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by Dwi Kesuma Sari

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³ The nutritional value of black soldier flies (*Hermetia illucen*) as poultry feed

A T B A Mahmud^{1,2}, Santi², DP Rahardja³, RRSRA Bugiwati³ and DK Sari⁴

¹ Post Graduate Study Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia.

² Animal Husbandry Department, Faculty of Agriculture, Al Asyariah Mandar University, Polewali Mandar, Indonesia.

³ Animal Husbandry Department, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia.

⁴ Veterinary Medicine Department, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia.

E-mail: anditenribauastuti@gmail.com

Abstract. Black soldier fly larvae or maggot (*Hermetia illucens*) is one type of insect that meets the requirements as alternative protein source of feed. The purpose of this research is to obtain high quality feed production. This research will be carried out in the Animal Husbandry Department of Unasman for the rearing and the nutrition analysis will be carried out in the Feed Chemistry Lab, Faculty of Animal Husbandry, UNHAS. This study was designed using a completely randomized design (CRD) consisting of 5 and 3 replications. The treatments in this study are as follows: A₀: 5 days, A₁: 10 days, A₂: 15 days, A₃: 20 days, A₄: 25 days. The results obtained are the rearing period that significantly affect the levels of dry matter, crude fat, and crude protein black soldier fly maggot (*Hermetia illucens*) and doesn't have significant effect on crude fibre levels. The rearing period of 25 days (A₄) has the highest dry matter content that is 30.47%. Crude fat at 25 days rearing time (A₄) is 34.09% significantly higher than A₀ (22.09%), A₁ (24.82%) and A₂ (26.79%). Maggot with a rearing period of 20 days (A₃) has the highest crude fibre content of the other treatments that is 10.50% and the lowest is A₀ (9.07%). The A₀ (49.91%) treatment is significantly higher than A₂, A₃, and A₄. The longer the rearing period of *Hermetia illucens* maggot, the level of dry matter, crude fat and crude fibre tends to increase. However, the crude protein decrease, although not significantly.

1. Introduction

Three main factors that must be considered in preparing poultry feed are the availability of feed ingredients, the price of feed ingredients, and the nutritional content of poultry feed ingredients. These three factors affect the five components of poultry feed ingredients that make up the largest feed compilers, namely bran, cooking oil and corn as feed energy sources, soybean meal and fish meal as feed protein sources. The availability of Indonesian raw materials is still dependent on imports, especially protein sources feed ingredients, both plant based and animal based. Poultry feed ingredient that must be imported is the cause of slump in poultry business, because the cost of this feed reaches

70 percent for broilers and 90 percent for laying hens [1]. Therefore, it is necessary to have alternative protein feed ingredients that have good quality, affordable prices and sustainable availability of.

Maggot or larvae of black soldier fly (*Hermetia illucens*) is one type of insect that meets the requirements of being used as an alternative protein source of feed. Food stuffs that contains more than 19% of crude protein are classified as protein source food [2]. [3] protein sourced from insects is more economical, environmentally friendly and has an important role naturally. Insects are reported to have high feed conversion efficiency and can be maintained and mass produced. Besides that, it does not compete with humans so it is very suitable to be used as animal feed ingredients, including poultry and fish[4]. Maggot is one type of natural feed which has 41-42% crude protein, 31-35% ether extract, 14-15% ash, 4.8-5.1% calcium, and 0.6-0.63% phosphorus in dry form [5]. Phosphorus has an important role in the poultry metabolism [6].

The maggot phase of the black soldier fly (*Hermetia illucens*) from birth to pupae consists of 4 namely baby larvae, adult larvae, pre pupae and pupae. The development phase of maggot / maggot age influences the production of both quality and quantity. This paper discusses the rearing of black soldier fly maggot (*Hermetia illucens*) using tofu pulp and chicken faeces media with different rearing period. The purpose of this research is to obtain high quality feed production.

2. Materials and methods

This research was conducted in April - July 2019. Rearing of black soldier fly maggot *Hermetia illucens*, this research will be carried out in the Animal Husbandry Department for the rearing and the nutrition analysis will be carried out in the Feed Chemistry Lab, Faculty of Animal Husbandry, UNHAS. The tools used are a basin, raffia ropes, kasha cloth and scales. The ingredients used are chicken faeces, tofu pulp, *Hermetia illucens* maggot. All ingredients for growing media are weighed and mixed with total weight of 2.5 kg and a percentage of 75% tofu pulp and 25% chicken faeces. Then each growth media was added with 1gr of *Hermetia illucens* eggs with the rearing period according to each treatment. This study was designed using a completely randomized design (CRD) consisting of 5 and 3 replications. The treatments in this study were as follows:

A₀: 5 Days

A₁: 10 Days

A₂: 15 Days

A₃: 20 Days

A₄: 25 Days

The data obtained were tabulated using Excel and analyzed using SPSS 24.

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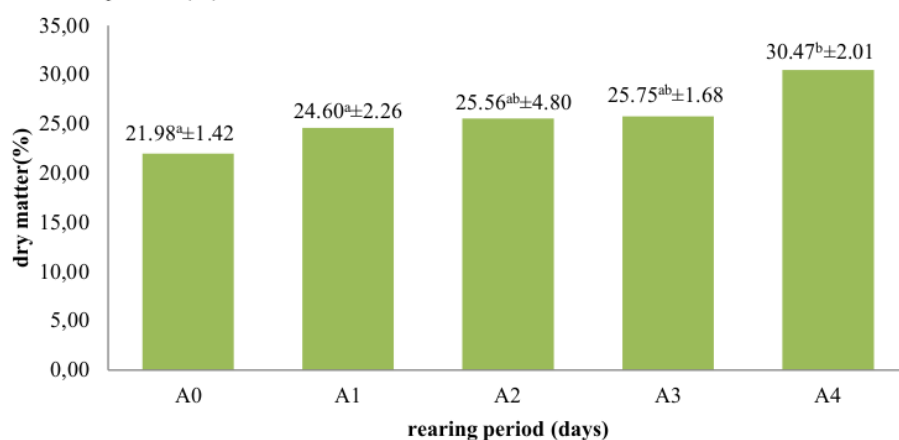
3. Results and discussion

3.1. Dry matter

Figure 1 shows that rearing period significantly affect the dry matter content of black soldier fly maggot (*Hermetia illucens*). The rearing period of 25 days (A₄) has the highest dry matter content that is 30.47% and is significantly different from A₀ (21.98%) and A₁ (24.46%). The duration of rearing is positively correlated with the dry matter content. The longer rearing period, the higher the dry matter content of black soldier flies (*Hermetia illucens*) due to the increase of crude fibre and crude fat content.[7] Dry matter content of BSF larvae tended to be positively correlated with increasing age, which is 26.61% at five days to 39.97% at 25 days.

Hermetia illucens maggot has four life phases and has different nutritional needs. Each growth phase has different content of dry matter due to different levels of feed consumption. [8] At 15 to 18 days is the highest level of maggot consumption in improving its life quality and after reaching 2-4 mg of dry weight will migrate. [9-11] This species as decomposers recycles nutrients in organic waste into maggot biomass which is high in protein and fat, a process called bioconversion. Dry matter contained in maggot is in the organic matter form, especially fat and protein, it can be seen in Figures 2 and 3. The development phase of the maggot is influenced by the feed quality.

Figure 1. Dry matter of black soldier fly maggot (*Hermetia illucens*) with different rearing periods (%)

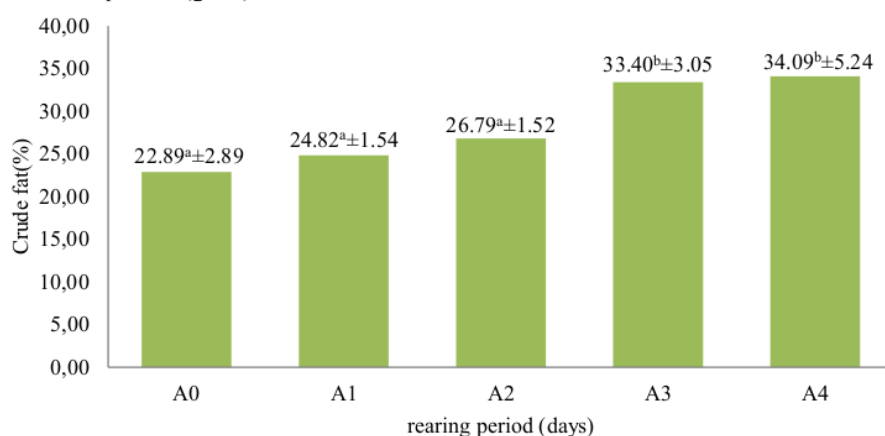


Note: different letters in superscript, average numbers are significantly different ($p < 0.05$).

3.2. Crude fat

Figure 2 shows the rearing period significantly affect crude fat content. Crude fat at 25 days (A₄) rearing time is 34.09% significantly higher than A₀ (22.09%), A₁ (24.82%) and A₂ (26.79%). The longer the maggot age, the higher the crude fat content due to the substrate consumed. The substrate used is tofu pulp and chicken faeces. The longer it is stored, it will naturally ferment and produce volatile fatty acids. [12] The ability of *Hermetia illucens* larvae to eat various types of organic matter and convert it to fat or calories is due to the presence of lipase and amylase enzymes in the digestive system. [13] Fat is essential for growth and as a food reserves for adult *Hermetia illucens*. Nutritional balance accelerates into the pre pupae phase.

Figure 2. Crude fat of black soldier fly maggot (*Hermetia illucens*) with different rearing periods (gram)

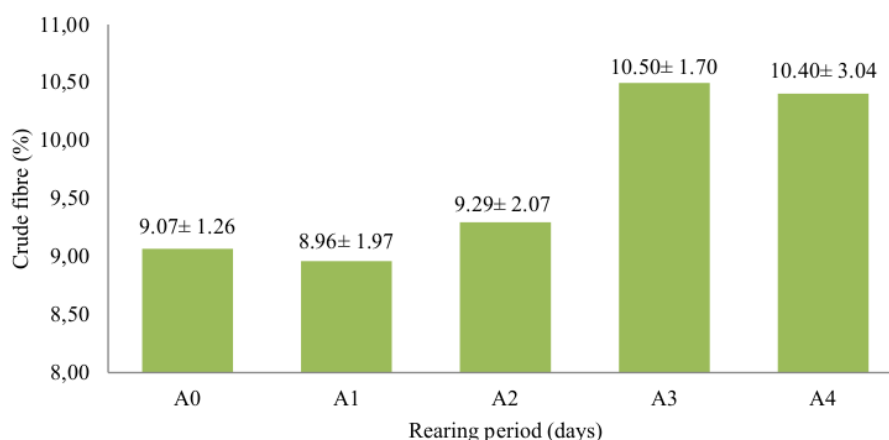


Note: Different letters in superscript, average numbers are significantly different ($p < 0.05$).

3.3. Crude fibre

Figure 3 shows that rearing period of black soldier fly maggot (*Hermetia illucens*) does not significantly affect the crude fibre content. Maggot with a rearing period of 20 days (A₃) had the highest crude fibre content of the other treatments which is 10.50% and the lowest was A₀ (9.07%). Crude fibre contents tend to increase with the age increase of maggot.

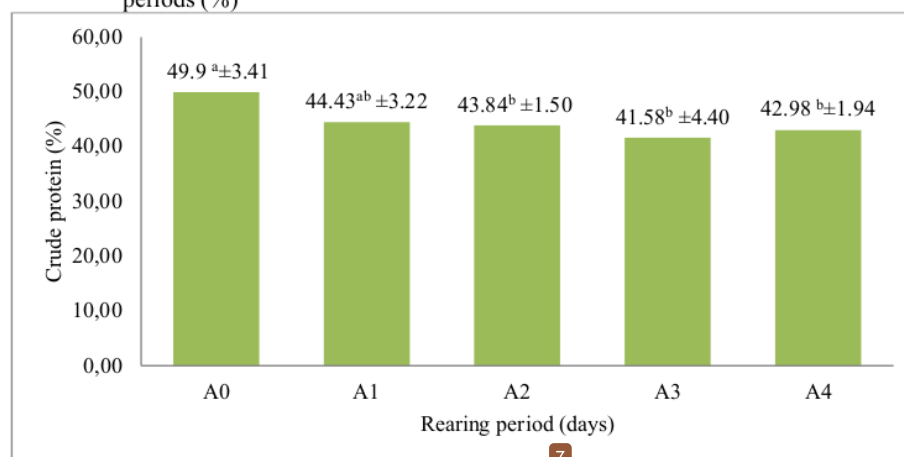
Figure 3. Crude fibre of black soldier fly maggot (*Hermetia illucens*) with different rearing periods (%)



Note: Different letters in superscript, average numbers are significantly different ($p < 0.05$).

Lignin contained in it is a type of fibre that is hard to convert into fatty acids. [14] Black soldier fly larvae (*Hermetia illucens*) in their digestive system have lignin digestive microorganisms converted into cellulose, energy source for aggot. [15]. [16] Lignicellulose converts lignin into simple sugars which are enzymes produced by the black soldier fly larvae (*Hermetia illucens*).

Figure 4. Crude protein of black soldier fly maggot (*Hermetia illucens*) with different rearing periods (%)



Note: Different letters in superscript, average numbers are significantly different ($p < 0.05$).

3.4. Crude protein

Figure 4. Shows that rearing period of black soldier fly (*Hermetia illucens*) significantly affected crude protein content. The A₀ treatment (49.91%) was significantly higher than A₂, A₃ and A₄. Crude protein content of black soldier fly maggots (*Hermetia illucens*) are inversely proportional to the rearing period. [17,18] The crude protein content of young larvae is higher than the older larvae, presumably because young larvae experience faster structural cell growth. Structural proteins, such as cell walls, also contribute to high protein content in young larvae.

4. Conclusion

Based on the results and discussion, it can be concluded that the rearing period of *Hermetia illucens* maggot affects the nutritional value. The longer the rearing period of *Hermetia illucens* maggots, the dry matter, crude fat and crude fibre contents tends to increase, but the crude protein content decreases, although not significantly.

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