FORMULATION AND PRODUCTION STAGES OF ECO-ENZYME-BASED ENVIRONMENTALLY FRIENDLY LIQUID DETERGENT

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ABSTRACT

This community service program was implemented in Kampung Pemulung, South Tangerang, with a focus on improving the skills of residents through training in making environmentally friendly liquid detergent based on eco-enzymes. Eco-enzymes are the result of the fermentation of organic household waste, such as vegetable and fruit scraps, which have the ability to act as natural cleaners and are safe for the environment. The activity began with counselling on the negative impacts of using chemical detergents on aquatic ecosystems, then continued with technical training covering formulation, mixing ingredients, simple quality testing, and the product packaging process. Intensive mentoring was provided so that participants thoroughly understood the production stages and could repeat them independently. The results of the activity showed an increase in the understanding and skills of residents in processing organic waste into useful products, as well as growing motivation to develop small businesses based on environmentally friendly products. Thus, this activity not only provides solutions to environmental problems but also supports the economic empowerment of the Kampung Pemulung community through sustainable product innovation.

Keywords: Eco Enzyme, Environmentally Friendly, Liquid Detergent, Community Empowerment

1. INTRODUCTION

Synthetic chemical detergents have long been the primary choice in household cleaning products due to their high cleaning power and ease of production. However, synthetic surfactants, phosphates, and other chemicals can have negative impacts on the environment, particularly when detergent waste contaminates water bodies (rivers and lakes), affecting aquatic life and ecosystem quality. Surfactant pollution poses a distinct ecological threat due to its toxic effects on aquatic microorganisms and the inability of some chemical components to decompose naturally(Arora et al., 2022). As an alternative, eco-enzyme, a liquid produced by fermenting organic household waste such as fruit and vegetable scraps with sugar or molasses and water, have gained attention as a more environmentally friendly cleaning agent. Eco-enzymes contain various enzymes and organic acids that can help degrade organic materials and pollutant compounds, and also have antibacterial effects. Several studies have shown the effectiveness of eco-enzymes in reducing pollutant content such as surfactants (LAS), treating wastewater, and significantly improving water quality((Gaspersz & Fitrihidajati, 2022)(Rizkita et al., 2023).

Eco-enzyme is a multifunctional natural liquid derived from the fermentation of brown sugar or molasses, vegetable/fruit waste, and water in a ratio of 1:3:10 and a fermentation period of 3 months. (Husin et al., 2024)(Husin et al., 2024). In recent years, eco-enzymes have become a major focus in the development of sustainable and environmentally friendly household cleaning products. The benefits of eco-enzymes as an active ingredient in household cleaning products are significant. Eco-enzyme liquid is 100% natural and chemical-free, readily biodegradable, and very safe for hands and the environment. This liquid can be used as a household cleaner, insecticide, antifungal, antibacterial, antiseptic, fertilizer, and to clean the air of toxins and pollution, as well as eliminate odors((Widiani & Novitasari, 2023)(Wafa et al., 2023)(Meilani Prasetio et al., 2022)). Eco-enzymes used as active ingredients in household cleaning products can make them more effective, efficient, and environmentally friendly. Furthermore, eco-enzymes can reduce the use of hazardous and toxic chemicals in household cleaning products, making them safer for the environment and human health. Therefore, developing eco-enzymes as active ingredients in household cleaning products is crucial and needs to be considered in efforts to create sustainable and environmentally friendly products.

Liquid detergent is one of the most widely used products in everyday life. Washing clothes has become a household staple. Most detergents on the market are made from chemicals, particularly surfactants and additives that are difficult for microorganisms to break down. These include surfactants (cleaning agents), Alkyl Benzene Sulfonates (ABS), which function as foam generators, abrasives as scrubbing agents, organic compound decomposers, oxidants as bleachers and organic compound decomposers, enzymes to break down proteins, fats, or carbohydrates to soften materials, anti-rust agents, and others(Bratha & Putri, 2022)(Qomarudin et al., 2025)). The chemicals in detergents function to increase cleaning power, create foam, and remove grease. However, these chemicals are toxic and negatively impact the environment because they are difficult for bacteria to break down, leaving them intact and foaming. Detergents made from chemicals and the resulting waste pose significant environmental risks. Therefore, the development of environmentally friendly liquid detergents is crucial.

Based on the review above, several research questions arise: How is the formulation of an effective eco-enzyme-based liquid detergent, in terms of cleaning power and environmental safety? What are the optimal production stages so that the community can produce independently and consistently? How does the training impact the knowledge, skills, and economic potential of the community in the Scavenger Village? The purpose of this community service is to formulate and implement an eco-enzyme-based environmentally friendly liquid detergent formulation and educate the community of the Scavenger Village to be able to produce independently, increase ecological understanding, and empower the local economy.

2. METHOD

This community service activity uses a participatory approach that emphasizes active community involvement in every stage of the activity. According to Chambers (1994), a participatory approach positions the community not only as an object but also as a subject that plays a role in the planning, implementation, and evaluation of the program. Thus, this activity is expected to foster a sense of ownership, increase capacity, and encourage program sustainability. Participatory methods are methods that encourage the participation of each individual in a group process regardless of age, gender, social class, or educational background of each individual, growing from their awareness and responsibility. In the theory of community development and empowerment, participatory-based training that involves the community in the process of practical learning, the use of local resources, and collaborative evaluation will improve technical skills and environmental awareness. The eco-enzyme detergent production training not only transfers technology but also forms attitudes and economic independence. Previous community service research shows that training and mentoring programs increase community knowledge and skills regarding eco-enzymes and natural cleaning products.(Rizkita et al., 2023).

The activity was carried out in the Scavenger Village, South Tangerang, with the main target community members who work as scavengers and housewives. The location was selected based on the socio-economic characteristics of the community, which has limited access to entrepreneurial skills but has the potential to utilize household organic waste as raw material for eco-enzymes. The first activity included conducting outreach on eco-enzymes directly by the Head of the Family Welfare Movement (PKK) with the assistance of students, conducting counselling, preparing tools and materials, and directly conducting practical exercises. The second activity was a practical activity on making liquid detergent using eco-enzymes. The activities are explained as follows:

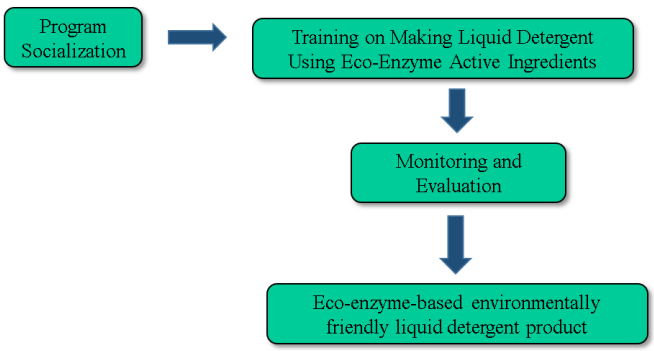

Figure 1. Stages of Implementation of the Training Activity "Making Environmentally Friendly Liquid Detergent Based on Eco Enzyme"
Sumber: Peneliti, 2025

Figure 1 explains the training activities for making eco-enzymes and the practice of making liquid detergents in the PKK group in the scavenger village, South Tangerang. The "Eco-Enzyme-Based Environmentally Friendly Liquid Detergent Making Training Activity" was held in July 2025 at the Amalia reading house, Ceger Scavenger Village, South Tangerang. The tools used to make eco-enzyme-based environmentally friendly liquid detergents are hand blenders, buckets, spatulas, stainless steel pans, stoves, measuring cups, scales, small 250 ml plastic bottles and others. While the materials used are 500 grams of methyl ester sulfonate (MES), 100 grams of sodium hydroxide (NaOH), 100 grams of glycerin, 100 grams of foam booster, 5 L of clean water, fragrance and 600 mL of eco enzyme.

Data Sources

The data sources for this activity consist of: 1) Primary data, obtained through field observations, brief interviews with the community, and direct participation in training on eco-enzyme production and liquid detergent formulation, and

2) Secondary data, derived from literature on eco-enzymes, previous research on environmentally friendly cleaning products, and community demographic data obtained from the local sub-district office.

Activity Stages

1) Identification of community needs through focus group discussions (FGDs) to explore residents' initial knowledge, problems, and expectations regarding the program.
2) Socialization and education regarding the impact of chemical detergents on the environment and the potential of eco-enzymes as an environmentally friendly alternative.
3) Participatory training on eco-enzyme production and liquid detergent formulation, where the community is directly involved in the mixing, fermentation, simple product quality testing, and packaging processes.
4) Mentoring for small-scale liquid detergent production to ensure skills can be replicated independently.
5) Participatory evaluation through interviews and questionnaires to assess improvements in community knowledge, skills, and interest in product development.

Data Analysis

In community service activities, particularly those using a participatory approach, data analysis focuses not only on quantitative results but also prioritizes contextual understanding and community voice. Participatory analysis involves the community not only as objects but also as active subjects in interpreting data, identifying problems, and formulating solutions (Chambers, 1994). Data from the activities is analyzed descriptively and qualitatively by comparing conditions before and after the activity. This analysis aims to assess increased community capacity, the potential for sustainable production, and the initial socio-economic impacts of the program. Therefore, participatory data analysis is crucial not only for presenting PKM results academically but also for ensuring the program's sustainability and relevance to community needs.

3. RESULTS AND DISCUSSION

Based on fermentation theory, organic waste fermented with sugar/melasse and water produces a mixture of active microbes and enzymes. The composition of the eco-enzyme (ratio of organic matter: sugar: water) influences enzyme activity and effectiveness as a cleaning or disinfectant agent. Studies of eco-enzyme characteristics show that variations in sugar type (e.g., coconut sugar vs. palm sugar) and fermentation time affect enzyme/protease/amylase content as well as pH and biological activity(Abdullah et al., 2023). One alternative that can be used as an active ingredient in the manufacture of environmentally friendly liquid detergents is eco-enzymes. Eco-enzymes have the ability to break down organic materials into simpler compounds, thus making the cleaning process more effective and efficient. Furthermore, eco-enzymes can also reduce the use of synthetic and toxic chemicals in liquid detergents, making these products safer for the environment and human health. Using eco-enzymes as an active ingredient in environmentally friendly liquid detergents can be an effective and efficient solution for maintaining environmental balance.

In this activity, the process of making environmentally friendly liquid detergent uses natural raw materials, namely Methyl Ester Sulfonate (MES). MES (Methyl Ester Sulfonate) is an alternative surfactant made from coconut oil, palm oil, soybean oil, tallow fat, and palm kernel oil. MES has several advantages compared to Linear Alkylbenzenyl Sulfonate (LAS). LAS is an anionic surfactant that is widely used in detergents but is toxic to aquatic organisms, while MES is more environmentally friendly because it is renewable, biodegradable, and the performance of the resulting cleaning product is better when compared to LAS(Istanti & Utami, 2022). MES also has maximum cleaning power because it can penetrate the pores of textiles and can work actively in hard water, does not cause skin irritation, is non-toxic, does not produce dangerous by-products and produces detergent waste that is environmentally friendly and easily decomposed.(Sutrisnawati et al., 2022). Using MES in the manufacture of liquid detergent is a good step because it reduces environmental pollution of water and living things. Furthermore, MES is readily available and affordable. The manufacturing process for this eco-friendly detergent includes the addition of an eco-enzyme solution, which is highly effective in removing stubborn stains during the washing process.

The initial phase of the activity, which involved outreach and education, successfully raised public awareness about the dangers of chemical detergents to the environment. Prior to the activity, most residents were only familiar with commercial detergents, unaware of their impact on water quality and health. The education materials emphasized that the Linear Alkylbenzene Sulfonate (LAS) and phosphate content in chemical detergents are difficult to decompose in nature and can degrade aquatic ecosystems (Gaspersz et al., 2023). Group discussions revealed increased public awareness, marked by a commitment to trying more environmentally friendly alternative products. In the participatory

training phase, the community was directly involved in the practical process of producing eco-enzymes and formulating liquid detergent. The training phases included:

1) Making eco-enzymes
   The ingredients used to make eco-enzymes include household organic waste, pineapple and orange peels, brown sugar or molasses, and clean water. In the first process, the ingredients are mixed in a 3:1:10 ratio (organic waste: sugar: water), then fermented in a closed container for 3 months. The resulting fermentation product is a brown liquid with a distinctive fermented aroma.

Figure 2. Socialization regarding household waste management
Source: PkM Team Documentation, 2025

Figure 2 explains the implementation of socialization of household waste management, in the form of organic waste and inorganic waste. It is necessary to convey to residents that household waste is solid waste generated from daily activities in the household, consisting of organic waste (food scraps, vegetables, fruit) and inorganic waste (plastic, metal, glass, paper). Based on Law No. 18 of 2008 concerning Waste Management, waste management must be carried out systematically, comprehensively, and sustainably, including waste reduction and handling. In modern waste management refers to the 3R concept (Reduce, Reuse, Recycle) (Reduce, Reuse, Recycle) (Rizky Maharja et al., 2022). 3R-based waste management is one of the alternative waste management methods available in Indonesia. However, this concept is still not widely understood by all levels of society, particularly in rural areas. Therefore, it is necessary to introduce 3R-based waste management to rural communities so that they can reduce waste production, sort waste at home, and recycle it, which can ultimately help reduce the amount of waste going to landfills.

Organic waste from food and beverage processing can be processed into useful products, including compost and eco-enzymes. The only organic waste processed into eco-enzymes is raw vegetable or fruit waste. The stages in making eco-enzymes include: preparation, fermentation, and evaluation. Preparation Process: The first step in making eco-enzymes is preparing the necessary materials and tools. The initial step in preparing the materials is sorting organic waste in the form of peels and raw fruits. Fruits and vegetables are chopped/cut into small pieces. Fermentation, which produces alcohol and acetic acid, which are disinfectants, can only be applied to plant products due to their carbohydrate (sugar) content.

The first step is to collect kitchen waste such as fruit peels or raw vegetable scraps. Ensure the ingredients are clean and free from other ingredients such as oil, salt, or leftover cooked food. Once collected, chop them into small pieces. Smaller pieces will speed up the fermentation process and ensure optimal results. Tip: Choose fresh, organic ingredients such as orange peels, apple peels, or carrot pieces, as these produce a fresher eco-enzyme aroma and their nutritional content aids the fermentation process.

Figure 3. Fruit and vegetable peels for Eco Enzyme ingredients

The process of rotting and fermenting meat is different from that of plants. Meat will quickly rot and produce pathogens at unregulated temperatures. The next ingredients that need to be prepared are brown sugar/palm sugar/molasses, and water. The tools needed are plastic bottles/buckets/airtight barrels that expand easily. Avoid using glass containers because the fermentation process produces a lot of gas. Fermentation Process: Once the necessary materials and equipment are ready, the next step is fermentation. After 3 months, filter the eco-enzyme using gauze or a sieve. The residue can be reused for a new batch of production by adding fresh waste. The residue/dregs can be dried, blended, and buried in the ground as fertilizer. The remaining EE dregs can be used for several purposes, such as: as a starter (ease) or to help speed up the subsequent EE production process. The following are the activities for making eco-enzymes:

Figure 4. Eco-enzyme Manufacturing Process
Source: PkM Team Documentation, 2025

2) Eco-enzyme based liquid detergent formulation
The activity began with a test to assess participants' initial knowledge of the benefits of eco-enzymes, the raw materials used to make environmentally friendly liquid detergents, the functions of each ingredient, and the benefits of liquid detergents containing eco-enzymes. This was followed by a presentation on the application of eco-enzymes and the liquid detergent manufacturing process. This presentation aimed to provide participants with insight into the application of eco-enzymes in various fields, such as health, the environment, and as an active ingredient in household cleaning products. The materials were also explained, explaining the function of the ingredients and the procedure for making liquid detergents containing eco-enzymes.

The liquid detergent-making practice was conducted directly by PKK women, accompanied by students who were tasked with providing direction and explanations regarding the technical aspects of liquid detergent production. Throughout the practice, participants enthusiastically asked questions to gain further understanding of the manufacturing process and the functions of the ingredients used.In addition to the eco-enzyme liquid, this liquid detergent is made using additional ingredients such as liquid soap base (biodegradable), table salt (thickener), and natural fragrance (optional). The manufacturing process is as follows: the eco-enzyme is added to the soap base,

stirred until homogeneous, and then tested for foam and cleaning power on light laundry. The result: a liquid detergent with adequate cleaning power, stable foam, and is safer for the skin and the environment.

Figure 5. Liquid detergent manufacturing process
Source: PkM Team Documentation, 2025

3) Product Packaging
The public is taught simple packaging techniques using clean, used plastic bottles, labeled with the product name, and including information on ingredients and instructions for use. The following is a picture of liquid detergent that has been packaged.

Figure 6. Result of packaged liquid detergent
Source: PkM Team Documentation, 2025

These findings align with research by Monica et al. (2022), which states that eco-enzymes can be active cleaning ingredients and possess antibacterial properties, making their application in household products highly feasible(Yatma et al., 2024). Residents of Kampung Pemulung (Scavenger Village) successfully understood and put into practice the process of processing organic household waste (fruit and vegetable scraps) into eco-enzymes through a fermentation process. This finding demonstrates that organic waste, previously considered worthless, can be utilized as a basic ingredient in household cleaning products. Participatory training demonstrated the community's ability to follow the stages of formulating eco-enzyme-based liquid detergent. These skills provide the initial foundation for independent production. The residents' high enthusiasm for trying and repeating the production steps demonstrates the success of the participatory approach. After counseling and discussions,

residents understood that chemical detergents can pollute water and ecosystems. This finding is important because environmental awareness is a key factor in the sustainable use of eco-enzymes as an alternative product. Following the eco-enzyme and liquid detergent production activities, many questions were received, indicating a motivation to make eco-enzyme liquid detergent a small business product. Residents believe this product has a selling value because it is environmentally friendly and can be marketed around residential areas.

2. CONCLUSION

Community service activities carried out in Kampung Pemulung, South Tangerang, have successfully increased the knowledge, skills, and awareness of residents regarding the use of household organic waste as raw material for eco-enzymes. Through a participatory approach, the community not only understands the negative impacts of synthetic chemical detergents on the environment, but is also able to practice the stages of producing eco-enzyme-based liquid detergents, from fermentation, formulation, to packaging. The utilization of household organic waste has been proven to produce eco-enzymes which are then formulated into household cleaning products (eco-friendly liquid detergents). This not only helps reduce organic waste accumulation, but also provides added economic value and alternative solutions for household products that are safer for the environment.

The results of the activity show that public knowledge about the concept of environmentally friendly products has increased significantly; residents are able to master the basic skills of making eco-enzymes and processing them into safe liquid detergents; and this program fosters motivation to develop small businesses based on environmentally friendly products, thus potentially supporting local economic empowerment. Thus, this pkm activity provides dual benefits, namely reducing environmental problems caused by organic waste and chemical detergents, while also opening new economic opportunities for the community through the development of eco-enzyme-based cleaning products.

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