Effect of Utilization of Maggot (*Hermetia illucens*) Meal Substituted Fish Meal in the Diets on Broiler Chicken Performance

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ABSTRACT

The present study was designed to elaborate the effect of substituting fish meal with maggot (*Hermetia illucens*) meal in the diets on feed efficiency of broiler chicken. Eighty day old chicks (DOC) CP 707 broilers were placed in battery cages and were assigned to each dietary treatment (5 treatments) which was replicated four times in a completely randomized design (CRD) arrangement. Diets were formulated to meet or exceed starter and finisher broiler requirements as recommended by NRC (1994). Treatment diets were formulated as follow: R0 = 100.0% fish meal (15.0% in the diet) + 0% maggot meal (0% in the diet); R1 = 75.0% fish meal (11.25% in the diet) + 25.0% maggot meal (3.75% in the diet); R2 = 50.0% fish meal (7.5% in the diet) + 50.0% maggot meal (7.5% in the diet); R3 = 25.0% fish meal (3.75% in the diet) + 75.0% maggot meal (11.25% in the diet); and R4 = 0% fish meal (0% in the diet) +100.0% maggot meal (15.0% in the diet). Parameters measured were: digestibility of energy, protein, Ca and P; daily feed consumption, daily gain, and feed efficiency ratio. Research results showed that the digestibility of dry matter, energy, Ca, and P were all not significantly ($P > 0.05$) different among the treatments. Whereas feed consumption, daily gain, and feed efficiency ratio of starter and finisher broiler chicks were significantly ($P < 0.05$) decreased as maggot meal substituted fish meal at the level of 100% or 15.0% in the diet (R4). It can be concluded that maggot (*Hermetia illucens*) meal could replace fih meal up to 75.0% or 11.25% in the diet without any negative effects on broiler chicken performance.

Keywords*:* Fish Meal, Maggot (*Hermetia illucens*) Meal, Broiler Chicken, Feed Efficiency Ratio

INTRODUCTION

Feed remains the most important cost of animal production. In addition, it is likely that animal production will ever be successful in a major way without access to local feed ingredients. The main reason for the failure of animal production in most tropical countries has been the inadequacy of the feed, in quantity as well as quality, because of its high imported costs or the inability of producing a satisfactory local substitute Harinder et al., (2014). Therefore, identification and characterization (chemical and animal feeding) of potential feedstuffs has considerable long term potential.

The lack of a locally grown protein feed is a major challenge for poultry production. Poultry producers rely on animal protein sources with a favorable amino acid profile such as fish meal. But fish meal is a limited resource and therefore it is important to find alternatives.

Fishmeal is the major source of animal-based protein for livestock. Fishmeal has remained a popular ingredient in animal feed because of its high protein content. The problem with fishmeal is that natural fish stocks in the oceans are reducing drastically across the world.

Maggots and maggot meal have proven to be a good alternative to fish meal in poultry Atteh and Ologbenla (1993). Maggots are very nutritious and rich in proteins, a vital element in every animal feed. Maggots, unlike soybean and fishmeal, are new to the scene as a suitable source of protein for animals Harinder et al., (2014). They are very rich in proteins and contain a wide range of amino acids and minerals that provide the necessary nutrition for livestock growth. Unlike the prices of soybean and fishmeal, maggots are abundant and readily available. This outcome will help farmers to save costs on animal feed while providing their poultry with high-value protein (*Iheukwumere et al*. 2009).

Yet, little is known about the effects of a substituting fish meal with maggots or maggots meal in broiler chicken. Therefore, the objective of the present study was to determine the effect of substituting fish meal with maggot (*Hermetia illucens*) meal in the diets on feed efficiency of broiler chicken.

MATERIALS AND METHODS

Birds and diets. A total of 80 day old chicks (DOC) CP 707 broiler chicken were randomly divided into 20 experimental units of 4 chicks each. The brooding temperature was kept at 32-35°C during first week and it was gradually decreased by 2°C after each week. Twenty-four hours light was provided by electric tube lights in the rearing house throughout the experimental period. Fresh water and feed were provided ad libitum throughout the experimental period. The birds were orally administered antibiotics, fortified with vitamins as anti-stress in drinking water on arrival for seven days. All other required medication schedule and routine management practices were carried out during the trial.

The dietary treatments were formulated to meet or exceed starter and finisher broiler requirements as recommended by NRC (1994). Treatment diets were formulated as follow: R0 = 100.0% fish meal (15.0% in the diet) + 0% maggot meal (0% in the diet); R1 = 75.0% fish meal (11.25% in the diet) + 25.0% maggot meal (3.75% in the diet); R2 = 50.0% fish meal (7.5% in the diet) + 50.0% maggot meal (7.5% in the diet); R3 = 25.0% fish meal (3.75% in the diet) + 75.0% maggot meal (11.25% in the diet); and R4 = 0% fish meal (0% in the diet) +100.0% maggot meal (15.0% in the diet). Each treatment was replicated four times. Feed and water were provided *ad libitum*.

The composition of five diets and calculated nutrients in starter and finisher periods are shown in Table 1 and 2. The birds were raised under standard management conditions and feed and water were supplied *ad libitum* throughout the experimental period.

Feed intake. Feed and water intake were recorded during the total experimental period. The uneaten feed was removed and weighed. The net quantity of feed consumed was recorded.

Faces collection. At the 21st and 49th day of the experiment (representing the beginning of the 4th and 8th week respectively), three birds each from each replicate were selected randomly into corresponding compartment of the metabolism cage for digestibility trial. The feed intakes during the periods were noted and the faeces collected on aluminum foil on daily basis, dried, and later pooled. They were weighed wet and samples from each replicates were taken and dried in the oven at 65°C for 72 h. The dried samples were kept for proximate composition determination.

Feed collection. Feed samples were collected during the experimental period and retained daily for later analysis of dry matter, energy, calcium, and phosphorus.

Feed and faecal analysis. Feed and faeces were assayed for sodium calcium and phosphorus (inorganic) according to methods defined by the A.O.A.C (1995).

Parameters measured. Parameters measured were: digestibility of energy, protein, Ca and P; daily feed consumption, daily gain, and feed efficiency ratio.

Table 1. Composition of starter diets

Ingredients	Treatments				
	R0	R1	R2	R3	R4
			(%)		
Yellow corn	54	54	54	54	54
Rice bran	10	10	10	10	10
Copra meal	8	8	8	8	8
Soybean meal	12	12	12	12	12
Fish meal	15	11.	7.5	3.7	-
Maggot meal	-	25	7.5	5	15
Mineral (Top mix)*)	1	3.7	1	11.	1
		5		25	
		1		1	
Total	100	100	100	100	100
Nutrient assayed					
Crude Protein	21.	22	22.	22.	22.
Ether extract	8	6.0	4	6	9
Total dietary fiber	6.0	4.8	6.0	6.0	6.0
Ca	4.7	0,8	4.8	4.8	4.8
P	0,8	8	0,8	0,8	0,8
Metabolizable Energy	9	0.7	8	7	7
(kkal/kg)	0.8	9	0.7	0.6	0.6
	5	298	4	9	3
	297	3.00	299	300	301
	4.00		2.00	1.00	0.00

Table 2. Composition of finisher diets

Ingredients	Treatments				
	R0	R1	R2	R3	R4
			(%)		
Yellow corn	55	55	55	55	55
Rice bran	21	21	21	21	21
Copra meal	3	3	3	3	3
Soybean meal	5	5	5	5	5
Fish meal	15	11.2	7.5	3.75	-
Maggot meal	-	5	7.5	11.2	15
Mineral (Top mix)*)	1	3.75	1	5	1
		1		1	
Total	100	100	100	100	100
Nutrient assayed					
Crude Protein	18.8	19.0	19.3	19.6	19.9
Ether extract	4.6	4.5	4.5	4.5	4.5
Total dietary fiber	4.0	4.4	4.4	4.4	4.5
Ca	0.86	0.85	0.85	0.85	0.84
P	0.91	0.86	0.81	0.76	0.71
Metabolizable Energy (kkal/kg)	310	311	312	312	313
	2.00	1.00	0.00	9.00	8.00

*) Top mix is a mixture of vitamins and mineral premix supplied the following per kilogram of feed: vitamin A = 5500IU, vitamin D3 = 1100 IU, vitamin E = 10.50mg, vitamin K = 1.500mg, vitamin B1 = 4.00mg, vitaminB2 = 2.000mg, vitaminB6 = 0.500mg, vitamin B12 = 2.000mg, niacin = 4.500mg, pantothenic acid = 0.200mg, iron = 17.50mg, copper = 2.00mg, manganese = 50.0mg, zinc = 25.00mg, iodine = 5.0mg, and selenium = 0.0600mg.

Statistical analysis. All data were analysed using the GLM Procedure (SAS Institute, 1989). A Completely Randomized Design (Steel and Torrie, 1990) was used to examine the treatment differences. After a significant F test, Tukey's test (where necessary) was used to inspect differences among group means. Differences between treatment means were considered significant when P < 0.05. Differences between treatment means were considered significant when P < 0.05.

RESULTS AND DISCUSSION

The results of the performance indices of the experimental chicken presented in Table 3 and 4. The digestibility of energy, protein, Ca, and P were all not significantly (P > 0.05) different among treatments. The substitution of fish meal with maggot meal up to 100% did not significantly (P > 0.05) the digestibility indices measured in the present study. Whereas feed consumption, daily gain, and feed efficiency of starter and finisher broiler chicks were significantly (P < 0.05) decreased as maggot meal substituted fish meal at the level of 100% or 15.0% in the diet (R4).

Table 3. Performance characteristics of the starter broiler chicks fed five regimes of diets with fish meal and maggot meal substituting each other

Parameters	Treatments				
	R0	R1	R2	R3	R4
- Dry matter digestibility (%)	57.80	57.40	57.06	56.70	57.90
- Energy digestibility (%)	63.05	64.07	64.30	63.90	63.70
- Calcium digestibility (%)	65.60	66.80	66.07	65.83	65.01
- Phosphorus digestibility (%)	64.08	64.88	65.01	63.30	64.80
- Feed consumption (g)	44.83^a	44.63^a	42.81^a	42.36^a	39.83^b
- Daily gain (g)	6.70^a	6.45^a	6.64^a	6.89^a	4.06^b
- Feed efficiency	0.14^a	0.14^a	0.14^a	0.14^a	0.10^b

$^{a, b,}$ Means on the same row with different superscripts differ significantly (P < 0.05)

Table 4. Performance characteristics of the finisher broiler chicks fed five regimes of diets with fish meal and maggots meal substituting each other

Parameters	Treatments				
	R0	R1	R2	R3	R4
- Dry matter digestibility (%)	58.82	58.42	57.96	56.77	57.96
- Energy digestibility (%)	64.03	64.77	65.37	63.60	64.72
- Calcium digestibility (%)	62.20	63.53	62.07	63.52	63.39
- Phosphorus digestibility (%)	68.68	67.88	66.87	67.13	66.02
- Feed consumption (g)	81.44^a	80.56^a	78.77^a	78.71^a	70.50^b
- Daily gain (g)	30.94^a	29.80^a	28.35^a	28.34^a	22.56^b
- Feed efficiency	0.38^a	0.37^a	0.36^a	0.36^a	0.32^b

$^{a, b,}$ Means on the same row with different superscripts differ significantly (P < 0.05)

The digestibility values are presented in Table 3 and 4 for starter and finisher period. The digestibility of dry matter, energy, calcium (Ca), and phosphorus (P) values were all not significantly (P > 0.05) affected by treatment diets. It can be said that maggot meal is comparable to fish meal in term of digestibility point of view. Maggot from black soldier fly (BSF) (*Hermetica illucens*) was used in the present study. This finding is in agrrement with

Atteh and Ologbenla (1993) who revealed that nutrient digestibility of maggots is high, but individual amino-acid digestibilites for poultry have yet to be determined. Relative to lysine, black soldier fly larvae meal contains higher levels of threonine, valine, isoleucine and leucine when compared to fishmeal. Insects are also relatively high in fat, supplying energy at levels comparable to, if not higher than, that of cereals or legumes.

The digestibility of insect proteins and their utilization in vivo have also been good. Studies conducted using housefly meal in broilers have also shown variable results. Pretorius (2011) reported apparent faecal crude protein digestibility of 69% whereas Hwangbo et al. (2009) reported a higher value of 98.5%.

Trials feeding insects to poultry have been published since the 1970s and have found that black soldier fly (BSF) larvae meal supported good growth in chicks. Maggot meal from black soldier fly has been used in many broiler trials, also with success. Awoniyi, et al., (2017) reported the research results using maggot meal in place of fish meal and found that weight gain, feed consumption, and feed efficiency for chicken between 3-6 weeks of age were not significantly influenced by dietary treatment. The diet with 25% of fish meal protein replaced with maggot meal was the most efficient in terms of average weekly weight gain and protein efficiency ratio (PER). The live, dressed and eviscerated weights as well as the relative length, breadth and weights of the pectoral and gastrocnemius muscles of the chickens at 9 weeks were not significantly influenced by the diets. They concluded that MGM is an inexpensive replacement for FM in broiler-chick feeding.

In other study, Hwangbo et al. (2009) recommended that diets of 10 and 15% maggot meal was the most efficient in terms of average weight gain for the 4 to 5 week old broiler chickens ($P < 0.05$). These results indicate that feeding diets containing 10 to 15% maggot in chicken dropping after biodegradation can improve the carcass quality and growth performance of broiler chickens.

Evaluating the suitability of maggot meal as a partial substitute of soya bean in broiler diets, Khan, et al., (2016) revealed that replacement of soya bean meal at the rate of 30% in broiler feed produced most favorable results.

By replacing 100% of groundnut cake (22% diet as fed) with maggot meal in 25-day old broilers, Adeniji (2007) found without adverse effect on performance and non-significant trend to lower feed intake and weight gain at 75 and 100% substitution. In China, Ren, et al., (2011) included 4.4% maggot meal in the Yellow dwarf 8-63 days broiler and reported that supplementation with maggot meal enhanced feed intake and average daily gain at 8-21 days with no negative effect on the slaughter performance and meat quality. Performance differences were non-significant in the later stages.

Inaoka, et al., (1999) replacing fish meal with maggot meal at 7% in a balanced diet for 0-24 days broiler in Japan and stated that identical growth performance, feed conversion ratio and meat composition; higher dressing percentage in maggot-fed broilers. Other study in South Africa (Pretorius, 2011) reported the inclusion of maggot meal at 10 to 50% in 0 to 35 days broiler and revealed that 25% maggot meal diet yielded better live weights, feed intake and daily gain when compared to the 25% fish meal diet in the growth phases.

In the present study, feed consumption, daily gain, and feed efficiency gave a non significant ($P > 0.05$) differences among treatments of R0 = 100.0% fish meal (15.0% in the diet) + 0% maggot meal (0% in the diet) up to R3 = 25.0% fish meal (3.75% in the diet) + 75.0% maggot meal (11.25% in the diet). Whereas feed consumption, daily gain, and feed efficiency gave a significant ($P < 0.05$) decreased at R4 (100.0% maggot meal or 15.0% in the diet) compared with the rest of treatments. The decreased in feed consumption and so did daily gain and feed efficiency could be due to the physical nature of maggot meal. As we observed that when grinded and milled, the color of maggot meal turned darker. As we know that poultry or broiler do not like darker color and sometimes refused to consume darker feed. So, it is reduced the palatability of broiler on darker feed. Feeds must also be highly palatable at this stage to encourage feed intake.

CONCLUSIONS

Maggot (*Hermetia illucens*) meal could replace fish meal up to 75.0% or 11.25% in the diet without any negative effects on broiler performance.

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