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RESEARCH ARTICLE

GROWTH PERFORMANCE OF BROILER CHICKENS FED ON BLACK SOLDIER FLY LARVA MEAL INCLUSIONS

Inwele, Amobi Maduabuchi[1]; Dahiru Adamu[1]; Obinna, Okpoko Valentine[2]; Sheamu, Yusuf[1]; Adike, Justina Isioma[3]

[1]Department of Biological Sciences, Federal University of Kashere, Gombe State
[2]Department of Biology, Admiralty University of Nigeria, Delta State
[3]Department of Zoology, Ahmadu Bello University, Zaira Kaduna State

*decency75@gmail.com; mi.amobi@fukashere.edu.ng

Abstract

Background:
The purpose of this study was to examine the potential advantages of incorporating Black Soldier Fly Larva (BSFL) meals into feed formulations for broiler chickens to improve their growth performance. The research was conducted in a mini-animal house at Federal Low-Cost Gombe, Gombe State, Nigeria.
Methods:
We acquired eighty-one 2-week-old Arbor Acres chicken strain from May Farms, Gombe. The BSFL were obtained from chicken waste and leftover fruits, then oven-dried, analyzed based on dry matter, and ground using a local milling machine. The BSFL meal was added to poultry diets by replacing dietary fishmeal at 0% (Control, A), 50% (B), and 100% (C). Each dietary treatment involved nine birds in triplicate in a completely randomized design. The birds were placed in pens marked with plywood and were fed the experimental diets for six weeks under similar management and dietary conditions. Data on weight gain, feed intake, feed conversion ratio, feed efficiency ratio, and linear body measurements were collected and analyzed.
Results:
The weight gain varied significantly ($p<0.05$) among the different treatment groups. Birds on Treatment C (1693.30±25.39 g) showed the highest weight gain, followed by those on Treatment B (1592.10±22.94 g), with the lowest mean final weekly weight gain observed in Treatment A (1416.03±32.66 g). Similarly, feed intake followed a similar pattern to weight gain. As for linear body measurements, the greatest increase in body length was recorded in Treatment C (20.54±1.01 cm), while the smallest was recorded in Treatment A (16.84 ±1.25 cm). Similar trends were seen for body width increase, thigh length increase, shank length increase, and wing length increase.
Conclusion:
The study showed that including BSFL in the diet promoted the growth of broiler chickens and could potentially serve as a significant protein source in poultry feed formulation.

Keywords: *Growth parameters, Dietary BSFL, Insect meal, feed formulation, Bird*

INTRODUCTION

Background

Animal protein availability among the human population which has been in steady increase in the developing countries of the world, Nigeria in particular has long remained a great concern. Poultry is a source of high-quality protein primarily in the form of meat and eggs providing about 36.5% of the total protein intake of Nigerians (Nworgu et al., 2012). In Nigeria, the gap being witnessed in supply and demand for animal protein will keep increasing considering the population growth rate (Amobi et al., 2019; 2020).

However, feed has remained one of the major problems of poultry production as a result of the high cost of dietary fishmeal which serves as a major source of protein in feed formulation. This has resulted in an increased cost of production far above what farmers can afford. There has been a continuous search for ways to abate the problems arising from the high cost of feed in poultry production (Suarez et al., 2009). Though many researchers have looked for alternatives using conventional grain legumes such as soya beans, groundnut, etc there remained constraints in their usage (Alphonsus et al., 2009; Suarez et al., 2009). Much research has been carried out on the use of lesser-known and under-utilized grain, legumes and oil seeds such as kidney beans (Candella et al., 2007), sesame meal (Ani and Adiegwu, 2005), pigeon pea (Okeke, 2000) and other meal such as snail offal meal (Amobi et al., 2019) but their use was limited due to the presence of anti-nutritional factors such as tannis; and the limited levels of essential amino acid lysine and tryptophan in like the profile of plant protein sources. Researchers however have reported that insect meals have appreciable high quality protein which can be used in the production of low-cost feed for poultry birds (Amobi and Ebenebe, 2018a, b). The use of grasshopper meals (Amobi et al., 2020); maggot meals (Adeniji, 2007; Nzamujo, 1999; silkworm caterpillar meal (Ijaiya and Eko, 2009) and desert locust meals (Adeyemo and Longe, 2008) have shown that insect meal can replace legume grains and fishmeal and based on their nutritional values they could effectively serve as a sustainable source of protein in feed formulation for poultry production. With all these appreciable and promising nutritional benefits of insect meals farmers are yet to fully adopt insect meal into feed formulation of poultry production. Therefore, this research was carried out to investigate the potential benefits of Black soldier fly larva (BSFL) meal inclusions in feed formulation on the growth performance of broiler chickens.

Methods:

Experimental site:

The study was carried out in a mini-animal house at Federal low-cost Gombe, located on Longitude 10o17’0” N, 11o 10’0” E, Gombe Local Government, Gombe State Nigeria (Oruonye et al. 2016).

Housing and Management of Experimental Birds:

A total of 81 two-week-old Arbor acres chicks purchased from May farms, in Gombe Nigeria, were used for this research. The experimental birds were randomly assigned to each of the nine brooding pens created by demarcating the brooder house using sealing boards (Amobi & Ebenebe, 2018a). Each pen which measured 2.6m × 3m housed nine birds in each of the three replicates representing the dietary treatments. The birds were given formulated diets and water using clean feed and watering troughs. Sixty-watt bulbs were used to supply light at night through electricity to provide illumination for continuous feeding while the birds were subjected to similar management and sanitation practices. Within this six-week feeding trial, the weight and linear body measurements were monitored while other performance indices were computed from the records (Amobi & Ebenebe, 2018a).

Source of the Black Soldier Fly Larva and Processing:

The Black Soldier Fly Larva (BSFL) was collected from chicken wastes and poultry dumps using hand picking method. The harvested BSFL were washed with warm water, sorted and oven dried at a temperature of 50 ^{o}C until they were dried and crispy with other feed ingredients, the broiler starter diets were formulated using Pearson square method and afterward was milled using Maxson milling machine (Model A2, Benin, Nigeria).

Experimental Diets:

The milled BSFL and other experimental diets were analyzed for proximate composition in accordance with the official standard of the Association of Official and Analytical Chemist (AOAC. 1990). Three formulated isocaloric and isonitrogenous broiler starter diets were used for the experiment designated as Treatment A, Treatment B and Treatment C. Treatment A (T1) which served as a control had no BSFL meal (0%) and 100% fishmeal, Treatment B (T2) contained 50% BSFL meal and 50% fishmeal while Treatment C (T3) contained 100% BSFL meal and 0% Fishmeal.

Experimental Designs:

Prior to the start of the experiment a total of eighty one (81) birds were initially weighed and randomly assigned to the three dietary treatments. Each treatment (0%, 50%, 100%) contains Nine (9) birds in triplicate in a Randomized design (Amobi & Ebenebe, 2018a).

Data Collection and Analysis:

The birds were weighed at the beginning of the experiment and thereafter at weekly intervals. Subtraction of the initial weight of the birds from the weekly weight gives the weight increase per week. Weekly feed intake was determined using a sensitive weighing scale (Camry EK 5055; Zhongshan Camry Electronic Co. Ltd, Zhongshan, China) in grams, the weight of leftover and spilled feeds subtracted from the weight of feed served gives the weight of feed intake every week. The weight gain, feed conversion ratio, and feed efficiency ratio were calculated using the following formulas:

Growth performance records

The data collected include:

- Feed intake (consumed): This was determined using the formula: Weight of feed fed – weight of feed leftover at the end of each day. The feed given and the leftovers were weighed using a sensitive weighing balance (Model EK 5055) to the nearest 0.1g.
- Weight gain: Weights of the broiler birds were taken weekly for 6 weeks to the nearest 0.1g with the aid of a sensitive electronic balance (Model EK 5055).

- Weekly Weight gain (WG) $= \frac{w_2 - w_1}{t_2 - t_1}$
- where W_1 = mean Initial weight; W_2 = mean Final weight Wt_1 = Initial time; t_2 = Final time
- Feed conversion ratio = feed consumed (g)/weight gain (g) (Okeke, 2000).
- Feed efficiency ratio = weight gain (g)/feed consumed (g).

Results:

Table 1 presents the proximate composition of the BSFL meal while the composition and proximate composition of the experimental diets are presented in Tables 2 and 3 respectively. Then, the result of the performance of broiler birds on the three dietary treatments is presented in Table 4 while the result of the performance of the broiler birds on a linear body measurement basis is presented in Table 5. The result of weight gain showed a significant difference ($p<0.05$) in the weight gain of the broiler chickens subjected to the three dietary treatments with the highest weight gain of 2353.50±36.99 g recorded for chickens on Diet C followed by birds on Diet B (2260.30±30.46g) while the least final weight gain of 2091.20± 46.92 g was recorded for birds on Diet A.

Table 1: Proximate composition analysis of BSFL Meal in % DM basis

Component	Nutrient composition
Dry matter	172 ± 2.10
Crude protein	42.70 ± 0.50
Crude fat	16.20 ± 1.00
Ash	6.40 ± 2.00
Metabolic energy (kcal)	688.42 ± 4.50

Table 2: Composition percentage of the experimental feeds as fed

Ingredients	Treatment A	Treatment B	Treatment C
Maize	47.0	47. 0	47.0
Wheat offal	16.0	15.0	15.0
PKC	22.78	22. 78	22.78
Fishmeal	10.0	5.0	-
BSFL meal	-	5.0	10.0
Bone meal	3.0	3.0	3.0
Lysine	0.2	0.2	0.2
Methionine	0.25	0.25	0.25
Premix	0.25	0.25	0.25
Salt	0.3	0.3	0.3
Enzyme	0.2	0.2	0.2
Toxynil	0.02	0.02	0.02
Total	100	100	100

* 1 kg of premix contains: vitamins A (5,000,000 I.U),Vitamin D3 (1,000,000 I.U), Vitamin E (16,000 mg),Vitamin K3 (800 mg), Vitamin B1 (1,200 mg), VitaminB2 (22,000 mg), Niacin (22,000 mg), Calciumpantothanate (4,600 mg), Vitamin B6 (2,000 mg), VitaminB12 (10 mg), Folic acid (400 mg), Biotin (32 mg), Cholinechloride (260,000 mg), Manganese (948,000 mg), iron(40,000 mg), Zinc (32,000 mg), Copper (3,400 mg),Iodine (600 mg), Cobalt (120 mg), Selenium (48 mg), Anti-oxidant (48,000 mg).

Table 3: Proximate Composition of Experimental diets (Starter feeds) in % DM basis

Parameters	Treatment A	Treatment B	Treatment C
Crude protein	20.05±0.42^{c}	20.10±0.50^{a}	20.09± 30^{b}
Moisture	8.40± 0.35^{c}	9.01±0.40b	9.15±0.50a
Crude fibre	4.40± 0.40^{c}	5.05±0.30^{b}	5.10 ± 0.20^{a}
Crude fat	7.10 ± 1.00^{a}	6.25±1.20^{b}	6.10±1.00^{c}
Ash	6.80±0.50^{a}	6.80±0.45^{a}	6.80±0.25^{a}

** a,b,c means with different superscript in a row are significantly different ($p<0.05$).

Table 4: Effect of dietary BSFL meal on growth performance indices of broiler chicks

Parameters	Treatment A	Treatment B	Treatment C
Initial mean weight (g)	675.17±10.20	668.20±7.52	660.20±11.60
Final mean weight (g)	2091.20±46.92	2091.20±46.92	2353.50±36.99
Mean weight gain (g)	1416.03±32.66^{c}	1592.10±22.94^{b}	1693.30±25.39^{a}
Total feed intake (g	4051.30^{a}	3749.60^{b}	3719.66^{c}
Feed conversion ratio	2.861^{a}	2.355^{b}	2.196^{c}

** a,b,c means with different superscripts in a row are significantly different ($p<0.05$)

The weight gain was significantly different ($p<0.05$) among the treatment groups where birds on Treatment C (1693.30±25.39 g) were highest followed by those on Treatment B (1592.10±22.94 g) and the least mean final weekly weight gain of 1416.03±32.66 g was observed in Treatment A. The highest mean feed intake of 4051.30g was recorded for chickens fed on dietary treatment A (Control diet) followed by treatment B (3749.60g) while the least mean feed intake of 3719.66g was recorded in treatment C. The highest feed conversion ratio of 2.861 was recorded in the chickens fed on treatment A followed by treatment B (2.355) while the lowest feed conversion ratio of 2.1966 was observed in treatment C (Table 4). The highest feed efficiency ratio was recorded in chickens fed on treatment C (0.455) followed by treatment B (0.424), while the least (0.349) was observed in treatment A (Table 4).
Also, Significant difference ($P<0.05$) was observed in the means of body length, body width, thigh length, shank length, wing length, and neck length increase of the broiler chicken fed with the three dietary treatments (Table 5).

Table 5: Effect of BSFL Meal on Linear Body Measurements (cm) of Broiler Chicks

Parameters	Treatment A	Treatment B	Treatment C
B L	16.84 ± 1.25[c]	20.67 ± 1.20[b]	20.54 ± 1.01[a]
B W	18.00 ± 1.18[a]	21.87 ± 1.35[b]	22.23 ± 1.20[a]
TH L	7.35 ± 1.01[c]	8.23 ±1.20[b]	22.23 ± 1.20[a]
S L	5.43 ± 1.13[c]	7.03 ± 1.26[b]	7.43 ± 1.18[a]
W L	9.50 ± 1.12[c]	12.17 ± 1.30[b]	12.60 ± 1.27[a]

**BL= body length, BW= body width, THL= thigh length, SL= shank length, WL= wing length; a,b,c means with different superscripts in a row are significantly different ($p<0.05$)

Discussion

The excellent performance of weight gain of the chicks on Diet C to those on Diets B and A respectively could be due to the better proximate composition of the dietary feed which is in line with the work of Amobi et al. (2020) who reported that Grasshopper-based diets resulted in a significant weight gain of broiler chickens and also Amobi and Ebenebe (2018) who reported that African palm weevil larvae based - feed and winged termite based – feed gave a better and significant weight gain than conventional feed and also can serve as a major source of animal protein in broiler feed formulation. Okah and Onwujiariri (2012) and Awoniyi et al. (2003) also reported a significant increase in weight gain of broiler chickens fed maggot meal and therefore stated that maggot meal diets were not nutritionally inferior to other plant protein diets. Also reported by Adeyemo and Longe, (2008) that, feeding desert locust meal (Schistocerca gregaria) to broilers resulted in a significantly ($P<0.05$) better performance on growth.The highest mean feed intake observed from chickens fed with dietary treatment A could be as a result of the higher crude fiber content of the BSFL meal-based diets (Treatments B and C). This agreed with reports of Amobi and Ebenebe (2018); Amobi et al. (2020) and Nielse (2011) who stated that a high fiber diet reduces hunger, thereby reducing feed intake. However, the findings disagreed with the findings of Hassan (2009) and Ranjhan (2001) who reported that birds on a high-fiber diet tend to consume more of the feed to meet their requirement for growth and development.The result of the Feed Conversion Ratio (FCR) was in line with the observations of Amobi et al. (2020); Amobi and Ebenebe (2018); Ijaiya and Eko (2009); Dube and Tariro (2014) who stated that the lower the feed conversion ratio, the better the food conversion efficiency of each experimental diet.The observed increase in the linear body measurements of the broiler chickens is not out of place because as the body weight increased, there seemed to be a corresponding increase in the linear body measurement of the broiler chickens which corresponds with the observations of Amobi et al. (2020); Amobi and Ebenebe (2018); Hassan (2009); Gabriel and Idris (1997) and Chisowa et al., (2015).

Conclusion

The result of this research clearly showed impressive growth performance with the inclusion of BSFL meal in the diets of the experimental birds. Therefore, BSFL meal can be completely incorporated into poultry feed formulation as the major source of protein.

Declarations

Ethics approval and consent to participate

This work followed ethical approval and consent in the use of animals for research purposes.

Availability of data and materials

The datasets generated and/ or analyzed during the study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Author's contributions

First author formulated the experimental diets using the black solider fly larvae meal and made significant contribution to the composition of the manuscript. Second author carried out the growth parameters and linear body measurements analysis. Third author analysed the data collected statistically and its interpretation. Fourth author sourced and prepared the black solider fly larvae meal. Fifth author carried out the proximate analysis of the experimental diets and the insect meal.

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Competing Interests

The author declares that there are no conflicts of interest related to this study.

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