Growth performance of broiler chickens based on grasshopper meal inclusions in feed formulation

Amobi, M. I.,[1]* Saleh, A.,[1] Okpoko, V. O.[2] and **Abdullahi, A. M.[1]**
[1]Department of Biological Sciences, Federal University of Kashere, PMB 0182 Gombe State
[2]Department of Biology, Admiralty University of Nigeria, Delta State
Corresponding author: decency75@gmail.com; mi.amobi@fukashere.edu.ng

Abstract

The purpose of this study was to investigate the potential benefits of substituting dietary fish meal with grasshopper meal on the growth performance of broiler chickens. The study was carried out in a mini-animal house of the Department of Biological Science, Federal University of Kashere, Gombe State, Nigeria. Seventy-two, 2-weeks old *Arbor acres* chicken strain were procured from May Farms, Gombe. The grasshoppers were collected using sweep net trapping method. They were oven dried and milled using local milling machine and incorporated into poultry diets by replacing dietary fishmeal at 0% (Control, A), 50% (B) and 100% (C). Each dietary treatment had 24 birds triplicates of eight birds per replicate in a completely randomized design. The birds were randomly allotted into pens demarcated with plywoods. The birds were fed the experimental diets throughout the six weeks period of the experiment and were subjected to similar managerial and dietary conditions during which time data was collected and used to evaluate weekly weight-gain, feed intake, feed conversion ratio, feed efficiency ratio and linear body measurements monitored. The weight-gain were significantly different ($p<0.05$) among the treatment groups where birds on Treatment C(1720.11±2.11 g) was highest followed by those on treatment B(1480.00±2.12 g) and the least mean final weekly weight gain of 1,287.98±1.20 g was observed in Treatment A; Also feed intake exhibited the same pattern of weight gain. For linear body measurements, the highest body length increase was recorded in Treatment C (21.39±1.01 cm) while the least was recorded in those on Treatment A, (15.49±1.10 cm). The same trend was observed for body width increase, thigh length increase, shank length increase and wing length increase. This study showed that dietary grasshopper meal promoted growth of broiler chicken and so would conveniently replace dietary fishmeal. Therefore, establishment of insect farms are highly recommended to produce enough grasshopper meal to meet the demands of poultry feed industries.

Keywords: *Arbor acres*; growth parameters; dietary grasshopper; chicken body; liner measurement.

Accepted: 11 December, 2020.

Introduction

The shortage of animal protein among the ever-increasing human population in the developing countries of the world, Nigeria in particular has long been recognized and remains a great concern. Poultry is a source of high quality protein primarily in the form of meat and eggs providing about 36.5% of total protein intake of Nigerians (Nworgu *et al* 2012). In Nigeria, the gap between supply and demand for animal protein is expected to increase considering the population growth rate (Amobi and Ebenebe, 2018a, b).

Feed however is one of the major problems of poultry production as a result of high cost of dietary fishmeal which serves as major source of protein in feed formulation. This has resulted in increased cost of production far above what local farmers can afford. There has been a continuing search for solutions to 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 but there are constraints in their usage (Alphonsus *et al* 2009; Suarez *et al* 2009).

Much work have been done 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 non-leafy 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 revealed 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 maggot meals (Adeniji, 2007; Nzamujo, 1999;

http://dx.doi.org/10.4314/tzool.v18i1.7
© *The Zoologist, 18:* 39-43 December 2020, ISSN 1596 972X.
Zoological Society of Nigeria

Onwujiariri, 2012; Awoniyi *et al* 2000), watermelon bug meal (Jumaa *et al* 2014), silkworm caterpillar meal (Ijaiya and Eko, 2009) and desert locust meal (Adeyemo and Longe, 2008) have shown that insect meal can replace legume grains and fishmeal and based on their nutritional values and availability they could effectively serve as a sustainable source of protein in feed formulation for poultry production.

With all these appreciable nutritional benefits of insect meals farmers are yet to fully adopt insect meal into feed formulation of poultry production. Therefore, this study was carried out to investigate the effect of substituting dietary fishmeal with grasshopper meal on the growth performance of broiler chickens.

Materials and method

Experimental site

The study was carried out in a mini- animal house of the Department of Biological Science; Federal University of Kashere located on Longitude 9^{0}52′37.59′′N, 11^0 0′11.92′′E, Akko Local Government, Gombe State (Oruonye *et al* 2016).

Housing and management of experimental animals

A total of 72 two-weeks old *Arbor acres* broiler chicks purchased from May farms located in Gombe, Gombe State, were used for the experiment. The birds were randomly assigned to each of the nine brooding pens created by demarcating the brooder house using sealing boards. Each pen which measured 2.6m × 3m housed 15 birds in each of the three replicates representing the dietary treatments. The birds were given the formulated diets and water ad libtum using clean feed and watering trough. Sixty watt bulb 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.

Source of grasshopper and processing

The grasshoppers were collected using sweep net trapping method. Sweep nets with metal handle were taken to designated farm lands located at Gombe and swept across the vegetations, trapped grasshoppers were dipped into a basin of hot water and then sorted out. The harvested grasshoppers were oven dried at a temperature of 50^{o}C until they were dried and crispy and then milled with other feed ingredients using milling machine of the brand name Maxson (Model A2, Benin, Nigeria) to formulate the broiler starter diets using Pearson square method.

Experimental diets

Three formulated isocaloric and isonitrogenous broiler starter diets were used for the experiment designated as Treatment A, Treatment B and Treatment C. Treatment A (T_1) which served as a control had no grasshopper meal (0%) and 100% fishmeal, Treatment B (T_2) contained 50% grasshopper meal and 50% fishmeal while Treatment C (T_3) contained 100% grasshopper meal and 0% Fishmeal. The milled grasshopper and experimental diets were analyzed for proximate composition in accordance with the official methods of the Association of Official and Analytical Chemist (AOAC. 1990).

Experimental design

The birds were weighed and randomly assigned to the three dietary treatments. Each treatment comprised 24 birds, with each treatment replicated three times in such a way that each replicate had eight birds in a completely randomized design.

Data collection and analysis

The birds were weighed at the beginning of the experiment and thereafter at weekly intervals. Subtraction of 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, weight of leftover and spilled feeds subtracted from weight of feed served gives the weight of feed intake on weekly basis. Feed conversion ratio, feed efficiency ratio and specific growth rate were calculated using the following formulas:

Feed conversion ratio
= feed consumed (g)/weight gain (g).

Feed efficiency ratio = weight gain (g)/feed consumed (g).

Specific growth rate = Log_{10}final weight – Log $_{10}$initial weight/Time (days) x 100.

Other linear body measurement indices taken were as follows:

Body length: is the length from the tip of the beak to the uropigeal gland.

Body width: The circumference of the body measured at the tip of the pectus.

Thigh length: The length between the hip bone that of the knee on the right limb.

Shank length: The length between the knee and the regiotarslis on the right limb.

Wing length: is the length from the base of the shoulder to the tip of the longest primary feather.

Neck length: The first neck bone of the skull and the last cervical vertebrae at the shoulder point.

All linear body measurements were carried out with the aid of thread stretched on a meter rule to the nearest 0.1 cm. Data were summarized and subjected to analysis of variance (SPSS, 2010) version 20.0 and the differences between treatments means were separated using Least Significance Difference (LSD) at 95% confidence limit.

Results

Table 1 presents the proximate composition of the grasshopper meal while the composition and proximate composition of the experimental diets are presented in Tables 2 and 3 respectively. Then, the result of performance of broiler birds on the three dietary treatments is presented on Table 4 while the result of the performance of the broiler birds on linear body measurement basis is presented on 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 1720.11±2.11 g recorded for chickens on Diet C followed by birds on Diet B (1480.00±2.12 g) while the least final weight gain of 1287.98±1.20 g was recorded for birds on Diet A.

Table 1: Proximate composition (%) of grasshopper meal in % DM basis.

Parameters	Percentage
Moisture	92.42± 0.50
Crude protein	52.50± 0.41
Crude fibre	8.30± 0.73
Fat	27.10± 0.80
Ash	4.25± 2.10
NFE	5.60± 0.20

Table 2: Composition of the experimental feeds

Ingredients	Treatment A	Treatment B	Treatment C
Maize	45.0	45.0	45.0
Wheat offal	15.0	15.0	15.0
PKC	25.78	25.78	25.78
Fishmeal	10.0	5.0	–
Grasshopper 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), Vitamin B2 (22,000 mg), Niacin (22,000 mg), Calcium pantothanate (4,600 mg), Vitamin B6 (2,000 mg), Vitamin B12 (10 mg), Folic acid (400 mg), Biotin (32 mg), Choline chloride (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	20.10± 0.45^b	20.05± 0.50^c	20.10± 0.55^a
Moisture	7.40± 0.42^c	8.10± 0.40^a	7.45± 0.40^b
Crude fibre	2.80± 0.60^c	3.00± 0.80^b	3.15± 0.83^a
Crude fat	6.28± 1.00^a	6.18± 0.80^b	6.14± 0.75^c
Ash	6.30± 1.65^c	6.50± 1.70^a	6.45± 1.60^b

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

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

Parameters	Treatment A	Treatment B	Treatment C
Initial weight (g)	620.12 ± 2.10	620.15 ± 3.04	620.01 ± 0.40
Final weight (g)	1908.10 ± 2.00	2100.15 ± 1.10	2340.12 ± 0.86
Weight gain (g)	1287.98 ± 1.20^c	1480.00 ± 2.12^b	1720.11 ± 2.11^a
Total feed intake (g)	3485.61 ± 24.10^a	3345.45 ± 20.12^b	3143.72 ± 18.20^c
Feed conversion ratio	2.71^a	2.26^b	1.83^c
Specific growth rate	1.16^c	1.26^b	1.36^a
Feed efficiency ratio	0.37^c	0.44^b	0.55^a

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

The highest feed intake of 3485.61±24.10 g was recorded for chickens on treatment A followed by those on Treatment B (3345.45±20.12 g) while the least value of 3143.72±18.20 g was observed in those on Treatment C. The highest feed conversion ratio of 2.71 was recorded in the chickens subjected to Treatment A followed by those on Treatment B (2.26) while the least FCR of 1.83 was observed in those on Treatment C. The highest specific growth rate of 1.36 was recorded in chickens on Treatment C while the least SGR of 1.16 was observed in Treatment A which all showed significant differences. The highest feed efficiency ratio was recorded in chickens subjected to Treatment C; 0.55 while the least was observed in Treatment A 0.37 (Table 4).

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 subjected to the three dietary treatments (Table 5).

Table 5: Effect of grasshopper meal on linear body measurements (cm) of broiler chicks.

Parameters	Treatment A	Treatment B	Treatment C
B L	15.49±1.10[c]	17.50±1.20[b]	21.39±1.01[a]
B W	21.86±1.02[a]	20.00±1.15[b]	21.86±1.30[a]
TH L	6.96±1.200[c]	8.96±1.10[b]	10.91±1.20[a]
S L	3.50±1.10[c]	4.40 ±1.20[b]	4.86 ±1.15[a]
W L	9.15±1.15[c]	10.00±1.25[b]	11.60±1.20[a]

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

Discussion

The better performance of weight gain of birds on Diet C to those on Diets B and C respectively could be due to better proximate composition of the dietary feed which is in line with the works of other authors on better performance of broiler chicks fed on insect meal. Amobi and Ebenebe (2018a) 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 could serve as a major source of animal protein in broiler feed diet; Wang (2007) posited that field crickets could replace legume grains without adversely affecting weight gain of broiler chickens. other authors: Awoniyi and Aletor (1999); Okah and Onwujiariri (2012) and Awoniyi *et al* (2003) also reported significant increase in weight gain of broiler chickens fed maggot meal and therefore stated that maggot meal diets was not nutritionally inferior to other plant protein diet. Ijaiya and Eko (2009), worked on replacement of fishmeal with silkworm caterpillar meal in the diets of broiler chickens and reported a significant improved performance (p<0.05), which was attributed to the pleasant aroma, palatability and nutrient bioavailability in insect- meal for adequate growth and development. Similarily, Adeyemo and Longe (2008) reported that feeding desert locust meal (*Schistocerca gregaria*) to broilers resulted in a significantly improved (p<0.05) better growth.

The highest feed intake recorded for chickens on Treatment A could be as a result of higher crude fiber content of the grasshopper based diets (Treatments B and C). This disagreed with the findings of Hassan (2009) and Ranjhan (2001) who reported that birds on high fibre diet tend to consume more of the feed to meet their requirement for growth and development. However, the findings agreed with Amobi and Ebenebe (2018a) and Nielse (2011) who stated that high fibre diet reduces hunger, thereby reducing feed intake.

The result of feed conversion ratio was in line with the observations of Amobi and Ebenebe (2018a); Ijaiya and Eko (2009); Wang (2007); Okah and Onwujiariri (2012) and Dube and Tariro (2014) that the lower the feed conversion ratio, the better the food conversion efficiency of each experimental diet.

Specific growth rate of the broiler chickens showed a significant differences (p<0.05) across dietary treatments which was in line with the observation of Okah and Onwujiariri (2012); Dube and Tariro (2014) and Awoniyi *et al (*2003). The higher feed efficiency ratio as recorded in treatments C and B shows that they had high/better efficiency potential to convert feed to appreciable body mass as evident in better weight gain of the broiler chickens subjected to various inclusion levels of grasshopper meal compared to those on control diet. These conformed to the observations of Amobi and Ebenebe (2018a); Ijaiya and Eko (2009); Teguia *et al* (2002) and Nielse (2011).

The observed gradual 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 and Ebenebe (2018a); Hassan (2009); Gabriel and Idris (1997) and Chisowa *et al* (2015).

Conclusion

From the findings of the study, grasshopper meal could be incorporated into the diets of broiler chicks to partly or completely replace fish meal in feed formulation. Also, the use of insect-based feed proved to be profitable in terms of growth performance and can also be used as a source of animal protein in feed formulation of broiler chickens.

References

Adeyemo, G. O. and Longe, O. G. 2008. Effects of feeding desert locust meal (*Schistocerca gregaria*) on performance and haematology of broilers. *Tropentag, 5(2):* 20-24.

Alphonsus, O., Aniebo, K., Ebere, S., Erondu, C. and Onyema, J. 2009. Replacement of fishmeal with maggot meal in African catfish diet. *Revista gricola, 9(3):* 666-671.

Amobi, M. I. and Ebenebe, C. I. 2018a. Performance of broiler chicks fed on two insects based-diets in South Eastern Nigeria. *J. Ins. Food & Feed, 4(4):* 263-268.

Amobi, M. I. and Ebenebe, C. I. 2018b. Quality of the carcass and organs of chicken fed with two different insect meals. *J. Ins. Food AND Feed, 4(4):* 269-274.

Amobi, M. I., Ebenebe, C. I., Nwobodo, J. C., Ezenwaeya, G. U., Okereke, N. H. and Okpoko, V. O. 2019. Effects of snail offal meal on performance of broiler chickens. *Int. J. Liv Produc., 10(2):* 43-48.

Ani, A. O. and Adiegwu, L. I. 2005. The feeding value of velvet beans (*Mucuna pruriens*) to weaner rabbits. *Proceedings of 30th Annual Conference of Nigerian Society for Animal Production (NSAP) at University of Nigeria, Nsukka,* pp. 186-189.

AOAC. 1990. *Association of Official Analytical Chemists, Official Methods of Analysis*. 15th ed. Washington DC, pp. 71-79.

Awoniyi, T. A. M. and Aletor, V. A. 1999. The effect of equi-protein replacement of fish meal with maggot meal in broiler chicken diet on their performance charac-teristics, organ weights and protein utilization. *Proceedings of the 24th Annual Conference of the Nigerian Society for Animal Production*, pp. 91-94.

Awoniyi, T. A. M., Aletor, V. A. and Aina, J. M. 2003. Performance of broiler chickens fed on maggot meal in place of fish meal. *Int. J. Poult Sci, 2(4):* 271-274.

Candela, M., Astiasaran, I. and Bello, J. 2007. Cooking and warm-holding effect on general composition and amino acids of kidney beans (*Phaseolus vulgaris*), chickpeas (*Cicer arietinum*) and lentils (*Lens culinaris*). *J. Agr. F Chem*, *45:* 4763-4767.

Chisowa, D. M., Mupeyo, B. and Kasamba, R. T. 2015. Evaluation of winged termites on sole sources of protein in growing Japanese quails. *Eur. Acad Res*., *2:* 15214-15227.

Dube, S. and Tariro, M. 2014. Effect of including some insects as feed supplementation broilers reared in Zimbabwe. *Int. J. Poult Sci, 13(1):* 42-46.

Gabriel, S. and Idris, A. A. 1997.Utilization of locust meal in poultry diets. *JONARES, 1(1):* 19-23.

Hassan, A. A. 2009. The effect of replacing graded levels of fish meal with grasshopper meal in broiler starter diet. *PAT, 5(1):* 30-38.

Igwe, C. U., Ujowundu, C. O., Nwaogu, L. A. and Okwu, G. N. 2011. Chemical analysis of an edible African termite (*Macrotermes nigerensis*): A potential to food security problems. *Biochem and Anal Biochem1:* 105. Doi: 10.4172/2161- 1009.1000105.

Ijaiya, A. T. and Eko, E. O. 2009. Effect of replacing fish meal with silkworm caterpillar meal on performance, carcass characteristics and haematological parameters of finishing broiler chicken. *Pak. J. Nutr, 8(6):* 850-855.

Nielsen, B. L. 2011. Promotion of insoluble fibre in the diet effects, behavior and hunger in broiler breeders growing at similar rates. *Animal, 5(8):* 1247-1258.

Nworgu, F. C., Oduola, O. A., Alikwe, P. C. and Ojo, S. J. 2012. Effect of basil (*Ocimum gratissimum*) leaf supplement on initiation of egg laying and egg quality parameters of laying hens. *J. F Agri. Envt, 10(2):* 337-342.

Okah, U. and Onwujiariri, E. B. 2012. Performance of finisher broiler chickens fed maggot meal as a replacement for fish meal. *J. Agri Tech*., *8(2):* 471-477.

Okeke, D. P. 2000. Replacement of soybean meal with bambara waste (*Voandzeia subterranean*) in broiler diets. M.Sc Thesis, Department of Animal Science, University of Nigeria, Nsukka.

Oruonye, E., Iliya, M. and Ahmed, Y. 2016. *Sustainable Mining practices in Nigeria. A case study of Maiganga coal Mining in Gombe state. Int. J. Plt and Soil Sci* 11: 1-9.

Ranjhan, S.K. 2001. *Animal nutrition in the tropics*. Revised Edition. Vicas Publishing House. 35pp.

Téguia, A., Mpoame, M. and Okourou Mba, J. A. 2002. The production performance of broiler birds as affected by the replacement of fish meal by maggot meal in the starter and finisher diets. *Tropicultura*, *20:* 187-192.

Suarez, J., Llorente, R., Romero-Zerbo, S. Y., Mateos, B., Bermudez-Silva, F. J. and Fonseca, F. R. 2009. Early maternal deprivation inuces, gender-dependent changes on the expression of Hippocampal CB (1) and CB (2) Cannabinoid receptors of neonatal rats. *Hippocampal, 19:* 623-632.

Wang, D. 2007. Nutritional value of the Chinese grasshopper for broilers. *Ani Feed Sci. Tech, 135 (135):* 66-74.

Citation: Amobi, M. I., Saleh, A., Okpoko, V. O. and Abdullahi, A. M.
Growth performance of broiler chickens based on grasshopper meal inclusions in feed formulation.
http://dx.doi.org/10.4314/tzool.v18i1.7

The Zoologist, *18:* 39-43 December 2020, ISSN 1596 972X.
Zoological Society of Nigeria.