The Black Soldier Fly Maggot Powder as a Feed Additive Increased the Bodyweight and the Percentage of Palatability of Broiler Chicken

Herawati(✉) and Fajar Shodiq Permata

Faculty of Veterinary Medicine, Universitas Brawijaya, Puncak Dieng Eksklusif, Kalisongo, Dau, Malang, East Java 65151, Indonesia
herawati58@ub.ac.id

Abstract. Maggot black soldier fly (BSF) becomes concerned about being a protein source alternative for livestock feed. Maggot BSF is easily cultivated and processed to powder from dry form. Broiler chicken is famous livestock that depends on commercial feed originating from corn. This research aimed to examine the effects of BSF maggot powder as a feed additive in Broiler chicken feed on the body weight and percentage of palatability. The method of this research was true experimental using 100 Days on chick (DOC) divided into 5 groups, namely 1) negative control group (Commercial feed), 2) Maggot 5%, 3) Maggot 10%, 4) Maggot 15%, and 5) Maggot 20%. The body weight was measured four times: 1) day 7th, 2) day 14th, 3) day 21st, and 4) Day 30th. The percentage of palatability was measured based on the daily feed served and daily intake feed. The results showed that all of the Maggot treatment groups have high body weight which Maggot 5% being the highest. Maggot 5% groups or Maggot 10%, has the highest percentage of palatability compared with negative control which used commercial feed. The increase in body weight and percentage of palatability in low concentrations is related to the nutrient and the composition of the maggot. However, this research concluded that Maggot BSF could be utilized as a feed additive to increase body weight (gram) and percentage of palatability at a 5% concentration.

Keywords: body weight · Broiler · feed additive · maggot BSF powder · palatability

1 Introduction

The Green economy is one of the sustainable development goals of the International agreement. One of the issue related to green economics is the ecological aspect of industry [1]. One innovation of livestock feed is alternative option that sustained manufacturing [2]. The most popular candidate livestock feed that accomplish the green economy issue is Maggot or larva flies [3]. The black soldier fly, called BSF or Hermetia illucens, is one kind of fly that is popular to cultivate because of its offspring, maggot [4]. BSF can spawn thousands of eggs every period of life that become abundant larvae maggots. The BSF

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adults only stay live for one week but the development maggot needs 30 to be prepupa stage [5]. This stage is the most beneficial product of BSF maggot for protein sources for livestock feed. The maggot contains a high protein of about 43–44%, a moderate lipid level of about 17–21%, and a Carbohydrate of 16–20% [6]. In addition, maggot contains many advantageous substances such as alkaline compounds for antimicrobial [7] and several enzymes for increasing metabolism [8]. The reported enzymes that had maggots are carboxypeptidase A and B, leucine aminopeptidase, collagenase, and serin proteases (trypsin-like and chymotrypsin-like enzymes) [9].

The method culture of maggot is simple and costless because the maggot BSF is a natural decomposer of organic waste [10]. Nowadays, many maggot farmers sell dry maggot BSF. This form can be processed quickly to be powder form for feed additive in livestock. Therefore, maggot becomes a sustainable protein source for livestock feed manufacturing [3].

The fulfillment of protein needs is still a global issue in humankind. The most favorite protein source is chicken meat from Broiler chicken [2]. However, Broiler chicken management faces the problem related to the high-priced of feed. Many researchers reported the alternative feed for broiler chicken such as sorghum, wheat bran, distillers dried grains with solubles (DDGS), Date wastes, millets, insects, and worms [11]. There are a few reports of using maggot as a feed additive for the Broiler. The most important outcomes examined in broiler management are bodyweight and percentage of feed palatability [6]. This factor that influenced those outcomes is a feed. Although the maggot BSF powder has several advantages as a feed additive candidate for Broiler, we have to examine the effect of maggot BSF powder in Broiler performance.

Based on those backgrounds, it is necessary to conduct the research utilizing maggot BSF powder as an alternative feed additive on Broiler chicken to increase the body weight and percentage of palatability to achieve the green economy for sustained livestock feed which environment friendly.

2 Methods

2.1 Material

This research utilized several materials such as 100 DOCs (days on chick), husk for litter, broiler feed, dry maggot BSF, nipple drinker, electric grinder, and gram unit scale.

2.2 Methods

2.2.1 Preparation Stages

The preparation of the research included making the maggot BSF powder from dry Maggot BSF using an electric grinder. Dry Maggot BSF was obtained from Banyumas district, Middle Java, Indonesia. Based on the information product, the dry maggot BSF contains protein 40–44%; lipid 15–25%, fibre 4–7%, phosphor 0.6–1.5%, and calcium 5–8%. The maggot BSF powder would be the feed additive mixed with chicken feed every day.

2.2.2 Management Broiler

One hundred broiler DOCs strain Lohman MB 202 Platinum were bought from JAPFA Comfeed, Indonesia. The chicken feed was BR 1 from JAPFA Comfeed too. The DOCs were divided into 5 groups (n = 20 per group) as follows in Table 1. The starter stage was considered on day 14^{th}, and the finisher stage was on day 30^{th}. The first maggot treatment as a feed additive started on day 8^{th} until day 30^{th}. The guideline for feeding refers to JAPFA Comfeed BR1 feed guide. This animal management already approved Ethical clearance from Universitas Brawijaya Ethics committee with certificate number 106-KEP-UB.

Table 1. The description of groups

Number	Groups
1	Control negative (normal broiler feed)
2	Maggot powder 5% feed additive per day
3	Maggot powder 10% feed additive per day
4	Maggot powder 15% feed additive per day
5	Maggot powder 20% feed additive per day

Note: Every group contained 20 DOCs, separating the flock for every 5 DOCs. Ten DOCs or two flocks would be managed for the starter stage, and the rest of the ten DOCs (two flocks) would be for the finisher stage

2.2.3 Bodyweight Measurement

Bodyweight (BW) of broiler chicken was measured every week per chicken using a Digital scale with gram unit. The term time of BW measurements was:

a. 7 days as a baseline of bodyweight prior to maggot BSF powder treatment
b. 14 days as BW of starter stage
c. 21 days as two weeks BW after treatment
d. 30 days as BW of finisher stage

2.2.4 Percentage of Palatability

Percentage of palatability was measured by every day in % unit from day 1 to day 30 based on daily feed serve (gram) and daily feed intake (gram) with this formula:

$$\text{Percentage of palatability (\%)} = \frac{\text{Daily feed serve (gram)} - \text{daily feed intake (gram)} \times 100\%}{\text{Daily feed serve (gram)}}$$

2.2.5 Data Analysis

Data of bodyweight was analyzed statistically using One Way ANOVA and continuing Tukey test with a significance level of 95% separated by time measurement variables. Data on the percentage of palatability was analyzed using Graphs and comparison descriptively.

3 Results and Discussion

3.1 Results

3.1.1 Bodyweight Variables (gram)

The results showed that all doses of Maggot BSF powder administered as feed additive increased the mean of bodyweight started seen on Day 14^{th} or one week of treatment, then continued on Day 21^{st} and Day 30^{th} (Fig. 1). Dose 5% maggot powder has the highest mean bodyweight, followed by amounts of 10% and 20% maggot powder. However, group maggot 15% has a similar result to control negative (Table 2). Although the trend bodyweight was an elevation in maggot powder treatment, the ANOVA statistic showed that there was no difference significantly ($p > 0.05$) due to maggot powder of all doses (Table 2). But, it is still appropriate to be considered that maggot powder could consistently elevate the body weight of broiler chicken with homogenous output as a 5% dose was the best.

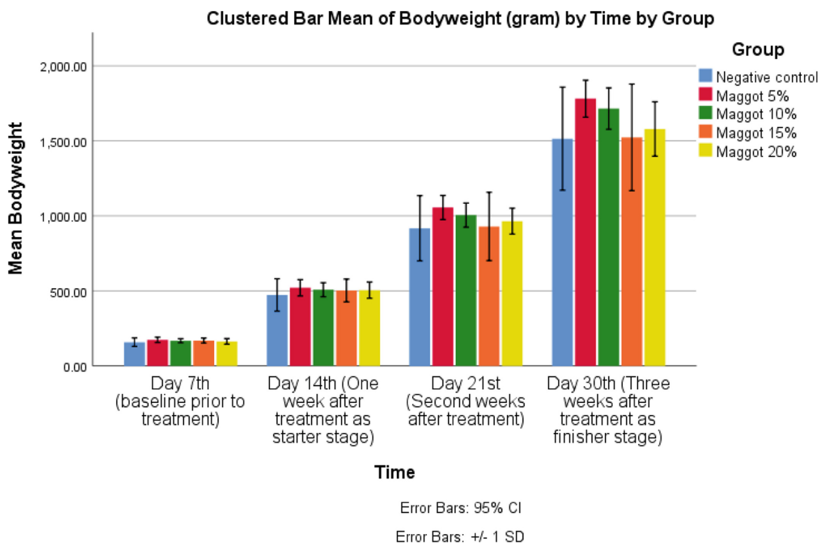

Fig. 1. The graph of the mean of BW (gram) among groups separated in time of BW measurement

Table 2. Mean of BW among groups and different times with p-value of One Way ANOVA

Groups	Mean BW measurement ± SD (gram)			
	Day 7th (baseline before treatment	Day 14th (One week after treatment as starter stage	Day 21st (Second week after treatment)	Day 30th (Three weeks after treatment as finisher stage)
Control negative	158.30 ± 28.74	472.95 ± 107.75	917.37 ± 217.38	1514.37 ± 343.57
Maggot 5%	173.90 ± 17.65	520.85 ± 53.73	1055.70 ± 80.90	1780.70 ± 123.34
Maggot 10%	167.95 ± 13.38	508.50 ± 46.33	1005.50 ± 80.26	1715.00 ± 138.07
Maggot 15%	169.40 ± 13.38	502.30 ± 75.76	929.40 ± 227.86	1522.90 ± 355.28
Maggot 20%	163.50 ± 19.28	504.90 ± 54.05	964.70 ± 86.51	1578.80 ± 181.33
One Way ANOVA p-value	0.135	0.304	0.270	0.75

3.1.2 Percentage of Palatability (%)

The research resulted that maggot BSF powder as a feed additive increased feed palatability in Broiler chicken. The excellent effect of maggot BSF powder was a consistently higher percentage of palatability, especially at group dose 5% and dose 10%, compared to other groups (Fig. 2). Although, the group dose of 5% has a high static palatability percentage after day 12th. The group maggot BSF powder dose of 15% and 20% have up-down fluctuation of palatability as well as the negative control group, which fed only commercial broiler feed (Fig. 2). This result added another excellent effect of maggot BSF powder for feed additive in Broiler chicken.

3.2 Discussion

The maggot BSF has opportunities to become a sustainable protein source. Maggot BSF has high nutrients such as protein, lipid and carbohydrate. Maggot BSF cultivation is easy and cheap as well. In this research, maggot BSF powder was used as a feed additive. The research resulted that the maggot BSF powder increased body weight and percentage of palatability with a dose of 5% giving the best results. This effect relates to substances of maggot BSF, especially enzymes. The enzymes contained in maggot are carboxypeptidase A and B, leucine aminopeptidase, collagenase, and serin proteases (trypsin-like and chymotrypsin-like enzymes) [9].

The carboxypeptidase A refers to the pancreatic exopeptidase that has a role to hydrolyse peptide bonds of C-terminal residues with aromatic or aliphatic side chains

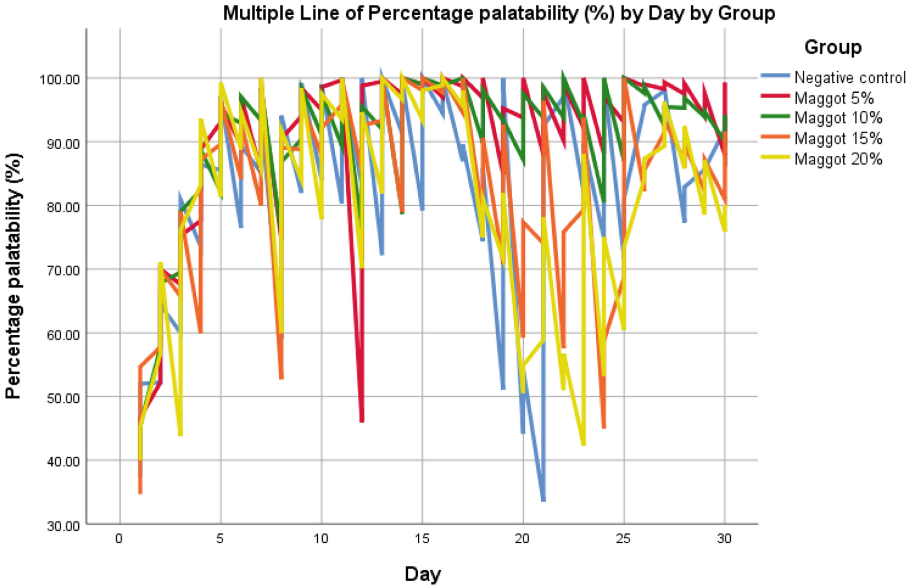

Fig. 2. The graph of the percentage of palatability (%) among groups and based on days.

[12]. The carboxypeptidase B is released from the pancreas in mammals that hydrolyze C-terminal lysine and arginine from substrates such as benzoyl-Glycine-Lysine or benzoyl-Glycine-Arginine [13]. Both enzymes help to degrade macromolecules such as cholesterol or fatty acid and polysaccharides like cellulose or starch. Broiler feed compound consists of corn starch dominantly. This research indicated that the higher dose of maggot BSF powder would disturb nutrient metabolism and might be caused by an imbalance of carboxypeptidase enzymes in the chicken gut.

Leucine aminopeptidases (LAPs) are metallopeptidases that cleave N-terminal residues from proteins and peptides [14]. Chicken feed sometimes has high leucine compound, especially for Layer chicken. Leucine (Leu) is a branched-chain amino acid (BCAA) essential for chicken. It is a good amino acid that affects protein synthesis and degradation, energy balance regulation, modulation of insulin secretion, a nitrogen donor for muscle production, and a critical regulator to initiate translation and protein synthesis [15]. Therefore, the leucine aminopeptidases from maggot BSF powder can help to fasten degraded protein compounds in feed and ease amino acid absorption to help muscle production. This enzyme involves increasing the body weight of a chicken.

Collagenase is an enzyme that facilitates the degradation of collagen. Collagenase helps to increase nutrient absorption by degrading the collagen of the basal lamina to open gap epithelium. However, this enzyme activity risks gut microbial penetration [16]. Abundant collagenase causes the epithelium intestine villi to be eroded or removed from the basal membrane [17]. This effect inhibits nutrient absorption. Collagenase from the maggot BSF powder is considered to have a good impact in adequate amounts and a harmful effect in plenty.

Serin proteases (trypsin-like and chymotrypsin-like enzymes) play a proteolytic-like enzyme role. Trypsin and chymotrypsin are essential enzymes for nutrient metabolism in the gut. This enzyme degrades the macronutrient protein to become amino acids. Endogenous trypsin and chymotrypsin are released from the exocrine part of the pancreas into the luminal duodenum [18]. In this research, maggot BSF powder adds trypsin-like and chymotrypsin-like enzymes, which increase the protein metabolism of feed ingested.

The good potencies of maggot powder above answered the demand of green livestock feed related green economy issue. Maggot BSF is a good decomposer of natural leftovers, so it accomplishes environmental problems related to organic waste [19]. Not only this benefit, but maggots also has promising other advantages as an alternative feed for livestock due to higher protein content [6]. This research delivered the proof of utilization maggot BSF powder to increase Broiler chicken performance.

This research indicates that maggot BSF powder would give a good effect in an adequate amount which is found in a dose of 5% toward bodyweight and percentage of palatability, but it would deliver bad results in quantity above 5%

4 Conclusion

This research concluded with these points:

1. Maggot BSF powder 5% as feed additive increased bodyweight homogeneously to broiler chicken
2. Maggot BSF powder 5% group has the highest percentage of palatability of feed
3. Maggot BSF powder can be used as a green ecological of alternative feed additive for chicken to achieve the green economy goals

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