Production of black soldier flies (\textit{Hermetia illucen}) maggot to the chicken feces media level

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Abstract. In addition to having high nutrition, \textit{Hermetia illucens} maggot also has fulfilling nutrients to be used as poultry feed ingredients. The aim of this research was to obtain high \textit{H. illucens} maggot production and as quality feed. This study was designed using a completely randomized design with four treatments of the media type and three replications. In total, 12 treatment combinations were produced, i.e. 4×3 experimental units, P0: 100% tofu waste, P1: 50% tofu waste and 50% chicken feces, P2: 75% tofu waste and 25% chicken feces, P3: 25% tofu waste and 75% chicken feces. The results obtained were chicken feces media at different levels significantly affected (p<0.05) the dry matter, crude protein, crude fat, and crude fiber level of black soldier flies (\textit{H. illucens}) maggot. The highest dry matter and crude protein level were on P1 and lowest were on P3. The crude fat level of P0 was significantly higher than P2 and P3 but equal to P1. Crude fiber level of P0 was significantly lower than P2 and was not significantly different from P1 and P3. In conclusion, media that had high production was found in P1 with the high dry matter, crude protein and crude fat levels, and low crude fiber level.

1. Introduction
Maggots are organisms derived from fly eggs, in the second phase of metamorphosis after the egg phase and before the pupa phase which then turns into adult flies [1]. Maggot can convert organic material into its biomass. The advantage of the maggot is that it can be produced in various sizes, according to needs [2]. The protein content of black soldier fly maggots is quite high, which is 40-50% with fat content ranging from 29-32% which can be used as feed [3]. Besides maggot has a storage organ called trophocytes which functions to store the nutrient content contained in the consumed culture media [4].

Maggot or larvae from the black soldier fly (\textit{Hermetia illucens}) is one type of insect that meets the requirements to be used as an alternative protein source of feed. Foodstuffs that contain more than 19% of crude protein are classified as protein sources of food [5]. Protein sourced from insects is more...
economical, environmentally friendly and has an important role naturally [6]. Insects are reported to have high feed conversion efficiency and can be maintained and mass-produced. Besides, it does not compete with humans so it is very suitable to be used as animal feed ingredients, including poultry and fish [7].

In addition to having high nutrition, *H. illucens* maggot also has fulfilling nutrients to be used as poultry feed ingredients. *Hermetia illucens* maggot can convert organic material into its biomass [2,8]. The advantage of maggot is that it can be produced in various sizes, according to needs. Besides maggot has a storage organ called trophocytes which function to store the nutrient content contained in the consumed culture media [4].

The media type is one of the factors which influence the production level, both quality and quantity. This paper discusses the rearing of maggot black soldier flies using tofu waste media and different levels of chicken feces. The purpose of this study was to obtain high production of *H. illucens* maggot and as a high-quality feed.

2. Materials and methods

This research was carried out in the Animal Husbandry Department for the rearing black soldier fly maggot and the nutrition analysis was carried out in the Feed Chemistry Lab, Faculty of Animal Husbandry, Universitas Hasanuddin. The tools used were a basin, raffia ropes, kasha cloth, and scales. The ingredients used were chicken feces, tofu pulp, *H. illucens* maggot.

All ingredients for growing media were weighed and mixed with a total weight of 2.5 kg. Then each growth media were added with 1 g of *H. illucens* eggs and grown for 20 days. This study was designed using a completely randomized design with four treatments of the media type and three replications. In total, 12 treatment combinations were produced, i.e. 4×3 experimental units, P0: 100% tofu waste (control); P1: 50% tofu waste and 50% chicken feces; P2: 75% tofu waste and 25% chicken feces; P3: 25% tofu waste and 75% chicken feces. The nutrient content of each treatment presented in table 1.

| Media                        | Crude protein (%) |
|------------------------------|-------------------|
| 100% tofu waste (control)    | 21.91             |
| 75% tofu waste + 25% chicken feces | 19.51             |
| 50% tofu waste + 50% chicken feces | 17.10             |
| 25% tofu waste + 75% chicken feces | 14.67             |

3. Results and discussion

Figure 1 showed that the use of chicken feces media with different levels had a significant effect (p<0.05) on dry matter content of black soldier fly maggot. The treatments P0, P1, and P2 were the same (p>0.05), but significantly different from P3 (p<0.05). The highest dry matter content was P1 (30.47%) due to the fulfillment of nutrient content, especially protein and the texture that was not too dry and wet. The good nutrient content was very important for maggot growth [10]. Reinforced by [9] the more nutrient content contained in the culture media, the maggot’s proximate results obtained will be better.

The low dry matter P3 (14.39%) was caused by high levels of crude fiber sourced from chicken feces so that it cannot be digested by *H. illucens* maggot. The discrepancy in culture media percentage to maggot growth with the media protein value is 14.69% besides that, the culture media condition is dominated by chicken feces, thus inhibiting the food absorption by the maggots in the larval phase [9]. *Hermetia illucens* maggots have four life phases and different nutritional needs. Each growth phase has different dry matter content due to different levels of feed consumption. This species as decomposers recycles nutrients in organic waste into maggot biomass which is high in protein and fat, a process called bioconversion [11–13]. The dry matter contained in maggot was in the organic matter
form, especially fat and protein, as seen in figure 2 and 3. The development phase of maggot is influenced by feed quality.

![Dry matter (%) of black soldier fly (Hermetia illucens) maggot on chicken feces media with different levels.](image)

Figure 1. Dry matter (%) of black soldier fly (Hermetia illucens) maggot on chicken feces media with different levels. Different letters in superscript showed significantly different (p<0.05) average numbers.

Figure 2 showed that the use of chicken feces media with different levels had a significant effect (p<0.05) on the crude protein content of black soldier fly maggot. The crude protein at P0 was significantly higher than P3 (p<0.05) but not significantly different from P1 and P2. The crude protein content from highest to lowest were P1 (42.98%), P2 (41.69%), P0 (38.59%), and P3 (26.34%). It shows that by using a higher level of chicken feces, crude protein content in black soldier fly maggot is lower due to low levels of crude protein in the media. High crude protein on maggot in the P1 treatment is from the media’s naturally fermented amino acids. Types of amino acids in H. illucens maggot are glutamic acid, aspartic acid, alanine, tyrosine, valine, lysine, and leucine [14]. The composition of the media had a significant influence on the protein content of maggot, BSF maggot protein contents are highly determined by the protein content of the media used [15].

The crude protein content in the P0 media (control) was higher than P1 and P2, but the maggot protein content that grows in P0 media was lower than P1 and P2. In accordance with the previous explanation, it shows that the texture of media affects the growth and media nutrients absorption by maggot, especially the protein of the media. The older the maggot, the higher the levels of crude fat due to the substrate consumed. According to [16], this was caused by the texture of tofu waste which is very dense or has a small air cavity that inhibits the aeration process in the media.

Figure 3 showed that the use of chicken feces media with different levels gives a significant effect (p<0.05) on the crude fat content black soldier fly maggot. The P0 treatment was not significantly different (p>0.05) with P1 and was significantly different (p<0.05) with P2 and P3. The highest crude fat content of maggot was P0 (39.41%) and the lowest was P3 (15.37%). The crude fat content in maggot is in the volatile fatty acid forms which are absorbed from the media. The fat contained in maggot is fatty acids from the consumed media with the help of the lipase enzyme found in H. illucens maggot [2.17]. The ability of H. illucens larvae to eat various types of organic matter and then convert it to fat or calories is due to the presence of lipase and amylase enzymes in the digestive system [18].
Figure 2. Crude protein (%) of black soldier fly (Hermetia illucens) maggot on chicken feces media with different levels. Different letters in superscript showed significantly different (p<0.05) average numbers.

Figure 4 showed that the use of chicken feces media with different levels gives a significant effect (p<0.05) on the crude fiber content of black soldier flies larvae. The P2 treatment was significantly higher (p<0.05) than P0, but equal to P1 and P3. Using the higher level of chicken feces in maggot growth media, will results in crude fiber content of maggot that tends to rise. High maggot crude fiber content at P2 and P3 are due to media crude fibers. The crude fiber in maggot is in cellulose form as an energy reserve for pupae preparation. Black soldier fly larvae have lignin digestive microorganisms converted into cellulose, energy source for maggot [19].

Figure 3. Crude fat (%) of black soldier fly (H. illucens) maggot on chicken faeces media with different levels. Different letters in superscript showed significantly different (p<0.05) average numbers.
Different levels showed significantly different (p<0.05) average numbers.

4. Conclusion

Based on the results and discussion, it can be concluded that the use of chicken feces media with different levels has a significant effect (p<0.05) on dry matter, crude protein, crude fat and crude fiber content in the black soldier fly (Hermetia illucens) larvae. The treatment that had the best nutritional content was P1 with the high dry matter, crude protein and crude fat, and low crude fiber.

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