Creating Value from Maggot Cultivation with Slow-released Pellet Production

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Abstract. Organic waste is a major environmental and economic challenge in rural Indonesia. This study aimed to provide an innovative solution to this challenge by developing a targeted socialization and training program to empower rural communities in adopting sustainable maggot pellet production practices. The study was conducted in Dusun Pasekan Lor, Balecatur, Sleman, Yogyakarta, Indonesia. The program was effective in increasing awareness of the benefits of maggot pellet production, from 61% to 94%. Participants also gained practical experience in pellet production, learning to blend maggots with ingredients like rice bran, duck concentrate, and starch. Two formulations were explored: a multi-ingredient blend for chickens and fish, and a cost-effective rice bran formula. The program also emphasized the importance of market penetration. Participants learned about product design, packaging, and pricing. The chosen dark green design, with clear information, effectively communicated the product's composition and benefits to potential customers. The study concluded that the targeted socialization and training program was an effective tool for empowering rural communities to adopt sustainable practices that provide environmental and economic benefits.

Keywords: financial, magot, pellet production

1 Introduction

Hermetia illucens, commonly referred to as the black soldier fly or maggot, exhibits considerable potential across a range of domains. This insect displays remarkable proficiency in the conversion of organic waste into compost characterized by its high protein and lipid content [1-3]. Additionally, it is widely employed in waste management strategies as well as the production of animal feed [4] and fertilizer [5]. Moreover, its applications extend to aquaculture where it serves as a valuable source of fish feed [6] and holds promise for biodiesel production [7, 8]. It is important to note that adult flies consume only water, exhibit no attraction to humans, refrain from biting or stinging, and are not known to act as vectors for any specific diseases [9].

The developmental stage most frequently exploited as feed for fish, livestock, or as fertilizer occurs during the sixth instar phase, known as the prepupa stage [3, 10]. During this stage, prepupae typically contain around 40% protein and 30% lipid on a dry weight basis [2, 3]. Additionally, it is noteworthy that during this phase, larvae exhibit an instinct to seek out clean environments prior to their transformation into pupae. This instinctual behavior, termed "self harvesting," ensures the larvae's transition to a suitable environment for pupation [11, 12]. However, there are notable limitations in utilizing larvae directly, due to shelf life and volume of the product. To address this, a conversion process is

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recommended wherein larvae are transformed into pellets [13, 14]. This approach offers enhanced efficiency, precise nutritional management, improved handling, and increased stability [15, 16].

The production of pellets made from black soldier fly (BSF) larvae enables livestock and fish to easily consume the nutrients, while ensuring controlled and gradual nutrient release [17]. This approach minimizes waste and maximizes efficiency. The economic potential of slow-release maggot pellet production is significant, as it provides new income streams for fish farmers and entrepreneurs, thereby increasing profitability. Furthermore, this practice aligns with circular economy principles and waste management by utilizing organic waste materials as feed sources, reducing waste, and contributing to sustainability in the agricultural sector.

The aim of this research is to assess the impact of the activity on maggot pellet production, including their awareness, skills, knowledge, perceptions, and willingness to engage in pellet-making. The findings of this study are expected to make a significant contribution to the advancement of knowledge in the field of maggot pellet production, promoting sustainable economic development. Additionally, it is anticipated that this research will provide further insights beyond previous studies and offer valuable guidance for future research and development in this field.

2 Methodology

2.1 Research Design and Methodology

This study employed a quantitative research design, incorporating a descriptive analysis approach along with a comprehensive literature review methodology. The selection of the research location was carried out using purposive sampling, taking into consideration both the specific area and the community engaged in utilizing maggots as a bioconverter. Consequently, Pasekan Lor-Balecatur, located in Sleman, Yogyakarta, Indonesia, was identified as the appropriate research site.

A cohort of 20 individuals, who had integrated maggot usage into their waste management practices, were purposefully chosen as participants for the training program. This initiative was conducted over the course of five months, spanning from November 2022 to March 2023. The ensuing data analysis encompassed a descriptive methodology aimed at comprehensively documenting and examining the various aspects associated with the dissemination, production, and branding of slow-release pellets.

2.2 Data Analysis

To facilitate data collection, a multifaceted approach was adopted, incorporating techniques such as surveys, interviews, and participant observation. This comprehensive methodology was employed to ensure a holistic understanding of the phenomenon under investigation.

2.3 Stages of Research

This activity consisted of three distinct stages: the socialization of pellet production, pellet manufacturing training, and basic branding training. During the initial stage, a comprehensive socialization program was conducted to enhance awareness and impart knowledge regarding slow-release pellets. Participants were educated about the significance of slow-release pellets, their production process, and potential benefits. Pre- and post-activity assessments were employed to gauge participants' comprehension before and after the socialization program.

In the subsequent stage, slow-release pellets were fabricated using a pellet machine featuring a 3 cm outer diameter and an external blade powered by a 5.5 HP gasoline engine. The manufacturing process adhered to specific formulations and techniques elucidated during the earlier socialization phase. The quality and efficacy of the produced pellets were evaluated based on predetermined criteria.
The final stage centered on the dissemination of branding strategies for the slow-release pellets. Participants received training in effective branding methodologies, encompassing aspects such as product design, appealing packaging, and marketing strategies. The effectiveness of the branding initiatives was assessed through metrics including community involvement and the reception of the branded product.

3 Results and Discussion
3.1 The Socialization of Pellet Production

The manufacturing process of maggot pellets involved conducting socialization and training sessions for residents of RT 03, emphasizing the importance of transforming maggots into slow-release pellets [16, 18]. The training focused on the techniques for pellet production, incorporating a blend of maggots and various other ingredients. This initiative aimed to heighten awareness regarding the crucial role of processing maggots into specialized pellets, providing clear instructions on the preparation procedures. It was anticipated that the production of these pellets would not only raise awareness but also contribute to the augmented market value of the product [19]. This aligns with the production concept, wherein the production stage serves as a pivotal phase in the value cycle, endowing goods or services with added value over time and through the production process [19, 20].

During the program, participants were instructed in the sequential procedure of pellet production. As part of the initiative, the training team generously provided essential tools and materials, including pellet machines, rice bran, duck concentrate, starch, and molasses. The training sessions saw a high level of enthusiasm from the residents, reflecting their keen interest in acquiring the necessary skills to elevate maggot cultivation into a more valuable and beneficial practice. It was observed that while fresh maggots were priced at approximately IDR 4,500/kg, maggot pellets were valued between IDR 5,000 and IDR 10,000 per 100 grams. Consequently, the community stands to gain greater profits by converting their Black Soldier Fly maggot yield into fish pellets rather than selling the fresh maggots directly to collectors.

Table 1. Changes in Residents' Awareness of Maggot Pellet Advantages

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Pretest</th>
<th>Postest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellets could prolong storage capabilities</td>
<td>80 %</td>
<td>100 %</td>
</tr>
<tr>
<td>Pellets provides controlling the nutritional composition of the feed</td>
<td>40 %</td>
<td>85 %</td>
</tr>
<tr>
<td>Pellets provides method for handling feed</td>
<td>35 %</td>
<td>90 %</td>
</tr>
<tr>
<td>The price increase due to conversion into pellets.</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>61%</strong></td>
<td><strong>94%</strong></td>
</tr>
</tbody>
</table>

Prior to implementing a maggot pelletization initiative in RT 03, the community's understanding of the process was assessed through a survey focusing on four key aspects: its impact on shelf life, nutritional control, ease of handling, and potential increase in market value (table 1). Before any socialization or training, participants' grasp of these benefits was moderate, averaging just 61%. However, following dedicated socialization sessions that emphasized the advantages of pelletization, their understanding significantly improved, with an average post-test score of 94%. The most dramatic shifts were observed in participants' awareness of pelletization's ability to control nutritional content (40% to 85%) and provide a more convenient handling method (35% to 90%). While most residents already recognized the potential price increase associated with pellets (90%), even this understanding solidified after the information sessions, reaching 100% in the post-test. This marked improvement in the community's knowledge highlights the effectiveness of the
socialization efforts, paving the way for a more informed and engaged adoption of maggot pelletization in RT 03.

### 3.2 Production of Maggot slow-released pellets

The utilization of maggots (Hermetia illucens larvae) as a sustainable protein source for animal feed has gained significant traction, but optimizing pellet formulations for different species remains crucial. This study investigated two distinct maggot pellet formulas, assessing their palatability, nutritional composition, and structural integrity across avian [21] and aquatic consumers [22].

The first formula combined 250-300 g wet maggots with 300 g rice bran, 200 g duck concentrate, 20-50 g starch, and 25 mL molasses. This multi-ingredient blend exhibited encouraging results for both chickens and fish. Chickens displayed a strong preference for Formula 1 due to its enhanced pellet durability, attributed to the inclusion of starch as a binding agent. Additionally, the pellets maintained buoyancy for approximately 5 minutes, fulfilling the feeding requirements of numerous fish species. Preliminary nutritional analysis indicated a well-balanced profile in Formula 1, with the duck concentrate and bran complementing the protein content of the maggots. However, further investigation into cost-reduction strategies is necessary, as the estimated raw material cost for Formula 1 stands at Rp. 6,000 per kilogram.

The second formula adopted a simpler composition, containing only 250 g fresh maggots and 500 g rice bran. While cost-effective at Rp. 3,000 per kilogram of raw materials, this formula demonstrated shortcomings in its appeal and functionality. Chickens readily consumed Formula 2 pellets, but their lack of structural integrity compared to Formula 1 rendered them less favorable. Crucially, these pellets readily disintegrated upon contact with water, making them unviable for fish feed applications. The absence of a robust binding agent like starch is likely the culprit, highlighting the need for further exploration of pellet formulation techniques, particularly for aquatic applications.

This study showcases the potential of maggot pellets as a versatile and sustainable feed source. However, tailoring formulas to specific dietary needs is paramount for optimizing palatability, nutritional value, and cost-effectiveness. Formula 1 presents a promising blueprint for both chickens and fish, while Formula 2 underscores the importance of structural integrity for aquatic applications.

### 3.3 Branding of Maggot slow-released pellets

The branding of maggot slow-released pellets involved a comprehensive dissemination program aimed at increasing residents' income by utilizing the results of maggot cultivation to create branded products. The objective was to enhance residents' knowledge and skills in managing the production and marketing of maggot slow-released pellets. During the dissemination, participants were educated on strategies to attract customers, including product design, unique product names, and attractive packaging. The training also covered pricing strategies based on capital and labour calculations. Additionally, specific criteria for product packaging were explained, including the inclusion of a name/trademark, product content, composition, function, expiry date, weight/volume, production permit, production code, and aesthetic design. In the case of BSF maggot slow-released pellets, a 250 ml bottle serves as the packaging container.
To facilitate the maggot slow-released pellet branding process, three different product designs were prepared, each with its own trade name and design options for the public to choose from as their preferred trademark. These designs were carefully selected based on their particular advantages and alignment with the information provided during the training session. Following a voting process, design (c), featuring a dark green background, was chosen as the most appealing option. This design effectively communicates the composition and benefits of the product, attracting consumers to make a purchase. It includes essential details such as volume, expiry date, and persuasive phrases aimed at capturing consumer interest. The nutritional richness of the product ensured rapid and healthy fish growth, which appeals to fish farmers. Moreover, design (c) resonates with the product and its benefits, further attracting consumers. The dissemination also emphasized effective promotion strategies for buying and selling the BSF pellet products to the public, encouraging creativity and innovation in packaging and marketing the maggot slow-released pellets.

4 Conclusions

In rural Indonesia, a comprehensive socialization and training program empowered residents to transform organic waste into slow-release maggot pellets for animal feed, significantly boosting their knowledge and skills in this sustainable practice. Participants’ awareness of pelletization's benefits, encompassing shelf-life extension, nutritional control, and increased market value, skyrocketed from an average of 61% to 94% after the program. The study also emphasized the crucial role of tailoring pellet formulas to different animal needs. While a multi-ingredient blend with duck concentrate and starch proved successful for both chickens and fish, highlighting palatability and buoyancy, a simpler formula solely relying on rice bran presented cost-effectiveness but lacked structural integrity, demonstrating the need for further research on optimal formulations. To maximize profitability, the program also incorporated branding strategies. Residents were equipped with knowledge on product design, packaging, and pricing, ultimately choosing a dark green design with clear information and persuasive phrases as their preferred trademark. This design effectively resonated with consumers, paving the way for increased sales and income generation. Overall, this study showcases the immense potential of maggot pellet production as a profitable and sustainable income source for communities, while highlighting the need for further research on optimizing formulas for specific dietary needs and addressing public perception of insect-based products to drive wider adoption and maximize this sustainable waste valorization approach.

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