Proceeding 2nd International Conference Khairun University (IConKU) 2024 *ISBN. 978-602-74809-2-6*
Postgraduate, Khairun University *Vol 1, No 1 (2024)*
Publish Online : June, 10 2024

Potential of Organic Waste Management Using Black Soldier Fly for Alternative Fish Feed in Ternate, North Maluku

Nurfadhilah Arif[1*], Sabaruddin[2], Muh. Hidayah[3], Tri Laela Wulandari[4]

[1,2,3] Forestry, Faculty of Agriculture, Khairun University, Ternate, Indonesia
[2] Fishery Resource Utilization, Faculty of Fishery, Khairun University, Ternate, Indonesia
**Corresponding Author: dhila.arif@gmail.com*

Received: May 28, 2024
Accepted: June 2, 2024
Available online: June 10, 2024

Abstract. *Society improvement has an effect on increasing the amount of waste. This also has an effect on increasing the need for animal protein consumption such as fish. There is a need to apply technology and scientific developments to overcome this problem. Cultivating BSF larvae by utilizing household organic waste can be a fast and appropriate solution. Managing organic waste with BSF larvae has a positive impact on the environment. This research aims to identify the potential of household organic waste for cultivating BSF larvae as raw material for making fish feed. The research results show that the amount of organic waste produced from household consumption in Ternate has great potential for BSF larvae cultivation, reaching 12 kg per day. BSF larvae's growth also shows good characteristics. The average of BSF larvae biomass weight after observation among 15 day shows B1 is 4.6 g and B2 is 4.1 g. it can be concluded that the potential for cultivating BSF larvae for fish feed in Ternate is very good for development*
Keywords: *waste, black soldier fly, fish feed, Ternate*

1. INTRODUCTION

The increasing population based on BPS data also influences the increasing need for protein consumption, one of which is fish. This is also in line with the increase in fisheries cultivation. Increasing cultivation capacity also influences increased feed requirements (Fauzi and Sari, 2018).

Feed technology is an important factor in increasing feed production. Artificial feed is one form of improving the quality of fish growth. Artificial feed is formulated to contain high nutritional value so that it can encourage faster fish growth (Djarijah, 2001). The main choice referred to as a source of protein in fish feed is fish meal because it has good digestibility and palatability (Lovell, 1989).

The availability of fish feed which is generally used fluctuates with high prices depending on market conditions. So there is a need for alternative feed to meet the feed needs of fish farming. It is hoped that alternative feed can be a solution to the current feed problem, namely the relatively expensive price of fish feed. Apart from that, there is pollution of the aquatic environment due to the accumulation of leftover feed (Fahmi, Hem, & Subamia, 2009).

According to Fahmi's research (2015), the requirements for materials that can be used as raw materials for feed are that it is not harmful to fish,

contain nutrients according to fish needs, available all the time, and it's availability does not compete with human needs. Based on these conditions, the idea is emerged to make BSF larvae an alternative feed for fish farming. This has also been revealed in several previous studies.

BSF larvae have a chewy texture and are able to produce natural enzymes that it can increase the fish's digestibility of feed (Diener, et al, 2009). BSF larvae is a source of protein which can be an alternative fish feed.

This research aims to determine the potential for managing organic waste from households by utilizing BSF larvae. Where the BSF larvae can be converted into fish food through a management process. Bearing in mind, the feed required for fish cultivation is not cheap, so it is necessary to develop alternative feed, one of which is BSF larvae.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

BSF larvae have a high protein content of between 40-50% of their biomass which can be used as a source of fish food (Amandanisa and Suryadarma, 2020). It is hoped that the use of BSF larvae can reduce dependence on commercial fish feed pellets which are increasingly expensive. Meanwhile, on the other hand, we can use organic waste from households as raw material for making fish food.

One type of fish that has been studied for feeding BSF larvae is the Siamese catfish (Pangasius hypophthalmus). The survival rate of Siamese catfish showed the best value of 90% in treatment with feeding containing 100% BSF larvae (Putri, et al, 2019). Using 100% BSF larvae feed is also the cheapest fish food with good quality.

BSF larvae application has also been carried out for the growth of Balashark fish. The use of BSF larvae as a raw material for fish feed has a significant influence on the growth of Balashark fish. Apart from that, giving BSF larvae also has an effect on improving the health status of fish. This can be seen from the increase in the number of red blood cells, white blood cells and cells that carry out phagocytic activity (Fahmi, et al, 2009).

Other research reveals that BSF larvaes also have a positive effect on the development of sangkuriang catfish (Clarias sp.). The results of research carried out by substituting BSF larvae flour in fish feed. BSF larvae flour substitution resulted in better survival rates for catfish (Fadlan, et al, 2022).

3. RESEARCH METHODS

This research was carried out in August-November 2023 at the Waste Management Center, Faculty of Agriculture, Khairun University, in Fitu Village, South Ternate District. The research stages can be seen in the research flow diagram.

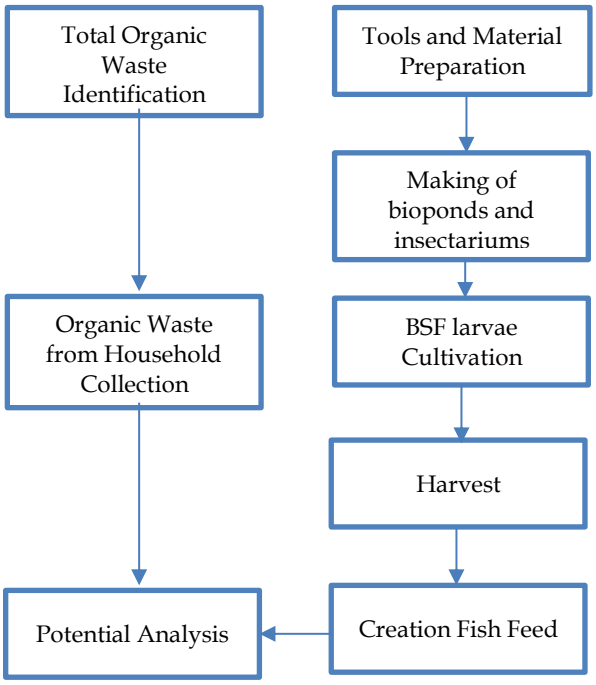

Fig.1 Research Flow Diagram

The tools used include equipment for making biofonds such as hammers, nails and saws, basins for hatching eggs, enlargement biofonds and migration biofonds as BSF larvae breeding containers, ovens for drying, meanwhile, crushers for crushing them into powder/flour feed. The materials used are BSF eggs, bran, organic waste which is transported every day from residents' homes, paranet, wood. Organic waste is obtained from household waste around the cultivation site, namely from Fitu sub-district and Sasa sub-district, South Ternate District.

This research began by identifying the types of household waste and the amount of organic waste available in Fitu and Sasa sub-districts. This was done to analyze the potential availability of organic material to be decomposed by BSF larvaes during the BSF larvae cultivation process. Identification is carried out by calculating the amount of household organic waste available compared to the amount of organic material needed by BSF larvaes per day.

The next stage is cultivating Black Soldier Fly (BSF) to produce the required larvae (BSF larvaes). BSF larvaes are able to bioconvert organic food during their development. This cultivation begins with hatching BSF eggs and then caring for them until they reach a certain BSF larvae size so they can be harvested. Some BSF larvaes will be harvested as raw material for fish feed, others will be left to cycle until they become adult flies and lay eggs again. It is hoped that this cultivation will always be sustainable.

The scenario used in this research is using two enlargement biofonds. The first biofond (B1) is used as a medium for BSF larvae enlargement by providing fruit waste. Meanwhile, the second Biofond (B2), BSF larvae enlargement media using organic materials in the form of mixed food waste. During the process of growing BSF larvaes in biofond, they are maintained and analyzed for data collection every 5 days.

The BSF larvaes that have been harvested are dried. Then, a comparison was made of the weight of the BSF larvae before and after drying. After drying, the BSF larvaes can be crushed into powder as a raw material for making fish food. BSF larvaes produced from cultivation can be given directly to fish or can be mixed with other commercial feed ingredients. Therefore, further stages can be carried out in the next research.

4. RESULTS AND DISCUSSION

Organic waste in the form of food waste in North Maluku has experienced a drastic increase since 2022. Ironically, in previous years the trend of food waste has decreased. The exact cause of this increase is not yet known. Based on data from the Ministry of Environment and Forestry, the amount of food waste in 2022 in North Maluku will increase by 15.86% from 2021.

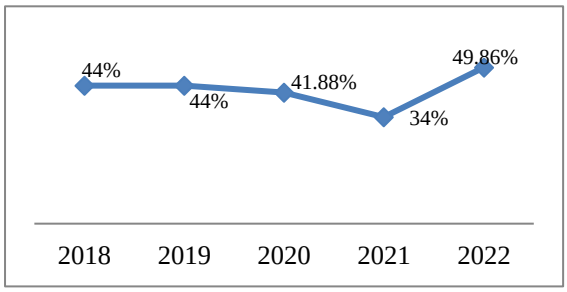

Fig.2 Amount of food waste in North Maluku in 2018-2022

Data collection on potential household organic waste was carried out using the purposive sampling method. This research involved several households around BSF larvae cultivation sites as a source of organic waste. Through the collection of organic waste, data was also obtained in the form of household waste management systems in Fitu Village and Sasa Village (Figure 5). Ternate people's awareness of environmentally friendly household waste management is still very minimal. Most Ternate people manage their waste by throwing it away or burning it. Meanwhile, the percentage of household waste management separately between organic and inorganic materials is only 2% of the total respondents.

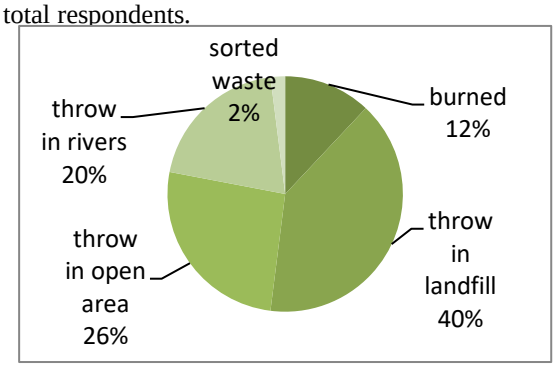

Fig.3 Household Waste Management in Ternate in 2023

The potential for household organic waste to be used as bioconversion material for BSF larvae cultivation can be seen from the amount of organic waste collected every day during the cultivation process.

The organic waste collected is in the form of food scraps and fruit waste. Poor household waste management still causes a mix of organic and inorganic waste. So, further efforts are needed to separate this waste through socialization. The separated fruit waste was obtained from several fruit sellers whose fruit was rotting and unsold. The average amount of organic waste collected during the cultivation period was 12.04 kg/day. This amount is more than enough to be used as bioconversion material for BSF larvae.

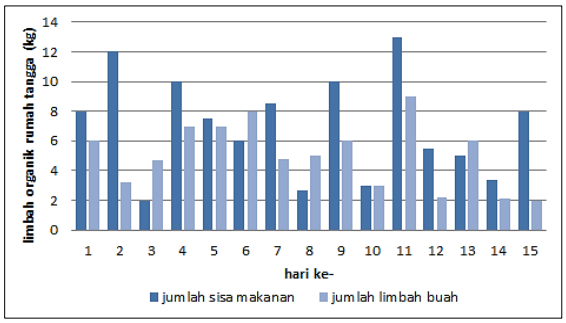

Fig.4 Amount of organic waste in Fitu and Sasa Villages for BSF larvae cultivation per day

The amount of household organic waste collected came from several houses in Fitu Village and Sasa Village. Organic waste collected from only a few houses does not cover all houses in Ternate. However, the collected organic waste can meet the needs for BSF larvae cultivation. If developed further, managing organic waste by cultivating BSF larvae could be a very effective solution in reducing the impact of environmental pollution by organic waste.

Organic waste contains potential nutrients that are important for the food composition of BSF larvae larvae. These nutrients affect the productivity and quality of BSF larvae larvae. The nutrients contained in BSF larvae larvae are around 40–50% protein, 20–30% fat and essential amino acids which can be used as an alternative ingredient for fish meal (Wardhana, 2016). Based on this, household organic waste can be used as a medium for developing BSF larvae.

Based on the results of cultivation observations, the egg hatching process is ±5 days and the enlargement phase (instar) is ±25 days before they become pupae. The media in which BSF larvae grow must contain sufficient nutrients.

BSF larvae can live in quite extreme environmental conditions, such as in organic waste media which is acidic and contains alcohol and ammonia derivatives. BSF larvae can also live in warm or cold temperatures. If there is a lack of food, BSF larvae do not die, they just vacuum temporarily until food is available again (Gold et al., 2018). Apart from that, BSF larvae can also live in water or meat media (Bonelli et al., 2019). Another advantage is that BSF larvae can live in a fairly high pH tolerance, do not become disease vectors, and are easy to cultivate. These characteristics of BSF larvae have high potential in carrying out bioconversion of organic waste more easily and quickly compared to other organisms.

BSF larvae cultivation in this study used two biofonds, namely biofond 1 (B1) which is a medium containing food waste and biofond 2 (B2) containing fruit waste. BSF larvae were observed for 15 days after the eggs hatched. The weight of the BSF larvae was measured every 5 days and averaged to obtain data on the weight of the BSF larvae biomass. The average increase in BSF larvae biomass weight after the 15th day in B1 was 4.6 g and B2 was 4.1 g (Tabel 1).

Table 1. Average Weigth Gain (gr) maggot biomass in organic waste media

Media	Days to-			Average Weigth Gain (Gr)
	5	10	15	
B1	2.4	4.8	7	4.6
B2	2.1	3.6	6.2	4.1

Maggot biomass continues to increase with the length of maintenance. Maggots will stop growing after entering the prepupa phase. The difference in maggot growth on media B1 and B2 is caused by different types of organic material. The composition of the water content in B2 is higher than in B1, thus disrupting the maggot consumption process. In fact, although maggots can live in conditions that have high water content and pH, maggots prefer media with relatively lower water content. Diener, et al (2009) stated that the most optimal media conditions for maggot development are those with a maximum water content of 60%.

The process of harvesting maggots as raw material for fish feed should be carried out at least two weeks after the cultivation period. This maggot harvest is carried out before entering the prepupa phase. Please note that the maggot's life cycle is only approximately 35 days. So it is recommended to harvest maggots a maximum of 25 days after the BSF eggs hatch. The harvesting process is carried out by separating the maggot biofond which contains organic material. Some of the cultivated maggots are used as broodstock which will turn into adult flies. This ensures that cultivation activities are sustainable. The maggots that have been harvested are then dried and the conversion value is calculated. To obtain 1 kg of dried maggots, around 3 kg of fresh maggots are needed (Fahmi, et al, 2015).

Based on several previous studies, BSF larvae feeding applications have been carried out on several types of fish. Most of these studies reveal that giving BSF larvaes as fish food has a good impact on almost all types of fish. If BSF larvae cultivation for fish food is carried out in Ternate, it is hoped that it will provide a new solution for fishermen.

5. CONCLUSION

Management of organic waste in North Maluku in general, and in Ternate in particular, is not yet optimal. Most people still do not sort household waste. They still choose to burn or throw their waste into open areas or rivers. In fact, household waste, especially organic waste, has great potential for maggot cultivation. The research results showed that maggot development was very good using organic waste as a growing medium. During 15 days of

observation in the instar phase, maggots were able to convert most of the organic waste provided. Furthermore, maggots have the potential to be used as raw material for fish feed.

ACKNOWLEDGEMENT

Thank you to the Faculty of Agriculture, Khairun University, which has provided material support for the implementation of this research. Thank you also to the Khairun University Waste Management Center for providing space for maggot cultivation.

REFERENCE

Amandanisa, A. dan Suryadarma, P. (2020). *Kajian Nutrisi dan Budi Daya Maggot (Hermentia illuciens L.) Sebagai Alternatif Pakan Ikan di RT 02 Desa Purwasari, Kecamatan Dramaga, Kabupaten Bogor*. Jurnal Pusat Inovasi Masyarakat, 2 (5): 796–804

Ambarningrum, T.B., Pratiknyo, H., dan Priyanto, S. (2009). *Indeks nutrisi dan kesintasan larva spodoptera litura f. Yang diberi pakan mengandung ekstrak kulit jengkol (pithecellobium lobatum benth.)*. J. HPT Tropika 9(2), 109-114.

Craig Sheppard, D., Larry Newton, G., Thompson, S. A., & Savage, S. (1994). *A value added manure management system using the black soldier fly*. Bioresource Technology, 50(3), 275–279

Diener, S., Zurbrügg, C., & Tockner, K. (2009). *Conversion of organic material by black soldier fly larvae: establishing optimal feeding rates*. Waste Management & Research, 27(6), 603–610.

Djarijah, A. S. (2001). *Budidaya Ikan Patin*. Yogyakarta: Kanisius

Fadlan, A., Syafitri, E., dan Manullang, H.M. (2022). *Substitusi tepung maggot sebagai pakan alternatif terhadap pertumbuhan dan kelangsungan hidup benih Ikan lele sangkuriang (clarias sp.)*. J.Aquac.Indonesia 1(2): 100-109

Fahmi, M. R. (2015). *Optimalisasi proses biokonversi dengan menggunakan mini-larva Hermetia illucens untuk memenuhi kebutuhan pakan ikan*. Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia, 1, 139–144.

Fahmi, M. R., Hem, S., & Subamia, I. W. (2009). *Potensi maggot untuk peningkatan pertumbuhan dan status kesehatan ikan*. Jurnal Riset Akuakultur, *4*(2), 221–232

Fauzi, R.U.A dan Sari, E.R.N. (2018). *Analisis Usaha Budidaya Maggot sebagai Alternatif Pakan Lele*. Industria: Jurnal Teknologi dan Manajemen Agroindustri, 7(1), 39-46

Lovell, R. T. (1989). *Nutrition and Feeding of Fish*. New York: Van Nostrand Reinhold

Putri, W. R., Helmi, H., Kusuma, H., dan Rangga, B. (2019). *Kombinasi Maggot pada Pakan Komer-sial terhadap Pertumbuhan, Kelangsungan Hidup, FCR dan Biaya Pakan Ikan Patin Siam (Pangasius hypophthalmus)*. Jurnal Ilmu-ilmu Perikanan dan Budidaya Perairan. 14(1), 7-16

Sihombing, S.M., Yulinas, dan Mirwandono. (2022). *Maggot Production of Various Organic Wastes (Vegetables, Fruits, Food Processing Industries): Potential as Alternative Feed Substitutes for Fish Meal*. Jurnal Peternakan Integratif, 10(2), 112-116.

Surendra, K. C., Tomberlin, J. K., van Huis, A., Cammack, J. A., Heckmann, L. H. L., & Khanal, S. K. (2020). *Rethinking organic wastes bioconversion: Evaluating the potential of the black soldier fly (Hermetia illucens (L.)) (Diptera: Stratiomyidae) (BSF)*. Waste Management, 117, 58–80

Yanuar, A., Tyasari, F.G., & Dughita, P.A. (2018). *Pemanfaatan Limbah Organik dari Rumah Makan Sebagai Alternatif Pakan Ternak Ikan Budidaya*. Agronomika, 13(1)