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COMMUNITY EMPOWERMENT THROUGH BLACK SOLDIER FLY MAGGOT FARMING USING HOUSEHOLD WASTE

Emmy Syafitri[1]*, Dwi Tika Afriani[1], Sri Mulyani[1]
[1]Universitas Dharmawangsa, Medan, Indonesia
*esyafitri@dharmawangsa.ac.id

Abstrak: Minimnya edukasi penanganan dan pengelolaan sampah, peningkatan jumlah rumah penduduk selama tiga tahun terakhir dan rendahnya pendapatan masyarakat adalah faktor yang meningkatkan kompleksitas permasalahan kualitas lingkungan di Desa Medan Krio, Kabupaten Deli Serdang, Provinsi Sumatera Utara. Salah satu upaya yang dapat dilakukan untuk mengurangi permasalahan sampah tersebut adalah dengan pemberdayaan masyarakat Medan Krio khususnya anggota PKK (Pemberdayaan Kesejahteraan Keluarga) melalui budidaya maggot lalat Black Soldier Fly (BSF) yang dapat mengurai sampah organik secara alami dan memiliki nilai ekonomi tinggi. Tujuan kegiatan pengabdian masyarakat ini adalah memberdayakan masyarakat Medan Krio dengan cara meningkatkan pengetahuan dan keterampilan mengelola sampah rumah tangga melalui sosialisasi dan pelatihan budidaya maggot BSF. Metode yang digunakan adalah sosialisasi, pelatihan, monitoring, dan evaluasi berupa pretest dan posttest yang keseluruhannya dilakukan secara luring. Kegiatan diikuti oleh 40 anggota PKK sebagai perwakilan dari beberapa PKK di Desa Medan Krio. Sosialisasi dan pelatihan ini memberikan pengetahuan, wawasan dan keterampilan baru bagi mitra. Peningkatan pengetahuan tentang morfologi maggot meningkat 80%, budidaya maggot 90%, pemanfaatan maggot 70%. Begitu juga peningkatan pengalaman budidaya maggot sebesar 100% dan motivasi untuk melakukan budidaya maggot sebesar 50%. Untuk pemahaman budidaya maggot meningkat sebesar 90%. Mitra kini telah memiliki rutinitas baru yang dapat meningkatkan perekonomian keluarga dari usaha budidaya maggot serta meningkatkan kesadaran untuk mengelola sampah rumah tangga dengan bijak dan bernilai ekonomis.

Kata Kunci: Pemberdayaan Masyarakat; Pengelolaan Sampah; Budidaya Maggot BSF; Peningkatan ekonomi keluarga

Abstract: The lack of education on waste disposal and management, the increase in the number of houses over the last three years, and the low income of the community are factors that increase the complexity of environmental quality problems in Medan Krio Village, Deli Serdang Regency, North Sumatra Province. One of the efforts to reduce the waste issue is the empowerment of the Medan Krio community, especially PKK (Pemberdayaan Kesejahteraan Keluarga) members through the cultivation of Black Soldier Fly (BSF) maggots, which can break down organic waste naturally and have high economic value. This community service program aims to empower the Medan Krio community by increasing knowledge and skills in managing household waste through socialization and training in BSF maggot cultivation. The methods used were socialization, training, monitoring, and evaluation results in pretests and posttests, all done offline. The participants of this program were 40 PKK members in Medan Krio Village. The results show that knowledge about maggot morphology increased by 80%, maggot culture by 90%, and maggot utilization by 70%. In addition, there was an increase in maggot cultivation experience by 100% and the motivation to carry out maggot cultivation by 50%. The understanding of maggot cultivation increased by 90%. The communities now have a new routine that can improve the family economy from the maggot cultivation business and increase awareness of managing household waste wisely and having economic value.

Keywords: community empowerment, waste management, maggot Black Soldier Fly cultivation, improvement of the family economy

Introduction

Medan Krio Village is part of Sunggal Sub-district, Deli Serdang Regency. The settlement situation in Medan Krio Village, regarding the number of households, has increased from 2020 to 2022 (BPS Kabupaten Deli Serdang, 2023). The increase in the number of households over the past three years has indirectly impacted environmental quality. In addition, some households still have toilets without septic tanks, and rainwater channels do not function sufficiently to regulate the amount of rainwater that collects in some households.

Environmental issues, such as landfills, are also on the agenda and must be resolved in this area. Population growth not followed by education in good waste management causes environmental problems. Waste management is limited to community awareness to support the sorting program between organic and inorganic waste. This situation has been going on in Medan Krio Village for a long time.

Based on research conducted by Affila & Afnila's (2021), Deli Serdang Regency produced a significant amount of waste between 2019 and 2020, namely 1443 tons/day, and it tends to increase along with human activities and needs. The COVID-19 pandemic has worsened the condition of waste management and handling, especially household waste. This problem opens up a significant opportunity. This opportunity can be developed into a creative economy program based on technopreneurship, considering that in this Society 5.0 era, technological sophistication has penetrated all sectors, including the economy.

Properly sorted waste is the first step toward being transformed into various crafts (Nasution et al., 2018), fertilizer production (Aristoteles et al., 2021), and maggot farming (Amran & Pane, 2020). Thus, in the future, waste will no longer be a problem. Instead, it will bring in rupiah for waste processing educational tours (Kartiwi & Amin, 2019). The daily organic waste produced can be managed as a living medium for BSF (Black Soldier Fly) maggots (Afriani et al., 2023).

Raising BSF maggots using organic waste will meet their food needs. Hulu et al. (2022) state that complex types of organic waste, such as household waste, tofu pulp, and coconut pulp, are the best maggot cultivation media. Besides being sold as fresh maggots, they can also be used as an alternative raw material for natural fish and livestock feed because they contain a high source of protein (Fauzi & Sari, 2018).

The same point was also stated by Syahputra et al. (2022), who noted that reducing the cost of fish farming can be achieved by offering alternative feed sources that are low in cost but have high protein levels. Maggots have a variety of benefits, including their high nutritional value, easy-to-prepare cultivation media, and the presence of antimicrobial and antifungal substances, which, when consumed, can increase fish immunity against disease (Lubis et al., 2022). Although already developed and known locally, BSF fly farming technology has not been widely adopted in the Medan Krio Village. Therefore, this environmentally friendly technology must be introduced to the community, especially in Medan Krio Village.

The maggot is the larva of the Black Soldier Fly (BSF). It has a wasp-like body, black in colour, and the length of the adult fly reaches 15-20 mm. The Black Soldier Fly (BSF) life cycle

lasts approximately 40-44 days. During this period, the maggot is highly dependent on the temperature and humidity conditions of the location and the availability of food sources (Oliveira et al., 2016). The Black Soldier Fly maggot is a clean insect, not a disease carrier. It provides many benefits as food for fish, livestock, and birds and as a protein substitute, reducing the need for farmers to purchase artificial feed sold at a high price (Hariani et al., 2022).

Some people in Medan Krio Village have been farming livestock and freshwater fish. In general, feed needs in aquaculture activities are often provided as artificial feed, but the price of artificial feed on the market is quite expensive. Therefore, it is necessary to supply efficient feed at competitive prices (Andriani et al., 2020). Erfanto et al. (2013) stated that feed costs accounted for 60-70% of the total cost of aquaculture production. Therefore, people need an alternative, cheaper source of feed. One solution is to provide maggots as a natural food. Currently, the need for natural feed is still met by purchasing from other traders. If this natural feed is maintained independently, it can reduce production costs.

Considering the above scenario, maggot fly cultivation is the right solution for creating a healthy Medan Krio environment and reducing waste problems through community empowerment. The waste problem can be resolved by cultivating maggots, and the community can create jobs and businesses to help the family economy. Based on the issues described and the proposed solutions, the objectives of this community service program in Medan Krio Village are as follows: 1) to equip partners with knowledge, technology, and skills in utilizing waste through maggot cultivation; 2) to increase community understanding and attitudes about the importance of reusing organic household waste, such as food waste, fruit peels, vegetables, dry leaves, and crop residues, by running a maggot cultivation business.

Method

The partners in this community service program were the PKK members from Medan Krio Village, Deli Serdang Regency, North Sumatra Province. The distance between the service site and the campus of Dharmawangsa University is 20 km. Forty PKK members from Medan Krio Village participated in this community service program. This program was conducted through two offline meetings (face-to-face) and thirty days of online activities via the WhatsApp application. This service program consists of several stages, including:

1. The lecture or presentation method aims to equip service participants by increasing their motivation to develop their potential, providing them with an understanding of the impact of waste and how to manage organic waste effectively, and imparting knowledge and skills through training program on the utilization of waste as a medium for cultivating BSF maggots
2. The demonstration method involves showing how to cultivate BSF maggots by preparing the necessary tools and materials and demonstrating the preparation and creation of maggot cultivation media to PKK members
3. The practice and mentoring method involves providing opportunities for PKK members to practice maggot cultivation in groups and offering assistance through the WhatsApp

application for independent practice activities carried out by PKK members

The community service programs were carried out by a PKM team consisting of three lecturers from Dharmawangsa University with backgrounds in accounting and aquaculture and one student from the accounting diploma program. The student acts as a PKM team supporter and field officer and provides pre- and post-program questionnaires. The community service programs were carried out in the following stages:

1. The first stage is the preparation of service programs, which consists of survey and observation activities at the service site. The PKM team also coordinated with the Medan Krio village chief and some PKK members regarding their experience in waste management and maggot cultivation, the preparation of socialization materials and maggot cultivation practice modules, and the purchase of maggot seeds and media materials. This stage ends with an agreement on the implementation of the programs, including the implementation schedule and technical activities to be carried out.
2. The second stage is the implementation of socialization. Socialization aims to broaden the partners' understanding of service topics, including human resource management for increasing motivation and developing self-potential, BSF maggot cultivation, and the production of BSF maggot media. Before the socialization, the PKM team gave the PKK members an initial questionnaire to assess their understanding and knowledge about BSF maggot cultivation. Administering a pretest (questionnaire) at the initial stage helps the PKM team analyze the understanding and increase the partners' knowledge about the service topic so that the initial objectives agreed upon with the partners can be achieved appropriately.
3. The third stage is the demonstration stage. After the partners have understood the concept of increasing motivation, self-potential, and waste management through maggot cultivation activities, the PKM team continues with demonstration activities regarding the preparation and production of maggot cultivation media to strengthen their insights and improve their skills. This demonstration phase is complemented by discussions and question-and-answer sessions between the PKM team and partners on maggot cultivation methods, as well as the provision of assistance in the form of maggot cultivation tools and materials to support partners in their practical activities for the first time. The direct practice method aims to see partners' reactions to the maggot body shape and how to prepare the BSF maggot growing media. It also serves as a first step and basis for partners' interest in maggot cultivation because if partners find maggots disgusting, the opportunity to develop maggot cultivation as an innovation to improve the family economy will be smaller.
4. The fourth stage is the mentoring stage, utilizing an online-based training model through the social media application WhatsApp Group. In this stage, PKM members were divided into two groups. They will independently carry out maggot cultivation activities using the tools and materials provided by the PKM team during the practice and demonstration program. The PKM team will supervise and guide the results of the maggot cultivation practices carried out by the PKM members. The PKM team will also provide additional maggot seeds in case of any mortality among the maggots during the independent practice.

The independent practice carried out by the PKM member groups will last for 30 days, corresponding to the maggot life cycle.

5. The fifth stage is the evaluation of the results of the service programs. The evaluation is conducted to assess the increase in motivation, knowledge, and skills of the partners regarding the material provided and the achievement of the objectives of the PKM activities by analyzing the results obtained. The evaluation instruments include questionnaires and posttests to measure the understanding of the PKM members as training participants and evaluations of the results of the maggot preparation and maintenance demonstrations. The posttest assesses the same understanding of maggot cultivation as the pretest administered at the beginning of the service program. It is designed to evaluate the increase in partners' motivation, knowledge, and skills in maggot farming. The socialization and training activities were concluded by motivating PKM members to view maggot cultivation as a means to manage waste and an opportunity for innovation to improve the family economy. The implementation of the PKM activities can be seen in Figure 1 below.

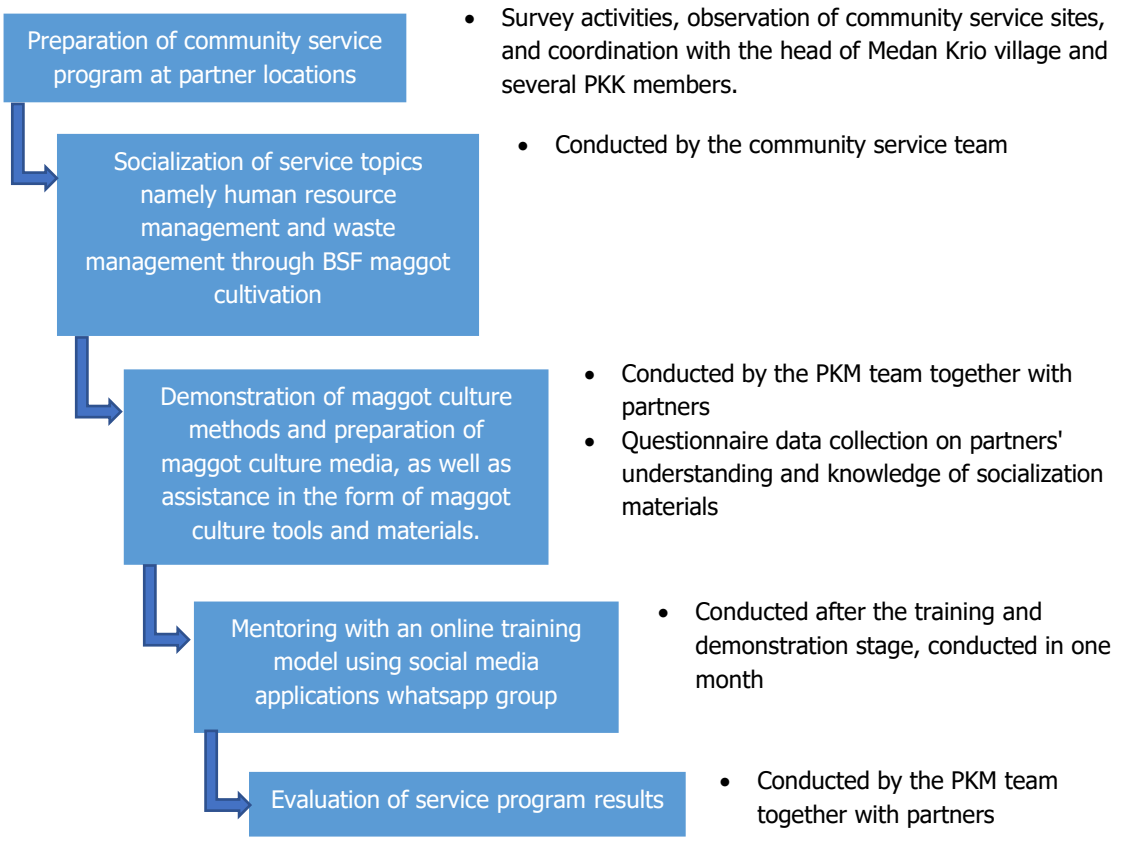

Figure 1. The Steps for Implementing Community Service Programs

Results and Discussion

Community empowerment through BSF maggot farming is a program proposed as a solution for household organic waste management in Medan Krio Urban Village, Deli Serdang

Regency. This training involved PKK members in Medan Krio Village as partners and participants in the socialization process. Based on the methods and stages of implementation agreed upon between the partners and the service team, several findings and results of the service implementation were obtained, which are described as follows:

Preparation Stage (Survey and Observation of the location of Program Partners)

This stage includes preparation, monitoring, and surveying the participant's position. Through field observations and surveys, data were collected to identify the problems faced by the partners, hoping to find the right solutions to address these problems. The results of observations and references show that waste management in Deli Serdang Regency is quite good, but there are still some significant obstacles. These obstacles include limited vehicle availability and low public awareness of the importance of waste management (Adhana & Ramadhan, 2020).

Field observations generated data validated by an interview with one of the PKK members. The interview data revealed that about 80% of the PKK members were unaware of the technology to recycle organic waste into something of economic value or how to manage proper waste disposal. As explained earlier, some members of the Medan Krio community are also involved in livestock and freshwater fish farming. Artificial feed is commonly used as the necessary feed for aquaculture activities, but commercially available artificial feed is quite expensive. Therefore, it is essential to ensure efficient feed at a competitive price. Erfanto et al. (2013) reported that feed costs in fish farming account for 60-70% of the total production cost. Therefore, alternative and cheaper feed sources are needed. Natural feed sources such as maggots are one of the potential solutions.

By analyzing the results and conducting field observations, the PKM team can provide solutions to the partners' problems. In addition, the PKM team confirmed the willingness of the village head and especially the PKM partners, namely PKK members, to cooperate in community service programs, such as training and mentoring PKK members. Following this agreement, the partners and the PKM team held a PKM event titled "Community Empowerment through Maggot BSF Cultivation Utilizing Household Waste." After identifying the priority problems and solutions, the PKM team made final preparations, which included preparing training materials, preparing maggots with household organic waste media, and coordinating with BSF owners who would provide seeds, media materials, and maggot eggs for the demonstration.

Training Phase (Socialization, Demonstration and Group Practice)

The socialization was held by a team of lecturers and students from Dharmawangsa University at Medan Krio Village Hall. It was attended by 40 participants representing PKK members of Medan Krio Village. The socialization activities were conducted in two sessions, starting at 09 a.m. and ending at 12 p.m. The material presented in the first socialization session was the improvement of human resources through developing self-potential motivation. In economic development, there must be improvement or growth regarding existing human resources by providing direction on the importance of managing time, oneself, and others. The

speaker took an example by demonstrating maggot cultivation. PKK members can learn how to manage maggot cultivation for optimal results (Figure 2).

Figure 2. Submission of HR Management Material Presented by the first speaker

The community empowerment program in Medan Krio Village is on the right track, but it is not yet optimal. Therefore, several strategies are expected to contribute to improvements. These include maintaining good relations between group members, the government, and the surrounding community to achieve a common vision of the goals. Open communication among group members, the government, and the surrounding community, putting aside the desire to win alone, and ensuring that there are no misunderstandings between members throughout the program are other strategies that can be used to achieve these goals. A sense of belonging will be created through dialogue with each group member, fostering a sense of togetherness and motivating group members to work together to achieve the intended goals.

The socialization and presentation of materials at the second meeting began with an initial assessment (pretest) of the participant's understanding of the materials to be socialized through a questionnaire. At this second meeting, practical activities or direct demonstrations by the speaker related to maggot farming preparation and working methods will continue. This community service significantly improves the quality of the environment and human resources. One is the increase in PKK members' knowledge and awareness of the importance of further organic waste management. In addition, the partners also understand the negative impact that can occur if this organic waste is not properly managed. On the second day of the service program, participants received a presentation on the introduction of BSF maggots, their life cycle, cultivation methods, and the benefits obtained from BSF maggot cultivation. In addition, material related to the definition of waste, organic waste suitable for the maggot life cycle, and its processing was also presented in this session (Figure 3). The PKK women were also motivated to raise awareness about the disposal of household organic waste. Odjo et al. (2019) argue that household organic waste in vegetables, fruits, and food waste provides very high growth for maggots, so organic waste decomposes faster into fertilizer and benefits the community.

Figure 3. Material presentation delivered by the second speaker

The second speaker explained that the use of maggots is becoming increasingly popular. Their use is becoming popular not only for decomposing organic waste but also in fisheries and livestock. The protein content of maggots makes them a valuable source of nutrition for livestock and fish. Natural feed such as maggots is now a popular choice among farmers. Sales in Medan City are also very profitable because the capital used to raise maggots is almost free, relying only on organic waste in reusable containers. The results of maggot cultivation can be sold at Rp. 20,000/kg. With the development of this cultivation, PKK Medan Krio members can invite the community or other housewives to improve the family economy through maggot cultivation. PKK members were very receptive to the idea of processing household organic waste using BSF maggots and learning how to cultivate them. The participants also asked the speaker various questions regarding using BSF maggots to process household organic waste.

At the end of the session, there was also an exercise on maggot farming and some preparations that participants needed to make, guided by the third speaker (Figure 4). The third speaker explained that maggots are good at decomposing organic waste. The speaker also taught how maggots grow by eating leftover fruit and food. During this session, the speaker showed the participants a live maggot. The PKK members were enthusiastic about the material and practices taught (Figure 5). Maggots still hatching find it easier to digest soft food, so the remaining fruit or organic waste is first crushed before being fed to them. The shredded waste is used as a growth medium for the maggot larvae. The metabolic and food wastes that the maggots cannot ingest can be used as nutrient-rich fertilizers and have proven very good for plant growth.

Figure 4. Presentation of Maggot Cultivation Material by the third speaker

Figure 5. Maggot Cultivation Practice with PKK Members

Cultivating maggots as a community group business is very easy. Maggot farming begins with preparing a site and a growing medium of organic waste, such as kitchen scraps or livestock manure. Black soldier fly (BSF) eggs are then placed on the medium. The eggs hatch into larvae within a few days. The larvae are fed regularly with organic waste until they reach harvest size in approximately two to three weeks. When the larvae reach optimal size, they are harvested for use as animal feed or for further processing. The remaining organic media decomposed by the larvae can be used as compost. In addition, some larvae are retained to develop into adult flies that will lay eggs again, thus repeating the cultivation cycle.

During the training, the service team also provided one set of egg-hatching tools and maggot-breeding media to representatives of each PKK member. The speaker explained that the equipment provided was a modified "biopond" to make cultivating maggots easier for ordinary people. The biopond is shown in Figure 6.

Figure 6. Modified Biopond

Using this "biopond," maggots and pupae can be easily separated. It also makes the harvesting process easier and cleaner. Due to its small size, the cultivation site can be anywhere, making it accessible to ordinary people.

Mentoring Stage

The results of the maggot cultivation will be rechecked after a while. All PKK members can participate in this program together and gain their own experience in cultivating maggots at home. At the end of the program, in about four weeks, the partners could gradually harvest 9 kg of maggots from their cultivation field (Figure 6). The partners were very enthusiastic about this program and requested to continue with other programs, such as cultivating BSF flies until they could lay eggs and complete the maggot-rearing cycle properly.

Figure 7. Maggot Harvest Results by PKK Members of Medan Krio Village

Fly farming practices are regularly monitored by the service team to ensure progress. The monitoring is done online through the WhatsApp application or via video call. The monitoring results showed that the majority of the participants (partners) were able to grow maggots until the harvest season. The harvested maggots are used as food for chickens, catfish, and lobsters. Based on the service team's observations, the participants (partners) were enthusiastic and committed to continuing BSF maggot farming. The partners argue that BSF maggots are easy to cultivate and that the harvest time is fast. In addition, their role as decomposers brings ecological benefits to the surrounding environment by converting household organic waste into a maggot-growing medium and compost.

There are usually several barriers to developing a maggot culture. For beginners, the most common obstacles are technical issues related to maggot care. For example, some members still do not understand the timing of maggot feeding and the proper use of containers in cultivation. To overcome this, the team has guided the cultivation of maggots and implemented a mentorship model where more knowledgeable members mentor their colleagues who are still struggling. This mentorship involves direct instruction or discussion groups, allowing members who are unsure of their steps to ask questions and receive solutions directly from those with a better understanding.

The next obstacle is the members' lack of understanding in calculating the selling price of maggots and determining the quality of maggots that can be sold at the highest to the lowest

price. To address this, the team helped sort the quality of maggots, set the selling price, and introduced partners to maggot consumers. In the future, at the request of partners, training on maggot quality assessment and workshops on setting the selling price will be conducted.

Evaluation of the Program

The program was evaluated by providing a pretest and posttest, filled out by PKK members who participated in the training. This evaluation aims to determine the success of socialization and how well PKK members understand maggot farming. The results of the questionnaires completed by the participants before and after the training are shown in Table 1 below.

Table 1. Pre- and post-program results of BSF maggot cultivation trainees

Parameters	Before Program	After Program
Understanding of the maggot in terms of its form, life cycle, and cultivation	20%	100%
Ever conducted maggot cultivation activities	0%	100%
Participants desire to develop maggot farming using household organic waste	50%	100%
Understanding of how to harvest and produce maggots completely (participant's absorption of training materials)	0%	90%
Participants knowledge of the benefits of maggots for the environment and can also improve the family economy	30%	100%

Based on the evaluation before and after the program, the participants' absorption value of maggot cultivation technology and ability to practice cultivation activities were very high, reaching 90% and 100%, respectively. The participant's knowledge of the role of maggots in the environment and how to increase family income increased to 100%. This aligns with the participant's desire to restart and develop maggot cultivation using household organic waste after the first harvest.

The potential of organic waste treatment using Black Soldier Fly (BSF) can significantly reduce waste mass. Based on research and practice, BSF larvae can efficiently consume organic waste. Treating organic waste with BSF can reduce waste mass by about 50-80% (Khaer et al., 2023). This efficiency can vary depending on the type of organic waste, environmental conditions, and treatment management. This significant reduction in waste mass makes BSF an effective and sustainable method of organic waste management.

At this stage, the development of the maggots after one month was also observed. Observations showed that the baby maggots grew well, and the population increased (Figure 7). It was also observed that the maggots could decompose household organic waste quickly.

Conclusion

Maggot farming programs that use household waste positively impact the community. In addition, the participants' knowledge of BSF maggot cultivation and human resource development in household organic waste management has increased. The service participants enthusiastically participated in the practical activities of BSF maggot cultivation, accepting the

well-presented theory and practicing immediately. Some of them successfully cultivated maggots. Through this program, the participants can reduce organic waste by 5 kg/day or reduce the mass of organic waste by about 50-80%. Another benefit is that some participants became more aware of information and communication technology.

Regarding the waste problem, the team offered training on effective organic waste processing techniques. The program provided involves organic waste processing techniques using BSF maggots. Maggots are very easy and cheap to cultivate using organic waste that is abundantly produced daily and can be processed in various ways. Thus, the organic waste produced daily by residents can be used as a medium for cultivating BSF maggots. This makes maggot farming a realistic solution for the community. With maggot farming, the waste problem can be solved, and the community can have a source of income through this program. A production and marketing management seminar was also conducted to complement the partners' knowledge in running the maggot farming business. This aims to help the community understand the factors to consider when running a business and how to market the products they produce.

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