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Performance of Finisher Broilers Fed Graded Levels of Bio-processed Black Soldier Fly Larvae Meal (BSFLM)

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ABSTRACT

This study was carried out to determine the growth performance and carcass characteristics of Finisher Broiler birds fed varying levels of Black Soldier Fly larvae meal (BSFLM) at Enugu State University of Science and Technology (ESUT) Teaching and Research Farm. A total of 128 Finisher broilers were used for the experiment which lasted for four (4) weeks. The 128 birds were randomly assigned to four (4) dietary treatment groups and each treatment was replicated four times with eight (8) birds per replicate in a completely randomized design. T_1, which was the control group had 0% inclusion of BSFLM. T_2, T_3 and T_4 contained 0.07%, 0.14% and 0.21% BSFLM treatment levels. The result of the experiment showed that at 0.21% (T_4) inclusion level of BSFLM, the final weight, total weight gain, average daily weight gain and feed conversion ratio were significantly ($P<0.05$) better than other treatments (T_1, T_2 and T_3); T_1 and T_2 were significantly ($P>0.05$) not different. The prime cuts of drumstick, thigh, breast and gizzard followed the same pattern observed with growth. It can be concluded that 0.21% inclusion of Black Soldier Fly Larvae Meal enhanced growth performance as well as carcass characteristics of finisher broiler.

1.0 Introduction

Feed ingredients from plant sources like cereals and legumes as well as ingredients from animal by-products like bone meal, fish meal, blood meal etc are becoming scarce and if available, costly to obtain. However, researches show that further optimization of feed and nutrition is potentially still possible in the form of using alternative feed sources.

Edible insect is an alternative feed source that can be used to improve livestock feed and nutrition. Some insect species have been developed as feed in several countries of the world and insect protein market is increasing by the day (Ebenebe, 2022). She opined that insects are very important food resource and can be used as an alternative source because they have ability to convert organic wastes into useful products (FAO, 2011).

The Black soldier fly is one of these insects and its larvae have already been used in the formulation of a complete diet for poultry, swine, and for several commercial fish species (Nguyen *et al,* 2015). They were found to support good growth and therefore it was generally concluded that BSF larvae can be a suitable protein source for animal feed. For example, this is the only insect species that have been approved for use as animal feed in the United States and Canada. It has been reported that Black Soldier Fly Larvae meal (BSFLM) has a Crude Protein of 50% and Crude Fibre of 35% with an amino acid profile similar to that of fishmeal. (Marwa *et al.,* 2019; van Huis 2018; Elwert and Katz 2010).

It is cheap also to grow it privately/commercially in Nigeria, especially by myriads of small-scale farmers who may not afford the increasing prices of fishmeal, blood meal etc.

In the light of its high crude protein content, the objective of this study is to evaluate the growth performance and carcass characteristics of Broiler finisher birds fed varying levels of Black Soldier fly larvae meal (BSFLM) grown in a biotechnologically home-made rearing unit for potential use by small scale farmers.

2.0 Materials and Methods.

The experiment was carried out at the Teaching and Research farm, Enugu State University of Science and Technology (ESUT), Agbani in Nkanu West Local Government Area of Enugu State, Nigeria.

2.1 Experimental Diets and Treatment

Four (4) experimental diets were formulated accordingly for the finisher broilers. Treatment (T_1) has 0% inclusion of black soldier fly larvae meal (BSFLM), while treatment (T_2), (T_3) and (T_4) contain graded levels of BSFLM at 0.07%, 0.14% and 0.21% respectively.

Table 1 shows the composition of the experimental diet.

The formulated experimental diet is shown in Table 1 below:

Table 1: Ingredient composition of the different diets for the Finisher Broilers (5-8 wks

	Treatment (kg)			
Ingredients	T_1 (0%)	T_2 (0.07%)	T_3 (0.14%)	T_4 (0.21%)
Maize	57.43	57.43	57.43	57.43
Soya Bean Meal	23.72	23.65	23.59	23.51
Wheat Offal	10.00	10.00	10.00	10.00
Fish meal	5.00	4.93	4.86	4.79
BSFLM	0.00	0.07	0.14	0.21
Bone Meal	3.00	3.00	3.00	3.00
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15
Methionine	0.20	0.20	0.20	0.20
Total	100	100	100	100

The proximate composition of BSFLM is shown in Table 2.

Table 2: Proximate Composition of BSFLM

Nutrient	% Composition
Dry Matter	89.23
Crude Protein	41.35
Crude Fibre	18.16
Ether Extract	21.32
Ash	5.34
Gross energy (Kcal/g)	3.12

2.2 Experimental birds

One hundred and twenty eight Ross day-old chicks were randomly allocated to four experimental diets in a completely Randomized Designed, with four (4) replicates containing (8) birds each. Hence each treatment contained thirty two (32) birds. Proper brooding as well as vaccination schedule was adopted during brooding.

2.3 Experimental Material

The egg of feed ingredient Black Soldier Fly were placed in the hatching shower where hatched larvae fall into the hatchling container. The hatchling container was replaced regularly with chicken feed as the substrate and the eggs allowed hatching within 5days to 1 week. Thereafter, they were placed in kitchen waste substrate to pupate. However, before pupating, the larvae (figure 1 below) were harvested and processed through sun drying and milling to produce the BSFLM.

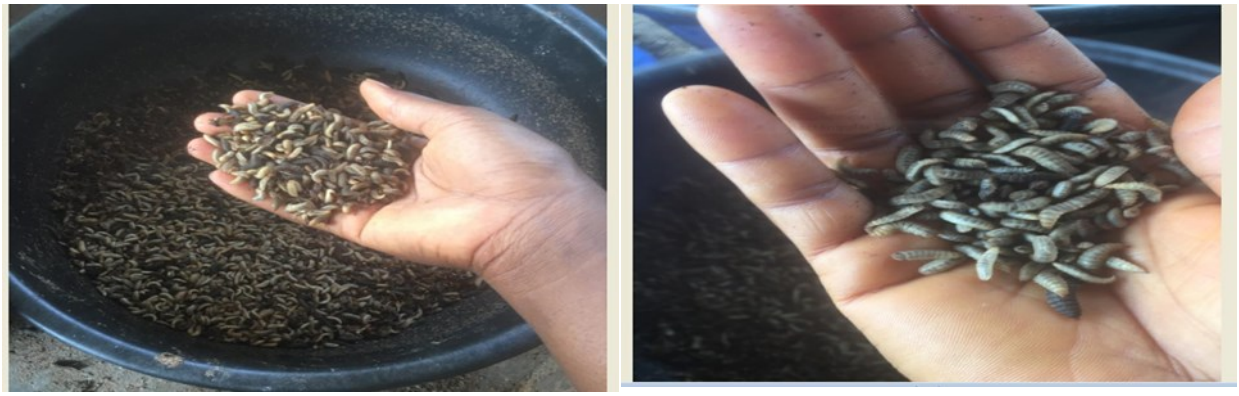

Fig. 1: Black Soldier Fly larvae used in preparing the BSFLM.

2.4 Data Collection

The experiment lasted for 28 days after a brooding period of 28 days, 28 days feeding period with experimental diets and one day for slaughtering. All measurements on body weight, feed intake and carcass weight were recorded using a digital scale.

2.4.1 Growth and Feed Intake

The weights of the birds were taken on a weekly basis. Feed intake was monitored weekly by placing a known amount of feed at the start of every day and taken the amount of feed left over at the end of the day. The difference between what was supplied at the start of day and left over was the feed intake. The average daily gain (ADG) and average feed intake (ADFI) was then calculated.

2.4.2 Carcass Characteristics

Two birds from each replicate were slaughtered at the end of the 8th week (by cutting the jugular vein) after an overnight fast to determine the carcass and eviscerated weights, thereafter the prime cuts, organs and offals were determined.

2.4 Statistical Analysis

The data collected were subjected to one-way analysis of variance and treatment means with significant differences from the analysis of variance were compared using Duncan's Multiple range Test as described by Obi (1990).

3.0 Result and Discussion

The growth response of broiler birds to BSFLM is shown in Table: 3

Table 3: Growth performance parameters of broilers fed Black Soldier Fly Larvae (Hermetia illucens) meal

Parameter	T_1 (0%)	T_2 (0.07%)	T_3 (0.14%)	T_4 (0.21%)	SEM	NS
Av. initial wt (g)	728.35	783.34	721.55	733. 86	21.20	NS
Av. final wt (g)	2547.54^{c}	2641.09^{b}	2642.42^{b}	2772.24^{a}	19.43	
Total wt gain (g)	1819.19^{c}	1857.75^{bc}	1920.87^{b}	2038.38^{a}	28.66	
Av. daily wt gain (g)	64.97^{c}	66.35b^{c}	68.61^{b}	72.80^{a}	1.02	
Tot. feed int. (g)	2155.98	2197.54	2209.73	2141.52	51.56	NS
Av. dly feed int. (g)	77.00	78.48	78.92	76.49	1.84	NS
Feed conv. ratio	1.19^{b}	1.18^{b}	1.15^{b}	1.05^{a}	0.04	

abc Mean values on the same row with different superscripts differ significantly (P< 0.05). NS= Not significant. Av. means average, int. means intake and conv. means conversion

3.2 Average Final Weight

There was significant (P<0.05) differences in the growth pa-

rameters. The final weight was heaviest in T_4 with weight of 2772.24g at 0.21% inclusion of BSFLM in the diet. The least was T_1, the control having a weight of 2547.54g at 0% inclusion of BSFLM in the diet. However, the average total weight and average daily weight gain were not significantly ($P>0.05$) different between T_1 (0%) and T_2 with 0.07% inclusion level of BSFLM, but significantly ($P<0.05$) heaviest in T_4 with 0.21% inclusion level. T_3 was moderate weighing the same with T_2 but heavier than T_1.

This positive effect on weight of the treated broilers over the control agrees with the work of Fortuoso *et al.,* (2019) who argued that it may be as a result of increase in crude protein of BSFLM thus providing essential amino acid to the diet. They further suggested that the improvement in weight might as well be as a result of increased levels of lauric acid in BSFL meals when compared with the control. They observed an 11% increase in broiler weight with inclusion of about 300mg lauric acid per kilogram of feed. They explained that lauric acid demonstrated strong antimicrobial effect and growth promoter ability with no toxicity to the broiler.

3.3 Average Feed Intake

The results of the average daily feed intake in Table 3 shows no significant difference ($P>0.05$) between the treatments (T_1 – T_4). This partially agrees with the finding of Onsongo *et al.* (2018) who did not find any effect of insect diets on performance parameters (feed intake, feed conversion ratio and weight gain) in broilers particularly when being fed with BSFL at different inclusion levels of up to 15%.

3.4 Feed Conversion Ratio

From Table 3, the feed conversion ratio (FCR) was significantly ($P<0.05$) better in T_4 compared to other treatment levels (T_1, T_2 and T_3) which did not differ ($P>0.05$) amongst themselves.

The reduced feed conversion ratio in T_4 showed better utilization of a kilogram of feed taken per kilogram of body weight. Positive conversion ratio supports results of Bovera *et al.,* (2016) which suggests that black soldier fly larvae meal supplies crude protein essential for broiler finisher growth. Other recent studies (Dabbou *et al.,* 2018; Gariglio *et al.,* 2019; Khan *et al.,* 2018a and b; Mohammed *et al.,* 2017) confirms the earlier report of Bovera *et al.,* (2016) that

Table 4: Carcass characteristics of broilers fed black soldier fly larvae (Hermetia illucens) meal.

Parameter	T_1	T_2	T_3	T_4	SEM	NS
Live weight (g)	2547.54^{c}	2641.09^{bc}	2642.42^{b}	2772.72^{a}	19.43	
Carcass weight (%)	81.66^{b}	84.64^{ab}	89.33^{ab}	90.04^{a}	2.19	
Eviscerated wt (%)	73.49^{b}	74.78^{ab}	76.95^{ab}	77.94^{a}	1.10	
PRIME CUTS						
Drumstick (%)	9.18^{b}	9.85^{ab}	9.85^{ab}	11.18^{a}	0.53	
Thigh (%)	8.74^{c}	9.09^{bc}	10.03^{ab}	10.41^{a}	0.39	
Breast (%)	13.72^{b}	14.39^{ab}	14.39^{ab}	16.39^{a}	0.76	
Wing (%)	7.71	7.71	7.71	7.75	0.16	NS
ORGANS						
Heart (%)	0.43	0.43	0.43	0.43	0.51	NS
Gizzard (%)	2.54^{b}	2.87^{ab}	2.88^{ab}	3.67^{a}	0.33	
Kidney (%)	0.55	0.55	0.55	0.55	0.05	NS
Liver (%)	1.71	1.71	1.71	1.71	0.15	NS
Spleen (%)	0.10	0.10	0.12	0.12	0.02	NS
PRIME OFFALS						
Head (%)	3.38	3.38	3.38	3.38	0.31	NS
Neck (%)	4.06	4.06	4.06	4.06	0.15	NS
Shank (%)	3.04	3.15	3.15	3.33	0.25	NS
Back (%)	11.63	11.63	11.63	11.63	0.31	NS

abc Mean values on the same row with different superscripts differ significantly (P< 0.05). NS= Not significant Av. means average, tot. means total, int. means intake and conv. means conversion

BSFLM had positive performance impact on Broiler weight and FCR.

3.5 Carcass Characteristics

The carcass characteristics are shown in Table 4.

The results of carcass characteristics as captured in Table 4 above, indicated significant ($P < 0.05$) difference between treatments on live, carcass and eviscerated weights relative to each treatment (T_1, T_2, T_3 and T_4). The carcass and eviscerated weights are expressed as percentage of live weight. From Table 4, T_4 had significantly ($P<0.05$) better percentage values (90.04/77.94) than T_1 (81.66/73.49), the control in carcass and eviscerated values respectively. However, the values were not significantly ($P>0.05$) different among the treated (T_2, T_3 and T_4) broilers.

The above trend was observed for prime cuts of drumstick; thigh; breast muscle and gizzard as an organ. T_4 was significantly ($P<0.05$) better than T_1 though similar ($P>0.05$) to T_2 and T_3. All other organs and offal were not significantly ($P>0.05$) different between the treatments.

The present results supports the work of Piertese *et al* (2018) who found that offal and internal organs showed no significant ($P>0.05$) difference in carcass characteristics. However, the current study partially agrees with the report of Gariglio *et al,* 2021 who found no significant ($P>0.05$) difference between treatments placed on 0%, 5%, 10% and 15% BSFLM for all carcass characteristics of prime, organ and offal weights.

4.0 Conclusion

The results presented in this study showed that Black Soldier Fly Larvae Meal (BSFLM) incorporation in broiler feed at 0.07%, 0.14% and 0.21% levels of inclusion generally improved the final weight, average total and daily weight gains as well as the feed conversion ratio.

The feed intake was not affected by the different inclusion levels of BSFLM.

0.21% inclusion level appears to be better with its heavier live weight, carcass percentage value over the control which had 0% inclusion level.

4.1 Recommendations

It is recommended that Black Soldier Fly Larvae Meal (BSFLM) can be included in the diet of the broiler finisher up to 0.21% for optimum yield.

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