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Empowering Mengwitani Village Community through processing used cooking oil into eco-friendly solid soap

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ABSTRACT

Used cooking oil, commonly produced from household cooking activities, poses serious risks to health and the environment if used repeatedly or disposed of carelessly. Repeated heating causes the formation of harmful compounds such as free fatty acids, aldehydes, and acrolein, while disposal into waterways can cause significant pollution. This community service program aims to enhance the knowledge and skills of housewives in Banjar Adat Taman Sari, Mengwitani Village, in processing used cooking oil into useful products, particularly solid soap. The activity conducted on July 24, 2025, employs a participatory learning-by-doing approach through interactive presentations and hands-on practice. Participants were introduced to the hazards of used cooking oil, purification techniques using activated carbon, and soap-making methods. Out of 37 participants, 4–6 was directly involved in the practical session, while the others followed via a live stream. The soap produced met the standards for cold-process soap in terms of color, scent, and texture. The program successfully raised environmental awareness, empowered women with practical skills, and opened up opportunities for household-scale businesses based on environmentally friendly practices.

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1. INTRODUCTION

Cooking oil is one of the essential commodities that is almost always used in daily household cooking activities, especially by housewives. The high intensity of cooking oil usage gradually generates waste in the form of used cooking oil, commonly known as used cooking oil or *minyak jelantah* (used cooking oil) (Murwaningsih, 2021). Cooking oil, which generally originates from plant-based sources, has a limited lifespan. After being used several times, its quality deteriorates and it turns into used cooking

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oil that is no longer suitable for consumption (Jawwad et al., 2022). In practice, used cooking oil is often discarded directly into the environment without any treatment or further processing, as it is considered to have no economic value (Agustine et al., 2023). Unfortunately, most people still lack awareness of the environmental impacts of improper disposal of used cooking oil. Common practices such as pouring used oil into drainage systems or onto soil can cause blockages, contaminate groundwater, and generate unpleasant odors.

From a socio-economic perspective, this habit also indicates that the community has not yet recognized the potential added value of household waste. In fact, used cooking oil can be processed into economically valuable products such as soap, biodiesel, and household candles, which can serve as an additional source of income for housewives (Zayed et al., 2024). Several studies have revealed that soap production is one of the most appropriate solutions for processing used cooking oil. Various methods for producing soap from used cooking oil have been developed, ranging from solid to liquid soap products (Azme et al., 2023). This processing not only reduces environmental pollution, but also has the potential to enhance household economic independence through home-based production. At the household scale, cooking oil consumption can reach 5–6 kg per month. Reusing the same cooking oil poses significant health risks, as it can generate harmful substances such as acrolein and malondialdehyde (Soni et al., 2024). In addition, when disposed of improperly, used cooking oil can contaminate the environment, increase Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) levels in water bodies, and cause unpleasant odors (Yuarini et al., 2024).

These conditions were also found in Mengwitani Village, specifically in Banjar Adat Taman Sari. Based on a preliminary survey conducted in Banjar Adat Taman Sari, Mengwitani Village, it was recorded that approximately 80 percent of households use cooking oil at least twice a day for cooking, and more than half of the respondents admitted to disposing of used oil directly into drainage systems without prior processing. As a result, drainage channels around the banjar area are frequently clogged and emit unpleasant odors, especially during the rainy season. This condition indicates that the community lacks both knowledge and skills to manage oil waste in an environmentally friendly and productive manner.

As a solution, a community service activity conducted on 24 July 2025 at Banjar Adat Taman Sari, Mengwitani Village, featured a resource person from the Faculty of Agricultural Technology, Udayana University, who provided counseling on the hazards of used cooking oil and its potential utilization. The activity was followed by a hands-on practice session on producing solid soap from used cooking oil that had been purified using activated charcoal. The solid soap production process involved mixing used cooking oil with coconut oil and olive oil, NaOH, and additional ingredients such as fragrance and coffee powder as a natural colorant.

This activity has novelty value because it integrates laboratory research results into community-based training. The training represents an implementation of the findings of a 2021 Study Program Superior Research Grant (PUPS) entitled "The Effect of Temperature and Stirring Time in the Purification of Used Cooking Oil as Raw Material for Solid Soap," which concluded that the use of activated charcoal at a temperature of 100°C and a stirring time of 80 minutes was able to reduce free fatty acid levels and improve the quality of the resulting oil, thereby affecting overall soap quality, including texture, pH, and foaming ability (Yuarini et al., 2024). Through this integration, participants not only gained practical knowledge, but also applied appropriate technology based on scientific research outcomes to improve soap quality and reduce household waste.

Through this activity, it is expected that housewives will develop greater awareness of the importance of household waste management and be able to process such waste into products that are beneficial for daily needs as well as potential microenterprise opportunities. The objective of this community service activity is to provide knowledge and skills to housewives in Mengwitani Village on processing used cooking oil waste into solid soap, in order to enhance environmental awareness, empower household economies, and encourage the adoption of sustainable lifestyles within the community.

2. METHODS

Locations and Partners

This community service program was conducted at Banjar Adat Taman Sari, Mengwitani Village, Badung Regency, Bali, on 24 July 2025. The activity involved 37 participants, all of whom were housewives. The program was part of the "Udayana Mengabdi" initiative of the Faculty of Agricultural Technology, Udayana University, in collaboration with the Student Creativity Program (KKN) of Udayana University and the University Center of Excellence in Science and Technology (PUI-PT) for Food Sovereignty. The main objective of the activity was to provide education and hands-on skills in managing household waste in the form of used cooking oil (UCO), particularly through purification and solid soap production as environmentally friendly products with economic value.

Prior to implementation, the organizing team coordinated with the Mengwitani Village authorities and the management of Banjar Adat Taman Sari to obtain activity permits and determine the training location and schedule. Participants were informed in advance about the objectives and stages of the activity, and participation was voluntary. During the activity, safety aspects were carefully considered, especially during the use of chemical materials such as NaOH, by providing gloves and simple safety guidelines.

Activity Plan

The implementation of the activity was designed using a participatory approach based on learning by doing, in which participants were actively involved in all stages, from counseling sessions to hands-on practice. This approach refers to the principles of Participatory Learning and Action (PLA), which position the community not merely as objects, but as the main actors in the learning and action process (Darmawan et al., 2020).

Prior to implementation, the team conducted a literature review and a preliminary survey within the community to identify baseline knowledge and practices related to the use and disposal of used cooking oil. The observations indicated that most households still disposed of used oil directly into drainage systems without prior treatment. Therefore, this activity focused on providing a practical solution through training in solid soap production.

Subsequently, the team designed the activity based on research findings from a previous year, namely a PUPS grant research entitled "The Effect of Temperature and Stirring Time in the Purification of Used Cooking Oil as Raw Material for Solid Soap." The study demonstrated that purifying waste cooking oil using activated charcoal at a temperature of 100°C with a stirring time of 80 minutes produced clearer oil with lower free fatty acid content and improved soap quality (Yuarini et al., 2024). The stages of the activity are presented in Figure 1.

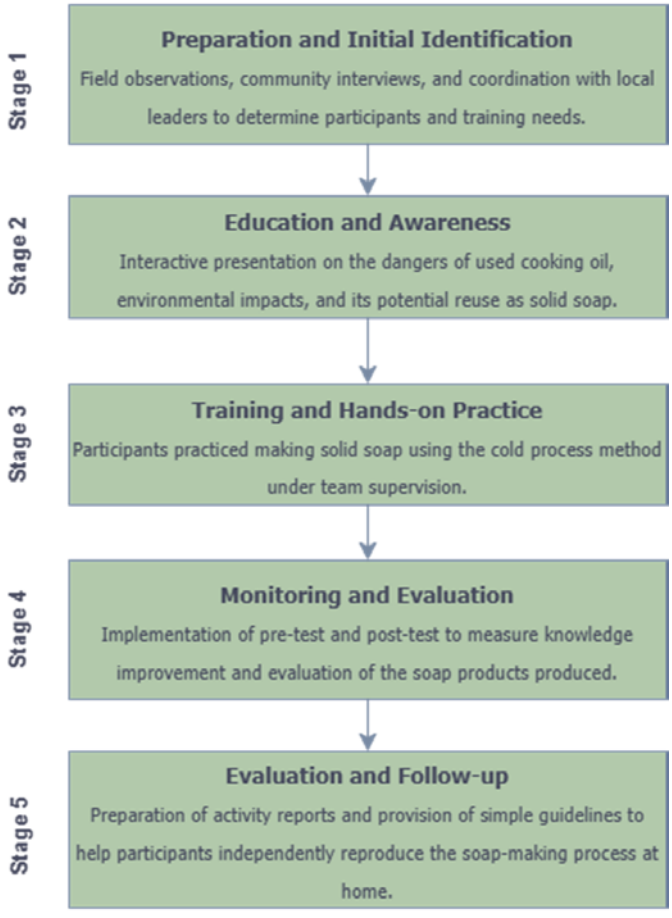

Figure 1. Community service program implementation flowchart

Program Implementation Method

Interactive presentation

The activity began with a presentation delivered by a resource person from the Faculty of Agricultural Technology, Udayana University. The presentation covered basic information on the hazards of repeated cooking oil use, the environmental impacts of oil disposal, and the potential for processing used cooking oil into soap. The resource person also explained the basic theory of the saponification reaction, purification techniques using activated charcoal, and an introduction to the materials used in soap making. The presentation method was supported by visual media in the form of PowerPoint slides, short videos, and examples of processed solid soap products.

To enhance interaction and ensure participants' understanding, a question-and-answer method was applied both during and after the counseling session. This method provided participants with the opportunity to raise questions or discuss difficulties encountered during practice, while also facilitating two-way discussion between participants and the resource person. According to Asafila et al. (2025), interactive presentation methods combined with question-and-answer sessions and visual media such as slides and videos are effective in encouraging active participant engagement.

Practice on making soap

After the delivery of the material, the activity continued with a practical session on solid soap production, although it was not conducted simultaneously by all participants. Due to limitations in time and equipment, the practice session was carried out only by participants who were willing to participate, namely approximately 4 to 6 housewives who voluntarily wished to try making soap from used cooking oil. The participants involved in this practice were guided directly by the organizing team, and all materials had been prepared in advance. The material composition consisted of purified used cooking oil (225 g), coconut oil (125 g), olive oil (75 g), distilled water (150 mL), NaOH (61 g), and coffee powder and fragrance as additives in appropriate amounts. The required equipment included stainless steel basins, measuring cylinders, scales, stirring tools, and soap molds.

The practice participants were required only to follow the formulation instructions according to the specified proportions, mix the ingredients, stir, and mold the soap. This process was directly supervised by the resource person and assisting staff to ensure safety and procedural accuracy. Meanwhile, other participants who did not take part in the practice were still able to observe the entire process through a live display on a monitor or by viewing directly from the front area of the room. This approach ensured that all participants gained learning experience even if they did not engage in hands-on practice.

Monitoring and Evaluation

Program monitoring and evaluation were conducted through pre-test and post-test using a simple questionnaire. The pre-test was administered before the counseling session to measure participants' baseline knowledge, while the post-test was conducted after the activity to assess improvements in understanding. The questions covered four main aspects, namely the hazards of repeated use of used cooking oil, the environmental impacts of used oil disposal, simple methods for oil purification using activated charcoal, and the steps involved in solid soap production.

Success factors were measured based on several quantitative and qualitative indicators. Improvements in participants' understanding were expected to be reflected in higher post-test scores compared to pre-test scores. Active participation was assessed based on the number of participants who asked questions or provided responses during discussions, with a target of at least 50 percent of the total 37 participants. The outcome of the soap-making practice served as a key indicator, in which all participants (37 individuals) received solid soap in individual cups. Program sustainability was supported through monitoring by the KKN student team, enabling participants to continue the practice independently at home.

3. RESULTS AND DISCUSSION

Results

Interactive presentation

In the first stage, the organizing team delivered the material through an interactive presentation using slide media equipped with process images, illustrative photographs, and a flow diagram of solid soap production, as shown in Figure 1. The material was divided into four main sections. First, the health hazards associated with repeated use of used cooking oil were explained in detail. The team described that cooking oil used repeatedly undergoes chemical degradation through oxidation, hydrolysis, and polymerization processes, resulting in the formation of harmful compounds such as free fatty acids (FFA), aldehydes, and acrolein (Grootveld et al., 2020). Second, the environmental pollution impacts caused by

the disposal of used cooking oil into drainage systems were discussed. The team explained that used cooking oil discharged into waterways significantly increases the organic load in aquatic environments, as indicated by elevated BOD and COD values. The oil layer on the water surface inhibits oxygen exchange, damages aquatic ecosystems, and can clog drainage systems and generate unpleasant odors (Turna & Yıldız 2024). Third, participants were introduced to appropriate technology for purifying used cooking oil using activated charcoal. Al Adawiyah (2022) explained that activated charcoal has a large surface area and active functional groups capable of adsorbing colorants, odors, and oxidation compounds in oil. The purification process is carried out by adding activated charcoal to filtered used cooking oil, followed by heating at a specific temperature before re-filtering. The result is clearer oil, free from rancid odors, and safer for processing into non-food products such as solid soap. Fourth, the team presented the basic principles of the saponification reaction as the core of the soap-making process. This reaction involves oils or fats reacting with a strong base such as NaOH to produce soap (Puspitasari et al., 2023).

The presentation session was conducted in an interactive manner, incorporating question-and-answer segments throughout the explanation. More than 60 percent of the 37 participants were actively involved, either by asking questions or volunteering to take part in the practice session, indicating a high level of enthusiasm for the material presented, particularly regarding the safe use of NaOH and techniques for processing used cooking oil to ensure safety. Subsequently, the material was directly practiced together at the activity site.

Figure 2. Presentation of material on used cooking oil and question-and-answer session

Practice on making soap

The second stage of this community service activity was a hands-on practice session on producing solid soap made from purified used cooking oil. Although the purification process was not carried out on site, the organizing team explained that the used cooking oil employed had first been filtered to remove solid impurities, then mixed with activated charcoal at a ratio of 1 liter of used cooking oil to 100 grams of activated charcoal. The mixture was heated at a controlled temperature of approximately 100°C for about 80 minutes. Purification with activated charcoal was carried out for 24 hours or adjusted according to the quantity and color of the used cooking oil. This process aimed to bind colorants, rancid odors, and oxidation by-products present in the oil. The mixture was then re-filtered to obtain clearer, odor-free oil that is safe to process into non-food products such as soap (Yuarini et al., 2024). Participants involved in the practice session were selected voluntarily, totaling 4–6 individuals, each equipped with personal protective equipment in the form of rubber gloves to ensure safety when handling strong alkaline solutions such as NaOH.

The soap-making process began with dissolving 61 grams of NaOH into 150 mL of distilled water in a stainlesssteel container, added gradually while stirring until the NaOH was completely dissolved, following the correct sequence to prevent excessive heat generation. The NaOH solution was then allowed to cool for 10 minutes. Next, 225 grams of purified used cooking oil were mixed with 125 grams

of coconut oil, 75 grams of olive oil, and 10 grams of coffee powder, and then slowly poured into the cooled NaOH solution while being mixed using a hand blender until reaching the trace stage, indicated by the thickening of the mixture. Once the mixture began to thicken, fragrance oil was added. The thickened soap mixture was then poured into small plastic cups to be distributed to the participants.

Participants who did not directly take part in the practice session were still able to follow the entire process through a live display on an LCD monitor or by observing directly from the front of the practice area. Thus, all participants obtained a clear understanding of the soap-making procedure. As a result of the practice session, approximately 40 cups of soap were produced, exceeding the success indicator of 37 cups, so that each participant received one cup of soap to take home. The distributed soap still requires a curing process of 2-4 weeks at each participant's home before use. Participants were reminded that during the curing period, the soap should be stored in a dry and well-ventilated place to allow the saponification reaction to proceed completely and the soap to become harder.

Figure 3. Materials and tools and practical process for making solid soap

Monitoring and Evaluation Results

Monitoring was conducted based on the results of the pre-test and post-test as shown in Figure 3. The pre-test and post-test were administered using a simple questionnaire containing questions on the hazards of repeated use of used cooking oil, the environmental impacts of disposing of used oil, simple methods for oil purification using activated charcoal, and the general steps of solid soap production. In addition, participants' skills were assessed based on their ability to follow practical instructions and apply basic hygiene and occupational safety aspects.

The pre-test and post-test results indicate a significant increase in participants' knowledge and skills after attending the training. Prior to the activity, the average level of participant understanding was still limited, particularly in technical aspects such as used cooking oil purification and the steps of solid soap production. Of the total 37 participants, only about 16 individuals (43 percent) demonstrated a good understanding of the material, while the remainder had not yet fully understood it. However, after the training, the level of understanding increased sharply, with 36 participants (97.3 percent) demonstrating adequate comprehension, and only 1 participant (2.7 percent) not yet fully mastering the material. Participants were better able to explain the health hazards associated with repeated use of used cooking oil, understand the risks of environmental pollution due to improper disposal, and practice simple oil purification methods using activated charcoal.

This community service activity produced a tangible impact on the participants. After completing the training, nearly all participants (98 percent) were assessed as having a good level of understanding and being able to independently reproduce the solid soap-making process. This also indicates that almost all participants were satisfied with the training on soap production from used cooking oil. As expressed by one of the participants who took part in the soap-making practice, who stated:

> *"...This was the first time I learned that used cooking oil can be made into soap like this. It is certainly very useful for us, because when we want to dispose of it, we are often confused, and it ends up spilling in the trash..."* (interview excerpt with Mrs. N S)

Participant satisfaction is also reflected in another testimonial, in which a participant stated:

> *"...The activity was very enjoyable and definitely broadened my knowledge. The presenter was very engaging, the explanations were easy to understand, and the practice session was also easy to follow. I would like to try this myself at home sometime..."* (interview excerpt with Mrs. W A R)

The soap products produced also demonstrated good quality in terms of color, aroma, and texture, making them suitable for household use and potentially developable as marketable products. Based on field reports from KKN students, several participating housewives have begun to independently apply used cooking oil utilization practices at home, such as filtering and storing used oil for soap production, rather than disposing of it into drains or gutters as previously practiced. This indicates that the training resulted in positive changes in the participants' social practices.

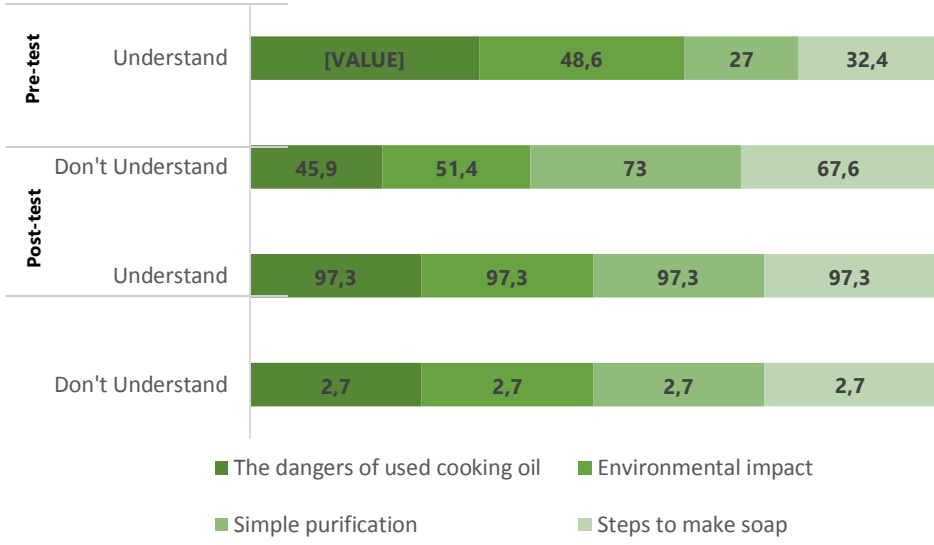

Figure 4. Pre-test and post-test results

Discussion

Household waste management, particularly used cooking oil, is an environmental issue that requires serious attention. Used cooking oil refers to cooking oil that has been repeatedly used, resulting in significant physical, chemical, and sensory changes (Prabasari & Rineksane, 2023). Repeated heating at high temperatures causes oil to undergo oxidation, hydrolysis, and polymerization, leading to the formation of free fatty acids (FFA), aldehydes, ketones, and carcinogenic compounds such as acrolein (Soni et al., 2024). From a health perspective, repeated consumption of used cooking oil has been associated with an increased risk of degenerative diseases, including liver cancer, atherosclerosis, and lipid metabolism disorders (Prabandari et al., 2024). From an environmental perspective, the disposal of used cooking oil into drainage systems can cause significant pollution. According to Turna & Yıldız

(2024), used cooking oil can contaminate even clean water by forming a thin surface layer that inhibits oxygen exchange, thereby disrupting aquatic organism life. In addition, solidified oil can clog drainage systems and trigger localized flooding.

In this community service activity, the proposed solution was the purification of used cooking oil using activated charcoal, followed by its processing into solid soap. Activated charcoal was selected due to its high surface area and porosity, which make it effective in adsorbing oxidation compounds, colorants, and rancid odors from used cooking oil. The purification process was carried out by adding activated charcoal to filtered oil, heating it at a controlled temperature, and then re-filtering the mixture. The resulting oil had a clearer color and a more neutral aroma, making it suitable for use in non-food products (Al Adawiyah, 2022). Subsequently, the purified used cooking oil was utilized in the saponification process, which is a reaction between triglycerides and a strong base (NaOH) that produces soap and glycerol (Puspitasari et al., 2023). The soap-making process in this community service activity employed the cold process method, in which the reaction occurs at low temperatures, thereby preserving oil quality and producing a milder soap (Winanti & Gultom, 2024).

The results of this community service activity indicate that an educational approach through interactive presentations followed by hands-on practice was able to enhance community knowledge and skills, particularly among housewives, in processing used cooking oil waste into a useful product in the form of solid soap. Participants gained a better understanding of the hazards of repeated use of used cooking oil, its environmental pollution impacts, and the steps involved in oil purification and soap production. In terms of approach, the method applied in this activity adopted the principles of Participatory Learning and Action (PLA), in which participants were not merely passive listeners but were actively involved in practice and discussion. Compared to conventional one-way counseling, the PLA approach has proven to be more effective in building understanding and changing behavior. This is evident from the evaluation results before and after the activity (behavioral impact), where 97.3 percent of participants reported understanding the material and 90 percent of them considered the training beneficial and intended to practice it independently at home.

Based on the activity outcomes, these findings are consistent with the study by Martha et al. (2022), which showed that training in herbal soap production using purified used cooking oil with activated charcoal improved the technical abilities of housewives in converting household waste into products with economic value. Participants also demonstrated a high level of understanding of purification principles and the saponification process through participatory and practical learning. Similar results were reported by Hanifa et al. (2024), where practice-based training for PKK cadres enhanced recycled soap production capacity and market readiness at the household level. The solid soap products generated in this activity exhibited a brownish cream color, a pleasant fragrance from fragrance oil, and a sufficiently hard texture, which are consistent with the characteristics of cold process soap as reported by Rifkowaty et al. (2023).

From a socio-economic perspective, although a formal entrepreneurial group has not yet been established, monitoring results by the KKN team indicate that several participants have begun processing used cooking oil at home and utilizing it for household laundry soap needs. Previously, most participants disposed of used oil into drains or trash bins. This behavioral change reflects increased environmental awareness as well as household economic savings. Socially, the activity also strengthened community cohesion, particularly among housewives who exchanged experiences in soap-making practices. Interactions during the activity fostered a sense of togetherness and a spirit of mutual support in managing household waste. Thus, this program not only focused on technical chemical outcomes, but also succeeded in cultivating environmental awareness and community self-reliance in transforming household waste into more useful products.

Despite the positive outcomes, the implementation of used cooking oil processing at the household level still faces several challenges. First, limited equipment and facilities may hinder participants from independently replicating the practice at home. A potential solution is the establishment of working groups or women's cooperatives that can provide shared facilities, as well as encouraging the involvement of village governments in supplying infrastructure and initial capital. Overall, this community service activity successfully provided knowledge, skills, and motivation to the community to creatively and economically process used cooking oil waste, while simultaneously supporting zero waste initiatives and sustainable environmental management.

4. CONCLUSION AND RECOMMENDATIONS

The community service activity conducted in Banjar Adat Taman Sari, Mengwitani Village, successfully enhanced the knowledge, skills, and environmental awareness of the community, particularly housewives, in processing used cooking oil waste into solid soap. Through a combination of interactive presentation methods and hands-on practice, participants gained an in-depth understanding of the hazards of repeated use of used cooking oil, its environmental pollution impacts, purification techniques using activated charcoal, and the solid soap production process using the cold process method. The results of the activity demonstrate high participant enthusiasm, as reflected in active participation during discussions, willingness to engage in practice sessions, and interest in developing similar products at home. The soap products produced exhibited color, aroma, and texture characteristics consistent with cold process soap standards, while also offering economic potential as environmentally friendly household products. From a social perspective, the activity also fostered a spirit of collaboration among residents, strengthened relationships among housewives, and increased awareness of household waste management. Overall, this program not only improved technical knowledge but also strengthened community capacity toward a "zero waste village" through behavioral changes in household waste management.

To support the sustainability of the program, several more targeted follow-up actions are recommended, as follows: (1) The village government is expected to play a role in providing shared facilities such as soap molds, precision scales, and personal protective equipment, so that participants are not burdened by limitations in production resources; (2) A joint business group or women's cooperative should be established with a focus on the production and marketing of recycled soap, so that the outcomes of the activity not only contribute to waste management but also enhance household income; (3) Monitoring should be conducted for at least three months after the program to assess the consistency of skill application and the resulting environmental impacts; (4) Advanced training on product marketing and packaging should be organized in collaboration with village authorities or partner institutions, so that soap products can be marketed sustainably.

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