

Pengolahan Sampah Organik Rumah Tangga melalui Biokonversi Berkelanjutan dengan Memanfaatkan Larva Black Soldier Fly (Diptera: Stratiomyidae) di Ngadilegi Utara

Sustainable Bioconversion of Household Organic Waste Utilizing Black Soldier Fly (Diptera: Stratiomyidae) Larvae in North Ngadilegi

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Abstract This program encapsulates comprehensive efforts undertaken by Bina Desa in North Ngadilegi, focusing on community-oriented initiatives such as Focus Group Discussions (FGD), the fabrication of waste sorting buckets, and counseling sessions addressing waste sorting and maggot cultivation. The counseling sessions, attended by a diverse group of 33 residents, including village officials, housewives, farmer groups, and youth organizations, aimed to instill knowledge and enthusiasm for sustainable waste management practices. The community's active participation underscores the potential impact of maggot cultivation in mitigating household organic waste while concurrently enhancing economic prospects. Maggot cultivation, particularly utilizing Black Soldier Fly (BSF) larvae, emerged as a promising solution for this problem. The study underscores the ease of BSF breeding and its affinity for organic waste, presenting a valuable opportunity for community-based waste management. The residents' demonstrated enthusiasm signifies a positive reception to the initiatives, fostering optimism for long-term adoption. The collective activities orchestrated by Bina Desa lay a foundation for holistic community development, emphasizing environmentally friendly practices and economic sustainability. As the program seeks to expand waste sorting and maggot cultivation infrastructure, it envisions a future where each household contributes to sustainable waste management, concurrently realizing economic benefits. This study contributes to the discourse on community-based waste management strategies and highlights the potential of maggot cultivation as a transformative solution for both waste reduction and local economic development.

Abstract

Program ini merangkum upaya komprehensif yang dilakukan oleh Bina Desa di Ngadilegi Utara dengan fokus yang berorientasi pada masyarakat seperti Focus Group Discussion (FGD), pembuatan ember pemilahan sampah, dan sesi penyuluhan tentang pemilahan sampah dan budidaya maggot. Sesi penyuluhan yang dihadiri oleh 33 warga terdiri dari perangkat desa, ibu rumah tangga, kelompok tani, dan karang taruna ini bertujuan untuk menanamkan pengetahuan dan antusiasme terhadap praktik-praktik pengelolaan sampah berkelanjutan. Partisipasi aktif masyarakat membuktikan adanya potensi budidaya maggot untuk mengurangi sampah organik rumah tangga sekaligus meningkatkan peluang ekonomi. Budidaya maggot atau larva Black Soldier Fly (BSF) muncul sebagai solusi yang menjanjikan. Penelitian ini menyoroti kemudahan pembiakan BSF dan hubungannya dengan sampah organik, sehingga muncul peluang pemanfaatan BSF dalam pengelolaan sampah. Antusiasme warga menunjukkan penerimaan positif terhadap inisiatif ini, sehingga muncul optimisme pelaksanaan dalam jangka panjang. Kegiatan kolektif Bina Desa ini menjadi dasar pengembangan masyarakat secara holistik, dengan menekankan pada praktik-praktik ramah lingkungan dan keberlanjutan ekonomi. Seiring dengan upaya perluasan

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jangkauan pemilahan sampah dan peningkatan infrastruktur budidaya maggot, program ini mengharapkan setiap rumah berkontribusi dalam pengelolaan sampah secara berkelanjutan dan pada saat yang sama mewujudkan peningkatan ekonomi. Studi ini berkontribusi pada upaya strategi pengelolaan sampah dan memanfaatkan potensi budidaya maggot sebagai solusi dalam pengurangan sampah serta peningkatan ekonomi masyarakat.

Kata kunci : Maggot, Black Soldier Fly, Pengelolaan Sampah, Sampah Organik

INTRODUCTION

The contemporary global waste crisis has become an increasingly formidable challenge, marked by a concerning surge in generated waste and its profound environmental consequences (Brack et al. 2022). Factors such as rapid population growth, urbanization, and unsustainable consumption patterns contribute to the exacerbation of this problem (Sharma and Jain 2020). Indonesia, being the fourth most populous country globally, has long grappled with substantial waste issues. According to the Ministry of Environment and Forestry (KLHK), Indonesia generated a staggering 36.1 million tons of waste in 2022. Of this total, food waste constituted the majority at 40.2%. East Java, as a province, was the second-largest contributor to this waste, producing 5 million tons. Traditional waste management methods, such as landfilling and incineration, have proven insufficient in addressing the gravity of the issue, resulting in environmental degradation, resource depletion, and significant public health concerns (Esparza et al. 2020). The prevalence of food waste in the overall waste generation highlights the insufficient efforts in waste processing by the majority of the population (Aditya et al. 2022; Kusuma et al. 2023). Recognizing the significance of organic waste processing, it becomes evident that implementing effective waste management strategies is essential to reduce waste volume, mitigate the potential for disease spread, and prevent environmental contamination (Sari 2017).

Various methods exist for organic waste management, and one noteworthy technique involves converting organic waste into bioenergy through the process of bioconversion. This method entails utilizing decomposing organisms to produce methane energy from the fermentation process (Mabruroh et al. 2022). Among the commonly used decomposers are microorganisms like fungi or bacteria and macro-organisms such as worms or larvae. In response to the imperative need for effective waste management solutions, the potential utilization of Black Soldier Fly (Diptera: Stratiomyidae) larvae has emerged as a promising avenue. Black Soldier Fly (BSF) larvae, or commonly referred to as maggots, exhibit remarkable capabilities in efficiently decomposing organic matter, particularly household organic waste (Rukmini et al. 2020). Their voracious appetite, rapid digestion process, and

ability to convert organic waste into nutrient-rich biomass position them as a valuable tool for bioconversion. Maggots are deemed safe for cultivation and do not act as disease vectors due to their short life cycle in the imago or fly phase, which does not require additional food (Ahmad and Sulistyowati 2021). BSF maggots thrive on eating various forms of organic waste, including food waste, fish waste, and animal waste, achieving significant organic waste reduction rates ranging from 62.68% to 73.98% (Danny et al. 2021). The exploration of the Black Soldier Fly's potential presents an opportunity to revolutionize organic waste management practices, offering a sustainable alternative that mitigates environmental pollution and concurrently generates valuable by-products such as animal feed, compost, and liquid fertilizer.

Despite the promising attributes of Black Soldier Fly larvae, a significant knowledge gap persists among communities, particularly in regions where awareness of their potential remains low (Rehman et al. 2023). This gap underscores the need for comprehensive educational campaigns to inform and empower the public about the capabilities of Black Soldier Fly larvae in waste management. Bridging this information deficit is crucial for fostering community acceptance and encouraging the widespread adoption of this environmentally friendly solution, ensuring that its benefits are realized on a broader scale. North Ngadilegi is one of the villages that has a dense population. One of the serious problems is the large amount of organic waste produced by North Ngadilegi. The density of the population and the lack of waste management in North Ngadilegi also causes waste transportation vehicles to operate twice a week. The cost required for the operation of the waste transportation truck is not small, considering the distance between North Ngadilegi and Wonokerto Landfill is quite far. The high operational costs of waste transportation trucks encourage residents to carry out waste processing independently. Therefore, the service team sought the application of organic waste processing methods by utilizing Black Soldier Fly (BSF) larvae.

Acknowledging the limited awareness and understanding of Black Soldier Fly larvae in North Ngadilegi, community engagement initiatives have been undertaken. These initiatives represent a proactive response to the waste crisis, emphasizing the importance of collaborative efforts between researchers, communities, and local authorities. Through community-based projects and educational programs, individuals are not only informed about the potential of Black Soldier Fly larvae but also actively engaged in sustainable waste management practices. The significance of these community-driven initiatives lies in their potential to bring about positive environmental change, demonstrating the crucial role of community engagement in

addressing the escalating challenges posed by the mounting waste crisis and provide economic development opportunities for the surrounding community.

METHODS

Bina Desa Agroteknologi, Faculty of Agriculture UPNVJT 2023 was carried out in North Ngadilegi, Plintahan Village, Pandaan District, Pasuruan Regency from September 18 to December 18, 2023. This chapter outlines the systematic approach employed in the community engagement initiative, structured across three pivotal stages. The primary aim of these stages is to address and provide solutions for the challenges associated with organic waste management in the community. Each stage employs specific methods tailored to achieve optimal results.

First Stage: Problem Observation

In this initial stage, a thorough observation of organic waste management issues within the community is conducted. The methods utilized include interviews and on-site inspections. Interviews serve as a direct means to gather perspectives and insights from community members regarding challenges and obstacles in organic waste management. Simultaneously, on-site inspections are carried out to identify the types and volumes of organic waste generated and assess the existing waste management infrastructure.

Second Stage: Community Awareness through Focus Group Discussion (FGD)

The second stage involves community awareness activities to enhance understanding of the potential and utilization of Black Soldier Fly (BSF) maggots in organic waste management. The method employed in this stage is the Focus Group Discussion (FGD). FGD provides an interactive platform for community members to engage in discussions, exchange ideas, and gain in-depth insights into the benefits of BSF maggots. Through FGD, it is anticipated that a better understanding and acceptance of BSF maggot-based waste management solutions will be fostered within the community.

Third: BSF Larvae Cultivation

The third stage is focused on the practical implementation of the proposed solution by cultivating BSF larvae. The methods utilized for this stage include demonstration and collaborative practice. The demonstration involves showcasing the entire process of BSF larvae cultivation, from setting up the environment to harvesting. Collaborative practice engages

active participation from community members in the cultivation process. This ensures that the community not only gains theoretical knowledge but also acquires practical skills to implement organic waste management solutions utilizing BSF larvae effectively.

Making Organic Waste Buckets and Maggot Cultivation

This section delineates the methodology employed in the creation of containers designated for the sorting of organic waste and maggot cultivation. The initial step involves the fabrication of a total of 34 20-liter buckets, adopting the concept of a stacked bucket system. In this configuration, the upper bucket functions as the receptacle for organic waste and maggots, while the lower bucket serves as a container for leachate liquid (Utami et al. 2020). The process of creating these buckets encompasses several key stages.



Figure 1. Holes in the bucket

To initiate the bucket fabrication process, the first stage involves the creation of perforations in the buckets. Employing a drill tool, a small hole is strategically placed at the bottom of the upper bucket. Simultaneously, the lid of the lower bucket is punctured in a circular pattern to facilitate the drainage of leachate liquid and provide structural support for the upper bucket. Subsequent to the hole-making process, the buckets undergo a thorough cleaning procedure. Utilizing stainless fiber, any surface impurities such as moss are removed by rubbing on accessible parts of the bucket. Additionally, a bendo or knife is utilized to scrape off any adhesive residue on the bucket's surface, particularly in hard-to-reach areas such as the interior. Following the cleaning phase, the next step involves painting the buckets designated for the containment of organic waste and maggots. The painting task is undertaken by the service team at the North Ngadilegi Hall. The selection of a blue color scheme is deliberate and aims to deter the attraction of other types of flies (Emerty and Mulasari 2020).



Figure 2. Painting buckets for organic waste and maggots

DISCUSSION

1. Focus Group Discussion (FGD) with North Ngadilegi Residents

FGDs conducted with the Head of North Ngadilegi and various resident representatives revealed the prevailing challenges in the community. A significant issue identified is the accumulation of household waste attributed to high population density. Furthermore, a noteworthy observation is that the majority of North Ngadilegi residents currently do not engage in the sorting and processing of organic waste. It is underscored that the proper sorting and processing of organic waste can yield numerous benefits for the community. In response to the identified issues, the collaborative efforts of Bina Desa Agroteknologi 2023 Student Team, the Head of North Ngadilegi, and members of local youth organizations materialized in an organic waste management program. This program centers on the cultivation of Black Soldier Fly (BSF) maggots as a sustainable solution.

The collaborative endeavor takes the form of the villager's and youth organizations contributing barrels to serve as containers for both organic waste sorting and maggot cultivation. Simultaneously, students from Bina Desa Agroteknologi 2023 Program's take on the responsibility of painting the barrels and conducting educational outreach activities within the community. The cooperative initiatives aim to address the challenges of waste accumulation in North Ngadilegi by introducing an innovative and eco-friendly solution. The provision of barrels for waste sorting and maggot cultivation signifies a practical approach to instigate change within the community. The involvement of local youth organizations and community leaders reflects a holistic strategy, ensuring that diverse perspectives and resources are leveraged for the success of the organic waste management program. Through this

collaboration, the program seeks to instill awareness, facilitate behavioral change, and establish sustainable waste management practices within the community.



Figure 3. FGD activities discussing problems in North Ngadilegi

The Black Soldier Fly (BSF) maggot emerges as a highly effective organism for the decomposition of organic waste. Mabruroh et al. (2022) highlighted that the utilization of BSF maggots can result in an impressive 80% reduction in the volume of organic waste. Moreover, when cultivated properly, the larvae of the BSF, upon reaching the adult phase, present a promising protein source that can serve as an alternative feed for fish and livestock (Salman et al. 2020). Notably, the maggot is recognized for its substantial nutritional composition, containing approximately 40-50% protein and 29-32% fat content (Bosch et al. 2014). The residual matter or excrement produced by the maggots holds significance in organic waste management. It serves as a high-quality compost organic fertilizer, exhibiting favorable nutritional content. The leachate generated during the maggot cultivation process also serves a dual purpose, functioning as a potent liquid fertilizer for plants. Triwandani et al. (2023) asserted that compost produced through BSF larvae processing attains a C-Organic content of 32.55%, a C/N ratio of 17%, moisture content of 12.89%, total N of 1.88%, P_2O_5 of 2.22%, and K_2O of 2.68%. Research by Ratni and Dewinda (2022) further supports the potential of BSF leachate residue as a valuable compost material. Their findings indicate that the leachate meets the nutrient content requirements outlined in SNI 19-7030-2004, making it suitable for use in composting. The decision to cultivate maggots as a strategic approach to organic waste management is motivated by the symbiotic relationship between maggots, agriculture, and livestock in North Ngadilegi.



Figure 4. Maggots or Black Soldier Fly (BSF) larvae

2. Waste Sorting Counseling and Maggot Cultivation Activities

The Waste Sorting Counseling and Maggot Cultivation activity took place on December 12, 2023, at the North Ngadilegi Hall. A diverse audience of 33 residents participated, including key figures such as the Head of Plintahan Village, Head of North Ngadilegi, members of the Madulegi Farmers Group, Women Farmers Group, housewives, and several members of youth organizations. The counseling session was facilitated by a lecturer from the agriculture faculty of UPN "Veteran" Jawa Timur, aiming to disseminate knowledge on effective waste management and the cultivation of Black Soldier Fly (BSF) larvae. The counseling session initiated with an overview of proper waste management practices, emphasizing the crucial step of waste segregation into organic and non-organic categories. The community was guided in understanding the sorting process, particularly highlighting the utilization of organic waste as a medium for maggot cultivation.

BSF flies are very easy to breed and BSF imago or adult flies can be found in the surrounding environment. According to Katayane et al. (2014) BSF flies like typical growth media in the reproduction process. Maggot itself likes food in the form of organic waste, such as vegetables, rice and all foods that have entered decay. The success rate of maggot development is determined by the growth medium, hence waste segregation is necessary. During the activity, most participants actively asked questions and showed high enthusiasm in maggot cultivation. This enthusiasm was characterized by the number of participants who asked specific questions about maggot cultivation and took turns looking at the maggot samples provided at the end of the activity. This activity is expected to provide motivation and new knowledge to residents so that organic waste management can be carried out sustainably. The next step that will be taken after the counseling is to increase the number of barrels by the North

Ngadilegi so that each house will have a barrel for sorting organic waste and maggot cultivation.



Figure 5. Implementation of Extension Activities; (a) Documentation of Maggot Cultivation Extension Activities; (b) Bucket Container for Sorting Organic Waste and Maggots

CONCLUSION

Bina Desa's initiatives for the North Ngadilegi community encompassed diverse activities, including Focus Group Discussions (FGD), the fabrication of waste sorting buckets, and counseling sessions on waste sorting and maggot cultivation. The counseling sessions attracted a participation of 33 residents, comprising village officials, housewives, farmer groups, and members of youth organizations. The community displayed remarkable enthusiasm towards these activities, instilling optimism that maggot cultivation can effectively mitigate household organic waste volumes in North Ngadilegi, concurrently fostering economic opportunities for the local populace. The collective engagement and receptiveness observed during these endeavors signify a promising foundation for the sustainable management of organic waste and the cultivation of Black Soldier Fly (BSF) maggots within the community. As Bina Desa endeavors to enhance waste management practices and promote economic empowerment, these activities mark a crucial step toward achieving holistic and impactful community development in North Ngadilegi.

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