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Effect of combination of beef cattle feces, dairy waste water solid, and organic kitchen waste as maggot growth media (*Black soldier flies*) on maggot population weight and density

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Abstract

The livestock industry is closely associated with waste. On-farm waste such as beef cattle feces and off-farm waste in the form of dairy waste water solids can have detrimental effects on the environment if left untreated. The high nutrient content of livestock industry waste can be effectively utilized to prevent environmental pollution. However, the large amount of organic waste poses a significant challenge due to population density and the lack of land for waste storage or processing, which are unresolved issues. This waste can be processed through bioconversion, with the use of *Black Soldier Flies* (BSF) larvae representing a new method of organic waste treatment. This research was conducted at the Beef Cattle Teaching Farm and the Laboratory of Microbiology and Animal Husbandry Waste Handling, Faculty of Animal Science, Padjadjaran University. The objective of this study was to investigate the impact of combining beef cattle feces, dairy waste water solids, and kitchen organic waste on the weight and density of maggot populations. The experimental method employed four treatments with five replications each: 100% kitchen organic waste (P0), 50% kitchen organic waste and 50% beef cattle feces (P1), 50% kitchen organic waste and 50% dairy waste water solids (P2), and 33.4% kitchen organic waste, 33.4% beef cattle feces, and 33.4% dairy waste water. The conclusion drawn from this study is that the combination of kitchen organic waste and beef cattle feces contributes to an increase in maggot population density.

Keywords: Maggot; Media; Feces; Dairy waste water solids; Waste

1. Introduction

Industrial beef cattle farming companies in Indonesia still prioritize livestock productivity without considering environmental aspects or the impact of livestock waste on the environment. Beef cattle feces contain high concentrations of nitrogen (N) and phosphorus (P), causing environmental problems if not handled properly. This can cause nutritional imbalances in the environment (Abdeshahian, Lim, et al., 2016; Mayasari et al., 2020). One of the wastes from processing livestock products is dairy milk production waste water or Dairy waste water solids which has a high concentration of contamination. Utilization of dairy processing industry waste has not been done well. The dairy processing industry is required to carry out waste treatment before the waste is discharged into the river. In addition to livestock waste, waste is still a big problem in many developing countries, including Indonesia. Currently, waste processing still piling up in landfills that continue to be used until it causes problems, such as air pollution (Siswanto et al., 2022).

Law Number 32 of 2009 states that every business is allowed to dispose of waste into environmental media with the requirement of meeting environmental quality standards. This waste can be processed through bioconversion.

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Bioconversion involves microorganisms to convert organic waste into high-value products. *Black Soldier Flies* (BSF) can consume organic waste around them as food to survive. BSF larvae have broad pH-tolerant characteristics that affect their ability to survive in various media (Mangunwardoyo et al., 2018: Yuwita et al., 2022). The growth of BSF maggot will be optimized if the nutrients for the needs of BSF maggot life are met. Food with quality substrates will encourage the development and growth of larvae due to adequate nutrition (Buana and Alfiah, 2021). The larvae of these insects have the ability to process various types of organic matter and convert them into a body consisting mainly of protein, fat, and chitin (Cickova et al. 2015).

A common problem with growing media is decay, so the maggots obtained are not clean or smelly. To produce clean and odorless maggots, maggot growth media can be fermented using microorganisms from commercial products such as EM4, Natura Organic Decomposer, and Probio-7 (Amran et al., 2021). This is the basis for researchers to conduct research related to the bioconversion process, seeing weight and population density as determining factors in the success of the decomposition process on growth media.

2. Material and methods

2.1. Material

The materials used in this study are; beef cattle feces, dairy waste water solids, kitchen organic waste, maggot eggs, tofu pulp, EM4, molasses, water, distilled water, and buffer solution.

Tools used: box basin, blue barrel, thermometer, pH meter, scale, sieve, gloves, plastic, wire ram, porcelain cup, oven, desiccator, and forceps.

2.2. Methods

This study used an experimental method with a complete randomized design (CRD) and a follow-up test of Duncan's Multiple Range Test with 4 treatments and 5 replicates. The treatments are as follows: P0 (100% Fermented Kitchen Organic Waste), P1 (Combination of 50% Fermented Kitchen Organic Waste and 50% Fermented Beef Cattel Feces), P2 (50% Fermented Kitchen Organic Waste and 50% Fermented Dairy Waste Water Solids), and P3 (33.4% Fermented Kitchen Organic Waste, 33.4% Fermented Beef Cattel Feces, and 33.4% Fermented Dairy Waste Water Solids).

This research was conducted in the following stages: a) The media used were 20 kg of beef cattle feces, 20 kg of dairy waste water solids, and 50 kg of kitchen organic waste, then mixed with EM4 solution in a ratio of 10 liters of water: 10 milliliters of EM4 and 100 milliliters of molasses, giving 50 ml for 1 kg of media. b) The media that has been mixed is fermented separately and carried out anaerobically in blue barrels for 7 days. c) Hatching maggot eggs is carried out for 3–4 days using 50 grams of tofu pulp; d) after the eggs hatch, the maggot is transferred to the enlargement media according to the treatment media that has been fermented, e) maintenance is carried out for 14 days, then parameter measurements are taken.

2.2.1. Observed Variables

The variables observed in this study were:

Population density, body weight, length, pH, temperature, and water content.

2.3. Parameters

2.3.1. Weight Measurement

The weight of maggot is calculated by weighing the weight of maggot before it is inserted into the media and has been harvested using a scale in each treatment.

2.3.2. Population density measurement

The measurement of maggot population density was carried out at the beginning and end. Population calculations were carried out using the Krebs (1989) metric volume method.

$$D=N/S$$

Description:
D: Maggot Population Density (tail/cm3)
N: Number of Individuals
S: Volume of Growing Media

2.3.3. Maggot Length Measurement

Maggot length measurements were measured using a caliper at the end of the study by sampling. The number taken for sampling was 10 heads of each treatment (Hartami et al., 2015).

2.3.4. Measurement of Water Content

Measurement of water content is carried out using the thermogravimetric oven method (SNI-01-2354.2-2006) with the principle of removing water molecules through heating with an oven at 105 °C for 16–24 hours, measuring the initial level carried out on the media before and after enlargement of BSF maggot.

2.3.5. Media Temperature Measurement

Temperature plays an important role in the rearing of BSF maggots. Temperature measurements were taken at the beginning and end of maggot rearing using a thermometer. Temperature measurements are taken at several points in one enlargement media.

2.3.6. pH measurement

One of the factors that affects the production of BSF maggots is pH. pH measurements were made on the media before maintenance and after the bioconversion process by maggot using a pH meter. Sample measurements were taken by dissolving the media with distilled water using a ratio of 1:9. The sample is dissolved until homogeneous and then measured using a pH meter until the pH does not change does not change.

3. Results and discussion

Temperature, pH, and Moisture Content of BSF Maggot Media

3.1. Temperature, pH, and Moisture Content of BSF Maggot Media

Temperature measurements were taken every day during maintenance, while pH and water content were taken on the media before and after degradation by maggots. Data on temperature, pH, and water content can be seen in Table 1 below:

Table 1 Mean temperature, pH, and moisture content of BSF maggot media

Treatments	**Culture Media Condition**		
	temperature (°C)	**pH**	**moisture content (%)**
P0	26± 0.548 [a]	3.92 ±0.054 [a]	75.44±2.736[a]
P1	26 ±0.548 [a]	4.69 ±0.108 [b]	77.44 ±0.963[a]
P2	27 ±0.447[a]	4.93 ±0.160[c]	81.76 ±0.565 [b]
P3	27± 0.548 [a]	4.79 ±0.139[c]	80.88 ±0.073 [b]

Notes: Different letters in the same column indicate significant differences (P<0.05).

The moisture content in Table 1. ranged from 75.44-81.76%. The moisture content of the treatment media greatly affects the growth of maggot. Rizki et al., (2017), stated that excessive moisture in the media can affect reproduction in this environment. To ensure optimal maggot growth, it is important to pay attention to the nutrient content of the media (Agustinus and Ming. 2019: Amran et al., 2021). The water content of the growth media has a direct impact on the water content of the BSF maggot produced. According to research by Tomberlin (2009), adult BSF maggots do not need food and only consume water. Since maggot larvae require water for reproduction, growth media that have a high-water content will affect the growth of the maggots produced.

One of the factors that can affect the growth of BSF maggots is the temperature of the media used. Based on Table 1. the media temperature ranged from 26 - 27 °C. Gunawan et al. (2022), showed that media temperature plays an important role in the bioconversion process of organic waste by larvae by encouraging composting and supporting larval growth. Temperature plays an important role in maggot growth and production. Consistent with the findings of Tomberlin et al. (2009) in Nugrahani et al. (2018), the temperature of the maggot growth media can affect maggot production and their breeding rate. This is in accordance with the findings of Gunawan et al. (2022), which state that young larvae can survive at temperatures below 20 °C and above 45 °C if the food supply is sufficient, but BSF larvae show optimal growth at temperatures between 30 and 36 °C. The temperature of the media can vary depending on environmental conditions due to heat transfer from the environment to the media container used. Due to high temperatures, larvae may die. Newby (1997) in Cheng et al. (2017) found that larvae can die quickly if the temperature exceeds 47 °C. In addition, continuous heat release during the bioconversion process can make the temperature around the larvae rise above the limit that can cause death (Cheng et al., 2017).

pH is one of the factors supporting the growth of BSF maggots. In Table 1. pH ranged from 3.92-4.93. This is in accordance with the research of Ramadhan et al., (2022) which shows that BSF larvae can eat various types of organic waste because of their tolerance to various pH of food. The study also confirmed that BSF maggots can survive in the pH range of 4 to 8 and can further degrade organic waste. According to Isroi (2008) in Mudeng et al. (2018), the optimal pH value for the composting process is between 6.5 and 7.5. Acidic decomposition processes lower the pH, while ammonia production from nitrogen-containing organic matter increases the pH. Mature compost usually has a pH close to neutral. BSF larvae can tolerate various biological inhibitors such as ethanol, acetic acid, temperature, and pH extremes in microaerobic fermentation (MF) of waste. BSF larvae can tolerate a pH range of 0.7 to 13.7 and can vary in initial pH from 2.7 to 2.7 and from 7.8 to 8.9, making them suitable for use in sewage treatment technologies (Alattar, 2012; Gunawan et al., 2022).

3.2. Density of the Population

The results of the calculation of the population density of maggots that have been reared for 21 days can be seen in Table 2.

Table 2 Effect of treatment on maggot population density

Treatments	Mean Maggot Population Density (tails/cm3)
P0	0.50 ±0.104 [a]
P1	1.08±0.172 [b]
P2	0.63±0.086 [a]
P3	0.76±0.299 [a]

Notes: Different letters in the same column indicate significant differences ($P<0.05$).

Table 2. shows that the population density of maggots P0 (control) and P1 shows a significant difference. This result is in accordance with the statement of Fatmasari et al., (2017) in Salsabil et al., (2021), an increase in the number of bacteria and organic components produced by decomposing bacteria due to the high content of organic matter, resulting in an increase in the total food material in the media and an increase in the population density of BSF maggots.

The population density in P1 is greater than the other treatments, the greater the maggot population density value, the smaller the maggot weight produced. The combination of beef cattle feces and SOD (P1) produces maggots with the highest population density and small maggot sizes but tends to be more uniform, due to differences in nutrients in each media. Maggots can grow well if their nutritional needs are met by media that are high in protein and carbohydrates (Sabdo and Priscilia, 2018; Amran et al., 2021).

The density of the resulting population is also influenced by the increase in body weight and maggot length. The higher the density value, the smaller the maggot produced, this is shown in P1 with the highest density value and the lowest weight. In their research, Taufiqqurrohman et al., (2021) found a relationship between maggot growth and population density. The availability of sufficient space and food will increase the weight and length growth of maggots, which tends to occur in populations with low maggot growth. Adult BSF larvae do not eat, they eat as much organic matter as possible and store fat and protein in their bodies to aid their metabolism during the pupal and adult stages (Newton et al., 2005).

3.3. Maggot Weight

The results of the calculation of maggot weights that have been processed by taking a sample of 10 heads per media unit are presented in Table 3 below:

Table 3 Effect of treatment on maggot weight

Treatments	Mean Maggot Body Weight (gram/tail)
P0	0.111 ± 0.031^{ab}
P1	0.078 ± 0.011^{a}
P2	0.135 ± 0.034^{b}
P3	0.130 ± 0.026^{b}

Notes: Different letters in the same column indicate significant differences (P<0.05).

Based on Table 3. The weight of P2 is higher than P0 (control), P1, and P3. This is due to differences in the nutritional content of the media used and the environmental conditions. This is in accordance with the opinion of Susanto (2002) in Fakhrieza et al., (2021), where environmental conditions, habitat, and food availability are known to play an important role in the growth of organisms. Existing food intake affects growth rates such as weight gain and survival time.

The fat content of the combination of dairy waste water solids and kitchen organic waste can also increase maggot body weight, which can be seen in the P2 treatment. Faradilla et al., (2023) need to know that the weight gain of BSF maggot is influenced by its fat content, such as fat in tembang fish. This is in accordance with the findings of Taufiqqurrohman et al. (2021), showing that changes in fat content affect larval weight and body length. This is because *Hermetia illucens* larvae convert energy into fat, which is used in the reproductive stage after the larvae become adults.

Very significant differences were also found in the weight of maggot treatment P1 with P0 (control), P2, and P3. This is due to the different content of organic matter. According to Rizki et al. (2017), the growth media chosen, depending on the maggot's natural environment, will affect the weight. The main reason for the increase in weight is the high proportion of organic matter in the media used. The fermentation process that occurs in the growth media is thought to be one of the factors that affects the body weight of *Black Soldier Flies* (BSF) maggots. According to Amran et al. (2021), the interaction between cultivation media and the type of microorganisms added plays an important role in determining the weight of maggot produced. This is because microorganisms can increase the nutritional value of the media and encourage larval growth.

One of the factors that affect maggot body weight is the amount of feed consumed. In line with the statement of Irsyad et al. (2023), The increase or decrease in larval body weight depends on how much they eat. According to Fajri & Kartika (2021), the amount of food consumed by larvae depends on the nutritional value of the type of food provided.

3.4. Length of Maggot

The results of the calculation of maggot length that has been processed by taking a sample of 3 heads per media unit are presented in Table 4 below.

Table 4 Effect of treatment on maggot length

Treatments	Mean Maggot Length (mm/tail)
P0	$14^{b} \pm 0.130$
P1	$11^{a} \pm 0.089$
P2	$15^{b} \pm 0.114$
P3	$15^{b} \pm 0.084$

Notes: Different letters in the same column indicate significant differences (P<0.05).

Based on the data in Table 4. it shows that P0 (control), P2, and P3 are significantly different from P1. In P1, the maggot length is shorter than in the other treatments. The results of this study indicate that the provision of different growth media affects the length of maggot produced. This is due to differences in nutrients in the growth media. Faradila et al., (2023), found that a high protein content in the media affects the length of maggots. This is in accordance with the research of Varianti et al., (2017), digested protein is converted into amino acids, which are used to build body tissues such as meat, which in turn causes weight gain.

The difference in maggot length in the P3 and P1 treatments can be caused by using media with different mixtures. DeHaas et al. (2006) and Awaludin et al. (2021) also found that the quality of the media on which the larvae grow is positively correlated with larval length and adult survival. Variations in larval growth are thought to be caused by variations in the availability of nutrients in the media and the amount of media consumed in each treatment. Therefore, these differences are also influenced by the nutrients used in the formation of body tissues (Fajri et al., 2021).

4. Conclusion

The combination of beef cattle feces, milk yield, and kitchen organic waste can support the growth of BSF maggots. Media combinations give different results in density, weight, and length. The best density was obtained in the combination of beef cattle feces and organic kitchen waste, while the best weight and length were seen in the combination of dairy waste water solids and organic kitchen waste.

Compliance with ethical standards

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Disclosure of conflict of interest

There are no conflicts of interest that need to be disclosed.

References

[1] Mayasari, N. Firmansyah, I & Ismiraj, M. 2020. Counseling on Beef Cattle Waste Processing Techniques in the Putra Nusa Farmer Group, Kondangdjaja Village, Cijulang District, Pangandaran Regency. Journal of Science and Technology Applications for Society. Vol 9 (3); 194-198

[2] Siswanto, A., Yulianto, M., Ariyanto, H., Pudiastutingtyas, N., Febriyanti, E., Safira, A., & Wardhana, M. 2022. Processing Organic Waste Using Maggot Media in the Polaman Resik Sejahtera Waste Bank Community, Polaman Village, Mijen District, Semarang City. Journal of Vocational Service. Vol 2 (3); 193-197

[3] Yuwitas, R. Fitria, L. & Jumiati. 2022. Bioconversion Technology of Restaurant Organic Waste with Black Soldier Fly (BSF) Larvae. Journal of Wetland Environmental Technology. Vol 10 (2); 247-253.

[4] Buana & Alfiah. 2021. Bioconversion of Cattle Manure using Black Soldier Fly (Hermetia illucens) Larvae. National Seminar of Applied Science and Technology IX 2021.

[5] Cicková H, Newton GL, Lacy RC, Kozánek M. 2015. The use of fly larvae for organic waste treatment. Waste Manag 35:68 - 80. https://doi.org/10 .1016/j.wasman.2014.09.026.

[6] Rizki, S. Hartami & Erlangga. 2017. Population Density Level of Maggot in Different Growing Media. Acta Aquatica. Vol 4 (1); 21-25

[7] Amran, M., Nuraini, & Mirzah. 2021. Effect of Fermentation Culture Media with Different Microbes on Black Soldier Fly (Hermetia illucens) Maggot Production. Journal of Animal Husbandry. Vol 18 (1); 41-50.

[8] Tomberlin JK, Adler PH, Myers HM. 2009. Development of the Black Soldier Fly (Diptera: Stratiomyidae) in Relation to Temperature. Enviromental Entomol. 38:930-934.

[9] Gunawan, I. Kartika N, Fajri N & Firiah, A. 2022. The Effect of Using Different Hatching Media on the Production of BSF Baby Maggot. Journal of Agribusiness and Animal Husbandry. Vol. 2 (1); 12-17

[10] Cheng JYK, Chiu SLH, Lo IMC. 2017. Effects of moisture content of food waste on residue separation, larval growth, and larval survival in black soldier fly bioconversion. Waste Manag 67:315-323. https://doi.org/10 .1016/j.wasman.2017.05.046

[11] Nugrahani, I. Fathul, F & Tantalo, S. 2018. Effect of Various Media on Media Temperature and Maggot Production. Journal of Livestock Research and Innovation. Vol 2 (1); 33- 38.

[12] Ramadhan, I. Arifin & Jumiati. 2022. Efficiency of Using Black Soldier Fly (Hermetia Illucens) Larvae to Decompose Organic Waste with Fermentation Material Variations. Journal of Environmental Science. Vol 20 (4); 717-725.

[13] Mudeng, N., Mokolensang, J., Kalesaran, O., Pangkey, H., & Lantu, S. 2018. Maggot (Hermetia illuens) cultivation using several media. Aquaculture. Vol 6 (3);1-6

[14] Salsabil, A. Nurhayatin, T & Herawati, E. 2021. Population Density Level of Weight and Length of Black Soldier Fly Maggot (Hermetia illuncens) with Different Feeding. Journal of Animal Husbary Scince. Vol 6 (1); 11-20

[15] Taufiqqurrohman, O. Oktarani, A & Kurniawan, R. 2021. Effect of Growth Media Type on Population Density, Weight, and Length of Maggot (Hermetia illuncens). Jab-Staba. Vol 5 (2); 23-28.

[16] Newton, L. A. R. R. Y., Sheppard, C. R. A. I. G., Watson, D. W., Burtle, G. A. R. Y., & Dove, R. O. B. E. R. T. (2005). Using the black soldier fly, Hermetia illucens, as a value-added tool for the management of swine manure. Animal and Poultry Waste Management Center, North Carolina State University, Raleigh, NC, 17(2005), 18.

[17] Fakhrieza, M., Dari, D., & Yuniastuti, T. 2023. Bioconversion of Cow Manure, Tofu Dregs and Vegetable Waste Using Maggot. Journal of Public Health. Vol 7(1); 604-610.

[18] Faradila, S. Syamsuddin. Muqarramah, N. Jariyah, A & Wahyuni, S. 2023. Different Growing Media on the Production Rate and Nutrient Content of Black Soldier Fly Maggot. Udayana Veterinary Bulletin. Vol 15 (3); 490-497.

[19] Irsyad, A. Dono, D & Puspasari, L. 2023. Effect of feed type on biology and nutritional indices of black soldier fly, Hermetia illucens L. (Diptera: Stratiomyidae). Journal of Plant Protection. Vol 6 (2); 95-104.

[20] Fajri, N & Kartika, N. 2021. Maggot production using chicken manure as poultry feed. AGRIPTEK (Journal of Agribusiness and Animal Husbandry). Vol 1 9 (2); 66-71.

[21] Varianti NI, Atmomarsono U, Mahfudz LD. 2017. Effect of feeding with different protein sources on protein utilization efficiency of local chicken crosses. J. Agripet. 17(1): 53-59.

[22] Awaludin, A. Hadist, I & Royani, M. 2021. Effect of Harvest Age on Maggot BSF (Black Soldier Fly) Production. Journal of Animal Science. Vol 6 (1); 36-44.

[23] Fajri, N. Kartika, N & Mariani, Y. 2021. Weight Level of BSF Maggot on Chicken Manure and Saoi Manure Media. Journal of Agribusiness and Animal Husbandry. Vol 1 (3); 77-83.