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Cost-benefit analysis and growth response of heteroclarias fingerlings fed diets containing graded levels of maggot meal as replacement for fish meal

J.K. Ekelemu
Department of Fisheries, Delta State University, Asaba Campus, Asaba, Delta State, Nigeria.

***Corresponding Author**
Name: J.K. Ekelemu
Email: jerimothekelemu@yahoo.com

Abstract: Maggot - meal was used to replace fishmeal in feed formulated, to feed 75 fingerlings of hybrid Heteroclarias randomly distributed in fives into 15 tanks of dimension 1m x 1m x 1m and grouped in threes to form 5 treatments labeled IA-C – VA-C. Fingerlings in each treatment were respectively fed rations with 0.0, 33.3 50.0, 66.6, and 100.0% replacement levels of fishmeal with maggot meal to determine the optimum replacement level and reduce cost of fish production. This study, revealed no significant difference (P>0.05) in the growth of specimens fed rations with 0.0, 33.3 and 50.0 % replacements, but were significantly different (P <0.05) from those fed rations with 66.6 and 100 % replacement. All specimens, were in good condition, with 'K' values being higher than 1. Food conversion ratio (FCR) for specimens fed rations with 66.6 and 100.0 % replacements were not significantly different (P>0.05), but were significantly different (P<0.05) from those fed with other rations. The specific growth rate (SGR) of specimens fed rations with 50.0 % replacement was significantly different (P<0.05) and better than results of specimens fed other rations. The study has proved that maggot-meal can be successfully used to replace fishmeal up to 50.0 % replacement level in fish feed production, without compromising fish production. This will result in a reduction in the cost of feed, maintain optimal production and reduce the cost of fish produced.
Keywords: Maggot – meal, Heteroclarias, Food conversion ratio, fishmeal.

INTRODUCTION

Fish is regarded as an alternative source of high quality protein. It is regarded as first class protein in containing Lysine, Methionine and Tryptophan which are lacking in protein of plant origin [1] and [2]. Fish which can be used as a means of supplying fhese essential nutrients is however not cheap, and therefore not affordable by all.

In aquaculture operations feed cost represents 40-70 % of the total production cost [3]. Furthermore of the different ingredients used in fish feed formulation, fishmeal is the most expensive, accounting for about 50 % of the total cost of the feed [4], [5], and [6]. Fishmeal is a major source of animal protein in the ingredients used in compounding fish feed. It is mostly imported and its price is very exorbitant which makes' the cost of finished fish feed to be high. The competition for fish and fish products by man and other animals such as poultry has necessitated a search for an alternative source of animal protein which is cheap and not competed for with fish. [7], in their work on replacing fishmeal with hydrolysed feathers in fish diets fed to *Clarias gariepinus* reported that growth was not significantly different (P>0.05) in both diets.

The use of insects as food for man and animals have been acclaimed important [8]. They are said to be high in protein and energy and contain high amounts of vitamins and mineral elements [9], [10]. The housefly *Musca domestica* larvae (Maggot) meal produced from caged layers manure is characterized by high nutrient content [11]. The maggot has a high crude protein content. [12], reported a dry matter of 33.0 % of larval biomass and a crude protein content of 54%. Maggot is also reported to be a good source of essential amino acids like arginine (3.7%) lysine (3.8%) and methionine (1.6%) [13]. As a result of the high nutrient value of maggot and the fact that it is cheap and not utilized by man, it can be used as an alternative source of animal protein for fish. Therefore the aim of this study is to investigate the growth performance of hybrid Heteroclarias (*Clarias gariepinus* x *Heterobranchus bidorsalis*) fed rations with different replacement levels of fishmeal with maggot-meal.

MATERIALS AND METHODS

The study was conducted in the Fisheries unit of the Faculty of Agriculture Teaching and Research Farm of Delta State University, Nigeria. Seventy – five (75), four week old Hybrid fingerlings of Heteroclarias (*Clarias gariepinus* x *Heterobranchus bidorsalis*) were used for the study which lasted six weeks. Fingerlings were first acclimated and fed fishmeal ad-libitum in a fish holding tank for one week. Thereafter the fingerlings were distributed randomly in fives, into 15 treatment tanks of dimension 1m x 1m x 1m. The triplicate treatments were labelled I_{a-c} – V_{a-c} and fed rations containing 40 % crude protein, using maggot-meal as replacement for fishmeal. Maggot were obtained from caged layers manure, sun dried and ground into powdered form. Other ingredients used in compounding the feed were groundnut cake (GNC), palm kernel cake (PKC), bone meal, wheat offal, yellow maize, lysine, methionine, vitamin premix and starch which served as binder. Using the Pearson's square method, five rations were compounded, with fish and maggot-meals occurring in the following proportions. Ration (1) 2:1, Ration (2) 1:0, Ration (3) 0:1, Ration (4) 1:1, Ration (5) 1:2. Ration 2 which had 100% fishmeal, was the control.

Table 1: Ration formulation at 40% Crude Protein as Requirement for Hybrid Heteroclarias *(Clarias Gariepinus* x *Heterobranchus Bidorsalis*) Fingerlings

Ingredients(g)	Ration I	Ration 11	Ration 111	Ration IV	Ration V
Fishmeal	278.1	417.5	-	208.75	139.4
Maggot-meal	139.4	-	417.5	208.75	278.1
Groundnut cake	265.9	265.9	265.9	265.9	265.9
Palm kernel	96.7	96.7	96.7	96.7	96.7
Wheat	91.3	91.3	91.3	91.3	91.3
Maize	53.7	53.7	53.7	53.7	53.7
Bone meal	30.0	30.0	30.0	30.0	30.0
Starch	20.0	20.0	20.0	20.0	20.0
Lysine	8.0	8.0	8.0	8.0	8.0
Methionine	8.0	8.0	8.0	8.0	8.0
Vitamin premix	8.7	8.7	8.7	8.7	8.7

Each of the five treatments labelled 1 to V was fed rations corresponding to its number. Weight and standard length were measured and used as growth parameters. Initial weight and standard length of fish in each treatment tank, were measured. Measurements were taken weekly to determine weight and length gain. Data collected from the weight, length and quantity of feed fed to fish during the study, were used to calculate the condition factor (K), food conversion ratio (FCR) and specific growth rate (SGR).

The parameters above were determined as follows;

(i) K $\frac{W \times 100}{L^3}$

Where W = weight of fish (g)

L = length of fish (cm)

(ii) FCR = $\frac{\text{quality of feed fed}}{\text{weight gain}}$

(iii) SGR (%)= $\frac{\log W_f - \log W_i \times 100}{t \text{ (days)}}$

where Wi initial weight of fish (g)

Wf = final weight of fish (g)

Log = natural logarithm

t = time (days) of experiment

The cost of compounding each ration and the quantity fed to fish were also calculated. Data collected were subjected to analysis of variance using the General Linear Models (GLM) of and Duncan's Multiple Test (DMRT) to separate the means, [14].

RESULTS

The means of initial weight and standard length of fish in the different tanks at the beginning of the study are presented in Table 2.

Table 2: Means of Initial Weight (g) and Standard length (cm) of Fish in each Treatment

Treatments	I	II	III	IV	V
Weight (g)	5.9	6.3	6.7	6.1	6.4
Standard length (cm)	7.7	7.5	8.5	7.5	7.4

The summaries of analysis of variance (ANOVA) and mean separations of the weekly gain in weight and standard length of fish in the five treatment tanks, are presented in Tables 3 to 5, while Table 6 shows the cost of producing each feed fed to fishes in the different treatments.

Table 3: Summary of Analysis of Variance For Weekly Gain in Weight (g) of Fish in Treatment Tanks

	TREATMENTS				
Week	I	II	III	IV	V
1	0.3500^{c}	0.2540^{d}	0.5500^{b}	0.8500^{a}	0.2500^{d}
2	0.9000^{c}	2.5000^{a}	1.0000^{bc}	1.4200^{b}	1.3380^{b}
3	2.5800^{b}	3.0000^{a}	1.4800^{c}	2.7000^{b}	2.5200^{b}
4	5.4930^{a}	4.2630^{ab}	2.5040^{b}	5.7180^{a}	4.2060^{ab}
5	8.9980^{a}	8.3200^{a}	3.2800^{b}	9.0440^{a}	3.0360^{b}
6	11.2670^{a}	12.7350^{a}	5.7600^{c}	12.0790^{a}	7.5680^{b}

Superscripts with the same alphabets on the horizontal rows are not significantly different (P>0.05), while those with different alphabets as superscripts are significantly different (P<0.05).

Table 4: Summary of Analysis of Variance for weekly Gain in Length (cm) of Fish in Treatment Tanks

	TREATMENTS				
Week	I	II	III	IV	V
1	0.87400^{a}	0.7300^{a}	0.7500^{a}	0.5900^{a}	0.4020^{a}
2	1.4440^{a}	1.2200^{ab}	0.6580^{b}	1.100^{ab}	0.6400^{b}
3	0.7200^{c}	1.5600^{a}	0.9200^{c}	1.6400^{a}	1.2000^{b}
4	2.8900^{a}	2.5000^{ab}	1.0400^{c}	2.5200^{ab}	1.7000^{b}
5	3.6400^{a}	2.8150^{a}	1.4800^{b}	3.5800^{a}	2.7000^{ab}
6	3.7900^{ab}	3.5900^{ab}	1.5200^{c}	4.1000^{a}	3.1200^{b}

Superscripts with the same alphabets on the horizontal rows are not significant different (P>0.05), while those with different alphabets as superscripts are significantly different (P<0.05).

Table 5: Summary of analysis of variance for the Condition Factor (K) food Conversion Ratio (FCR) and Specific Growth rates (SGR) of Fish in Treatment Tanks

	TREATMENTS				
Week	I	II	III	IV	V
K	1.0098^{a}	1.0314^{a}	1.1017^{a}	1.0802^{a}	1.0345^{a}
FCR	4.6417^{c}	7.4567^{a}	4.6700^{c}	5.7330^{b}	6.3583^{ab}
SGR	0.6801^{ab}	0.4782^{b}	0.5741^{b}	1.1330^{a}	0.7939^{ab}

Superscript with the same alphabets on the horizontal rows are not significant different (P>0.05), while those with different alphabet as superscripts are significantly different (P<0.05).

Table 6: Cost of producing 1kg of each of the feeds, quantity of feed fed (g) and the cost of ration fed (N: K)

Treatment	Ratio Feed (N: K)	Cost of 1kg of ration fed (g)	Quantity of	Cost of Ration fed (N: k)
I	1	94.59	274.2	25.93
II	2	95.64	274.2	26.22
III	3	46.21	274.2	12.67
IV	4	78.40	267.1	17.26
V	5	64.61	271.8	21.31

DISCUSSION

The high cost of purchasing fishmeal to produce fish feed and the concomitant high cost fish produced, has necessitated the exploration of non-conventional animal protein sources to replace fishmeal in fish feed formulation. Production of fish feed follows the same principle as in poultry feed production. [15] in their study of the replacement of fishmeal with non-conventional ingredients such as Broiler offal in Broiler diets, reported that the cost of producing feed can be considerably reduced while still maintaining optimum production through this means. This study revealed a significant positive response in the growth of Heteroclarias to the use of maggot-meal as replacement for fishmeal in the formulation of fish feed. The work of [7], agrees with this study on the use of non-conventional ingredients to replace fishmeal. In their study, there was no significant difference (P>0.05) in growth of *Clarias gariepinus* fingerlings fed diets containing fishmeal or hydrolysed feathers as source of animal protein.

Using weight gain as an index for growth, there was significant weight gain at week 6 in response to the different rations fed. However there was no distinct pattern of growth, in treatment 1 which had (33.3% replacement) and treatment III which had (100% replacement) were better than those of treatment II, which had (0% replacement) and treatment V, which had (66.6% replacement) in the first week. By the second week response to ration 1 and 3 dropped, while growth in treatment II became the best followed by treatment IV which had (50% replacement). This ambiguous pattern may not be unconnected with the feeding regime of the fish as at the time of measurements. If a fish is weighed just after feeding, it will not weigh the same as when the stomach is empty or half full. It was often observed during sampling for weight and length, that although fishes were not fed, some of them had distended abdomens, which suggested they contained undigested food in their stomachs. Those which had food in their stomachs invariably weighed more than those with empty stomachs. This was evident in cases, where small sized fishes in terms of length, weighed more than the large sized ones. Thus weight may not be a good index for determining growth. Length on the other hand is a better index for determining growth because any length attained is permanent and irreversible. Length considered here is standard length. In week one, there was no significant difference (P>0.05), in increase in length from all the tanks. This is understandable as the fish having been suffering from withdrawal syndrome and were probably adjusting to the new diet as fed to them. By the end of week two, response to ration 1 in treatment I was significantly higher than all others (P<0.05) but similar to those in treatments II and IV. Response to ration 2 and 4 in treatments II and IV respectively, were not significantly different from each other (P>0.05) but were significantly different (P<0.05) and better than those in treatments III and V fed ration 3 and 5. By the fifth week, response to ration l, 2 and 4 were not significantly different from each other (P>0.05) but were similar to that of treatment V. They were significantly different ((P<0.05) from the response to ration 3. Response to ration 4 was slightly better but not significantly different (P>0.05) from the response to ration 2.

There were no significant differences in the condition factors of fishes in all the treatments (P > 0.05). The fishes were in good condition, as they all had average values of **above** 1. Fishes in treatment II had the best food conversion ratio (FCR) and were significantly different from those in treatments I, III and IV (P<0.05). Food conversion ratio in treatments IV and V were similar to each other (P>0.05). The specific growth rate (SGR in tanks I and V were not significantly different from each other (P>0.05). The specific growth rate was highest in treatment IV fed ration 4. It was significantly different from those of treatments II and III (P<0.05), but was similar to those of treatments I and V.

The cost benefit analysis of the growth performance of fishes in treatment IV, fed with ration 4, (50% maggot inclusion), was better than the response to the other rations. The cost of producing 1kg of feed here was N78.40k. The mean increase in length and weight of fish within the study period in treatment IV were respectively 4.1cm and 12. 1g. The cost of producing the fish was only N17.26k. This performance was better than the control ration in treatment II and those of treatment V, with 0.0 and 66.6% inclusion of maggot- meal respectively. Thus ration 4 with 50% maggot replacement is recommended for use in fish feed formulation. This is supported by the conclusion drawn by [16], who reported the feasibility of using fish offal as partial replacement for fishmeal, in diet formulation of fish, to reduce cost of feed and fish produced, without compromising performance.

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