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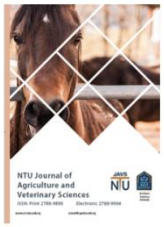

The potential of the housefly maggot as a source of crude protein in the diet of broiler chickens

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A B S T R A C T

This study aimed to determine the effect of maggot meal inclusion in feed for broilers on their growth rate and weight gain. A total of thirty (30) day-old broiler chicks were randomly allocated into two groups of 15 each. One group was fed with commercial feed, while the second group was fed with self-formulated feed compounded with the housefly maggot as a source of crude protein. The experiment lasted for six (6) Weeks, and feed and water were offered ad libitum for 42 Days. The average live weight gain (2284.20 g/bird) observed in the commercial diet group was not significantly different from the self-formulated diet treatment group (2042.20 g/birds) ($P>0.05$). The P value (0.001) was found to be a significant relationship between the feed conversion ratio and the grouping. However, there is no significance found in the relationship between time (p-value = 0.11) and the treatment given. Cost evaluation Table revealed the maggot inclusion self-formulated diet had the least feed cost/kg gain of 320 units at the starter phase and 160 units at the finisher phase, as against 672 units and 336 units for commercial diets at starter and finisher phases, respectively. Cost evaluation also revealed that the self-formulated diet was cheaper to compound and had the lowest cost.

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Introduction

The biological value of protein is the measure of how well a food protein supports [1,2]. Foods with high Biological Value are often called "complete" because they provide all the essential amino acids for tissue synthesis, particularly in amounts that meet or exceed requirements. Foods with low Biological Values are often called "incomplete" because they lack substantial amounts of one or more of the essential amino acids required by humans and animals [3].

The expectation from poultry meat is to have maximum productivity within a minimum time while consuming less feedstuff. However, it should be noted that there has been an increase in the cost price/kg due to the increased demand for this commodity worldwide[4]. As a result, alternative production systems have been introduced which may lead to significant benefits in cost price/Kg [5]. The Incorporation of insects as a primary source of protein in poultry diets is an alternate way to reduce feed cost without affecting the weight gain, which will have significant implications on the economics of the poultry production system [6,7].

The use of insect meal has been linked with positive effects on birds' performance and reduction in costs associated with animal maintenance [8,9]. Digestibility of nutrients are influenced by environmental temperature, age, sex, ration, crude protein content and many other factors e.g., availability, type(s) of dietary fibre, amino acid profile etc., Insect based diet can be a good alternative to fish meal or soya bean meal because its price remains stable throughout the year unlike fishmeal which shows huge fluctuations [10].

Materials and methods

Experimental Location

The experiment was conducted at Tanke Ajanaku, Ilorin East Local Government. latitude 8.48N, longitude 4.61E of the Greenwich meridian, Ilorin, Kwara State (North Central), Nigeria.

Ethical Approval

The ethical review committee of the faculty of veterinary medicine, University of Ilorin Ilorin, approved and endorsed the research study with approved reference number UREC/FVM/15/32TA074

Housing and Management

All birds were housed in a deep litter system with wood shavings as flooring, with feeders and drinkers.

The feed and water were available to the birds ad libitum throughout the trial. Birds were vaccinated against coccidiosis, Marek's disease and Newcastle disease during the study.

Collection of Maggots

Housefly larvae used in this experiment were collected from the maggotry situated at the Faculty of Veterinary medicine, University of Ilorin, where they were reared at 2-5 days old on chicken manure. The pupae were separated and sun dried for 3 to 4 days.

Maggot Meal Production

The dried pupae were grounded along with other feed ingredient as a replacement for fish meal at the feed mill.

Experimental Diets

The experimental feed consists of a formulated starter diet and finisher diet which the fish meal has been replaced with maggot mill procured from a reputable local feed mill and starter diet and finisher diet gotten from a commercial feed mill (e.g. Hybrid and Top Feed).

The design is a two-way random design, which consists of two groups, with each group consisting of 15 birds. At starter phase, all broiler chicks in the same group will be fed with the ration under the same management conditions. This same procedure will be done and repeated during the finisher phases.

The experimental diet consists of a self-formulated diet in which the fish meal and soya bean have been replaced with maggot meal, and the same diet in which the fish meal and soya bean remain.

Feed Formulation

A complete feed for broiler chickens containing 22% protein, 4.0% fat and 5.0% fibre was formulated using standard methods. A basal diet of corn and soybean meal with the addition of fishmeal to meet the requirement for essential amino acids (AA) in poultry diets was used as the control diet throughout this experiment

Experimental Layout and Management of Birds

The house was thoroughly cleaned, washed, disinfected and allowed to dry before litter material was introduced. Thirty (30) day old broiler chicks were randomly allocated in two replicates each to the broiler starter and finisher dietary treatments. The experiment lasted from six (6)

Weeks, feed and water were offered ad – libitum for 42 Days. Daily feed intake (DFI) was calculated on daily basis while birds were weighed at weekly intervals to observe weight changes.

Feed conversion ratio (FCR) was calculated as

$$= \frac{\text{Feed Intake (g)}}{\text{Live weight (g)}}$$

Table 1. Percentage composition of maggot meal inclusion in self-formulated diet fed to broiler at the starter and finisher phase.

Ingredient	Starter	Finisher
Maize	50.40	55.00
Soya beans	25.00	20.00
Maggot meal	10.00	10.00

Table 2

Calculated analysis	Starter	Finisher
Crude Protein	21.91	1.66
Crude fibre	21.67	1.9
Ether extract	5.70	0.63
Calcium	6.87	0.86
Total Phosphorus	9.56	2889
Me (Kcal/kg)	8.76	2989

Gross Margin Analysis

This was computed by deducting the cost of feed from total expected revenue.

Dietary Treatments

Broiler chickens were randomly assigned to 1 of 2 dietary treatments with 2 replicates per treatment (N = 15 birds/replicate) and an initial body weight of 40 ±2g.

The dietary treatments were a control diet containing fishmeal at 10% inclusion rate and 1 experimental diet containing Maggot Meal in place of fishmeal at 10% inclusion rate. Each treatment had 2 replicates with 15 birds per replicate (N = 15/replicate).

Measurement of Feed Intake and Body Weight Gain

Feed intake was measured daily and body weight was recorded weekly. At the end of the 42-day period, Feed Conversion Ratio (FCR) and Average Daily Gain (ADG) were calculated for each replication using standard methods.

Statistical Analysis

The data was obtained then tabulated and analyzed according to statistical procedure of Student's t-test and the treatment means was computed using Least Significant Difference (LSD) at 5% level of probability through computerized statistical package i.e., Student Edition of Statistics (SXW), Version 8.1 (Copyright 2005, Analytical Software, USA).

Results

Chemically, the composition of maggot meal used in this study falls within the range which have been reported by different researchers and they are as follows; Crude protein which were differently reported as 45%, 47.1%, and 48%. Some other researches also relate lower values and higher values as compared to the aforementioned. The protein content of maggot is high, which is between 39%

and 63%. The differences which are recorded by different researchers can be explained by factors such as different ages of the maggots at harvest, the type of substrate that was used to grow the maggots, the species of maggot, the methods used in processing like sun-drying or oven drying and even the type of analytical procedure done.

Having fed the broiler birds with both maggot meal inclusive self- formulated feed and Commercial diet for a space of Six (6) weeks, their growth performance parameters, average weekly body weight, feed conversion ratio and Feed cost per each diet were observed and presented in Tables. The total live weight gain per week of broilers under 2 different treatment groups are presented in Table 1. Below. In case of average total live weight, highest one (2284.20 g/bird) was observed in Commercial diet group and that was significantly (P<0.05) different from Self-formulated diet treatment group (1042.20 g/birds) lower body weight (P>0.05). From the Table 1, it is seen that live weight of broilers in each treatment groups were gradually increased with ages.

Values of growth performance on the two diets were not statistically different. Birds fed with commercial diets however had body weight and weight gain that were numerically superior to birds fed the maggot inclusion self-formulated feed.

The total feed intake was highest (1329.33 g/bird) in group which was fed with Commercial feed and was lowest in group provided with Self- formulated feed. The difference in among the two treatment groups was found statistically significantly ($P<0$.05) in term of total feed intake (Table 2). The growth performance of the broiler birds (Table 2) showed that average feed intake ranged from 600.00 – 840.00g at the starter phase and 1200.-1400.0g at the finisher phase, Average weight gain from 400.0– 450.0 g at the starter phase and 800.0-1000.0g at the finisher phase (Table 1). From the Table 2, it is also seen that the feed intake of both Commercial and Self formulated diet group was increased with the increases of ages.

The average feed intake per weeks was increased significantly with the advancement of ages.

The Feed cost/kg gain was observed to be statistically (P < 0.05) affected by the dietary treatments. Cost evaluation Table revealed the maggot inclusion self-formulated diet had the least feed cost/kg gain of 640.00 units at starter phase and 320.25 units at finisher phase as against 2294.48 units and 1145.52 units for commercial diets at starter and finisher phase, respectively (Tables 3 and 4).

Cost evaluation in Table 5 and 6, also revealed that the self-formulated diet was cheaper to compound and had least cost of 640.00 units/ kg and 320.25 units/kg feed.

Table 3. Total Feed Intake of Broiler in Two Treatment Groups (g/Week/Bird)

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Commercial	583.3	833.2	1033.3	1167.1	1233.4	1329.33
Maggot inclusion Self formulated	583.2	595.5	625.3	805.4	842.4	1051.33

The P value (<0.05) was found to be 0.01 which showed a weak relationship between the treatment. The result shows there is a weak significance between the commercial feed and the self-formulated maggot inclusion feed sample bird feed intake.

Table 4. Average weekly feed conversion ratio

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Commercial	3.14	1.26	1.09	1.24	1.51	1.72
Self-formulated	3.16	1.24	1.01	1.06	1.05	1.03

The P value (0.001) was found to be a moderately significant relationship between the feed conversion ratio and the grouping. This buttresses the point seen in our table that shows the birds fed with commercial feed having higher feed conversion ratio than self-formulated feed. However, there is no significance found in the relationship between time (P value = 0.11) and the treatment given. Hence the age of the birds was not a factor to the feed conversion ratio.

Table 5. Overall performance of birds in the first six weeks

	Self-Formulated	Commercial
Total Weight Gain (g)	7288.41± 234.45	7522.7 ± 205.24
Total Feed Intake (g)	6603.30	6179.63
Feed conversion Ratio	1.15	1.21
Mortality	0	1

Table 6. Cost Economic Evaluation of broilers fed with commercial and Self-formulated diet.

Cost Economic Evaluation				
Parameters	Self-formulation		Commercial	
	Starter	**Finisher**	**Starter**	**Finisher**
Total feed intake (kg)	1.6	0.83	2.0	1.0
Feed cost (Unit/kg)	320	160	672	336
Total feed cost (Unit)	512	132.8	1344	336
Total gain (Unit)	18000		22380	

Discussion

The need to reduce the cost of production, especially for smallholder producers has been an issue of concern among poultry producers. This is due to high cost of commercial feeds especially during periods when local grains are scarce and expensive [11]. Broiler chicken production is one of the most important livestock activities worldwide, which contributes immensely towards food security through employment generation and poverty alleviation [12]. There is need to encourage the production of safe and healthy feed by recycling waste materials using indigenous technology, this will reduce cost of production of livestock products for smallholder farmers (especially poultry) where they are most needed [13].

The maggot meal (larvae and pupae) of common housefly (*Musca domestica*), the most prevalent fly species in Nigeria, was found to be a good source of crude protein and energy for broilers [14], with an overall quality comparable to that of commercial diets, and its inclusion in the feed did not influence the growth and physiological parameters such as mortality, weight gain, feed intake and FCR .

Commercial poultry feeds are made from by-products of meat and dairy production. Thus, they are relatively expensive. By using maggot meal as a source of protein and energy, the cost of poultry production is reduced since this product is made from waste materials which can be recycled to feed livestock for purposes other than human consumption [15].

Therefore, the result obtained in this study shows that not only is maggot meal a good source of protein and energy for poultry, but it can be used as an ingredient in self-formulated diets without fear of fly attack [15]. This will make poultry production affordable for smallholder farmers who cannot afford commercial feeds.

In conclusion, this study revealed that since broilers fed with commercial diet had the highest final body weight, followed by those fed maggot inclusion self-formulated diets as it is clear from Table 4. However, the least amount of feed intake and FCR was recorded in birds maintained on self-formulated diets at both stages (Table 3).

This may be as a result of the difference in nutrient and energy levels so as to increase the feed intake and weight gains at lower cost [16]. At finisher phase, birds maintained on self-formulated diets had better overall performance (final body weight, mortality, FCR) than those on commercial diet [17]. The higher weight gain recorded for birds managed on commercial diet might be as a result of the inclusion of antibiotic in the formulation which was not included in this study [18] .

These findings indicate that commercial broiler diets contain more nutrient and energy which support

better weight gain and FCR [19]. The lower feed intake recorded for commercial diet may be due to the inclusion of antibiotic in the basal diet. The quality diet of foods has been found to have a better performance for broiler. This is due to the fact that the high quality of food means it has more nutrients and energy which supplies enough nutrients to the bird thus improving weight gain. In this study, there was a significant difference between the starter and finisher phases, the quality of food has nutrient and energy, which supplies enough nutrients that improve weight gain during the starter phase. This is because at the starter phase the bird grows rapidly, thus needs more nutrients for fast growth [20].

The present work could be used as a reference to enhance profitability of broiler by devising cost effective diets [19]. The inclusion of the calorific value of a high-protein food source, such as maggots, should be considered in diets for monogastric animals [21, 22].

Offal from livestock processing can provide a cheap and plentiful source of raw materials to produce insect larvae, which could be very cost-effective as feed ingredients for poultry species if they are processed efficiently [22].

There is a high cost associated with the commercial diet due to the inclusion of antibiotic in the formulation [23]. However, it can be expected that if maggot inclusion self-formulated diets were produced at large scale and satisfactory results obtained, there would be potential for business opportunities for small scale feed manufacturers who make maggot inclusion self-formulated feed [24]. The costs associated with commercial diets are due to the inclusion of antibiotics in the formulation. Moreover, the maggot inclusive self-formulated diets produced at a large scale would attract business opportunities for small scale poultry feed manufacturers. The study is an important step towards the rearing of insects by rural producers using organic wastes for augmenting the income of the rural population and providing effective management strategies [25].

The higher final body weight recorded for birds maintained on maggot inclusion self-formulated diets may be attributed to the fact that this diet has better nutrient composition, contains a maize-Soya blend which is cost-effective and readily available locally [26].

The inclusion of maggot meal in self-formulated diet for broilers was also observed to have lessened the cost of production because it is cheaper than other energy and protein sources available [24]. The low-cost efficacy of this product makes it a potential alternative to other expensive commercial feeds presently used in the market [24]. It is important to state that the absence of fly droppings did not affect broiler chickens' performance; this may be attributable to maggots' ability to digest and break down almost 80% of their host body tissues. This also implies that flies or larvae do not contribute much towards polluting meat products, even when the maggot meal is included in the feed [25].

The results also revealed that the inclusion of maggot meal in broiler's diet did not affect its hygiene and it could be safely included in poultry diets without fear of fly attack. This implies that use of this product can be advantageous for intensive farming businesses where keeping a clean environment is an important factor towards business success [24].

Conclusion

Maggot inclusion self-formulated diets are the most cost-effective at both starter and finisher phases of broiler production since it is more profitable for small-scale poultry producers to make their own feed using low-priced raw materials available close to home rather than buying expensive commercial feed. The gross margin for the self-formulated feed (A1) was observed to be higher than values for the commercial diets (A2) thus making the self-formulated feed to be more profitable

Based on these studies, further research is required to determine the effects of different levels of maggot meal inclusion in self-formulated diets on the performance and economics of broilers.

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Competing Interests

No competing interest

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