Substitutions of fish meal with larvae meal black soldier fly 
(*Hermetia illucens*) on the performance of female quail

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Abstract. BSF larvae meal contains protein which is very high so that it can be used as a protein source to replace fish meal. This study aims to determine how much the use of BSF larvae meal in substituting fish meal for consumption, weight gain and feed conversion in quails. This study used 200 7-day-old female quails that were kept for 6 weeks 42 days with an average initial weight of ± 23 grams. This study uses a completely randomized design (CRD), which consists of 4 treatments and 5 replications. Using experimental ration: P0 Ration without addition of BSF larvae meal; P1 = BSF larvae meal 3.183% (6.67% crude protein of fish meal); P2 = BSF larvae meal 6.370% (3.34% crude protein of fish meal); P3 = BSF larvae meal 9.565% (0% crude protein of fish meal). The parameters measured were the amount of consumption, weight gain, quail carried out every week during the study and feed conversion rate as an indicator of the efficiency of ration use. The results showed that ration consumption and weight gain and feed conversion did not significantly affect (P> 0.05) meaning substitution of fish meal with BSF larvae meal until P3 could be carried out without negatively affecting the performance of quails.

1. Introduction

Quail is a type of small poultry that has a very fast production rate compared to some other commercial poultry commodities, because the quail is able to produce eggs at the age of 45 days of maintenance. In addition, the superiority of poultry does not require a large enclosure location so that farmers who have a narrow location can participate in participating in quail cultivation. Maintenance management is relatively easier compared to other types of poultry.

One of the main keys in supporting the success of quail cultivation both broiler and laying is feeding. In general, quality feed will provide maximum results to achieve production targets. Apart from the genetic quality of quail livestock, the protein content of feed has an important role in supporting the growth of tissues in the animal's body so that it is expected that appropriate feeding can increase livestock growth. Beski et al., [1] states that the protein component has an important role in an animal feed formula because it is involved in the formation of body tissues and is actively involved in vital metabolism such as enzymes, hormones, antibodies and so on.

One type of animal protein that is most often used in the composition of quail rations is fish meal. The protein content of fish meal is very high depending on the type and quality of fish used. But the
price of fish meal is relatively expensive compared to several other protein sources. So we need an alternative cheap feed that can replace the position of fish meal as a source of animal protein.

Currently the Black Soldier Fly (BSF) larvae are widely studied because they have a high protein content between 40-50% and are easily cultivated. This alternative is very suitable for quail farmers to be used as a protein source to replace fish meal. The amino acid profile contained in BSF meal is similar to soybean meal, specifically the content of methionine or methionine + cystine which is an essential amino acid for growth in broilers and is also expected to be able to support quail growth. Teguia et al., [2] reported that the use of BSF larvae meal was able to replace fish meal up to 6.75% in the ration in the starter and finisher phases and resulted in better weight gain. This was also added by Akpodiete and Inoni [3] the use of up to 75% BSF larvae meal in replacing fish meal was considered to be far more economically beneficial because it could improve livestock performance.

Nevertheless BSF larvae meal contains chitin which can inhibit protein digestibility, in addition to the existence of the deficiency of essential amino acids such as methionine for growth. Therefore it is necessary to conduct research on the use of BSF larvae meal in substituting fish meal to the level of 10% in the total number of quail rations to see how the performance.

2. Methodology
This research was conducted in April-May 2019 in the Non-Ruminant Laboratory of the Faculty of Animal Husbandry, Hasanuddin University Makassar. The material used in this study was 200 quail of 1 week-old female obtained from breeders located in the Gowa area with an average weight of ± 23 grams. Each quail is placed in a 90 x 60 x 30 cm3 battery cage made of ram wire and bamboo. Each enclosure consists of 10 quails, equipped with a Philips 15 watt incandescent bulb and drinking water containers and digital scales.

The feed ingredients used to prepare the experimental ration consisted of yellow corn, soybean meal, rice bran, coconut cake, premix, lysine, DCP methionine, fish meal and BSF larvae meal. The composition and nutrient content of the feed ingredients used in the study are presented in Tables 1 and 2.

| Type | Rations | Treatment | P0 | P1 | P2 | P3 |
|------|---------|-----------|----|----|----|----|
| Corn (%) | 43.74 | 44.70 | 43.83 | 44.66 |
| Soybean Meal (%) | 10.00 | 10.02 | 13.50 | 12.70 |
| Fine bran (%) | 23.00 | 22.16 | 24.00 | 23.40 |
| Coconut cake | 12.00 | 12.00 | 7.50 | 8.13 |
| Fish meal (%) | 10.00 | 6.67 | 3.34 | 0.00 |
| BSF larvae meal (%) | 0.00 | 3.18 | 6.37 | 9.56 |
| Premix (%) | 0.05 | 0.05 | 0.05 | 0.05 |
| Lysine (%) | 0.2 | 0.21 | 0.19 | 0.02 |
| Methionine (%) | 0.01 | 0.01 | 0.02 | 0.03 |
| DCP (%) | 1.00 | 1.00 | 1.20 | 1.45 |

Description: The result of the calculation analysis of feed

The study was conducted experimentally at the Non Ruminant Animal Laboratory. The design used in this study was a complete random design (CRD) consisting of four treatments and five replications, randomly divided based on the treatment as follows: : P0 Ration without addition of BSF larvae meal; P1 = BSF larvae meal 3.183% (6.67% crude protein of fish meal); P2 = BSF larvae meal 6.370% (3.34% crude protein of fish meal); P3 = BSF larvae meal 9.565% (0% crude protein of fish meal).
Table 2. Content of the nutrients feed quail Age 1-6 weeks.

| The content of the nutrients          | P0       | P1       | P2       | P3       |
|--------------------------------------|----------|----------|----------|----------|
| Energy metabolism (kcal / kg)         | 2773.5   | 2738.1   | 2752.0   | 2742.5   |
| Crude protein (%)                    | 20.72    | 20.01    | 19.99    | 20.48    |
| Crude Fiber (%)                      | 3.98     | 4.00     | 4.04     | 4.29     |
| Crude fat (%)                        | 7.03     | 7.03     | 7.43     | 7.62     |
| L-Lysine (%)                         | 0.48     | 0.40     | 0.55     | 0.68     |
| DL-Methionine (%)                    | 0.48     | 0.43     | 0.43     | 0.43     |
| Phosphor (%)                         | 1.08     | 1.00     | 1.00     | 0.97     |
| Calcium (%)                          | 1.23     | 1.17     | 1.18     | 1.20     |

Based on the calculation and analysis of NIR
P0 Ration without addition of BSF larvae meal; P1 = BSF larvae meal 3.183% (6.67% crude protein of fish meal); P2 = BSF larvae meal 6.370% (3.34% crude protein of fish meal); P3 = BSF larvae meal 9.565% (0% crude protein of fish meal).

Testing of experimental data is performed using ANOVA analysis. The duncan further test is to find out the significant difference between treatments if it is below a significant level (P ≤ 0.05).

Sanitary enclosure is carried out before quail maintenance, aiming to prevent quails from plague. Quail female aged 8 days then weighed before being put in 20 randomly enclosed cages. Each treatment and repetition were filled with 10 quails. Feed and drinking water are given ad libitum according to the treatment in the morning and evening.

Retrieval of consumption data is done by weighing the remaining food at the place of eating and calculating the difference with the amount of giving for one week to find out what is the average amount of consumption in each day Gadzirayi and Mupangwa [4] Weight weighing is done every weekend during the study, so the weekly weight gain results of Gadzirayi and Mupangwa [4].

The final weight gain (g / tail) is done at the end of the maintenance period as an illustration of the final weight results of Gadzirayi and Mupangwa [4]. While the value of feed conversion is seen from the amount of consumption (g) divided by the amount of weight gain (g) during the study.

3. Results and discussion

Feeding of fish meal substitution with BSF larvae meal up to 10% level based on analysis of variance shows no significant effect (P ≥ 0.05) on quail performance which includes feed consumption, weight gain (PBB), final body weight and feed conversion presented in Table 3. as follows.

Table 3. Quail performance maintained by the substitution of Fish Flour with BSF Larvae Flour at different levels in the ration during the study period.

| Parameter              | P0       | P1       | P2       | P3       |
|------------------------|----------|----------|----------|----------|
| Feed consumption (g/b/d)| 12.98±0.53| 12.93±0.49| 12.91±0.64| 12.49±0.32|
| weight gain (g/b/d)    | 2.85±0.09 | 2.78±0.11 | 2.87±0.11 | 2.70±0.13 |
| Final weight (g/b)     | 143.00±4.23| 140.48±4.41| 143.46±5.33| 136.74±6.16|
| Feed conversion        | 4.55±0.214| 4.65±0.217| 4.50±0.15 | 4.63±0.26 |

P0 Ration without addition of BSF larvae meal; P1 = BSF larvae meal 3.183% (6.67% crude protein of fish meal); P2 = BSF larvae meal 6.370% (3.34% crude protein of fish meal); P3 = BSF larvae meal 9.565% (0% crude protein of fish meal).

3.1. Feed consumption

The amount of feed consumption can be influenced by several factors including environmental conditions, texture, shape, color and odor of the feed, but of these factors the color and odor have different characteristics between the two treatment materials. BSF larvae meal has a darker color than fish meal however the use of fish meal substitution up to 10% level using BSF larvae meal tends to have
in common so it does not affect the amount of feed consumption at each treatment level. This is supported by Widjaja and Hearudin [5]. Stating that bright colors such as red and yellow provide aggressiveness and activity response to poultry compared to dark colors so that it affects the increase in the amount of feed consumption. this was also confirmed by Nascimento et al [6] stating that the response of feed consumption was higher in the yellow lighting treatment compared to blue.

Another factor that influences consumption is the smell of feed. Fish meal with BSF larvae meal has different odor characteristics. In general, fish meal has been widely used by the poultry feed industry as a main protein source and the characteristic odor of fish meal does not affect the palatability of poultry, in contrast to BSF larvae meal which is still conventional feed and has not been widely used by farmers as a source of protein. but this does not affect the amount of consumption because the sense of smell in quails is not well developed so it is not able to distinguish the smell of feed properly, this was also explained by Amrullah [7] explaining that poultry has a tongue that serves to recognize the taste of food. While the olfactory senses are less developed.

Based on Table 3, the average value of feed consumption ranged from 12.49 to 12.98 g / head / day. This shows that the average feed consumption is still included in the standard category. This opinion is supported by Listyowati and Roospitasari [8] stating that the average consumption of quail feed ranges between 8-15 g per day. at the age of maintenance 3-6 weeks.

This study is in line with the results of Mawaddah et al [9] stating that the use of BSF larvae flour in substituting MBM does not show any real influence and can be used up to 100% in replacing MBM in the composition of quail ration. This opinion was also reinforced by Harlystiarini [10] stating that the use of BSF larvae meal in substituting fish meal did not show a significant effect on feed consumption and feed conversion.

3.2. Weight gain
One of the factors that influences weight gain is nutrient content such as the protein feed given. The use of BSF larvae meal up to 10% substitutes fish meal in this study has no effect because the need for essential amino acids is still met, although the quality of amino acids in fish meal like methionine is better than BSF larvae meal. This is due to methionine also found in several other mixed feed ingredients such as soybean meal, bran, and corn in addition to the supplementation of essential amino acids such as lysine and methionine which increase with increasing amount of fish meal substitution with BSF larvae flour. This is in accordance with the advice of Atteh et al. [11]; Bamgbose [12]). Furthermore, Bamgbose [12] suggested that the use of BSF larvae meal should be supplemented with methionine so as not to negatively influence the performance of broilers. The presence of methionine amino acid deficiency in BSF larvae meal was also clarified by McDonald et al. [13] stated that the most efficient amino acid in BSF larvae meal was methionine, so the chemical score obtained was 19.02%.

Another factor affecting weight gain is the amount of feed consumption. In this study the amount of consumption has no significant effect so that weight gain is also not affected because the amount of nutrients that can be absorbed by the animal's body depends on the amount of consumption and quality of feed. This opinion is also supported by Leeson and Summer [14] asserting that the percentage of weight gain generated is largely determined by the amount of consumption.

3.3. Final weight
Based on the results of the analysis of variance, the final body weight with the treatment of BSF larvae meal in replacing fish meal had no significant effect (P≥0.05) between treatments, this value is directly proportional to other parameters including ration consumption and weight gain in the fish meal substitution treatment. with BSF larvae meal at different levels means that utilization of BSF larvae meal can be used up to 10% in the total composition of quail ration.

Final quail body weight in table 3. ranges from 136.74-143.00 g / head and meets the weight standards of some previous researchers, as reported by Anggorodi [15] that adult male quails have a body weight of about 100-140 g / tail. According to Sujana et al. [16] quail weight at the age of 6 weeks in the city of Bandung was 127.9 grams.
3.4. Feed conversion

Feed conversion value is used to see how much the amount of feed consumption to produce body weight in the same unit means that if the feed conversion is low indicates that the quality of the feed is getting better. Feed consumption, body weight, gender and age are the factors that determine the variation in North and Bell feed conversion values [17].

Based on the research results, substitution of fish meal with BSF larvae meal up to 10% level showed no significant effect on feed conversion value. This is due to the amount of feed consumption and quail weight gain in this study also had no significant effect. This is in line with the opinion of Anggarodi [18] states that the amount of consumption and weight gain is directly proportional to the value of feed conversion. Generally the conversion value is in line with the value of consumption and the ability of the animal's nutrient absorption to produce body weight which is determined by the quality of the feed.

In contrast to the case of feed which has poor quality generally has a high feed consumption value while weight gain is not optimal even decreases it can cause very high feed conversion values. Feed conversion value is included in the standard category, this is in accordance with research by Hazim et al., [19] ideal feed conversion is 3.67 - 4.71.

4. Conclusions

The use of BSF larvae meal in the ration can be done up to the level of 10% substituting fish meal without giving a negative effect on quail performance.

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