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Utilization of Maggot Meal as Replacement for Fishmeal on Diet of *Heterobranchus bidorsalis* Juveniles

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Abstract

This study was carried out to examine the growth performance and nutrient utilization of *Heterobranchus bidorsalis* Juveniles fed maggot meal as an alternative to fish meal in their respective diets. The experimental design consists of five (5) dietary treatments with three (3) replicates each. Diet 1 with 0% Maggot meal (MGM) inclusion served as control; Diet 2 (25% MGM); Diet 3 (50% MGM); Diet 4 (75% MGM) and Diet 5 (100% MGM). The result for *Heterobranchus bidorsalis* test fish fed with diets containing maggot meal was able to replace fishmeal totally as the diet containing 100% of maggot meal was the best performer among other treatments. The highest value for mean weight gain was (3.01g), Feed intake was (6.36g) and Relative weight gain was (18.70).Theses values increased with increase in the inclusion of maggot meal. However, the feed conversion Ratio performance declined with increase in maggot meal inclusion in the diet. Therefore, maggot meal can replace fishmeal in the diet of *H. bidorsalis* totally.

Keywords: Maggot meal, Musca domestica, Fish Feed, Heterobranchus bidorsalis

Introduction

Nutritionally, fish is about the cheapest and direct source of protein and micro nutrients for several millions of Africans (Bene and Heck, 2005). It provides 40% of animal protein consumption in Nigeria and it is also a very important source of animal protein for livestock in developed and developing countries (Ozigbo *et al.,* 2014). In Nigeria, fish demand as estimated by Ruma (2008) was 2.1 million metric tons at 11.5kg per capita consumption with domestic production from the wild estimated at 5% leaving a gap of 41% which is about four times the level of local production. Once fish are removed from their natural environment to an artificial one, nutritive food must be supplied in order to enable them grow (Aliu *et al.,* 2016). This could be in the form of complete rations, where the artificial diet furnishes all the nutrients required by the fish or supplementary diets, where part of the nutritional needs of fish is supplied by the natural food in the aquatic environment (Eyo, 2003). Both intensive and semi-intensive fish culture systems involve input of supplementary and complete feed, which account for up to 40 % and 60 % of production costs respectively (Fagbenro *et al*., 2003) and can sometimes negate the economic viability of a farm if suitable feed are not used. This problem has become a major source of fear and phobia to many prospective fish farmers in Nigeria and urgent solution must be proffered if fish farming is to be attractive, lucrative and sustainable (Madu *et al*., 2003). The major item in recurrent cost in fish production is feed. This item alone has progressively taken the larger shares of cost of production (Balogun *et al*., 1992). Carefully compounded feed when fed at the recommended level (rate) are usually backed by the manufacturer's guidance to meet the nutrient requirements of physiologically defined farm animals for a sustainable level of production (Falayi, 2003). The principal cost in manufacture of compound feed is that of raw materials, this could amount to as much as 80 percent or more, of the manufacturing costs in large size mills. Due to increasing transportation costs and the need to conserve foreign exchange, the tendency in most developing countries will be to use locally available ingredients (Aliu *et al.,* 2016). This study was to examine the growth performance, survivability, and optimum inclusion level of *Heterobranchus bidorsalis* Juveniles fed maggot meal as an alternative to fish meal in their diet.

Materials and Methods

Experimental Design

The experimental design consists of five (5) dietary treatments with three (3) replicates each. This was conducted in 15 aerated plastic aquaria (60 x 45 x 30cm^3). Clariid catfish Juveniles from the same brood stocks were stocked randomly at five (5) Juveniles per aquarium tank of 40 litres in a completely randomize block design.

Study Location

The study was carried out in the Department of Aquaculture and Fisheries experimental farm, University of Benin, Edo State, Nigeria located on latitude 6°36'N and Longitude 06°19'E in the humid rainforest region of Southern Nigeria. Annual temperature ranges between 1498mm to 3574mm with a mean of 2430mm. Relative humidity and daily sunshine ranges between 63.31 to 81.71% (with a mean of 73.5%).

Preparation of Experimental Diet for culture fish

***Experimental diets*:** Fishmeal, Yellow maize, bone meal and vitamin premix were bought from retail outlet in Benin City, Nigeria. Each experimental design consists of five (5) dietary treatments (Table 1) with three (3) replicates each. Diet 1 with 0% MGM inclusion serves as control; Diet 2 (25% MGM); Diet 3 (50% MGM); Diet 4 (75% MGM) and Diet 5 (100% MGM). In preparing the diets, ingredients were milled, mixed and prepared as described by Martinez-Palacios *et al.* (1996). The milled ingredients were then sieved through standard sieve Nos. 16 and 20 (maximum of 1.19 mm). The homogenously mixed feed was processed into pellets (2mm) with gelatinized corn starch component as the binder. After preparation, pelleted diets were oven-dried at 100°C for 5 hours. Feed samples were then stored in polythene bags in cupboard at laboratory temperature (27°C). Dried granules of feed samples were then taken for proximate analysis. All ingredients were locally sourced for the trial conducted.

Experimental Procedures for Culture Fish

The juveniles were fed crumbled 2.0mm size pellet of experimental diets twice daily to satiation between 8.00-9.00 hrs and 15.00-16.00 hrs GMT. Feeding was monitored for each unit to ensure that fishes will not be underfed or overfed. Experimental units were cleaned daily while changing of total water, weighing of fish (g) and feed was done weekly. Weekly weight gains and feed consumption was monitored for twelve weeks.

Data Collection for culture fish

Data on the quantity of feed consumed by the fish as well as weight gained by the fish was collected each weekly for each unit for which the following performance was evaluated (Bagenal, 1978).

1. Weight Gained (WG)= W2-W1 $_{(g)}$
2. Feed intake = initial weight of feed – final weight of feed
3. Relative Weight Gain (RWG%)=(W1–W0) / W0 × 100
4. Specific Growth Rate (SGR) %= {(In W1 –In W0)/ T} × 100

Where:W0: mean initial weight (g), W1: mean final weight (g), T: time in 7 days between weighing, ln = natural logarithm

5. Feed Conversion Ratio (FCR)= feed intake (g) / weight gain (g)
6. Protein Efficiency Ratio (PER)= weight gain (g) / protein intake (g)
7. Net Protein Utilization (NPU)= {(BP1–BP0)/ CP} × 100.

Where: BP0: Initial body protein content (g), BP1: Final body protein content (g), CP: Protein intake (g)

8. Survival rate (SR %) =

$$\frac{\text{Total number of fish harvested}}{\text{Total number of fish stocked}} \times 100$$

Chemical Analysis

The various diets, maggot meal and the experimental fish (initial and final carcass) were analysed for their proximate composition which include their moisture content, nitrogen, ether extract, crude fibre and nitrogen-free extract (NFE) according to the procedures of Association of Official Analytical Chemists (AOAC, 2000). The moisture content was determined by heating the samples in an oven at a temperature of 105°C for 24 hours and recording the weight loss, the crude protein content was estimated by multiplying the nitrogen content by 6.25, lipid content was determined by ether extraction, while the ash was determined by combusting the samples in a muffle furnace at 600°C for 5 hours.

Statistical Model

The data obtained from the feeding trials were analysed using the computer software Genstat Version 8.1 (2005). Completely randomized design in a one-way ANOVA was used to calculate the mean. The differences in mean were compared using Duncan's multiple range tests at 5% significant level (Duncan, 1955).

Results and Discussion

Results

Growth Performance and Nutrient Utilization of Heterobranchus bidorsalis

Weight gain

The mean Weight gain increased with increase in inclusion of maggot meal as replacement of fishmeal up until 100% replacement level. The result showed that the highest mean weight gain was recorded in Diet 5 (3.01g); this was followed by Diet 4 (2.70g) while the least mean weight gain (2.31g) was recorded in Control Diet. ANOVA showed that there was no significant different (P>0.05) among all the Diets.

Feed intake

The result of the feed intake followed similar trend like that of the weight gain. The feed intake increased gradually from Diet 1 to Diet 5. The highest feed intake value (6.36g) was recorded in Diet 5 with 100% replacement level; this was followed by Diet 4 with feed intake value of 5.67g. The least amount of feed consumed (4.97g) was recorded in Diet 1 with 0% maggot replacement level. There was no significant difference (P>0.05) between Diet 1 and Diet 2. Diets 1 and 2 were significantly different (P<0.05) from Diet 5. Also, Diet 3 and 4 was not significantly different

(P>0.05) from other diets.

Feed conversion ratio

The Feed conversion ratio performance declined with increase in inclusion of maggot meal as replacement of fishmeal up until 100% replacement level. The result showed that the best Feed Conversion ratio was recorded in Diet 1 (1.96), this was followed by Diet 2 (2.34) while the worst feed conversion ratio (2.83) was recorded in Diet 5. ANOVA showed that there was no significant difference (P>0.005) between all the diets.

Protein efficiency ratio

The result of the Protein Efficiency ratio is shown above and it showed an irregular trend. However, The Protein Efficiency ratio decreased gradually from Diet 3 to Diet 5 but declined from Diet 1 to Diet 2. The highest Protein Efficiency value (2.93) was recorded in Diet 3 with 50% replacement level, this was followed by Diet 4 with Protein Efficiency value of 1.67. The least Protein Efficiency Ratio (1.13) was recorded in Diet 5 with 100% maggot replacement level. There was no significant difference (P>0.05) between Diet 1, Diet 2, Diet 4 and Diet 5. Diets 2 was significantly different (P<0.05) from other diets.

Relative weight gain

The mean Relative Weight gain increased with increase in inclusion of maggot meal as replacement of fishmeal. The result showed that the highest mean relative weight gain was recorded in Diet 5 (18.70g), this was followed by Diet 4 (16.97g) while the least mean Relative weight gain (10.80g) was recorded in Control Diet. ANOVA showed that there was no significantly different (P>0.05) among all the Diets.

Specific growth rate

The result of the Specific Growth Rate showed irregular trend. The Specific growth rate decreased from Diet 1 to Diet 2 but increased gradually from Diet 2 to Diet 4 but declined in Diet 5. The highest specific growth rate value (2.63) was recorded in Control Diet with 0% replacement level, this was followed by Diet 4 with Specific growth rate value of 1.83. The least value of Specific growth rate (1.57) was recorded in Diet 2 with 25% maggot replacement level. There were no significant differences (P>0.05) between Diet 2, Diet 3, Diet 4 and Diet 5 while they were significantly different (P<0.05) from Diet 1.

Discussion

Feeding Trial with Heterobranchus bidorsalis

The mean Weight gain increased with increase inclusion of maggot meal as replacement of fishmeal up until 100% replacement level. The result showed that the highest mean weight gain was recorded in Diet 5 (3.01g). This is in contrast to Kolawole and Ugwumba (2018), Ezewudo *et al.* (2015), Olaniyi and Salau (2013) and Akinwande *et al.* (2002), who reported that fingerling performed better when fed with control diet and diet containing 60% and 75% maggot protein inclusion level for fingerling of *Oreochromis niloticus* and *Clarias gariepinus*. In another research conducted by Mustapha (2001), the best growth rate was recorded among fingerling fed with diet containing 75% oven dried maggot meal, followed by 50% maggot inclusion and the least growth was exhibited by fingerlings fed diet containing 100% oven dried maggot meal as the protein source. This result also disagrees with the result recorded by Omoruwou and Edema (2011), and Ajani *et al*. (2004), who recorded the highest weight gain in 50% maggot meal inclusion in the diet of '*Heteroclarias'* and *O. niloticus* fingerlings respectively. However, this agrees with report of Ogunji *et al. (*2008) who observed a better performance of diets containing maggot meal over those fed 100% fish meal. High levels of fishmeal replacement with housefly maggot meal have been associated with low body weight gain in both fish and chickens (Ogunji *et al*., 2008; Oyelese, 2007). Earlier studies indicated that housefly maggot meal should only partially substitute fishmeal in the diets of omnivorous fish species such as catfish and Nile tilapia (Ogunji *et al*., 2008; Oyelese, 2007). Some authors reported replacement of fishmeal with housefly maggot meal at 50% or less provided the optimum level in chicken feed (Adeniji, 2007; Awoniyi *et al*., 2003). These earlier studies are in contrast with the present study which showed increased substitution of fishmeal by housefly maggot meal improved the growth, survival and feed efficiency of *H. bidorsalis* with the total replacement diet giving the optimal results.

The Feed conversion ratio performance declined with increase in inclusion of maggot meal as replacement of fishmeal up until 100% replacement level. At the end of the trial, the feed conversion ratio values recorded in this study were similar to the 1.33-2.25 reported for *Heterobranchus longifilis* (Otchoumou *et al*., 2012) and 1.5 – 2 (Craig and Helfrich, 2002) as the best feed conversion ratio for the good growth of most species in aquaculture. However, the growth rate, weight gain, feed Intake and Relative Weight Gain increased progressively with dietary protein level to a maximum at 100%. This observation was in agreement with that observed in *Heterobranchus longifilis* (Otchoumou *et al*., 2012) and in *Heterobranchus bidorsalis* (Jamabo and Alfred-Ockiya, 2008). These authors observed increasing growth with the increase in dietary protein level in these two species. Similarly, a diet with inadequate protein content can result in reduced weight gain because the fish cannot eat enough feed to satisfy their nutrient requirements for growth. Maximizing the utilization of dietary protein for growth is related to both the dietary inclusion level of protein and the availability of non-protein energy sources, such as lipid and/or carbohydrate. Inclusion of non-protein energy has been shown to spare dietary protein from catabolism to provide energy and enhance its utilization for growth, a process known as protein-sparing (Helland and Grisdale-Helland, 1998). In this study, the good growth performances observed from larvae of *H. bidorsalis* fed with diet containing 100% protein level could be due to the good nutritional quality of the nutrient contained in the experimental diets and the good biological value of dietary protein provided to larvae by maggot meal. In fact, housefly maggot meal has a balanced and rich amino acid profile and it is rich in methionine (Ogunji *et al*., 2008). Although Fish meal has been found difficult to be completely replaced in the diet of fish because of the quality of its essential amino acids combination (Dasuki *et al.,* 2014) the results obtained in this research supports the total replacement of fish meal with sun-dried maggot meal reported by Fasakin *et al.* (2003) but differs from the report of Michael and Sogbesan (2015) who reported better results in fish meal based diet and a combination of fish meal and maggot meal compared to other treatments that involved total replacement of fish meal with either maggot meal, single cell protein or a combination of the two.

Conclusion

The study clearly demonstrated that *H. bidorsalis* test fish were fed with diets containing maggot meal as a replacement for fishmeal. It was also observed that Maggot meal was not just able to replace fishmeal totally but also the diet containing 100% of maggot meal was the best performer as it recorded the highest value for Weight gain, Feed Intake and Relative weight gain. These values increased with an increase in the inclusion of maggot meal. However, the Feed Conversion Ratio performance declined with an increase in maggot meal inclusion in the diet.At the end of this present study, the following recommendations are deemed necessary:-

1. Maggot meal can be included even up to 100%Inclusion Level in diet of *H. bidorsalis*
2. Further trials should be carried out using other inclusion levels of maggot meal in *h. bidorsalis* diet.

Table 1: Growth Composition of the Experimental Diets(%) on as fed basis

Ingredients	Diet 1 0% MGM	Diet 2 25%MGM	Diet 3 50%MGM	Diet 4 75%MGM	Diet 5 100% MGM
Fishmeal (65.5% CP	32.00	24.00	16.00	8.00	0.00
MGM (47.1% CP)	0.00	8.00	16.00	24.00	32.00
SBC (48.0% CP)	35.36	35.36	35.36	35.36	35.36
Yellow maize (9.5% CP)	20.00	20.00	20.00	20.00	20.00
Palm oil	8.00	8.00	8.00	8.00	8.00
Bone meal	4.00	4.00	4.00	4.00	4.00
Vitamin premix	0.60	0.60	0.60	0.60	0.60
Vitamin E gel	0.04	0.04	0.04	0.04	0.04
Total	100	100	100	100	100

MCM= Maggot Meal, SBC= Soya bean cake, CP= Crude protein

Table 2: Feed consumption and Nutrient Utilization of *Heterobranchus bidorsalis* fed diet containing maggot meal

	T1 0% Control	T2 25%	T3 50%	T4 75%	T5 100%	SEM
Weight (g)	2.31^{a}	2.58^{a}	2.69^{a}	2.70^{a}	3.01^{a}	0.41
Feed Intake (g)	4.97^{a}	5.11^{a}	5.61^{ab}	5.67^{ab}	6.36^{b}	0.56
Feed Conversion Ratio (FCR)	1.96^{a}	2.34^{a}	2.50^{a}	2.57^{a}	2.83^{a}	0.40
Protein Efficiency Ratio (PER)	1.35^{a}	1.27^{a}	2.93^{b}	1.67^{a}	1.13^{a}	0.33
Relative Weight Gain (RWG)	10.80^{a}	11.65^{a}	13.81^{a}	16.97^{a}	18.70^{a}	3.66
Specific Growth Rate (SGR)	2.63^{b}	1.57^{a}	1.81^{a}	1.83^{a}	1.58^{a}	0.34

N.B: Values with same superscript on the same row are not significantly different (P>0.05

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