



Production of Organic Liquid Fertilizer from Cigarette Butts as an Alternative Biopesticide for Farmers

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Article Info

Article history:

Received: December 5, 2024

Accepted: January 28, 2025

Published: May 16, 2025

Keywords:

Biopesticide

Cigarette butts

Liquid fertilizer

Organic waste

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Jurnal Pengabdian Masyarakat

Abstract

The current challenges farmers face include a high dependence on synthetic chemical pesticides, which negatively impact the environment and human health. The abundance of cigarette butt waste also poses a serious environmental problem. This Community Service activity aims to provide education on processing cigarette butt waste into organic liquid fertilizer as an environmentally friendly and economical alternative biopesticide for farmers. The method applied in this community service activity began with the collection of cigarette butts, which were then fermented to produce organic liquid fertilizer. The fermentation process was carried out by adding certain materials to enhance the nutrient content of the fertilizer. Finally, the fertilizer was field-tested by applying it to plants to assess its impact on plant growth and health and educate farmers on using this organic fertilizer. The results of the community service activity show that there is an increase in the understanding of the participants regarding the production of organic liquid fertilizer from cigarette butts. Participants acknowledged the benefits of this community service activity and recognized that organic waste from cigarette butts can be an environmentally friendly alternative pesticide. The evaluation of the community service activity shows an increase in participants' understanding of making organic liquid fertilizer from cigarette butts, as well as awareness of the potential of this waste as an environmentally friendly biopesticide.

To cite this article: Sukamdani, H. B., Sukwika, T., Satrio, N.B., Sulistyadi, Y & Eddyono, F. (2025). Production of organic liquid fertilizer from cigarette butts as an alternative biopesticide for farmers. *Bubungan Tinggi: Jurnal Pengabdian Masyarakat*, 7(2), 542-552.

INTRODUCTION

Cigarette butts are one of the most common and difficult-to-decompose types of waste. As one of the most prevalent forms of tobacco waste, cigarette butts contain more than 7,000 chemicals, some of which are toxic and can persist in the environment for a long time, such as arsenic, cadmium, and benzene. According to a report by the World Health Organization (WHO), cigarette butts contain harmful chemicals such as nicotine, tar, and heavy metals that can contaminate soil and water, and pose health risks to both humans and animals (WHO, 2021). On the other hand, the agricultural sector faces significant challenges in pest management. The chemical pesticides commonly used often cause environmental problems, such as soil and water contamination, and increased pest resistance (Dewi, 2023; Noviana & Sukwika, 2020; Stewart, 2019). Therefore, it is crucial to find alternative, more sustainable solutions that are safer for the environment and human health.

Mitigating the environmental impact of cigarette butt waste and managing pests sustainably is an urgent need in society, particularly among farmers. The partners involved in this project include farmers, waste managers, and educational institutions committed to sustainability. Farmers need more environmentally friendly pesticide alternatives to reduce their dependence on harmful chemicals. Waste managers require innovative solutions to manage and utilize cigarette butt waste effectively. Educational institutions will play a vital role in providing training and socialization about the benefits and usage of this organic liquid fertilizer (Ellis, 2019; Waqfin et al., 2022; Warintan et al., 2021).

The primary issue faced by farmer partners concerning the title "Production of Organic Liquid Fertilizer from Cigarette Butts as an Alternative Biopesticide for Farmers" is the excessive use of chemical pesticides, which can damage the environment and harm plant health. In addition, many farmers struggle to obtain affordable and effective organic fertilizers and pesticides. Cigarette butts, which are often difficult to manage as waste, can be used as raw material for organic liquid fertilizer and biopesticides. By utilizing this waste, it is hoped that farmers' dependence on synthetic chemicals will be reduced, agricultural sustainability will be improved, and negative environmental impacts will be minimized.

The main problems to be addressed through this community service project are two key aspects: the management of cigarette butt waste and pest control in agriculture. Improper disposal of cigarette butts leads to significant environmental pollution due to the harmful chemicals they contain, which are difficult to break down (Kumar, 2020; Mikola et al., 2020; Sharma, 2019). Additionally, using chemical pesticides in agriculture can have negative effects, such as soil and water contamination and human health risks. Therefore, solutions are needed to address the waste issue and provide safer, more environmentally friendly pesticide alternatives.

The solution to address cigarette butt waste and pest control in agriculture is to develop organic liquid fertilizer from cigarette butts that also functions as a biopesticide. This process involves processing cigarette butts into an environmentally friendly liquid fertilizer that is effective in controlling plant pests. Utilizing cigarette waste reduces the negative impact of waste and provides a safer and more sustainable pesticide alternative for farmers. Applying this method can increase agricultural yields and reduce reliance on synthetic chemicals, while supporting greener and more sustainable agricultural practices.

The goals of this community service program are as follows: (1) Reducing Environmental Impact from Cigarette Butt Waste: This project aims to process cigarette butts into organic liquid fertilizer. By utilizing cigarette butts, which are often discarded improperly, it is hoped that environmental pollution will be reduced and difficult-to-decompose waste will be minimized (Nalhadi et al., 2020; Sharma, 2019; Waqfin et al., 2022). (2) Improving Soil and Plant Quality: The liquid fertilizer produced is expected to improve soil quality and provide plant nutrients. This fertilizer will help enhance soil fertility, improve soil structure, and increase plant nutrient absorption (Papageorgiou, 2020; Patel, 2020; Warintan et al., 2021). (3) Producing Environmentally Friendly Biopesticides: Developing biopesticides from liquid fertilizer that can naturally control pests, without harmful chemicals. The aim is to provide a safer alternative for farmers and reduce the negative effects of chemical pesticides (Stewart, 2019; Warintan et al., 2021). (4) Education and Socialization for Farmers: Training farmers on how to use the organic liquid fertilizer and biopesticide, as well as its benefits for sustainable farming. Socialization will be conducted to raise awareness about the benefits of using organic liquid fertilizers and biopesticides (Waqfin et al., 2022; Warintan et al., 2021).

This community service activity's objectives are to reduce the environmental impact of cigarette butt waste, improve soil and plant quality, produce environmentally friendly biopesticides, and educate farmers.

METHODS

This Community Service (PkM) activity uses an action-based and exposure-based approach. The main objective of this method is to address the issue of cigarette butt waste and provide practical solutions for pest control in agriculture. This method involves processing cigarette butts into organic liquid fertilizer that can also function as a biopesticide. The approach also includes demonstrations and socialization for farmers on effectively using this alternative fertilizer and pesticide (Stewart, 2019; WHO, 2021). A diagram illustrating the technical process for making biopesticide from cigarette butts is shown in Figure 1.

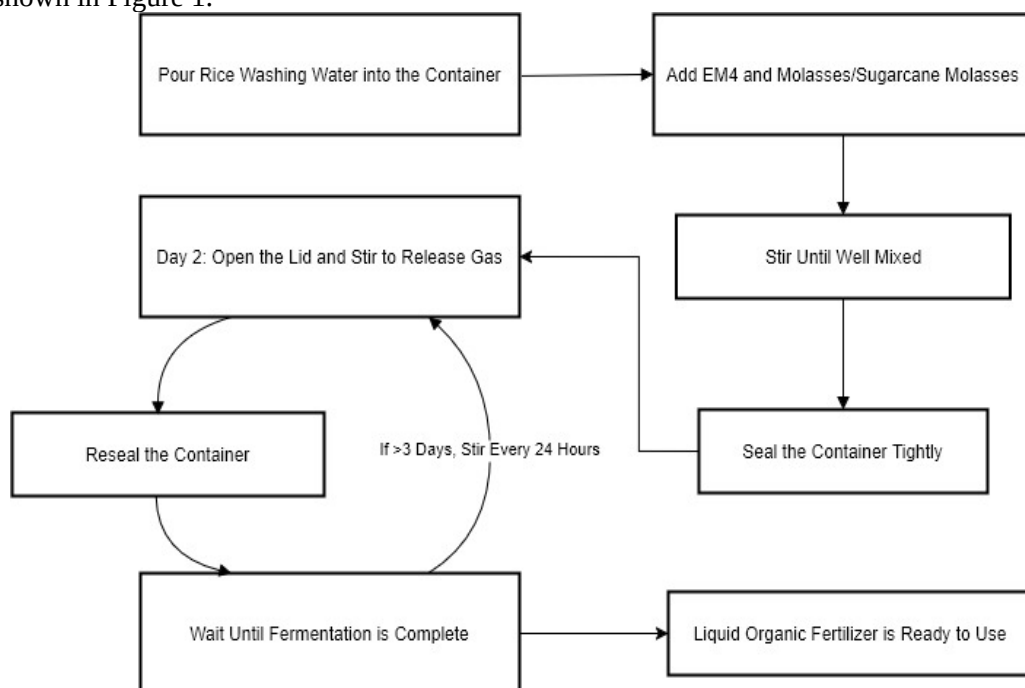


Figure 1 Technical process for making biopesticide from cigarette butts

The diagram above generally illustrates the process of making biopesticides. It begins with the primary material, which weighs 100 grams, and undergoes several processing stages. First, the material is extracted to draw out the active compounds contained within it. Next, the obtained extract undergoes a separation process to obtain the fraction with the highest concentration of active compounds. This active fraction is then formulated into a biopesticide by adding additives such as solvents or emulsifying agents. This process results in a final product as a ready-to-use biopesticide.

The key stages to note in the diagram are:

- **Extraction:** Extracting active compounds from plant material using a specific solvent.
- **Separation:** The purification process of the extract to obtain the fraction containing the highest concentration of active compounds.
- **Formulation:** The process of creating the final biopesticide product with the addition of supplementary materials.

Implementation Plan Stages

- (1) Collection and Processing of Cigarette Butts: The first stage involves collecting cigarette butts from various sources such as disposal centers and waste management facilities. The cigarette butts are then processed through a series of chemical and biological steps to extract useful components and neutralize harmful substances. This process involves drying, crushing, and fermenting the cigarette butts to produce organic liquid fertilizer ([Kumar, 2020](#); [Mikola et al., 2020](#)).
- (2) Formulation of Liquid Fertilizer and Trial: In this stage, the organic liquid fertilizer produced from the cigarette butts is formulated to ensure its quality and effectiveness. This fertilizer is then tested on plants to assess its impact on plant growth and its ability to function as a biopesticide. The trials include laboratory tests and field applications to observe its effectiveness in pest control ([Ramirez, 2020](#); [Stewart, 2019](#)).
- (3) Training and Socialization for Farmers: Once the organic liquid fertilizer is ready for use, the next step is to provide training and socialization for farmers. This training covers how to make and apply the liquid fertilizer and its benefits as an alternative pesticide. Socialization will occur through workshops, seminars, and educational materials to increase farmers' awareness of the advantages of using this organic liquid fertilizer ([Papageorgiou, 2020](#); [Patel, 2020](#)).
- (4) Evaluation and Monitoring: The final stage involves evaluating the results of applying the organic liquid fertilizer on a larger scale. Monitoring will be conducted to assess the effectiveness of the fertilizer and pesticide in daily agricultural practices. Data collected during monitoring will be used to improve the process and provide future recommendations for farmers and waste managers ([Noviana & Sukwika, 2020](#); [Sukamdani et al., 2022](#)).

Work Procedure

Table 1 outlines the detailed work procedures for this PkM activity to support the realization of the proposed method.

Table 1 Procedures for making organic liquid fertilizer from cigarette butts as an alternative biopesticide

No	Stage	Activity
1	Collection of Cigarette Butts	Identify waste sources and collect cigarette butts systematically through collaboration with waste management centers or disposal facilities.
2	Processing and Fermentation	Cigarette butts are dried, crushed, and fermented using appropriate binding agents and microorganisms to reduce toxicity and produce liquid fertilizer.
3	Formulation and Trial	Develop liquid fertilizer formulations and conduct trials on plants, observing growth parameters and pest control effectiveness.
4	Training and Education	Prepare training materials and conduct workshops and seminars for farmers on using organic fertilizer and pesticides.
5	Evaluation and Adjustment	Monitor the results, provide feedback for process improvement, and update methods based on evaluation findings.

Figure 2 shows the process of the community service activity, including the interaction between the implementation team and participants and a group photo session between the team and the participants involved in creating organic liquid fertilizer from cigarette butts as an alternative biopesticide for farmers



Figure 2 Process of utilizing biopesticide, interaction with the implementation team, and group photo session

In this activity, interactive learning was used, specifically using computers as offline media for education. The materials were delivered in the form of lectures accompanied by demonstrations on how to make organic liquid fertilizer from cigarette butts as a biopesticide alternative for farmers. The aim was to align participants' perceptions and enhance their understanding of the concept and stages of data processing using this application.

RESULTS AND DISCUSSION

At the beginning of the PkM implementation, the team gave participants a perception survey. The purpose of this survey was for the PkM team to determine if the activities were on target and had a significant positive impact on the participants (Noviana & Sukwika, 2020; Sukamdani et al., 2022; Sukamdani et al., 2023). Based on the results, it was clear that the PkM activities substantially affected the participants.

The Special Instructional Objectives (TIK) describe the condition before and after the participants' perception. The pre-perception indicates what participants need to understand, while the post-perception reflects what they have learned. Based on the results of the pre- and post-perception surveys, the PkM team was able to assess the changes in participants' understanding based on the technical guidance materials taught.

Based on the Special Instructional Objectives and the performance assessment results, as shown in Table 2, the following measurement parameters were identified: (1) General understanding of biopesticide from cigarette butts, (2) Understanding how to prepare biopesticide from cigarette butts, (3) Knowledge of the benefits of cigarette butts as a biopesticide, (4) Utilization of alternative organic materials from cigarette butts, and (5) Use of biopesticide for plant bacteria and fungi. The questions participants had to answer were identical before (pre-perception) and after the activity (post-perception).

Table 2 Composition of TIK pre- and post-implementation of PkM

Special Instructional Objective (TIK)	Question Points	Number of Questions	Pro-portion
1. General understanding of biopesticide from cigarette butts	1-2	2	20
2. Understanding how to prepare biopesticide from cigarette butts	3-4	2	20
3. Knowledge of the benefits of cigarette butts as biopesticide	5-6	2	20
4. Utilization of alternative organic materials from cigarette butts	7-8	2	20
5. Use of biopesticides for plant bacteria and fungi	9-10	2	20

Table 3 presents the progress in achieving TIK from the activity of creating organic liquid fertilizer from cigarette butts as an alternative biopesticide for farmers. The table shows that the average TIK performance score before and after the technical guidance was 27.42% and 89.87%, respectively. This means that the TIK performance showed an improvement of 62.45%.

Table 3 Progress of TIK performance for PkM activities

Special Instructional Objective (TIK)	TIK Achievement (%)		
	Initial Perseption	Final Perseption	Progress
1. General understanding of biopesticide from cigarette butts	25,10	80,90	55,80
2. Understanding how to prepare biopesticide from cigarette butts	30,50	90,70	60,20
3. Knowledge of the benefits of cigarette butts as biopesticide	25,30	100,0	74,70
4. Utilization of alternative organic materials from cigarette butts	15,50	87,55	72,05
5. Use of biopesticides for plant bacteria and fungi	40,70	90,20	49,50
Average	27,42	89,87	62,45

Distribution of participants' understanding: Pre- and post-perceptions are shown in Figure 3.

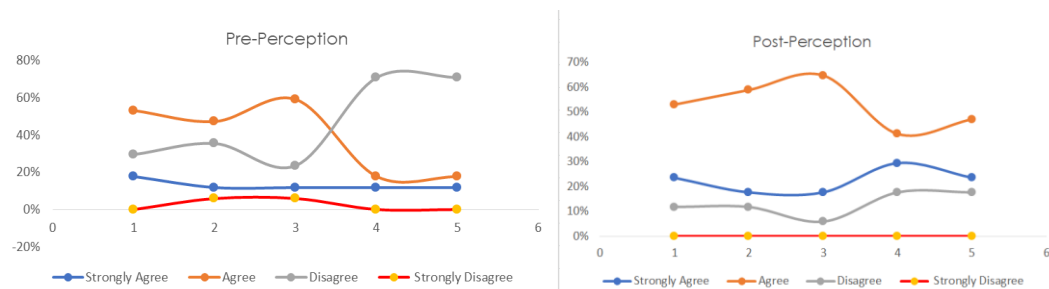


Figure 3 Distribution of participants' understanding: Pre and post-perception

Participants' perceptions of achievements in community service are shown in Figure 4.

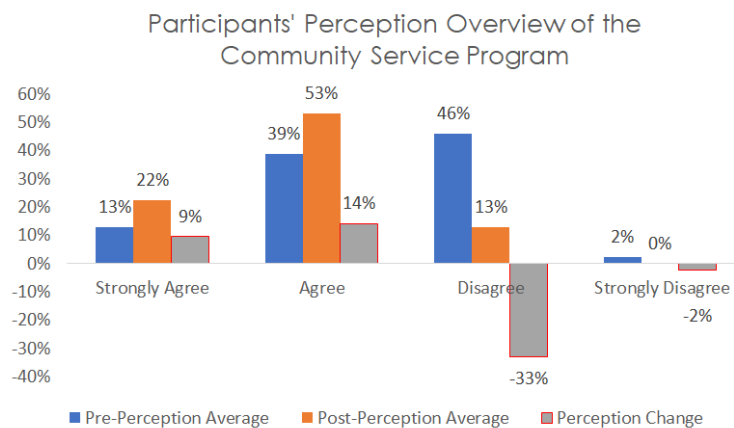


Figure 4 Overview of participants' perception of achievements in PkM

Based on the graph in Figure 4, it can be concluded that:

1. Increase in Positive Perception: After participating in the PkM program, the percentage of farmers who "agree" and "strongly agree" with the use of organic fertilizer from cigarette butts significantly increased. This indicates that the educational program was effective in shifting farmers' perceptions.

2. Decrease in Negative Perception: Conversely, the percentage of farmers who "disagree" and "strongly disagree" with this organic fertilizer decreased significantly. This suggests that the program effectively addressed doubts and uncertainties about the topic.

Greatest Perception Shift: The largest perception change occurred in the "disagree" category, which decreased by 33%. This shows that the program successfully convinced many farmers who were initially hesitant. Overall, the graph shows a significant positive shift in farmers' perceptions regarding the use of organic liquid fertilizer made from cigarette butts after attending the PkM program.

The graph in Figure 4 shows a significant positive trend in farmers' perceptions of using organic liquid fertilizer made from cigarette butts after participating in the PKMB program.

Factors Affecting the Improvement of Positive Perceptions:

Effective Education and Counseling: The education program successfully improved farmers' understanding of the benefits of making organic liquid fertilizer. This is reflected in the increase in the percentage of farmers who "agree" and "strongly agree," indicating they have more confidence in its effectiveness.

Hands-on Experience and Field Evidence: Direct testing and presenting real cases in the field played a crucial role in changing farmers' perceptions. Farmers who were initially skeptical began to see more tangible results after using the fertilizer, which boosted their trust in the technology.

Impact on Agricultural Productivity:

While the improvement in perception regarding the use of organic fertilizer is significant, further evaluation is needed to assess the direct impact on agricultural productivity. Increases in crop yields, soil quality, and reductions in chemical fertilizers are some aspects that should be measured to assess the program's long-term success. The graph generally shows some interesting trends, further detailed in the following matrix in Table 4.

Table 4 Progress matrix of pre-perception and post-perception performance of the pkm activity

Pre-Perception	Post-Perception
• Fluctuating Approval: The level of farmers' approval of various aspects of using organic fertilizer made from cigarette butts tends to vary. This indicates that farmers' understanding and interest in the topic are not uniform across all aspects. • Initial Interest is Quite High: Farmers are generally very interested in this idea despite fluctuations. This is shown by the percentage of respondents who chose the "agree" and "strongly agree" categories in several questions. • Doubt and Uncertainty: On the other hand, the percentage of respondents choosing "disagree" and "strongly disagree" categories is still quite significant in some questions. This indicates that many farmers still have doubts and uncertainties about the benefits and safety of using this organic fertilizer.	• Increased Approval: After participating in the community service program, the percentage of farmers who "strongly agree" and "agree" with using organic liquid fertilizer made from cigarette butts increased. This suggests that the education program was effective in changing farmers' perceptions. • Decrease in Disagreement: Conversely, the percentage of farmers who "disagree" and "strongly disagree" has decreased, suggesting that doubts and uncertainties were addressed through the program. • Perception Fluctuations: Although there is an overall trend of improvement, fluctuations remain in the level of approval for each question. This suggests that the program's effectiveness may differ for each aspect of the topic.

Implications for Community Service Programs:

The results of the pre- and post-perception graphs provide some important implications for the community service program:

- (1) Focus on Education: The program needs to focus more on educating farmers about the benefits, how to make, and the safety of using organic liquid fertilizer made from cigarette butts ([Kumar, 2020](#); [Riza et al., 2021](#)).
- (2) Specific Training Materials: Training materials should be tailored to the needs of farmers, emphasizing aspects that are still not well understood ([Kumar, 2020](#); [Mikola et al., 2020](#)).
- (3) Addressing Doubts: The program should aim to address farmers' doubts and concerns about the use of this organic fertilizer, such as by providing scientific evidence or testimonials from other farmers who have successfully used it ([Dewi, 2023](#); [Sukamdani et al., 2022](#)).
- (4) Program Effectiveness: The implemented community service program has proven effective in increasing farmers' understanding and interest in using organic liquid fertilizer made from cigarette butts ([Mikola et al., 2020](#); [Sharma, 2019](#)).
- (5) Areas for Improvement: Despite the progress, there are still areas that need improvement, such as providing more specific information on how to address the challenges farmers may face in applying this technology ([Riza et al., 2021](#); [Tien, 2018](#)).
- (6) Ongoing Evaluation: It is important to continue evaluating the program regularly to measure long-term success and adjust as needed ([Noviana & Sukwika, 2020](#); [Waqfin et al., 2022](#)).

PkM Success Indicators:

Based on the results of the graph in Figure 2, here are some measurable success indicators for the PkM:

1. Change in Perception:
 - Increase in Percentage: An increase in the percentage of farmers with a positive perception (strongly agree and agree) about using organic fertilizer.
 - Decrease in Percentage: A decrease in the percentage of farmers with a negative perception (disagree and strongly disagree).
 - Shift in Distribution: A shift in the distribution of answers towards more positive responses.
2. Knowledge Improvement:
 - Understanding Benefits: Farmers can explain the benefits of organic fertilizer more thoroughly and comprehensively.
 - Mastering the Production Process: Farmers can correctly and independently make organic fertilizer.
 - Applying in Practice: Farmers are able to apply organic fertilizer to their crops.
3. Behavioral Change:
 - Technology Adoption: An increase in the number of farmers using organic fertilizer in their farming practices.
 - Recommendations to Other Farmers: Farmers recommend using organic fertilizer to other farmers in their community.
4. Productivity:
 - Increased Harvests: An increase in crop yields after using organic fertilizer.
 - Reduced Use of Chemical Pesticides: A decrease in chemical pesticides.

The evaluation results provide several important implications for the PKM program: (1) Program Effectiveness: The PKM program has proven effective in changing farmers'

perceptions and behaviors. (2) Areas for Improvement: Despite progress, there is still room for improvement, such as providing more specific information on addressing challenges farmers may face in applying this technology. (3) Ongoing Evaluation: It is essential to continue conducting program evaluations regularly to assess long-term success and make necessary adjustments.

CONCLUSION

The community service program has successfully changed farmers' perceptions of using organic liquid fertilizer made from cigarette butts. However, there is still room for improvement and development for future programs. Throughout the PKM activities, there was a significant increase in farmers' understanding of the benefits and how to make organic liquid fertilizer from cigarette butts. The percentage of farmers who strongly agreed and agreed with this organic fertilizer increased by 62.45% compared to the pre-test. This indicates that the educational program implemented was quite effective.

Recommendations for farmers who are still unsure about the effectiveness of organic liquid fertilizer should include more in-depth education, including real-life case examples and field tests. In addition, routine and intensive training on making and applying organic liquid fertilizer from cigarette butts will further improve their understanding and confidence. On the other hand, the government needs to expand the educational program on organic liquid fertilizers through national extension services, in collaboration with the Ministry of Agriculture and natural resource management agencies. Financial support in the form of subsidies or production tool assistance will encourage the adoption of this technology. Additionally, further research on the effectiveness of the fertilizer in controlling pests and plant diseases should be conducted to reassure skeptical farmers.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

HBS and NBS were responsible for designing the background, developing the methodology, and collecting data. TS and YS performed data analysis, interpreted results, and wrote the initial draft. HBS and FE served as research supervisors, provided critical input, and revised the manuscript. All authors contributed to discussions and the final revision of the manuscript.

ACKNOWLEDGMENTS

We would like to thank the management of Universitas Sahid Jakarta and the facilitators who helped implement the PKM activities. We also thank the LPPM of Universitas Sahid for all their support.

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