

# The Effect Of Combination Of Livestock Waste And Household Organic Waste as Growth Media on Media Moisture Content, Weight, Population Density, And Length Of Maggots Black Soldier Fly (*Hermetia illucens*)

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**ABSTRACT:** Maggot BSF is a solution for handling organic waste. This research aims to determine the right combination of media to obtain quality BSF maggots. The study was conducted at the Microbiology and Animal Waste Management Laboratory, Faculty of Animal Husbandry, Padjadjaran University. The method used was experimental and a completely randomized design (CRD) with 4 treatments and 5 replications. The treatments consisted of P0 (Media mixed with fermented household organic waste), P1 (Media mixed with sheep faeces + fermented kitchen organic waste), P2 (Media mixed with milk sludge + fermented household organic waste), and P3 (Media mixed with sheep faeces + milk sludge + waste fermented kitchen organic). The results showed that the highest media moisture content was obtained by P2 which amounted to 82,54%. The combination of different media types had a significant effect ( $P < 0.05$ ) on the growth of BSF maggots. The best results were obtained by P2, namely a combination of milk sludge and kitchen organic waste with an average population density of BSF maggots of 1.30 individuals/cm<sup>3</sup>, weight of 0.097 grams/individual, and length of 1.47 cm/individual. Meanwhile, the lowest result was obtained by P1, namely a combination of sheep faeces and kitchen organic waste, which received a population density of 0.73 individuals/cm<sup>3</sup>, a weight of 0.057 grams/individual, and a length of 0.99 cm/individual.

**KEY WORDS:** Larvae, Media, Combination, Growth, Waste

Date of Submission: 25-06-2024

Date of acceptance: 03-07-2024

## I. INTRODUCTION

The livestock industry is one of the businesses that can produce solid waste and liquid waste containing organic matter and microorganisms, so it has a serious impact on the environment. The wastewater produced has the potential to pollute the environment if the production process uses excessive chemicals. The organic matter contained can increase BOD (Biological Oxygen Demand) and COD (Chemical Oxygen Demand) and reduce DO (Dissolved Oxygen) levels as a water pollution parameter. This is based on the statement of Kahlon et al. (2018) which states that pollution caused by organic waste in aquatic ecosystems can drastically deplete oxygen, so that waste decomposes faster than dissolved oxygen is obtained. The amount of light needed by aquatic organisms to photosynthesize will be reduced when a large amount of material is suspended in wastewater[1]

Sheep manure is one of the wastes from sheep farming that contains nutrients such as nitrogen (N), phosphorus (P), potassium (K) and water. Sheep manure contains 1.28% nitrogen, 0.19 phosphorus, 0.93% potassium, 0.59% calcium, 0.19% magnesium, 0.09% sulfur, 0.020 iron[2] This shows that waste from livestock farms can be a resource with high potential as energy and nutrients for life, both for microorganisms, animals, and plants. In addition to sheep on-farm waste, the off-farm livestock industry, namely the milk processing industry, produces waste, namely milk sediment. Milk sediment is a by-product resulting from the processing of milk raw materials into processed products[3]. Apart from the high water content, the resulting milk sediment still contains organic matter that can be used as fertilizer because it is a good medium for decomposing

microorganisms. In addition to waste from the livestock industry, a very serious environmental problem to be faced by the government and society is waste, especially organic waste which is still rarely processed.

Maggot is the larva of the black soldier fly (*Hermetia illucens*) which has the ability as a decomposing agent or detritivore of organic waste and as additional animal feed. BSF maggot has several main advantages over other insect species to be used as animal feed, namely that these insects are polyphagous and have high amylase, lipase, and protease activities[4]. The BSF maggot growth medium used in this study is organic waste in the form of sheep feces, milk sediment, and kitchen organic waste which still contains pathogenic microbes and maggots will have difficulty digesting it so that the fermentation process must be carried out first. The fermentation process is carried out by adding probiotics in the form of EM4. Fermentation is carried out as an effort to convert complex compounds in sheep feces, milk sediment, and household organic waste to be more easily consumed by maggots and prevent the presence of pathogenic microorganisms.

According to Wahyuni et al, (2020) BSF maggot can grow and develop on media that has sufficient content for its nutritional needs. Therefore, it is necessary to know the right combination to support the cultivation of BSF maggot[5]. The combination is done in order to produce the best quality BSF maggot.

## II. MATERIAL AND METHODS

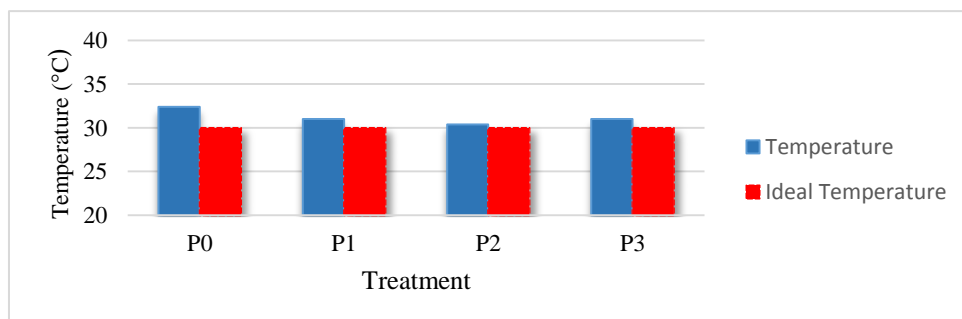
The research was conducted at the Laboratory of Microbiology and Animal Waste Management, Faculty of Animal Husbandry, Padjadjaran University. The maggot enlargement process was carried out using a container in the form of a tray with a size of 27 cm wide, 36.5 cm long, and 14 cm high as many as 20 pieces. The tools used in addition to the trays are digital scales, vectors, pH meters, and stationery, while the materials used are sheep feces, milk sediment, kitchen organic waste, tofu pulp, molasses, and EM4.

This research was carried out in the following stages: a) each cultivation medium was put into a silo of 20 kg of sheep faeces, 20 kg of milk sediment, and 25 kg of kitchen organic waste. b) Make a fermentation solution using EM4, molasses and water in a ratio of 10 millilitres of EM4: 1 litre of molasses: 10 litres of water. Then pour it into a silo containing 1 litre of media each for sheep faeces and milk sludge and 2.5 litres for kitchen organic waste, then close the silo tightly and let it sit for 7 days. c) BSF eggs of 1 gram per tray are hatched for 3-4 days using 50 grams of tofu dregs. After hatching, the baby maggots are sown onto growing media in the form of fermented media. The enlargement process from baby maggot to larva lasts 14 days. d) Parameter calculations, including weight, population density, maggot length and, pH and water content of the media, were carried out at the end of the research while temperature observations were carried out every day.

This research used an experimental method with a Completely Randomized Design (CRD) with five replications and four treatments. Treatments consisted of P0 (Media derived from organic waste), P1 (50% Media mixed with sheep faeces + 50% household organic waste), P2 (50% Media mixed with milk sludge + 50% household organic waste), and P3 (33.3% Sheep faeces mixed media + 33.3% milk sludge + 33.3% fermented household organic waste). The data obtained will be calculated using the analysis of variance (ANOVA) method, followed by Duncan's Multiple Range Test, to determine differences. The software used for statistical analysis is IBM SPSS 27.

## III. RESULTS AND DISCUSSIONS

The temperature of each medium was investigated daily using an analog thermometer while the pH was observed after the fermentation process was complete by taking a 25 gram sample from each culture medium. The average temperature and pH of the BSF maggot culture media are presented in Fig. 1 and 2.



**Figure 1: Average of temperature**

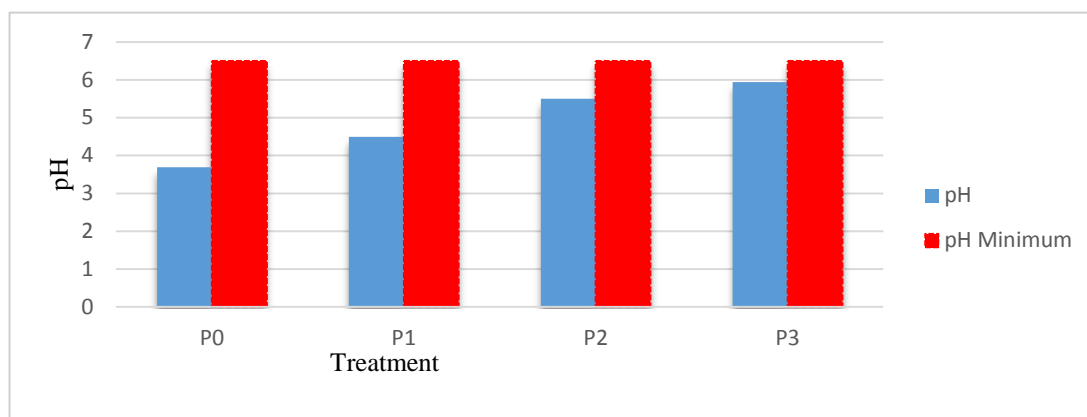


Figure 2: Average of pH

Based on the results of the observations presented in (Fig. 1), BSF maggots can live at temperatures ranging between 30.4-32.4°C, which is the ideal temperature for the growth of BSF maggots. According to Tomberlin et al. (2009), the development of BSF maggots will be slower if they are developed on media with a temperature of 27°C, compared to a temperature of 30°C and BSF maggots will not survive if the media temperature reaches 36°C[6]. The high and low temperatures of the culture media can be caused by several factors, including the C/N ratio value and sunlight intensity[7]. Culture media containing too much crude fibre will also produce high C in the hydrolysis process by microbes, which will cause the release of heat, increasing the temperature. In this study, the temperature in the P0 culture medium was higher compared to other treatments. This is thought to be due to the nutritional content of the P0 culture medium containing more vegetables, so the fibre content is high. This opinion is supported by the research results of Purnamasari et al. (2021), which stated that the highest crude fibre was obtained in maggot media, which came from market waste containing vegetables, so it had a high crude fibre content[8].

The pH value in this study also has quite significant differences. The BSF maggot culture media used has a pH range of 3.69-5.94. This value tends to be acidic because the culture medium has gone through a fermentation process. The pH value in the culture medium will indirectly influence the growth of BSF maggots. This statement is supported by the opinion of Kresnawati et al. (2019), who stated that the temperature and pH of the growth media could influence the growth of amyolytic bacterial colonies found on the bodies of BSF maggots[9]. The bacteria found in the intestines of BSF maggots help them convert organic waste into fat and protein into their body biomass[10].

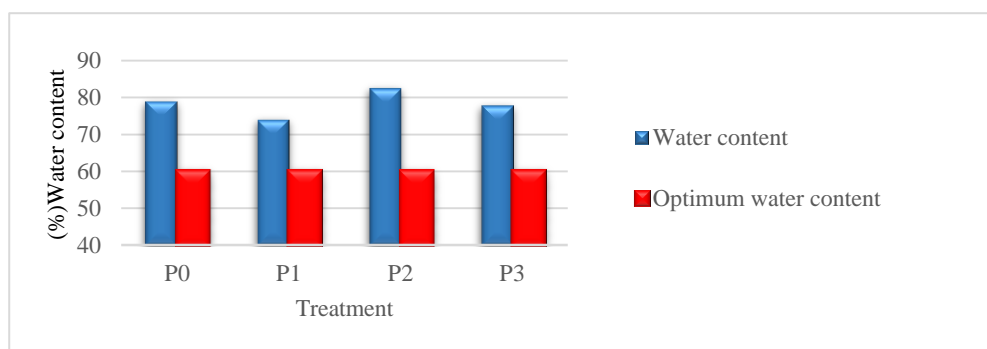


Figure 3: Average of Water Content

In accordance with (Fig. 3) the water content contained in the BSF maggot culture media ranges from 74.08-82.54%. According to Yuwono & Mentari, (2018) the ideal water content in BSF maggot media is 60% [11]. The water content in the BSF maggot culture media will greatly impact the weight and nutritional quality of the BSF maggot produced. This is in accordance with the opinion of Fahmi (2015) which states that BSF maggot can absorb water from its culture media, so that it can affect the water content of the resulting BSF maggot [12].

The moisture content of the BSF maggot culture media is a variable that plays a major role in the maggot growth process. Other studies have shown that media moisture content ranging from 50%-80% is optimal for larval development, final weight, and feed conversion efficiency [13]. Lalander et al. (2020) have even experimented with growing BSF larvae at a moisture content of 90%-97%, but the resulting survival rate and body weight were lower than the media moisture content of 75%-88% [14].

Based on the results of this study, the highest water content was produced by P2, which is thought to be due to the fact that both materials, namely milk sediment and household organic waste, still have a fairly high water content. In addition, fermentation ingredients such as EM4, molasses and water can also influence. According to Makkar et al. (2014) the water content of BSF maggot culture media will affect the texture of the media and affect larval movement, feed consumption, and growth [15]. P2 media moisture content is still in the range of optimal moisture content but this is not proportional to the weight produced because in addition to moisture content there are other factors that can affect the weight of BSF maggot. Gold et al. (2018) showed that prepupae usually weigh 0.055-0.299 grams depending on the media used [16].

The maggot population density level at 21 days can be seen in Table 1. Based on the results of observations in Table 4, the highest average maggot population density was obtained from treatment P2 with an average population density of 1.30 individuals/cm<sup>3</sup> with a pond area of 27 cm, length of 36.5 cm, and height of 14 cm, which has a volume of 13,797 cm<sup>3</sup>. The overall results of the maggot population density are listed in Table 1.

**Table I. Average population density level of BSF maggots**

Treatment	BSF Maggot population density (heads/cm <sup>3</sup> )
P0	1.24 <sup>b</sup> ± 0.450
P1	0.73 <sup>a</sup> ± 0.145
P2	1.30 <sup>b</sup> ± 0.386
P3	0.95 <sup>ab</sup> ± 0.164

**Note: Different superscript letters in the same column indicates significantly different (P<0.5)**

The results in Table 1 show that P0, P2, and P3 have the same influence on the density of the BSF maggot population but are significantly different from P1. This is because the media content in P0, P2, and P3 has relatively the same nutrient levels and media conditions. Based on the results of this research, the lowest population density was obtained from P1 culture media, as well as the lowest weight and length of BSF maggots. The low population density in the research results of Niu et al. (2022) was obtained from drum fertilizer media, which shows an abundance of nutrients that influence the weight and length of BSF maggots [17]. However, in contrast to the results of this study, the lowest weight and length of BSF maggots were obtained from the P1 culture medium. This phenomenon is thought to be unfavourable to the nutritional content of sheep faeces and kitchen organic waste in this study, thereby inhibiting the growth and development of BSF maggots.

According to Amran et al. (2021), increasing the number of BSF maggot individuals will increase population density. This is even better if the resulting weight is high because this shows that the nutritional content and condition of the media are sufficient to meet the growth and development needs of BSF maggots. Media that has good nutritional content will have a positive influence on the growth of BSF maggots.

Weight is the weight of an object in a specific condition. The weight of BSF maggots was calculated by weighing the BSF maggots per head that had been harvested on the 20th day using analytical scales. Rizki et al. (2017) argue that weight is the weight of an organism that has experienced growth [18]. The results of calculating the weight of BSF maggots on different media can be seen in Table 2.

**Table II: Average weight of BSF maggots on different media**

Treatment	BSF Maggot Weight (gram/head)
P0	0.096 <sup>b</sup> ± 0.013
P1	0.057 <sup>a</sup> ± 0.005
P2	0.097 <sup>b</sup> ± 0.021
P3	0.095 <sup>b</sup> ± 0.034

**Note: Different superscript letters in the same column indicate significantly different (P<0.5)**

The data from the table above shows that different feeding treatments had a significant effect (P<0.05) on the weight of BSF maggots. Table 3 shows that P1 significantly differs from other treatments, where P1 also has the lowest average weight of BSF maggots. The nutritional content of the culture media greatly influences these results. The analysis results carried out at the Ruminant Animal Nutrition and Food Chemistry Laboratory, Faculty of Animal Husbandry, in 2023 showed that the content of sheep faeces and kitchen organic waste before fermentation used in the research contained 14.37% and 19.41% protein. This content greatly influences the weight growth of BSF maggots. Apart from that, the aroma of the culture media also influences the weight growth of BSF maggots. The mixed media of sheep faeces and household organic waste after fermentation produces a reduced aroma compared to the ingredients, so this is thought to reduce the level of consumption of BSF maggot feed. This is to the statement by Herlinae et al. (2021) that BSF flies prefer media containing nutrients and a sharp aroma[19].

The results of observations on the length of BSF maggots in different cultural media also gave varying results. The following are the results of calculating the length of maggots per head, which are presented in Table 3. The results of research regarding the effect of treatment media on the growth of BSF maggots show that the average length of BSF maggots produced has differences between culture media.

**Table III: Average Length of BSF Maggots on Different Media**

Treatment	BSF maggot length (mm/head)
P0	13.5 <sup>b</sup> ± 0.149
P1	9.9 <sup>a</sup> ± 0.037
P2	14.7 <sup>b</sup> ± 0.127
P3	13.3 <sup>b</sup> ± 0.081

**Note: Different superscript letters in the same column indicatesignificantly different (P<0.5)**

The results of the analysis of variance showed that each treatment was significantly different (P<0.5) in terms of BSF maggot length. This shows that differences in fermented culture media influence the growth in length of BSF maggots. Based on Table 3, the highest average length of BSF maggots in each treatment was found in treatment P2 (milk sludge + kitchen organic waste); this is thought to be due to the provision of milk sludge mixed with fermented kitchen organic waste containing nutrients and organic materials that high enough for the growth and reproduction of BSF maggots, resulting in an average length of BSF maggots of 1.47 cm/head. These results are higher than the results of research by Nguyen et al. (2013), which showed that the length of BSF maggots fed organic waste was 0.14 cm[20].

Based on the results of the analysis conducted in the Ruminant Animal Nutrition and Food Chemistry Laboratory of the Faculty of Animal Science in 2023, it shows that the content of milk sediment has a protein content of 13.41% and kitchen organic waste has a protein content of 19.41% so that the protein content of P2 media is half of each of these media contents. The high protein content in the culture media is directly proportional to the quality of the BSF maggot produced. This is supported by the statement of Rizki et al, (2017) which states that the length growth of BSF maggot is influenced by several factors, one of which is the protein content of the media.

#### IV. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of research that has been carried out, it can be concluded that the combination of milk sludge and kitchen organic waste has the best effect as a culture medium on the weight, population density and length of BSF maggots. The media used in this study were sheep feces, milk sediment, and fermented kitchen organic waste with the best results obtained from a combination of milk sediment and kitchen organic waste. In accordance with the results of this study, it is recommended that in the processing of dairy processing industry waste, BSF maggot can be used as a decomposer.

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