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Effectiveness of Giving Black Soldier Fly Maggot Flour in Basal Rations on the Quality of Quail (Coturnix-coturnix Japonica) Eggs

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ABSTRACT
Protein is a nutrient that need by quail for gowing. However it price is expensive so it is necessary to look for alternatives. This study aims to determine the effectiveness of Black Soldier Fly (BSF) maggot flour as a substitute for fish meal thus protein alternatives. The study design was carried out experimentally using a completely randomized design (CRD) with 4 treatments, namely P0 = ration without BSF Maggot Flour, P1 = Basal ration with 15% BSF maggot flour, P2 = Basal ration with 20% BSF maggot flour, P3 = Basal ration with 25% BSF maggot flour, each treatment had 5 replications. The research parameters were egg weight, egg white index, egg yolk index, and haugh units.
The results showed that there was a real influence on egg weight and egg yolk index. However, it did not show a real influence on the egg white index and haugh unit. The use of a basal diet with 25% BSF maggot flour showed better results than treatment with a lower dose. In conclusion that basal rations and BSF maggot flour as much as 25% are suitable for use as quail (Coturnix-Coturnix Japonica) feed to increase the quality value of quail eggs.
Keywords: BSF maggot flour, egg weight, egg yolk index, protein, ration

1. Introduction

Protein is a nutrient that plays an important role for gowth, egg formation and affects the quality of eggs produced. Quail is one of the best egg-producing poultry. Quail start laying eggs at the age of 42 days. Female quail can produce as many as 250-300 eggs in one year. Quail egg weight is 10 g / item or 7-8% of body weight. Quail plays an important role as a contributor to animal food from livestock to meet the protein needs of the community.

The nutritional content or nutritional value of quail eggs is not inferior to that of other poultry. Quail farming is believed to increase the supply of animal protein sources. The protein content of quail eggs is quite good when compared to other poultry eggs. The protein content is high, but the fat content is low so it is very good for consumption and has a good impact on health [1].

One of the commonly used protein source feed ingedients for animal feed is fishmeal. Fishmeal has a high protein content but has an expensive price. Therefore, it is necessary to find

additional feed sources of protein or as a substitute for protein for animal feed. One source of protein as a substitute for fishmeal that can be used is BSF maggot. BSF maggot *(Hermetia illucens)* is a fly larva derived from the BSF fly (Black soldier fly). BSF maggot undergoes several stages during its life cycle, starting with eggs produced by BSF flies, then hatching into larvae called BSF maggot. The utilization of BSF maggot in rations is in addition to being an alternative feed ingedient for animal protein sources that have relatively similar nutrient composition and content and have relatively good essential amino acids.

Maggot flour as a substitute for fishmeal not only provides benefits for poultry metabolism, but also has an impact on the quality of eggs produced by poultry. Maggot flour has a protein content of 49.67% with fat content reaching 29.65%. The high protein and amino acid content which is not much different from other protein feed sources, makes maggot flour promising to be used as a substitute for other protein sources. The amino acid value contained in maggot flour is also not inferior to other protein sources, making BSF maggot flour an ideal raw material for use as animal feed [2]. In addition to having a fairly high nutritional content, maggot meal has a more economical price than fishmeal, when used as animal feed [3].

Factors affecting quail egg quality include the nutritional content of the feed. The higher the protein content contained in the feed, the better the quality of the eggs produced. The internal and external quality of quail eggs is one of the important things in the quail farming business [4]. Therefore, in quail farming, it is necessary to pay attention to the quality of quail in order to meet the high interest and satisfaction of the public for quail eggs. The internal and external quality of quail includes the yellow and white index of quail eggs, quail egg production, shell quality of quail eggs and the weight of quail eggs. Based on the description above, the author is interested in making research by utilizing BSF maggot flour as a substitute for fishmeal that can improve the quality of quail eggs.

2. Method

The research design used was a complete randomized design (CRD) with 5 treatments and 4 replicates, where each replicate consisted of 5 animals per plot, totaling 100 animals.
The treatments are as follows:
P0 (control): Ration without BSF Maggot Flour
P1: Basal ration with 15% BSF maggot meal
P2: Basal ration with 20% Maggot BSF meal
P3: Basal ration with 25% BSF maggot meal.

3. Results and Discussion

3.1 Egg Weight

Egg weight was obtained by weighing the quail eggs produced by each treatment. The egg weight of the research results can be seen in Table 1.

Based on the results of the study, it is known that the highest quail egg weight is found in P3 (25% maggot BSF flour and basal ration) which amounted to 10.93 g / item. While the lowest egg weight data was found in P0 (without BSF maggot flour) which amounted to 9.09 g / item. Rumngevur (2023) explains that a normal quail egg standard has an egg weight of about 10 g (about 8% of the mother's weight) or close to 11.91 g [5].

The results of the Analysis of Variance (ANOVA) test, showed that there was a very significant effect ($P < 0.01$). Based on the results of the DMRT further test, it shows that the maggot treatment as much as 25% (P3) shows a very significant effect on other treatments with egg weights reaching 10.93 **g**/**item** ($P < 0.01$). Egg weight is increasingly evident with increasing doses of maggot flour due to differences in crude protein content in feed. This difference in protein content comes from the proportion of different protein source feed in**g**edients. This explains that BSF maggot meal can increase quail egg weight. Egg weight increased as the dose of maggot meal increased. Very significant egg weight was found in P3 (25% BSF maggot meal). This explains that the availability of amino acid content increases in feed derived from BSF maggot flour with increasing doses. This is in accordance with Aksara *et al.*, (2023) which states that the content of essential amino acids such as linoleic acid and methionine will be converted into glycerol and fatty acids which **g**eatly affect egg weight **[6]**.

Egg weight is influenced by the protein content of the feed. BSF maggot flour is one of the protein source feed in**g**edients that can be one of the raw materials to replace fishmeal. This is because

the amino acid content contained in BSF maggot flour is no less complete than fish flour.

Table 1. Weight of quail eggs fed with BSF maggot meal (g/item)

Treatments	Repetions					Total	Average
	U1	U2	U3	U4	U5		
P0	9,00	8,67	9,11	9,33	9,33	45,44	9,09[a]
P1	9,44	9,89	10,00	9,89	10,33	49,56	9,91[b]
P2	10,56	10,33	10,56	10,44	10,67	52,56	10,51[c]
P3	10,89	10,56	11,22	11,11	10,89	54,67	10,93[d]

Notes: Different superscripts in the same column indicate a significant effect of feeding BSF maggot flour on quail egg weight (*Coturnix-coturnix japonica*).

This is supported by Rendi et al. (2023) stated that maggot flour can replace 50% fishmeal without negatively affecting egg production, egg weight and eggshell strength [7]. The maximum egg weight indicates that the addition of maggot concentration in feed and the increase in feed protein content support the palatability of quails to maggot flour-based feed. This is supported by the statement of Amran *et al.* (2023) which states that maggot increases the palatability of quail so that it will increase ration consumption and the availability of protein in the body becomes sufficient for egg production [8].

3.2 Egg Yolk Index

The yolk index is the result of the comparison between the height of the quail egg yolk and the diameter of the quail egg. The yolk index of quails fed with basal feed with additional BSF maggot flour can be seen in the table below.

Table 2. Yolk Index of Quail fed with BSF Maggot Meal

Treatment	Repeat					Total	Average
	U1	U2	U3	U4	U5		
P0	0,44	0,49	0,47	0,47	0,45	2,32	0,46[a]
P1	0,54	0,55	0,54	0,51	0,50	2,63	0,53[b]
P2	0,56	0,60	0,53	0,57	0,55	2,81	0,56[c]
P3	0,60	0,63	0,66	0,59	0,59	3,08	0,62[d]

Description: Different superscripts in the same column indicate a significant effect of feeding BSF maggot flour on quail egg yolk index (*Coturnix-coturnix japonica*).

Based on the results of the study, it is known that the highest yolk index was found in P3 (25% maggot BSF flour and basal ration) which amounted to 0.62. While the lowest yolk index data was found in P0 (without BSF maggot flour) which amounted to 0.46. SNI 3926: 2008 states that the yolk index ranges from 0.33-0.52. The difference in yolk index explains that there are differences in the quality of eggs fed with basal rations and BSF maggot flour. This statement is supported by Mawaddah *et al.*, (2018) which states that the yolk index is highly dependent on differences in protein content and different doses in each treatment [9].

The results of the Analysis of Variance (ANOVA) test explain that there is a very significant effect ($P < 0.01$). The existence of a very real effect, requires further testing to determine the most influential treatment.

The results of the DMRT further test showed a very significant effect of feeding BSF maggot flour on quail yolk index increase ($P < 0.01$). This is because maggot flour has a complete amino acid content and low fat content.

Nisa *et al.*, (2023) stated that the higher the concentration of maggot flour, the higher the yolk index produced [10]. The yolk index increased as the dose of BSF maggot meal increased. This explains that the provision of maggot in quail feed has an effect on the yolk index. This is in accordance with Harmayanda *et al*. (2016) which states that different doses of feed given will produce different yolk indices [11].

The higher dosage level of maggot flour produces a high yolk index indicating that the yolk is denser and there is no evaporation from the egg white. The high protein content of maggot flour and the different dosage amounts cause the proteins that play a role in the formation of egg yolks to also differ, thereby increasing the yolk index value. The yolk index of the research results is higher and in accordance with SNI standards because the measurement of the yolk index is carried out on fresh eggs or new egg production, so there is no egg storage that causes the transfer of water from egg white into egg yolk. The yolk index of the research results is in accordance with SNI 3926: 2008.

3.3 Egg White Index

Egg white index was obtained from the ratio of egg white height to egg white diameter. The diameter of thick egg white and the diameter of liquid egg white were summed up and then divided by two to become the diameter of the comparison for egg white height. Egg white index results can be seen in the Table3 below.

Table 3. Egg White Index of Quail fed with BSF Maggot Meal

Treatment	Repeat					Total	Average
	U1	U2	U3	U4	U5		
P0	0,15	0,18	0,12	0,14	0,18	0,75	0,15[a]
P1	0,15	0,15	0,16	0,16	0,17	0,79	0,16[a]
P2	0,18	0,15	0,15	0,18	0,16	0,82	0,16[a]
P3	0,15	0,15	0,16	0,14	0,16	0,76	0,15[a]

Notes: The same superscript in the same column indicates no significant effect of feeding BSF maggot flour on quail egg white index (*Coturnix-coturnix japonica*).

Based on the results of the study, it is known that the highest quail egg white index is found in P1 (15% maggot BSF flour and basal ration) and P2 (20% maggot BSF flour and basal ration) which amounted to 0.16. While the lowest egg white index data were found in P0 (without BSF maggot flour) and P3 (giving 25% BSF maggot flour and basal rations) which amounted to 0.15. The results of the egg white index study were higher than the results of research by Samuel *et al*. (2023) which stated that quails fed with moringa leaf flour produced a quail egg white index of 0.11. The egg white index of the research results is in accordance with the standard egg white index SNI 3926: 2008 which ranges from 0.05-0.17 [12].

The results of the Analysis of Variance (ANOVA) test explain that there is no significant effect (P>0.05). The absence of a very real effect, so no further tests are needed. This explains that BSF maggot flour has no impact on egg white index egg quality. Maggot meal did not have a significant effect on egg white index. The relatively uniform egg white index is also due to the absence of storage in the egg so that air from outside does not enter the egg through the pores and no gas exchange occurs in the egg. Yuwanta (2010) states that extensive air exchanging with gas in the contents of the egg through the pores of the egg shell will cause water evaporation and egg white to become more liquid [13].

Purnomo (2017) stated that the egg white index is influenced by the age of the livestock. Older animals will produce a wider egg white diameter so that the egg white index is smaller. The relatively similar egg white index in each treatment is due to the homogeneous age of the quail [14].

3.4 Haugh Unit

Haugh Unit is calculated with the aim of knowing the state of the egg albumen, namely the correlation between egg weight and egg white height. Indonesai National Standard (2008) The HU value of eggs is divided into quality I; HU > 72, Quality II; HU 62-72 and Quality III; HU < 60, thus the average HU value of the four treatments is included in gade AA or quality I [12]. The haugh unit value is strongly influenced by the quality and measurement results on egg white. If the measurement

value of egg white height is getting better, it will positively affect the haugh unit value of the eggs produced. Haugh unit also explains the quality of the eggs obtained.

Based on the results of the study, it is known that the highest quail egg haugh unit is found in P2 (20% maggot BSF flour and basal ration), which is 105.05. While the lowest egg haugh unit data was found in P0 (without BSF maggot flour) which amounted to 101.76. The results of quail egg haugh unit research are higher than the results of research by Samuel *et al*. (2023) which states that quails fed with moringa leaf meal produced quail egg haugh unit of 92.94 [15]. The results of quail egg haugh unit research is in accordance with the standard SNI 3926: 2008 which is 100 for fresh eggs and >70 for eggs that have undergone the storage process.

The haugh unit value of quail eggs fed with basal rations and BSF maggot meal can be seen in the Table 4 below.

Table 4. Haugh Unit of Quail Eggs Fed with BSF Maggot Meal

Treatment	Repeat					Total	Average
	U1	U2	U3	U4	U5		
P0	101,02	106,78	95,04	99,94	106,01	508,79	101,76[a]
P1	104,01	102,12	104,86	104,54	106,21	521,74	104,35[a]
P2	107,93	102,68	101,72	106,89	106,03	525,25	105,05[a]
P3	103,57	103,36	106,11	100,97	105,14	519,16	103,83[a]

Notes: The same superscript in the same column indicates no significant effect of BSF maggot flour on the haugh unit of quail eggs (*Coturnix-coturnix japonica*).

The results of the Analysis of Variance (ANOVA) test explained that there was no significant effect (P>0.05). The absence of a very real effect, so no further tests are needed. This explains that BSF maggot flour has no impact on egg white index egg quality. This explains that BSF maggot flour does not have an impact on the haugh unit of quail eggs.

The absence of a significant effect on haugh unit value is caused by the egg white index value which has no significant effect either. Mulyadi (2017) explained that egg white value and haugh unit value have a correlation that is interrelated. The higher the egg white value, the higher the haugh unit value and vice versa because the maximum absorption of nutrients, especially amino acids, can maintain ovimucin and lecithin so as to improve egg quality, amino acids are used to increase the viscosity of egg white and haugh unit will increase [16].

The lower haugh unit value in P0 (without BSF maggot flour) is due to the lower egg weight in P0. This is in accordance with the statement of Rahmasari (2021) which states that low egg weight will show a tendency for high egg white and haugh unit values to also decrease [17]. The haugh unit results were higher than other studies, explaining that the eggs whose haugh unit values were calculated were freshly produced eggs. So that the relationship between egg weight and egg white viscosity in it there is no contamination of outside air with the contents inside the egg which results in runny eggs.

Purwanti and Nahariah (2020) explained that BSF maggot flour did not have a significant effect on the haugh unit of quail eggs. This is due to the absence of maggot influence on egg white quality so that it has an impact on the haugh unit value. It was also explained that the addition of maggot flour has not been able to provide different haugh unit values between treatments even without maggot flour [18].

Prasetyo *et al*., (2024) explained that in maggot there is chitin content. Haugh units are not significantly influenced by the chitin content in maggot which provides a limiting factor in quail because it can bind complexly to proteins so that proteins are not digested optimally [19].

4. Conclusion.

Feeding 25% BSF maggot meal with basal rations can improve quail egg quality, namely egg weight, egg white index, yolk index and haugh unit of quail eggs. Feeding BSF maggot meal in basal rations showed a good effect on egg weight and yolk index.

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