



# Community Empowerment of PCM Kokap on Sustainable Municipal Waste Management through Black Soldier Fly Farming

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## ABSTRAK

Pengelolaan sampah kota merupakan salah satu permasalahan lingkungan rumit yang banyak ditemui di wilayah Yogyakarta, termasuk di Kokap, Kulon Progo. Selain itu, kesadaran masyarakat setempat terhadap pentingnya pengelolaan sampah juga belum terbangun dengan baik karena kurangnya pengetahuan mengenai hal ini. Oleh karena itu, program ini bertujuan untuk meningkatkan pemahaman dan keterampilan teknis anggota Pimpinan Cabang Muhammadiyah (PCM) Kokap mengenai pengelolaan sampah yang dimediasi lalat tentara hitam. Program pemberdayaan masyarakat ini melibatkan 15 anggota PCM (berusia antara 40-55 tahun) dan dilaksanakan dengan metode experiential learning melalui pendekatan partisipatif. Diawali dengan diskusi kelompok terfokus dan dilanjutkan dengan uji coba pertanian BSF menggunakan sampah kota yang dilakukan oleh anggota selama 40 hari. Pengawasan intensif dilakukan melalui WhatsApp Group. Hasil penelitian menunjukkan bahwa seluruh anggota PCM berhasil mengembangkan siklus BSF yang lengkap. Sebagian larva BSF telah dimanfaatkan sebagai pakan unggas dan ikan. Keberhasilan uji coba ini tidak terlepas dari tingginya antusiasme anggota dalam mengikuti petunjuk teknis yang diberikan secara virtual. Secara keseluruhan, program ini berhasil memberikan edukasi kepada masyarakat sasaran yang ditandai dengan keberhasilan anggota PCM Kokap dalam melaksanakan uji coba pengelolaan sampah kota. Hal ini juga memberikan peningkatan pemahaman anggota mengenai nilai ekonomi produk BSF sebagai alternatif sumber pendapatan sekunder. Keberhasilan program ini dapat menjadi proyek percontohan untuk membangkitkan kesadaran masyarakat dan kapasitas untuk lebih bertanggung jawab terhadap sampah kota yang dihasilkan.

## ABSTRACT

Municipal waste management is one of complicated environmental problems found in many areas of Yogyakarta, including in Kokap, Kulon Progo. In addition, the awareness from local society towards the importance of waste management has not well built yet due to the lack of knowledge on this issue. Therefore, this program was aimed to promote better understanding and technical skill of Pimpinan Cabang Muhammadiyah (PCM) Kokap members regarding black soldier fly-mediated waste management. This community empowerment program involved 15 PCM members (aged ranging from 40-55 years old) and carried out using the experiential learning method through participatory approach. It started with focus group discussion and followed by the trial of BSF farming using municipal waste performed by the members for 40 days. Intensive supervision was provided through WhatsApp Group. Results showed that all PCM members were success in cultivating a complete cycle of BSF. Some of the BSF larvae had been used as feed for poultry and fish. The success of this trial was associated to the high enthusiasm from the members in following the technical guidelines provided virtually. Overall, this program has successfully educated the targeted community marked by the accomplishment of PCM Kokap members in executing the trial of municipal waste management. It also conferred the increased member's understanding regarding the economic value of BSF products to be alternative source of secondary income. The success of this program could be a pilot project to generate society awareness and capacity for higher responsibility with the municipal wastes produced.

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## 1. INTRODUCTION

Organic waste is type of waste where its management so far has not optimal yet. Organic waste. Organic waste is commonly composed of food waste, municipal waste, agricultural/livestock/fishery residues, animal and human feces, thus making it possible to be naturally degraded (biodegradable) (Das et al., 2019; Kaza et al., 2018; Mertenat et al., 2019). However, previous studies reported that the accumulation of organic waste had been significantly piled up worldwide and remained improperly managed, especially in those mid- and low-income countries including Indonesia (Lohri et al., 2017; Singh & Kumari, 2019; Yao et al., 2019). The unmanaged wastes as well as ineffective methods used for waste management contributed significant amounts of annual greenhouse gas emissions and causing various issues in public health, economic, and social aspects. Previous study recorded that waste accumulated in 2022 reached 12 million tonnes per year dominated by food wastes and mainly originated from household activities (Pascall et al., 2022; Song et al., 2021). It was also reported that 38% of this waste remained unmanaged. Regarding its management, previous study mentioned that most of organic wastes were sent to landfill, while the remaining were buried, composted, and or burnt (Suyanto et al., 2015). This report confirmed that the waste management was fully dependent on landfill, instead of involving the community participation. This kind of dependence might burden the landfill as the rate of waste processing in landfill was slower than the daily waste accumulation rate.

Since the landfill capacity is limited in managing the waste, the participation and responsibility from the community is supposed to be magnified, hence the management can be more effective. However, public awareness regarding this issue has not spread evenly in all regions of Indonesia, including Kokap Sub District (Kulon Progo Regency). Local people in Kokap admitted their inexperience in organic waste management due to the lack of knowledge regarding this issue. Concerning the household as well as small and medium enterprises activities occurred, the waste accumulation is unavoidable. This risk might decline the environmental quality and endanger the public health in this location. On the other hand, Kokap is targeted to be one of tourism villages by promoting the local wisdom. Referred to this situation, the local people in Kokap needs to be empowered, specifically on how to maintain the environment sustainably through the management of their own municipal waste.

Management of organic waste can be performed through various ways and the most widely known methods are the microbes-mediated ones, such as composting and anaerobic digestion. Both methods would convert the soft-textured waste into compost or biogas (Davis et al., 2014; Surendra et al., 2020). In contrast, those solid-textured organic wastes were commonly processed through thermal conversion, thus resulting in various bioenergy products. Another processing method designated for organic waste is insect-based bioprocessing. The use of insect farming on organic waste exhibited various advantages, such as significant reduction on waste dry matter, production of nutrient-rich fertilizer, as well as reduction on pathogens and odors (Beskin et al., 2018; Lalander et al., 2018; Nyakeri et al., 2019). Various species of insects had been proven for its ability on organic waste processing, but the most widely studied one recently was black soldier fly (BSF) (*Hermetia illucens*). Studies on organic waste valorisation mediated by BSF as well as the animal feed production has been intensively investigated during the last seven decades (Somroo et al., 2019; Surendra et al., 2020; Xiao et al., 2018).

BSF farming has been proven as an eco-friendly yet profitable method of waste management since its by-products possessed high economic value resulted in relatively short duration of farming. Regarding its applicability, BSF-mediated bioconversion has been reported to be low space and maintenance due to the polyphagous characteristics of BSF with low risk of human pathogenic contamination (Liu et al., 2019; Singh & Kumari, 2019). Several studies also emphasized the possibility of BSF farming on organic waste to be subjected as income and employment sources (Beesigamukama et al., 2023; Kim et al., 2021). Therefore, this program was designated to empower local people in Kokap regarding the management of municipal waste mediated by BSF. This program was in collaboration with Pimpinan Cabang Muhammadiyah (PCM) Kokap and was expected to promote better understanding and technical skill of PCM members in maximizing the potential of their own waste through BSF farming. For long term purpose, this program was aimed to strengthen the contribution from the community in maintaining the environmental quality by managing their waste independently.

## 2. METHOD

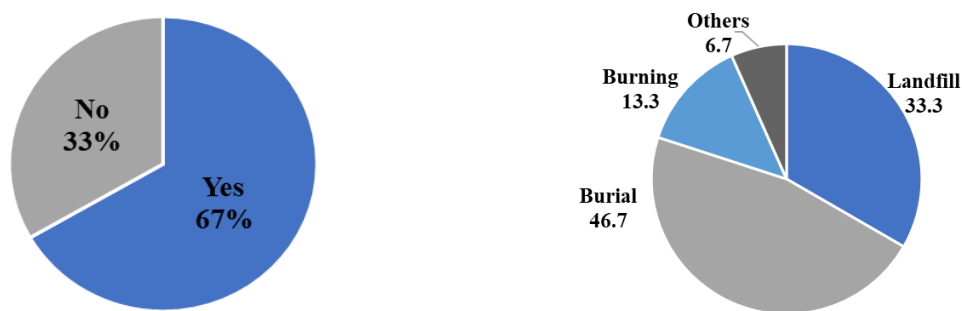
This program is in partnership with Pimpinan Cabang Muhammadiyah (PCM) Kokap based in Kokap Sub District, Kulon Progo Regency. This program involved 15 members of PCM and was composed of two main activities, namely focus group discussion (FGD) and supervision of municipal waste management through BSF farming. FGD was carried out through interactive discussion to introduce the

concept of BSF farming on organic waste as well as its economic value. During FGD, the preliminary knowledge and interest from PCM members regarding this topic was carefully observed through pre- and post-tests. Trial of BSF farming on municipal waste was carried out for 40-43 days. Each PCM member cultivated 1 box of BSF under the supervision of Ombah Group Indonesia Ltd. along with the facilitators. Intensive technical supervision was provided virtually during the trial through WhatsApp Group. Progress on each life cycle of BSF (from egg to imago) was regularly observed from each member.

### 3. RESULT AND DISCUSSION

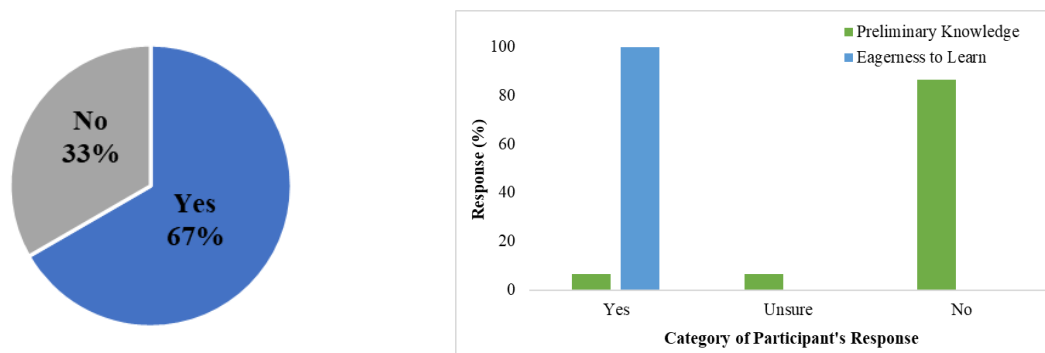
#### Result

This program was started with the focus group discussion (FGD) to provide basic knowledge for the PCM members related to BSF and its capacity in digesting the municipal wastes. Although the participants attended belong to X-generation (40-55 years old), the members expressed high enthusiasm during the FGD [Figure 1](#).



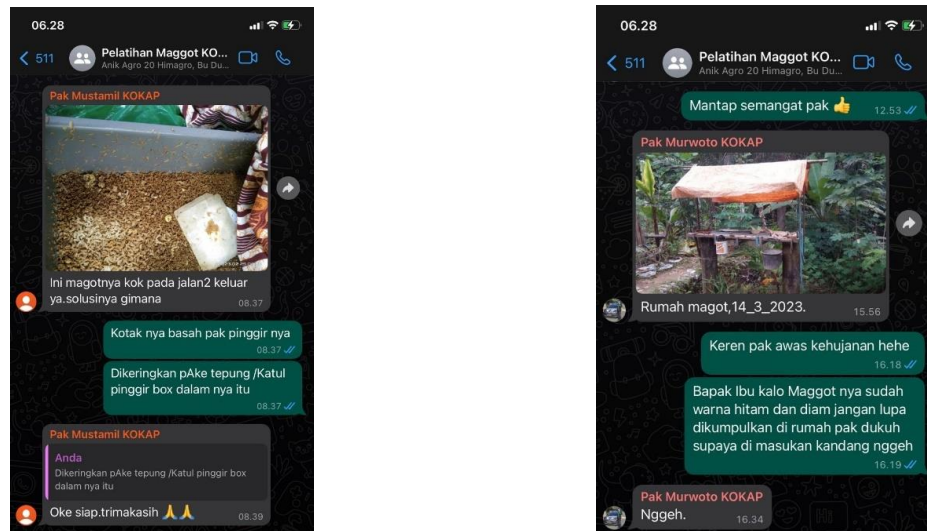
**Figure 1.** Mapping on Habit of Waste Separation (Left) and Choice of Waste Management Method (Right) Applied by the Members of PCM Kokap

Base on [Figure 1](#), during FGD, the preliminary knowledge of PCM members was evaluated through pre- and post-tests. Based on the pre-test performed, 67% members had performed waste separation between food and non-food wastes. However, the waste itself had not been properly managed yet so far. About 46.7% members preferred to bury the waste, while the remaining chose to throw it away to the landfill (33%) or burn it (13.3%). Moreover, PCM members claimed their inexperience in using composting method for waste management. Regarding BSF-mediated waste bioprocessing, most members mentioned that they had heard previously as show in [Figure 2](#), but still had no chance to learn about it practically.



**Figure 2.** Mapping on Participant's Perception (Left), Preliminary Knowledge, and Interest regarding BSF-mediated Waste Processing (Right)

After FGD, PCM members were supervised to manage the municipal waste through BSF farming trial. Technical supervision was provided in all BSF growth stages, from egg, larvae, pupae, imago until the imago laid its eggs. To facilitate an intensive yet indirect supervision, WhatsApp Group was used as communication platform involving 15 PCM members during the BSF farming trial. Interactive discussion through WhatsApp Group were recorded during the trial since the members discussed their progress on BSF farming with the facilitators is show in [Figure 3](#).



**Figure 3.** Screenshot of Interactive Supervision in WhatsApp Group Created during BSF Trial to Discuss the Technical Guideline (Left) and Share the Progress from PCM Members (Right)

Completing 40-days trial with virtual supervision, all members were successful to cultivate the BSF until the life cycle was complete. Even some members decided to continue the BSF farming to the next cycle independently and provide special place to support the BSF farming activities is show in [Figure 4](#). Aside from the supervision related to BSF farming, PCM members were also supervised on how to apply the BSF as additional feed for poultry and fish. Some of the larvae produced was used for chicken and fish feeds, while the remaining was continued to complete its growth cycle.



**Figure 4.** Overview of BSF Farming Trial Performed by PCM Members, Started from Egg Hatching (Left), Larvae Maintenance (Middle), until Imago Maintenance (Right)

High enthusiasm from PCM members highlighted the applicability of BSF-mediated waste bioprocessing for home-scale application. Besides, the success of the members in completing the trial also emphasized the efficacy of virtual supervision to overcome the distance problem restricting the intensive yet direct supervision for PCM members. Considering the demographic profile of PCM members dominated by 40-55 years old-aged individuals, the level of tech savviness was remarkable enabling them to receive the technical supervision provided via WhatsApp Group.

## Discussion

Waste problems are complicated to be handled since its accumulation rate is undoubtedly faster than its processing rate. In addition, significant growth of human population contributes greatly toward the striking increase of waste accumulation. Regarding the organic waste, previous studies reported that organic wastes have not been properly managed yet, particularly in many developing countries ([Kaza et al., 2018](#); [Singh et al., 2021](#)). Considering its characteristics, managing organic wastes was known to be more challenging and complicated due to its high water content, unavoidable risk of potential waste-borne pathogens, and chemical contents triggering unstable enzymatic activities. This condition caused higher



tendency on throwing the waste to the landfill, thus creating environment, public health, economy, and social issues (Lohri et al., 2017; Singh & Kumari, 2019). Moreover, landfilling is getting less effective to manage such abundant waste problem. Not only due to its high operational cost, the rate of waste processing in the landfill is slower and incomparable with the rate of daily waste accumulation (Sekarsari et al., 2020; Varelas, 2019).

The life cycle of BSF takes 40-43 days to complete, beginning with egg, larvae, pupae, and imago. Of all growth stages, larvae play a vital role for the bioprocessing of organic waste. Numerous studies have described the powerful capacity of BSF larvae in converting various types of organic wastes, such as vegetables and fruits wastes, animal manures up to coffee pulps (Beskin et al., 2018; Dzepe et al., 2019, 2020; Smet et al., 2018). BSF larvae uses organic waste as its feed where the waste will be converted into biomass and residue possessing similar characteristic to immature compost. This bioconversion process is based on modifying the microflora contained in organic wastes, hence the abundance of undesirable bacteria can be minimized (Fowles & Nansen, 2020; Gold et al., 2018; Meneguz et al., 2018). From the characteristic of BSF biomass produced, it was reported to be rich in protein and lipid content (Barragan-Fonseca et al., 2018; Xiao et al., 2018). This capacity along with its short life cycle allows BSF to be a potential yet powerful solution for more sustainable waste management. Moreover, its mass production could be potential income and employment generation (Beesigamukama et al., 2023; Kim et al., 2021).

Regarding the sustainability aspect, BSF-mediated waste bioconversion offers more promising efficacy for long term implementation compared to landfill and composting. This method of organic waste bioconversion showed better feasibility in terms of organic waste valorization and environmental benefit (Dzepe et al., 2021; Raksasat et al., 2020). Therefore, it was considered as an economically viable approach to mitigate the bottlenecks found in previously developed waste management methods as well as recycle high quantity waste into various valuable outputs. Previous studies also highlighted the economic value of BSF larvae products potentially generated from organic fertilizers, livestock feed, and biofuel precursor for diesel engines (Gao et al., 2019; Liland et al., 2017; Wong et al., 2020). On other hand, several studies also confirmed the capacity of this method in producing lower greenhouse gas emissions during the bioconversion process (Chen et al., 2019; Ermolaev et al., 2019; Pang et al., 2020). Waste bioconversion mediated by BSF exhibited lower impact on environmental quality compared to those bioconverted from other animal sources, thus strongly suggesting the high sustainability value of this method (Parodi et al., 2020; Ravi et al., 2020; Smetana et al., 2019).

The utilization of BSF in managing the organic waste has successfully grabbed global interest as a highly profitable concept of circular economy (Beesigamukama et al., 2021; Bortolini et al., 2020; Houben et al., 2020). Not only producing protein-rich biomass for animal feed, BSF bioconversion also generated the production of organic fertilizer that would improve soil productivity (Chia et al., 2019; Song et al., 2021). This BSF-composted fertilizer contributed a powerful aid to tackle the issue of poor soil quality threatening the crop production and food security in numerous agrarian countries (Stewart et al., 2020; Wortmann et al., 2019). Moreover, unlike commonly used composting methods, fertilizer produced by BSF required shorter duration due to high bioconversion rate. Therefore, this feature would be a great benefit for farmers in developing countries as the source of low-cost and high quality fertilizer (Choi & Hassanzadeh, 2019; Lalander et al., 2019).

The use of WhatsApp for community empowerment was getting more attention since the COVID-19 pandemic (2020-2022) due to the restriction on social activities regulated in most countries. WhatsApp is an application of high-speed messaging based on Facts Net. This application is recently preferred in most countries as an easy platform for message and information sharing. WhatsApp is also complemented with specific features for sharing location, picture, video, and audio with no cost, both among individuals and groups (via WhatsApp Group). In addition, it is also featured with real-time notification of message delivery status for the users (Church & Oliveira, 2013; Hidayat et al., 2022). The presence of this digital social media platform has successfully completed the previously developed platforms, SMS, email, messenger, Facebook, and Twitter.

Since the number of WhatsApp users in Indonesia hit the 4th largest number worldwide, WhatsApp is considered as the most accessible communication platform, thus showing remarkably effective media to be used for community interaction, such as this empowerment program. During COVID-19 pandemic, WhatsApp has been widely used to educate the society related to COVID-19 mitigation and prevention (Dewiyuliana & Septiana, 2021; Leonita & Jalinus, 2018). Other studies also used this platform to facilitate virtual learning (Febriani, 2020; Hudri & Nurhayati, 2020; Khan, 2021). Referring to these previous studies, it could be concluded that its utilization was potential to reach such a diverse array of demographic profiles, instead of young generation only. Similarly, the results of this program emphasized the efficacy of WhatsApp to facilitate a virtual community empowerment for those living in remote areas (Kusnaeni, 2020; Mulyono et al., 2021; Saner, 2016).

This research can make a positive contribution to community empowerment, especially at PCM Kokap, in sustainable management of city waste. Involving the community in this project can increase their awareness of the importance of waste management and provide new skills through maintaining Black Soldier Fly Farming. This study may have limitations in generalizing the results to different regions or contexts. Each community has unique characteristics, and what works in PCM Kokap may not automatically work in other places with different conditions.

#### 4. CONCLUSION

Based on the results achieved, it can be concluded that PCM members exhibited better knowledge and higher technical skill after successfully completing the trial of BSF farming using the municipal wastes. High enthusiasm and tech savviness from PCM members contributed greatly to provide more effective technical supervision, thus improving the success of BSF trial completion. Results of this program highlighted that PCM members seemed to recognize the economic value of BSF farming using municipal waste. It could be a prospective source of income generation. However, this enthusiasm must be complemented with comprehensive know-how related to the characteristics of high value BSF products for the future mass production. Supports from regional government are highly needed in linking the BSF producers with prospective market target for the commercialization purpose.

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