



EMPOWERING AN ECO-CONSCIOUS GENERATION: EXCITING INTRODUCTION TO ECOENZYME-BASED HALAL DETERGENTS

Linda Lisdiana¹, Neneng Windayani^{2*}, Ai Mae³, Riduan Zain⁴

^{1,2}UIN Sunan Gunung Djati Bandung

³SMPN 1 Tanjungsari Sumedang

⁴UIN Sunan Kalijaga

email : lindalisdiana11@gmail.com¹⁾
nenengwinda.ftk@uinsgd.ac.id²⁾
aimae12@guru.smp.belajar.id³⁾
rinduan.zain@uin-suka.ac.id⁴⁾

* Corresponding Author

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Abstrak

Pengabdian ini bertujuan memperkenalkan praktik berkelanjutan kepada generasi muda melalui proyek Pembelajaran di SMPN 1 Tanjungsari. Metode yang digunakan Service Learning meliputi kegiatan pembelajaran, lokakarya, praktik fermentasi limbah, produksi deterjen ekoenzim, serta edukasi dan refleksi komunitas untuk meningkatkan pembelajaran holistik dan kesadaran lingkungan siswa. Proyek ini melibatkan 30 siswa klub sains yang diajarkan cara membuat deterjen halal berbahan dasar ekoenzim dari limbah organik. Ekoenzim, hasil fermentasi limbah organik, merupakan alternatif ramah lingkungan pengganti deterjen kimia yang merusak ekosistem dan kesehatan manusia. Melalui rangkaian ceramah, lokakarya, dan kegiatan praktik, siswa mempelajari proses fermentasi, formulasi produk, dan pentingnya sertifikasi halal. Hasil proyek menunjukkan peningkatan signifikan dalam kesadaran lingkungan dan keterampilan praktis siswa, formulasi deterjen yang efektif dan dapat terurai secara hayati, serta dampak positif terhadap masyarakat melalui kampanye kesadaran dan pengurangan limbah organik. Proyek ini menekankan pentingnya pendidikan lingkungan yang praktis dan relevan secara budaya untuk membentuk kebiasaan berkelanjutan pada generasi muda.

Kata kunci: *Pengabdian Masyarakat; Ekoenzim; Produk Ramah Lingkungan; Pendidikan Lingkungan; Deterjen Halal; Fermentasi Sampah Organik.*

Abstract

This community service aims to introduce the younger generation to sustainable practices through a Learning project at SMPN 1 Tanjungsari. The methods used by Service Learning include learning, workshops, waste fermentation practices, eco-enzyme detergent production, as well as community education and reflection to improve students' holistic learning and environmental awareness. The project involved 30 science club students who were taught to make ecoenzyme-based halal detergents from organic waste. Ecoenzyme, the fermentation of organic waste, is an eco-friendly alternative to chemical detergents that damage ecosystems and human health. Through a series of lectures, workshops, and practical activities, students learned about the fermentation process, product formulation, and the importance of halal certification. The project results showed significant improvements in students' environmental awareness and practical skills, effective and biodegradable detergent formulations, and positive impacts on the community through awareness campaigns and organic waste reduction. The project emphasized the importance of practical and culturally relevant environmental education to form sustainable habits among the younger generation.

Keywords: Community Engagement; Ecoenzyme; Environmentally Friendly Products; Environmental Education; Halal Detergents; Organic Waste Fermentation.

INTRODUCTION

The escalating environmental challenges of the 21st century, characterized by pollution and resource depletion, necessitate innovative and sustainable solutions (Arora et al., 2018). One significant contributor to environmental degradation is the widespread use of conventional detergents, which often contain harmful chemicals that adversely affect aquatic ecosystems and human health (Hakeem et al., 2020). This detergent not only damages aquatic ecosystems but also has the potential to threaten human health. This shows the need for innovative and environmentally friendly solutions and following people's cultural values, especially in Muslim communities that need products with halal certification (Arora et al., 2018; Hashim & Sulaiman, 2022). However, there is still a gap in environmental education in schools, where learning tends to be theoretical without providing practical skills that are relevant to real issues (Goldman et al., 2023). In response, there is a growing imperative to explore and adopt eco-friendly alternatives that align with environmental sustainability and public health principles (Abatan et al., 2024).

SMPN 1 Tanjungsari has embarked on a pioneering Service Learning project to initiative address the critical need to educate and engage young minds in sustainable practices while providing practical solutions to everyday environmental issues (Gani et al., 2023). Despite increasing awareness about environmental issues, practical ecological education remains a significant gap within the school curriculum. Traditional educational methods often fail to connect theoretical knowledge with real-world applications, leading to a disconnect between students' understanding and their daily practices (Goldman et al., 2023). Furthermore, there is a lack of integration of Islamic principles in environmental sustainability, particularly in the context of halal products, which are essential in predominantly Muslim communities (Hashim & Sulaiman, 2022).

This project introduces a novel approach by integrating eco-enzyme technology into the production of halal detergents, a concept that is both innovative and relevant to the student's cultural context (Kamaluddin et al., 2023). A study by Mohamad et al., 2018 highlights the importance of friendly detergents that use natural materials and are biodegradable to reduce water pollution (Astuti et al., 2021). This research shows that the use of materials such as eco-enzymes can be an effective and friendly alternative environment in the detergent industry (Sari et al., 2021). Additionally, research by (Azme et al., 2023) emphasizes the importance of halal literacy among consumers, especially in understanding critical points of raw materials used in daily products such as detergent (Mahardika et al., 2022). This study found that the level High halal literacy is closely related to



increased consumer awareness and preferences towards safe and halal products quality. Furthermore, research on enzymes in the manufacture of detergents produced from land in Türkiye, research results show. The enzymes produced show that there were 10 isolates producing amylase, 9 isolates producing lipase, 7 isolates producing cellulase, and 6 isolates producing protease which provides benefits for making detergents (Bektas et al., 2023). Research by (Kamaluddin et al., 2023) studied consumer attitudes and perceptions of Muslims against household cleaning products halal. The research results show that

Consumers are increasingly selective in choosing products that are not only effective but also fulfilling halal standards. Halal literacy is considered important in educating consumers about its importance ensure that the products they use are free from prohibited ingredients or doubtful (doubtful of halalness) (Meylinda & Matondang, 2023). Ecoenzymes, derived from fermented organic waste, offer a sustainable alternative to chemical-based detergents (Ihtiar *et al.*, 2023). By involving students in the hands-on process of creating these eco-friendly detergents, the project bridges the gap between theoretical knowledge and practical application, fostering a deeper understanding and commitment to environmental stewardship (UNESCO, 2020).

The urgency of this initiative is underscored by the pressing need to reduce the environmental footprint of household products and to instill eco-conscious habits in the younger generation. As future custodians of the environment, students must develop an early appreciation and understanding of sustainable practices (Shayan et al., 2022). Moreover, the integration of halal principles ensures that the project is culturally resonant and widely acceptable within the community, promoting broader adoption of eco-friendly products (Meylinda & Matondang, 2023).

The novelty of this research lies in the development of a Service Learning approach that connects theoretical learning and real practice, by actively involving students in the fermentation, formulation, and product testing processes (Salam et al., 2019). This approach also emphasizes the importance of collaboration between schools, communities, and experts to create innovative solutions that can be implemented in everyday life. The theory of experience-based learning (experiential learning) is the main basis for this project, where students are invited to learn through direct involvement in meaningful activities, so they can connect academic concepts with practical applications (Pribadi & Hidayah, 2023).

This Service Learning project aims to achieve two goals: reducing chemical pollutants to produce real environmental benefits and fostering an environmentally responsible society. This initiative empowers students with practical knowledge and skills to create sustainable solutions, bridging theoretical understanding with actionable results. The results are expected to show that by involving students in hands-on activities such as environmentally friendly

detergent production, they not only develop deeper environmental awareness but also produce effective, biodegradable detergents, which directly address ecological challenges (Suwandana et al., 2022).

MATERIALS AND METHODS

The Service Learning project "Empowering an Eco-Conscious Generation: Exciting Introduction to Coenzyme-Based Halal Detergents" was implemented at SMPN 1 Tanjungsari, involving 30 students from the Science Club, supervised by one teacher mentor. The participants were selected based on their active involvement in the club and interest in environmental sustainability (Mwaura & Desouza, 2020).

Phase 1: Preparation and Academic Learning

The project began with a series of lectures and workshops designed to provide students with a theoretical understanding of coenzymes, their benefits, and the environmental impact of conventional detergents. These sessions covered topics such as enzyme chemistry, fermentation processes, and the principles of halal certification. Environmental scientists and halal certification experts were invited to speak with students, providing real-world insights and answering questions. Formation of Working Groups, The 30 students were divided into six groups of five, each tasked with specific roles such as research, materials collection, fermentation, production, testing, and outreach.

Phase 2: Collection and Fermentation of Materials

Students collaborated with local markets and households to collect organic waste materials, primarily fruit and vegetable scraps. This not only provided raw materials for the coenzymes but also raised community awareness about waste reduction. Under the guidance of the teacher mentor, students learned and applied the fermentation process. They prepared the organic waste by chopping it into small pieces and mixing it with water and brown sugar in airtight containers. The ratio used was 3 parts organic waste, 1 part brown sugar, and 10 parts water by volume. Over three months, students monitored the fermentation process, recording observations such as pH changes, smell, and visual signs of mold or fermentation. Regular stirring was performed to ensure aeration and prevent spoilage. Any mold growth was addressed by removing affected parts and adjusting the sugar concentration to stabilize fermentation. Mold growth and foul odors were observed during fermentation. Variations in raw materials and fermentation conditions affected detergent quality. And then balancing academic schedules with project activities was difficult for some students.

Phase 3: Production and Testing of Halal Detergents

The groups formulated coenzyme-based detergents by combining the coenzyme solution with natural surfactants and other biodegradable ingredients. Detergents were tested for cleaning power using standardized methods. Detergent



quality testing with reference in SNI 06-4075-1996, but the tests in this study were limited to pH parameter tests, clean power tests, and organoleptic tests including color, aroma, impression after use, and itchy reaction. Measurements are carried out using a pH meter device. Clean power testing is carried out by spreading the chili sauce, soy sauce, and oil stains on a white cloth and letting it sit until dry then washed using the detergent made. Organoleptic testing is carried out with the main focus of observing physical properties including color, change in shape, smell, viscosity, impression after use, and reactions (Nurrosyidah et al., 2023). Then pre-test and post-test surveys were conducted to evaluate students' knowledge and skills before and after the project. The surveys included Likert-scale questions and open-ended responses. Statistical analysis was performed using paired t-tests to compare pre-and post-assessment scores, with a significance level of $p < 0.05$. Descriptive statistics were used to summarize other observations.

Phase 4: Community Outreach and Education

Students organized demonstrations and workshops within the school to showcase their eco-enzyme-based detergents. They educated their peers, teachers, and community members about the benefits of using eco-friendly and halal products. The groups created brochures, posters, and digital content to spread awareness about their project and encourage others to adopt sustainable practices. Students maintained reflective journals documenting their learning experiences, challenges faced, and personal growth. Regular group discussions facilitated by the teacher mentor allowed students to share insights and feedback. Each group presented their findings and experiences to a panel of teachers and community leaders, highlighting the project's impact and future potential.

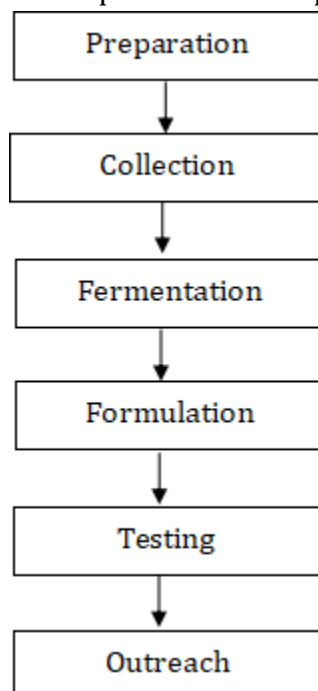


Figure 1. Research Flow

This method, structured around the Service Learning framework, ensured that students were actively engaged in both academic learning and practical application. By integrating theoretical knowledge with hands-on activities and community service, the project successfully fostered an eco-conscious mindset among students, empowering them to contribute to environmental sustainability in meaningful ways. The sequence of research procedures can be seen in Figure 1.

RESULTS AND DISCUSSION

The implementation of the Service Learning project "Empowering an Eco-Conscious Generation: Exciting Introduction to Ecoenzyme-Based Halal Detergents" yielded significant results in multiple dimensions, including educational outcomes, product development, and community impact. Increased Environmental Awareness, first, Pre- and Post-Assessment: A pre- and post-assessment survey demonstrated a marked increase in students' knowledge about environmental issues, particularly regarding the negative impacts of conventional detergents and the benefits of eco-friendly alternatives. Before the project, only 30% of students had a basic understanding of these topics. Afterward, 90% of students could articulate the environmental and health benefits of ecoenzyme-based detergents. The results of evaluating student knowledge before and after the project can be seen in Table 1.

Table 1. The Results of Evaluating Student Knowledge Before and After The Project

| No. | Paired Samples (Pre-Post) | Mean | Std. Deviation | Std. Error Mean | t | df | Sig. (2- tailed) |
|-----|---|-------|-------------------|-----------------------|-------|----|------------------------|
| 1 | Impact of Chemical Detergents | 60.00 | 34.64 | 20.00 | 17.00 | 2 | 0.0034 |
| 2 | Benefits of Environmentally Friendly Products | 50.00 | 35.36 | 20.41 | 17.00 | 2 | 0.0034 |
| 3 | Organic Waste Fermentation Process | 60.00 | 42.43 | 24.50 | 17.00 | 2 | 0.0034 |

This table shows the results of the paired sample t-test between students' understanding before and after the project. Sig value. (2-tailed) = 0.0034 indicates that there was a statistically significant increase in students' understanding after the project was carried out ($p < 0.05$) (Sugiyono, 2016).

Two, Enhanced Practical Skills, and Laboratory Skills: Students gained hands-on experience in scientific methods, including fermentation processes, chemical testing, and product formulation. They reported a better understanding of how theoretical concepts apply in real-world scenarios.



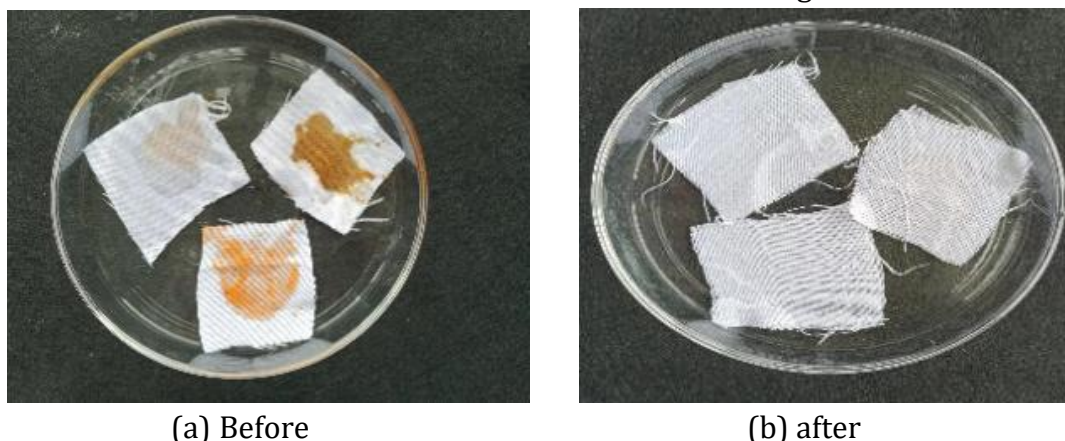


Picture 2. Detergent Manufacturing Process

Working in groups enhanced students' teamwork and problem-solving abilities (Ramaila & Molwele, 2022). They navigated challenges such as managing fermentation conditions and optimizing detergent formulations collaboratively, which improved their critical thinking and cooperative skills. 3) Cultural and Ethical Understanding (halal compliance): The integration of halal principles into the project provided students with a deeper appreciation of how cultural and ethical considerations intersect with scientific and environmental efforts. Students learned the importance of creating products that are not only effective and sustainable but also culturally appropriate and ethically sound.

Product Development

Successful formulation of ecoenzyme-based detergents, the student groups successfully formulated ecoenzyme-based detergents that demonstrated comparable cleaning power to commercial products. The detergents were tested on various stains and surfaces, showing effective cleaning performance without the harmful effects associated with conventional chemical detergents.



(a) Before

(b) after

Picture 3. Clean Power Test

The cleaning power test was carried out on cotton fabric stains using soy sauce, chili sauce and vegetable oil stains. The results show that Eco Enzyme detergent is able to remove stains with good ability. all stains can be removed on

the fabric. Thus, ecoenzyme detergent has the same cleaning power as the conventional detergent (Pribadi & Hidayah, 2023).

Tests conducted on the biodegradability of the ecoenzyme detergents indicated that they broke down more rapidly and completely in natural environments compared to traditional detergents, thus reducing potential ecological harm. Halal Certification, Compliance Verification: The project included consultations with halal certification bodies to ensure that the produced detergents met all necessary halal criteria. The successful alignment with halal standards provided a valuable learning experience and ensured the products' acceptability within the community.

Community Impact

The demonstrations and workshops conducted by students reached over 500 individuals within the school and local community. Surveys indicated a high level of interest and positive reception toward ecoenzyme-based detergents, with most participants expressing willingness to switch to these environmentally friendly alternatives. These findings are consistent with (Celaya et al., 2021) which highlights the importance of participatory approaches in raising public awareness of sustainable solutions. However, ensuring long-term adoption remains a challenge requiring continued efforts. The brochures, posters, and digital content created by students were widely distributed, amplifying the project's reach and impact. Feedback from the community confirmed the effectiveness of these materials in raising public awareness and education. Research by (Suryani, 2024) supports that well-designed educational materials can enhance environmental literacy and encourage behavioral change at the community level.

The project facilitated a significant reduction in organic waste within the school and surrounding households. By collecting and utilizing organic waste for ecoenzyme production, students demonstrated the relevance of waste-to-resource principles. Previous research, such as (Yeboah et al., 2023), shows that this approach can be applied across various contexts to support sustainable waste management. The project not only achieved its educational objectives but also made a tangible impact on the community by promoting eco-friendly and culturally appropriate cleaning solutions. Long-term impacts can be realized through the sustainability of the introduced practices, such as organic waste utilization and the use of environmentally friendly products. Ellery & Ellery (2019) suggest that community-based service-learning projects like this have the potential to create lasting behavioral changes when supported by follow-up initiatives, such as continuous training and local policy support (Ellery & Ellery, 2019).

Key Findings and Implications

The project successfully integrated chemistry, environmental science, and ethical studies, offering a holistic learning experience (UNESCO, 2020). Students were able to observe the direct application of their classroom knowledge in real-



world scenarios, which significantly enhanced their understanding and retention of academic concepts. The integration of diverse subjects also enriched students' critical thinking and problem-solving skills. The project fostered active participation, which helped develop a sense of ownership and responsibility among the students. Engaging in hands-on activities and witnessing the tangible outcomes of their efforts strengthened their commitment to environmental stewardship and sustainable practices. This active involvement nurtured leadership and collaboration skills, which will be valuable to students in their future endeavors

The successful creation of coenzyme-based detergents underscored the potential of innovative, sustainable solutions to address pressing environmental challenges. This project demonstrated how simple biotechnological processes and locally sourced materials can be harnessed to produce effective, eco-friendly products. The integration of green chemistry in the production process also highlighted the feasibility of adopting sustainable practices in daily life (Factor, 2024). By ensuring the detergents adhered to halal principles, the project addressed cultural sensitivities, making the products more acceptable to the community. This element was crucial in promoting broader community adoption, emphasizing the importance of considering cultural and ethical dimensions when developing sustainable products (Nugroho, 2024). This approach also fostered inclusivity, ensuring that environmental sustainability was accessible to diverse groups.

Increased awareness and adoption the outreach efforts significantly raised awareness about environmental issues and the advantages of coenzyme detergents. The positive reception and willingness of community members to adopt these products suggest that the project successfully transferred both knowledge and sustainable practices to the community. This not only benefitted the local environment but also contributed to long-term shifts in consumer behavior toward more sustainable products. Sustainable waste management by converting organic waste into coenzymes, the project promoted sustainable waste management practices (Suryani, 2024). This innovative approach reduced waste and demonstrated how waste can be transformed into a valuable resource, encouraging community members to rethink their waste disposal habits and consider circular economy principles in their daily lives.

Challenges and Lessons Learned

Fermentation process, one of the major challenges faced during the project was the inconsistency in the fermentation process. Problems such as mold growth, foul odors, and variations in fermentation conditions sometimes delay the timeline and affect the quality of the coenzyme. These inconsistencies stemmed from factors like the quality of raw materials, fermentation temperature, and lack of precise monitoring tools. Future projects could benefit from more detailed training

on fermentation techniques, especially regarding maintaining optimal conditions. Additionally, using standardized protocols and improving the monitoring process could help ensure greater consistency in the final product (Yeboah et al., 2023). Achieving consistency in the final detergent formulations was another challenge. Variations in the raw materials and fermentation conditions often led to differences in the effectiveness and quality of the detergents. To overcome this, future projects should implement more stringent quality control measures, including detailed guidelines for raw material selection, consistent fermentation processes, and regular product testing (Rebello et al., 2019). The development of a standard operating procedure (SOP) for product formulation could also minimize variations and enhance the reliability of the results (Nurrosyidah et al., 2023).

Balancing academics and project work, some students faced difficulties in balancing academic responsibilities with project activities, as both required significant time and effort (Gbadamosi, 2014). To ensure the project did not interfere with academic performance, careful planning, and time management were essential. The flexibility in scheduling, as well as periodic progress reviews, helped mitigate this challenge and ensured the project ran smoothly. Future projects could introduce additional time management workshops or more structured timelines to support students in balancing academic and extracurricular responsibilities. Community participation, although initial community engagement was positive, maintaining long-term participation was a challenge. As the project progressed, it became more difficult to sustain the momentum of community involvement. This issue could be addressed by incorporating follow-up activities, such as periodic workshops or community feedback sessions, to keep the community engaged. Moreover, involving community members in the planning and execution phases from the outset could strengthen their investment in the project's long-term success (Deep, 2023).

Recommendations for Future Projects

Scalability and replication, to facilitate replication in other schools or communities, a detailed project template should be developed. This template should include step-by-step guidelines, best practices, and common challenges, along with potential solutions. By providing a clear structure, future projects can replicate the success of this initiative more easily, especially in settings with limited resources (Union, 2023). Forming partnerships with local businesses, environmental organizations, and halal certification bodies can provide additional resources and expertise, enhancing the project's scalability. Collaborative efforts would also lend credibility to the project and ensure its long-term sustainability. However, potential barriers in different contexts, such as varying levels of community engagement, regulatory differences, or resource availability, must be critically evaluated when planning to scale up. Identifying such barriers in advance



can help prepare for challenges and ensure smoother implementation across diverse settings.

Enhanced Training and Support, offering more comprehensive training at the beginning of the project on both fermentation techniques and product formulation will address many of the technical challenges encountered. Hands-on workshops led by experts, coupled with real-time troubleshooting sessions, will improve students' skills and confidence. Additionally, the inclusion of specific training on managing common fermentation issues can reduce inconsistencies (Saragih et al., 2023). Establishing mentorship programs with professionals in environmental science and biotechnology could provide continued support, helping students overcome obstacles and refine their skills. Mentors can offer valuable insights, help troubleshoot problems, and encourage students to stay focused on the project's goals (Treanor et al., 2021).

Sustained Community Engagement, to sustain community interest, follow-up initiatives such as regular workshops, check-ins, or the creation of local coenzyme production hubs can be implemented. These activities will foster a sense of ownership and continuity, encouraging community members to stay engaged with the project in the long run. Conducting regular impact assessments to measure both the environmental and social outcomes of the project will help refine future projects and demonstrate their effectiveness. Such assessments can provide valuable feedback for improvement and showcase the project's impact, encouraging continued community participation (Okatta et al., 2024).

CONCLUSIONS AND SUGGESTIONS

The Service Learning Project succeeded in achieving all the stated objectives. This project significantly increased students' environmental awareness, as evidenced by their increased understanding of the negative impact of chemical detergents on the environment as well as the importance of environmentally friendly alternatives. In addition, students can develop practical skills in organic waste fermentation to produce eco enzymes, formulation, and testing of coenzyme-based halal detergents, which reflects the application of scientific concepts in real life. The resulting product is proven to be effective, biodegradable, and meets halal standards, so it is culturally and socially accepted by the community. Outreach activities through demonstrations and education also increase public awareness of the importance of using environmentally friendly and halal products. Concerning the Sustainable Development Goals (SDGs), this project contributes to SDG 4 (Quality Education) through a project-based learning approach that improves students' skills and understanding of sustainability. This project also supports SDG 12 (Responsible Consumption and Production) by reducing organic waste and promoting alternative products that are safer for the

environment. In addition, the long-term impact of reducing pollution from chemical detergents contributes to SDG 13 (Tackling Climate Change).

In order for this project to be replicated and expanded, standard guidelines need to be developed that cover fermentation procedures, detergent formulations, as well as quality testing methods to ensure consistency of results. Collaboration with environmental institutions and halal organizations is also needed to increase the credibility and reach of the project. More in-depth technical training must be provided to participants so that their fermentation and detergent formulation skills improve. In addition, community involvement needs to be strengthened through ongoing workshops and the formation of environmental care groups. Integration of this project into the school curriculum through a Project Based Learning (PBL) approach will also increase its impact. Further research is needed to evaluate the long-term impact of ecoenzyme detergents on local ecosystems and develop innovative products based on halal and environmentally friendly principles.

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