented in Table 1.

Table 1. Participants' knowledge and interest before and after the eco-enzyme production training (n = 38)

Indicator	Pretest		Posttest	
	Yes	No	Yes	No
Knowledge of the definition of eco-enzyme	8 (21.1%)	30 (78.9%)	38 (100%)	0 (0%)
Knowledge of the eco-enzyme production process	2 (5.3%)	36 (94.7%)	38 (100%)	0 (0%)
Interest in utilizing eco-enzyme	33 (86.8%)	5 (13.2%)	38 (100%)	0 (0%)

The evaluation results showed an increase in the proportion of participants who reported having knowledge of eco-enzyme after the training. Before the activity, 8 participants, or 21.1%, reported knowing the definition of eco-enzyme, whereas 30 participants, or 78.9%, reported that they did not. After the training, all participants responded "Yes." A greater change was observed in participants' knowledge of the eco-enzyme production process, which increased from 2 participants, or 5.3%, in the pretest to 38 participants, or 100%, in the posttest. These findings indicate that the participants' primary limitation before the activity was their technical knowledge of the concept and production process of eco-enzyme.

Participants' initial interest in utilizing eco-enzyme was already relatively high. Before the training, 33 participants, or 86.8%, expressed interest, and this number increased to 38 participants, or 100%, after the activity. Therefore, the main contribution of the training was reflected in the increase in participants' knowledge, whereas the change in interest represented a strengthening of an interest that had already been established. The posttest results reflect participants' immediate responses after the activity and do not demonstrate the long-term adoption of eco-enzyme or changes in organic waste management behavior.

The increase in participants' knowledge following the training was consistent with the findings of previous community service activities. Eco-enzyme production training that combined the delivery of instructional materials with hands-on practice was reported to increase the proportion of participants with a good level of knowledge from 33% to 83% [11]. A similar activity also reported an increase in community knowledge of eco-enzyme from 44.4% before the training to 88.8% after the training [12]. These comparable findings suggest that combining instructional delivery with demonstrations and hands-on practice can help participants understand the utilization of organic waste and the stages involved in eco-enzyme production

Figure 1. Delivery of materials on organic waste management and eco-enzyme

After the pretest had been administered, the activity continued with the delivery of materials on organic waste management and eco-enzyme production. The first session addressed the types, problems, and potential uses of organic waste, while the subsequent session covered the definition, benefits, raw materials, ingredient composition, fermentation process, storage, harvesting, and utilization of eco-enzyme. The materials were

delivered through lectures, discussions, and question-and-answer sessions before participants proceeded to the practical activity.

Following the delivery of the materials, the activity continued with a demonstration and hands-on practice of eco-enzyme production guided by the community service team. Participants were directly involved in sorting, cutting, weighing, and mixing the organic materials with brown sugar or molasses and water according to the composition described in the Methods section. The mixture was then transferred into a fermentation drum, tightly sealed, and labeled with the production date and estimated harvesting date. The hands-on activity enabled participants to become familiar with the equipment, ingredient composition, and initial stages of the eco-enzyme fermentation process.

The prepared mixture was fermented for 90 days in a shaded and well-ventilated area protected from direct sunlight, sources of contamination, and chemicals. Participants were informed that, after the fermentation period, the liquid should be filtered using a strainer or gauze cloth and separated from the solid residue. Successful fermentation was indicated by a brownish color, a fresh acidic aroma characteristic of fermentation, and a pH below 4.0. The filtered eco-enzyme could subsequently be stored in a tightly sealed container for further use.

Figure 2. Hands-on eco-enzyme production practice with participants

The community service program not only provided participants with knowledge about producing eco-enzyme as an environmentally friendly product from organic waste, particularly fruit and vegetable residues, but also facilitated hands-on production activities and the provision of supporting equipment. The equipment and materials provided included a fermentation drum, molasses, brown sugar, and other supporting tools. The eco-enzyme mixture was prepared using a ratio of 1:3:10 for brown sugar or molasses, organic material, and water, equivalent to 1 kg of brown sugar or molasses, 3 kg of organic material, and 10 liters of water. The provision of these materials and equipment was intended to support the community in continuing the fermentation process after the training. The resulting eco-enzyme has the potential to be used as an organic fertilizer, a cleaning agent, and a natural pesticide.

This community service program introduced the utilization of fruit and vegetable residues as an alternative approach to organic waste management at the household and agricultural levels. Processing organic materials into eco-enzyme has the potential to increase the utility of waste that was previously underutilized while reducing the amount of organic material disposed of directly. The knowledge and practical experience gained by the participants also provide an initial foundation for the independent production of eco-enzyme

The handover of the fermentation drum and supporting equipment strengthened the prospects for the sustainability of the program, as the community was provided with the initial means to continue the eco-enzyme production process after the training. In the context of community empowerment, this activity not only transferred knowledge but also enhanced the community's capacity to manage organic waste using a simple technology based on locally available resources. However, the sustainability of the program still requires a clear division of responsibilities in maintaining the containers, monitoring the fermentation process, harvesting the product, and utilizing the final output. Coordination between the participants and the Deli Serdang Regency Land Office as the implementation partner is also necessary to ensure that the activity does not end at the training stage, but instead develops into a sustainable organic waste management practice.

Figure 3. Handover of community service equipment

4. Conclusions

The eco-enzyme production training resulted in increased community knowledge of the technical aspects of organic waste processing and strengthened participants' interest in utilizing the technology. This capacity building has the potential to provide an initial foundation for the independent and sustainable adoption of eco-enzyme production by housewives and farmers in Pematang Johar Village. These achievements supported the main objectives of the program, namely community empowerment and improved organic waste management at the source through the utilization of fruit and vegetable residues as valuable raw materials. The findings highlight the importance of integrating simple, accessible, and locally based waste-processing technologies with a participatory approach to support rural environmental management. Further monitoring is required to assess product quality, the consistency of community adoption, the amount of organic waste diverted from disposal, and the potential for expanding the program at the village level.

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