

# Development of fish pellets based on BSF maggot by-product organic fertiliser in an effort to improve the economy

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## ABSTRACT

The village of Sukamakmur has the potential for freshwater fishery resources through catfish farming. Black Soldier Fly larvae (BSF) cultivated by the Farmer Group Tirta Bakti II can solve farmers' dependence on factory-made feeds, alongside the underutilization due to a lack of technological input in processing by-products. This service activity aims to develop the application of fish feed technology using BSF to meet the nutritional needs of fish, increase the market value of fish pellet products, and establish partnerships with catfish farmers and community groups in the village. The development activities involve outreach efforts to explain the production process from the materials used to the manufacturing process. The product development results indicate that the material formulation used in making fish pellets consists of a successive mixture of BSF: bran: fish meal: tapioca flour in a ratio 4:2:1:1 with a floating capability of approximately 5-7 minutes. Based on the service activities that have been carried out, this service can encourage continued production in the Tirta Bakti II Farmer Group as a new initiative in managing BSF, with the impact of improving the economy through new activities and marketing.

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## 1. INTRODUCTION

Sukamakmur Village is one of the villages in Ajung Sub-district, Jember Regency, East Java, which livelihoods predominantly rely on agriculture, fisheries, and animal husbandry. Notably, the village holds significant potential in freshwater fisheries management due to the favorable conditions for fish cultivation. Among the various options, catfish farming stands out as a promising venture. The local community benefits from catfish cultivation, citing easy marketing and manageable maintenance as key

advantages. However, the management of catfish farming in Sukamakmur Village has faced challenges, particularly with the increasing cost of feed that does not align with the selling prices (Basuki et al., 2021).

To address this issue, there is a pressing need for efforts to optimize the quality and availability of catfish feed. The significance of feed in supporting fish growth and survival cannot be overstated (Muntafiah, 2020). Currently, the costs associated with fish feed constitute a substantial portion, ranging from 70-89% of total production costs. Mitigating these costs requires exploring alternative feed ingredients with high protein content that are readily accessible. One such alternative is maggot, as highlighted by Mulyani & Haris (2021). Maggot, processed into pellets for fish feed, proves advantageous due to its high protein content, offering a potential solution to enhance fish growth while managing production costs effectively.

Pellets, a synthetic form of food created by blending various ingredients into a dough-like consistency, which is then shaped into small bars or spheres, typically measuring 1-2 cm in size. Utilizing maggot as a key component in pellet production emerges as a viable solution to address the feed requirements in fish farming, capitalizing on maggot cultivation by the Tirta Bakti II farmer group, known for its expertise in utilizing maggots as decomposers. The inherent high protein content of maggots underscores their suitability as a primary ingredient in fish feed pellets, aligning with the economic goals of the Tirta Bakti II farmer group. Collaborative efforts with this group aim to enhance maggot-based products, further augmenting the economic value of maggot (PPID Kabupaten Jember, 2023).

Situated in Sukamakmur Village, the Tirta Bakti II farmer group specializes in maggot cultivation, acknowledging the larva's impressive animal protein content ranging from 30-45%. This high protein content positions maggot as a valuable supplementary feed for black soldier flies or fish enlargement (Amandanisa & Suryadarma, 2020; Budiharjo et al., 2022). The Tirta Bakti II farmer group currently utilizes maggot as an organic waste decomposer, producing both solid (*kasgot*) and liquid (POC) organic fertilizers. Additionally, dried maggot serves as animal feed, while some larvae are allowed to pupate, contributing to the life cycle of black soldier flies and the continuous production of maggot eggs.

The potential of maggot in meeting animal feed requirements, particularly for catfish farmers, is significant. According to Wahyuni et al. (2017), a female fly can lay up to 500 eggs, which hatch into maggot larvae in four days. A single gram of maggot eggs has the capacity to yield 3-4 kg of maggot or larvae. Maggot's ability to decompose organic waste, reaching 2-5 times its body weight within 24 hours (Bosch et al., 2014), underscores its versatility. Research by Ogunji et al. (2007) and Bidayani et al. (2023) suggests that up to 30% of traditional fishmeal used in feeds can be effectively replaced by maggot. The ultimate goal of community service activities is to transform locally cultivated black soldier fly maggots into fish pellets, catering to the nutritional needs of fish. This endeavor not only aims to elevate the market value of fish pellet products but also to create new entrepreneurial avenues for the local community. Moreover, the service activity aspires to foster strong partnerships with catfish farmers and farmer groups in the village.

## **2. METHODS**

### **Activity Design**

#### **Implementation time**

The manufacture of fish pellets was carried out in Langsatan Hamlet, Sukamakmur Village, Ajung Subdistrict starting in June to July 2023. The best formulation obtained was then socialized as a form of partner empowerment on August 9, 2023. Socialization is carried out by direct exposure to farmer groups regarding formulations, manufacturing processes, to online marketing strategies and BEP calculations of the selling price of pellets that will later be produced. The schedule for the implementation of the entire fish feed making service activity can be seen in Table 1.

**Table 1.** Service implementation activities

<b>Meeting 1</b>		<b>Introduction of Service Activities to Partners</b>
Activities	Introduction to the community service program Introduction of the implementation team in carrying out the service Introduction of tools and materials for service implementation Introduction of sample products to be made	Monday, May 22, 2023
Goals	Explain the service program that will be implemented Introducing the implementation team in the service process Introducing equipment and materials as formulations in pellet making Introducing the product to be made (catfish pellets)	
<b>Meeting 2</b>		<b>Raw material assistance for pellet making</b>
Activities	Assistance in selecting pellet making materials Assistance in processing maggot as the main ingredient of fish feed	Tuesday, May 23, 2023
Goals	Assisting farmer groups in selecting raw materials for pellet making Assisting farmer groups in processing maggot before mixing with other ingredients	
<b>Meeting 3</b>		<b>Pellet Making Assistance</b>
Activities	Explanation of the formulation of catfish pellet making ingredients Assistance in the process of making catfish pellets	Saturday, July 15, 2023
Goals	Explaining to farmer groups regarding catfish pellet formulation Accompanying farmer groups in catfish pellet production activities	
<b>Meeting 4</b>		<b>Introduction to Product Packaging and Labeling</b>
Activities	Introduction to appropriate types of packaging and labeling on products Packaging and label design assistance Assistance in product packaging	Monday, July 17, 2023
Goals	Introduce types of packaging and labels Assisted in making packaging and label designs Assisting in product packaging	
<b>Meeting 5</b>		<b>Product Marketing Introduction</b>
Activities	Introduction to potential <i>market places</i> Assistance with marketing activities	Wednesday, August 9, 2023
Goals	Introducing some potential <i>market places</i> that are currently popular with the general public Accompanying marketing activities	
<b>Meeting 6</b>		<b>Monitoring and Evaluation</b>
Goals	Monitoring fish feed making activities Monitoring of packaging and labeling systems Monitoring product marketing activities	Friday, August 11, 2023
Goals	Monitor the selection of materials by farmer groups to ensure that the selection of materials is in accordance with the advice described earlier and to maintain the quality of the pellets. Monitor pellet production activities to always comply with SOPs Monitor product marketing activities	

## Materials and tools

The equipment used as support in the manufacture of Maggot BSF-based fish pellets uses a pellet printing machine as shown in Figure 1.



**Figure 1.** Fish pellet grinder machine

The grinding machine is used in molding the fish feed after mixing the ingredients according to the formulation (Figure 1). Other equipment used are baking sheet, oven, sieve, plastic container, digital balance, and sealer. The baking sheet and oven are used as one of the pellets drying processes to reduce the moisture content of the pellets. The sieve is used to separate the pellets from the pellet crumbs, while the sealer is used to package the pellets. The materials used to make BSF maggot-based fish pellets are BSF maggot, tapioca flour, fish flour and rice bran.

## Partners involved in the activity

This service activity was carried out by involving several related partners, including the Tirto Bakti II Farmer Group located in Langsatan, Sukamakmur Village, Ajung Subdistrict, Jember Regency. This farmer group is a medium for carrying out the service process by developing the potential of maggot cultivation carried out by the farmer group to maximize cultivation results and the economic sustainability of the farmer group. In addition, there is the role of the Institute for Research and Community Service (LP2M) of the University of Jember as a funder for the implementation of this service program. Also, the Agricultural Extension Service who oversees and provides advice and input on community development programs at the Tirto Bakti II Farmer Group.

## Activity Method

### Preparation

Preparatory activities are carried out using the survey method to obtain facts from existing symptoms, recognize problems, obtain justification for ongoing activities and practices and evaluate things that are done (Sugianto, 2010). This activity is the first step in mapping the needs of the cultivator group and the problems faced. The form of preparatory activities is carried out by visiting the Tirto Bakti II Farmer Group by conducting interviews and observations about understanding technology and mastering the utilization of maggot products.

### **Mentoring and introduction to production**

The presentation of the results of the trial pellet formulation was carried out by describing the process and composition of the materials used and showing samples of the results of each formula. In addition, buoyancy testing was also carried out and direct feeding to catfish around the farmer group environment. The discussion process was also carried out after the presentation of the results and processes used in each formulation. The results of the discussion obtained information related to additional ingredients that have the potential to be used in pellet formulations, namely fish.

Training activities were carried out to increase participants' knowledge and motivation on pellet making through socialization. Activities carried out include the delivery of material and simulation of pellet making to partners. The training used in community service activities is as follows: (1) Material delivery, related to the stages in making BSF maggot-based catfish pellets, and the product packaging process; (2) Simulation/practice, some of the participants will be involved in the pellet making process and product packaging process.

### **Monitoring and evaluation**

Monitoring and evaluation were carried out by the implementation team together with farmer groups as BSF maggot raw material providers. The monitoring and evaluation stage is carried out to provide solutions to problems faced by farmer groups in the production process to marketing. Monitoring and evaluation are carried out by measuring the success parameters based on the planned program indicators and objectives. These monitoring and evaluation activities are carried out when each stage of the service activity has been carried out, so that the results of the evaluation of the activities that have been carried out can become a reference for the future and improvement material for the next stage of the service activity to be carried out. In addition, another indicator of success is the increase in the economy of the Tirto Bakti II farmer group in Sukamakmur Village, which is a partner for this service.

### **Post program activities**

Post-program activities are an indicator of the sustainability of a service activity. The purpose of post-program activities is to determine the adaptive power and independence of the Tirto Bakti II farmer group as the target community towards all service activities that have been carried out in program sustainability. Post-program activities can be periodically followed by the service team as a form of responsibility for the activities that have been built together with the partners.

## **3. RESULTS AND DISCUSSION**

### **Product Development**

The maggot cultivation process undertaken by the Tirto Bakti II Farmer Group yields maggots ready for incorporation into fish feed pellets. The maggot, combined with rice bran, fish flour, and tapioca flour, becomes an integral part of the fish feed pellet manufacturing process, contributing significantly to the protein content. These maggot-based fish feed pellets address the crucial need for feed availability, a pivotal factor in achieving optimal production levels. For our partners, this initiative serves as a valuable diversification of BSF maggot cultivation products, offering a pathway to enhance aquaculture productivity and elevate the well-being of farmer group members.

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In the realm of aquaculture development, particularly in tilapia, goldfish, and catfish farming, the availability of high-quality feed in sufficient quantity plays a pivotal role in ensuring maximum production (Styana et al., 2019). The success of this partnership paves the way for further developments, including the establishment of self-sustaining feed sources in fish ponds. This strategic move enables our partners to directly experience the benefits and profits generated from their fish farming endeavors. The ongoing evolution of this collaboration holds the potential to empower farmers by providing them with a greater degree of control over the entire fish farming process, fostering sustainability and prosperity within the community.

### Stages of Implementation

#### Presentation

Presentations were made as a form of conveying the theory used in the development of Maggot BSF-based fish feed products. The presentation of the material presented refers to the material that has been compiled in the delivery of the process of making Maggot-based fish feed pellets, namely: [https://drive.google.com/drive/folders/1yWZiTS0yYEwE7YxBoqhGFBrttUrf-yu?usp=drive\\_link](https://drive.google.com/drive/folders/1yWZiTS0yYEwE7YxBoqhGFBrttUrf-yu?usp=drive_link). This aims to provide an understanding for the people of Sukamakmur Village to make fish feed products. The delivery of the material is carried out with a question and answer system to invite the discussion process from the speaker and also the community in making the product. It is hoped that the local community can develop this product, which in turn can open the way for new businesses in improving the economy in the maggot management business. An explanation of the pelletization stages is shown in Figure 2.

The culmination of the fish feed production process is showcased through a product exhibition presented to the Sukamakmur Village community (Figure 2). This demonstration meticulously follows the stages undertaken in the development of fish feed production, with detailed explanations and hands-on practical demonstrations for the community. The maggot BSF fish feed production process involves several key stages: roasting the maggot, mixing the ingredients, grinding the mixture, and the final drying phase.

To initiate the process, maggot roasting is performed, where the semi-dry maggot, previously reduced in water content through sand roasting, forms a crucial component. Subsequently, all ingredients—maggot, rice bran, fish meal, and tapioca starch—are meticulously weighed according to the formulated ratio of 4:2:1:1. The next step involves thorough mixing to ensure an even distribution of all components. Grinding of the mixture is then carried out using an 8 Hp powered grinding machine equipped with a 2 mm mesh pellet printer. This meticulous grinding process is repeated at least three times to achieve optimal mixing results.

The final stage is the feed drying process, which can be executed through either natural or mechanical means. Sun drying, lasting 2-3 days, is a traditional method, while mechanical drying employs an oven for 2 hours at a temperature of 55p C. Following the drying process, it is essential to allow the pellets to cool for 30-60 minutes before packaging. This precautionary measure, emphasized by Mubaraq et al. (2022) also Iswar & Mazmur (2020), prevents the formation of water vapor within the packaging, reducing the risk of pellet moisture and potential mold growth. The packaging is typically done using sacks or specialized plastic materials, ensuring the preservation of the fish feed pellets, and maintaining their quality. This comprehensive production process not only contributes to the community's understanding but also equips them with practical skills for sustainable fish feed production.

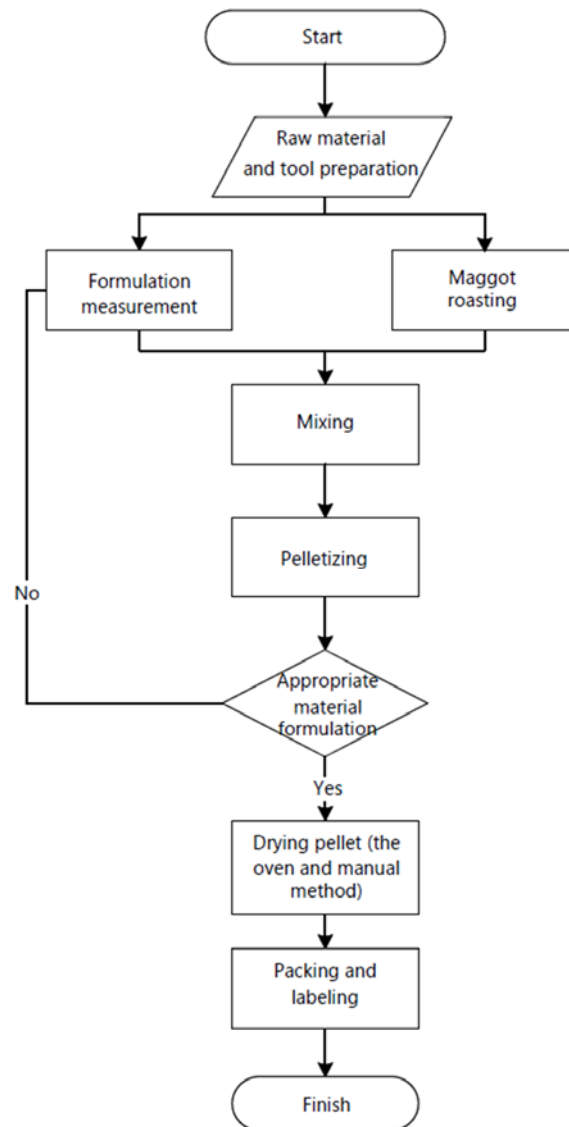


Figure 2. Flowchart of pellet making

### Activity materials

In this community service program, the activity material implemented is assistance in making catfish pellets from BSF maggots. The activity material is based on research that has previously been tested to get the best formula in making pellets from the basic ingredients of maggot BSF. The potential of BSF maggot cultivation that has not been optimized underlies the innovation of catfish pellets. The form of assistance is carried out starting from the selection of raw materials, printing, to the packaging, and marketing of pellets (Yuhanna & Yulistiana, 2017).

The participants of the mentoring were members of the Tirto Bakti II farmer group. The Tirto Bakti II farmer group had previously cultivated BSF maggot and processed it into fish feed, namely dried maggot (Figure 3). However, the process of making dried maggot is less effective in maintaining the

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nutrition of BSF maggot and the marketing is only sold to local fish farmers. Therefore, mentoring can be one of the solutions in improving the quality of utilization of derivative products from BSF maggot accompanied by increasing the selling value of these products.



**Figure 3.** Dried maggot products produced by Tirto Bakti II Farmer Group

**Figure 4.** Discussion of service program with Tirto Bakti II Farmer Group

The first day of implementation was carried out with an explanation of the service program, namely assistance in developing catfish pellets from BSF maggot (Figure 4). In addition, there is also an introduction to the service group members which aims to make the service group and residents or farmer groups know each other, making it easier to implement. This introduction also presents an introduction to the tools that will be used, namely a pellet molding machine with 8 HP power. The last agenda is the introduction of examples of products to be made. This meeting is a prelude to the implementation of activities that are expected with this introduction, the Tirto Bakti II farmer group gets an overview of the program to be implemented.



**Figure 5.** Assistance in material selection and maggot processing

The second day of implementation was assistance in selecting materials and assistance in processing maggot before pellet molding (Figure 5). Material selection is very important in making pellets, especially in the selection of maggot which is the main raw material. Processing of maggot before molding is drying maggot by roasting. These drying aims to reduce the water content in maggot. The drying process is only carried out until semi-dry conditions to maintain the protein content in maggot. Drying can improve the physical quality of the pellets so that when molding the pellets are denser and can float longer.

The third day of implementation was an explanation of catfish pellet formulation followed by assistance in making pellets (Figure 6). This activity aims to provide education to farmer groups regarding



effective formulations in pellet production. Formulation is very important in making pellets because it not only affects nutrition but also affects the physical appearance of the pellets themselves.

The fourth day of implementation was the introduction of types of packaging and labels (Figure 7). Assistance in packaging and label design, and assistance in product packaging. The introduction of packaging types in this activity is by introducing standing pouch type packaging and kilo plastic packaging for per kilogram packaging. The introduction of labels is also based on the regulations for using labels. Not only introduction, but assistance is provided from packaging methods to how to design packaging and labels so that later the service activities are completed the farmer groups can be independent in designing and can develop the design, making it more attractive in the future.



**Figure 6.** Socialization and demonstration of fish pellet making

The implementation of the fifth meeting was the introduction of several marketing places conducted with socialization in the development and marketing of maggot BSF-based fish pellet products utilizing e-commerce (Shopee, Tokopedia, and Lazada) as a form of technological advancement. In addition, product marketing using the Instagram social media *platform* was given as a form of introducing maggot BSF-based fish pellet products to a wider range of people.

The implementation of the sixth meeting was the monitoring *of* the entire process from the selection of materials, production, to marketing (Figure 8). Monitoring aims to determine the extent of understanding and how production and marketing activities can develop. Based on monitoring activities, an evaluation will also be carried out if there are obstacles in the implementation of production activities.

### **Activity Results**

Service activities in the development of fish feed produced from Maggot BSF as one of the cultivation results of the Tirto Bakti II Farmer Group are carried out with the result that fish feed contains high protein. The manufacturing process is based on the formulation we provided earlier. The benchmark for the achievement of maggot-based fish pellet development activities includes 3 criteria, namely: (1) Time and number of meetings in accordance with the activity plan; (2) The ability of partners to make maggot-based fish feed pellets with the formulations that have been given; (3) The ability of implementers to provide assistance and provide recommendations for the formulation of maggot BSF-based fish pellets in an effort to improve the economy.

Community service activities carried out in Sukamakmur Village can be said to have sufficient participation as evidenced by the presence of 53 local people. This activity is also supported by the active participation of members of the Tirto Bakti II Farmer group and Fajriyah Ulfah, S.TP, MP as agricultural extension workers as field assistants for the service team. Socialization activities are not only in the form

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of offline counseling and product manufacturing demonstrations, but also active dialogue and questions and answers about fish feed. In addition to socialization, equipment support was also provided by the Sukamakmur Promahadesa team in the form of a pellet printing machine given to the Tirto Bakti II Farmer Group in supporting the manufacture of fish feed independently. The evaluation results showed an increase in knowledge in partner members. The following is a picture of the fish feed pellet products that have been produced by partners as an implementation of the achievement of the activity (Figure 9).



**Figure 7.** Packaging and label design assistance

**Figure 8.** Monitoring and discussion after the service activity

**Figure 9.** One of the product forms of maggot-based fish feed pellets that have been produced

#### 4. CONCLUSION AND RECOMMENDATIONS

Based on the problems that occur in the Tirto Bakti II Farmer Group, namely the lack of knowledge about the process of developing innovative products, it can be concluded that the utilization of BSF maggot into fish pellets can provide a high-quality source of nutrition for fish by ensuring that fish nutritional needs can be met optimally. The development was carried out in order to meet the needs of fish feed among the surrounding community which has economic value with a high protein content. The utilization of BSF maggot as a source of protein in fish pellets can be a sustainable and environmentally friendly solution because it reduces dependence on factory-produced fish feed. Based on the service activities that have been carried out, this service can provide knowledge about the process of developing maggot that can be produced as a product of high economic value, namely by utilizing maggot as the main ingredient in making fish pellets. In addition, the involvement between catfish farmers and the Tirto Bakti II Farmer Group can create a mutually beneficial partnership relationship. Tirto Bakti II Farmer Group can continue the management of this maggot-based fish pellet product which is expected to make a positive contribution to the local economy by creating employment opportunities and increasing the income of Sukamakmur Village.

The suggestions that can be given from the results of the service activities are as follows: (1) Formulation adjustment is one of the obstacles in the development of fish feed pellets from maggot due to considerations in paying attention to floating pellets with aromas preferred by fish. It is advisable to explore alternative ingredients that can increase buoyancy or that can help form a lighter feed structure. Ensure even distribution of ingredients during mixing and molding to obtain good consistency in the feed yield; (2) The use of machines in the manufacture of products is taken into account in the machine specifications, so that the feed manufacturing process cannot take place quickly in large-scale printing. This is because the printing cylinder will not be able to print large quantities at the same time. Consider

updating or replacing the pellet molding machine with a model that has a larger and more efficient production capacity. Choose a machine that is specifically designed for large-scale purposes with specifications that support fast and effective printing; (3) The program should be followed up through cooperation with other partners or industrial parties outside the institution who are more experienced in order to find out a broader response to the implementation of a community service program that has been carried out. The partners can provide useful information about the needs that are aligned between the capabilities and knowledge that will be used to be able to carry out similar community service programs.

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