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GROWTH PERFORMANCE, NUTRIENT UTILIZATION, SURVIVAL AND BODY INDICES OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*, BURCHELL 1822) REARED ON MAGGOT MEAL BASED DIET

[*1]Akinwole, A. O., [2]Dauda, A. B. and [1]Ogunkunle, V. O.

[1]Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan, Nigeria
[2]Department of Fisheries and Aquaculture, Federal University Dutsin-Ma, Dutsin-Ma, Katsina State, Nigeria

*Corresponding author's email: tdabak@gmail.com +2348062085120

ABSTRACT

Growth performance, nutrient utilization, survival and body indices of African catfish *Clarias gariepinus* juveniles fed diets containing maggot meal as total replacement of fish meal was evaluated for 42 days. A total number of 60 fingerlings of *Clarias gariepinus* with average weight of 10 g were randomly distributed into six circular tanks (Diameter of 45 cm and depth of 29 cm) at the rate of 10 fish per tank. There were two treatments, DT1 (maggot meal based diet) and DT2 (fish meal based diet) of 28.70 and 34.65% CP respectively and triplicated. The fish were fed twice a day. Water quality parameters were monitored on a weekly basis throughout the experimental period. Growth, nutrient utilization and body indices parameters were evaluated at the end of experiment. Crude protein, crude lipid and ash were higher in fish meal based, while crude fibre was higher in maggot meal based diet. The selected water quality parameters were not different significantly (P>0.05) between the treatments. Mean weight gain, specific growth rate, protein intake, protein efficiency ratio, lipid intake and lipid efficiency ratio (17.25±0.70 g, 2.39±0.06 %/day, 95.50±1.27 g, 1.81±0.06, 23.96±0.32 g and 7.20±0.24 respectively) were all significantly higher (P<0.05) in DT2. Feed conversion ratio was higher significantly (P<0.05) in DT1. Survival, hepatosomatic index and condition factor were similar (P>0.05) between the two treatments. Though, the aforementioned body indices indicated that the total replacement of fish meal with maggot meal is not harmful to the fish, a partial replacement may be better for optimum output.

Keywords: *Clarias gariepinus*; fish meal; maggot meal; Nutrient utilization

INTRODUCTION

The world food fish production is tending towards reliance on aquaculture, as capture fisheries is facing increased challenges of over exploitation of stocks, aquatic pollution and climate change with the attendant consequences of reduced quantity of fish catch (Dauda *et al*., 2018a). Aquaculture's contribution to the global fish supply is steadily increasing in recent times, where it has gone from 73.7 million tonnes in 2014 to 80 million tonnes in 2016, representing an increase from 44.69% to 46.81% of global fish production in just two years (FAO, 2018). In Nigeria, aquaculture production is also growing steadily albeit some constraints. Among these constraints, cost of fish feed is classified as a major constraint (Dauda *et al*., 2015). The high cost of fish feed is largely dictated by the cost of animal protein source which is mainly fish meal (Dasuki *et al*., 2014; Daniel, 2018). There have been continuous efforts to either reduce fish meal inclusion or totally replace it with some other feed ingredients. For instance, El-Sayed *et al*., (1998) experimented on replacement of fish meal with shrimp meal, blood meal, meat and bone meal, poultry by-product meal, and a combination of blood meal, meat and bone meal in the diet of *Oreochromis niloticus.* More readily available protein sources are plant proteins, but many of them can only serve for partial and not total replacement. Plant ingredients contain various levels of anti-nutritional factors, with less nutrients digestibility, as well as problems of nutrients bio-availability and palatability (De Francesco *et al*., 2004; Engin *et al*., 2005; Bonaldo *et al*., 2011). Most researchers opined that fish meal can only be partially replaced with plant protein sources (Daniel, 2018). However, the lesser the amount of fish meal in fish feed the cheaper the potential cost of the feed. Therefore, the needs to continuously seek potentially cheaper animal sources that can effectively replace fish meal. Maggot meal is a quality protein source produced from waste material of either plant or animal origin, with crude protein content of between 43 and 48%. (Fasakin *et al*., 2003; Aniebo *et al*., 2009; Michael and Sogbesan, 2015). Fasakin *et al*. (2003) replaced fish meal with differently processed maggot meals, sun-dried full-fat, defatted oven-dried and defatted sun-dried. The authors reported a significantly reduced daily weight gain, protein efficiency ratio and specific growth rate in sun-dried maggot meal. There was no significant difference between the defatted maggot meal treatments and fish meal treatment. However, further treatment of maggot meal by defattening may increase the cost of production of the maggot meal and eliminate the price advantage of the maggot meal ahead of fish meal. Michael and Sogbesan (2015) experimented with various percentage replacement of fish meal with maggot meal and single cell protein. The best growth performance was obtained in the treatment with 30% fish meal and 10% maggot meal followed by the control with neither maggot meal nor single cell protein. The worst result was obtained in the treatment that had single cell protein completely replacing fish meal. The needs for further experimentation on the replacement of fish meal with maggot meal is a continuous efforts, in order to possibly standardise the use of maggot meal in the diet of fish. This study experimented on the complete replacement of fish meal with maggot meal in the diet of African catfish (*Clarias gariepinus)* juveniles.

MATERIALS AND METHODS

Experimental site, facilities and animal source

The experiment was conducted in the Research Laboratory of Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan, Nigeria. Six plastic tanks each with a diameter of 45 cm and depth of 29 cm were used for the experiment. Each of the tanks was filled with 25 litres of water, and designated for the two treatments in triplicates. The systems were stagnant-water renewal systems with 50% water change twice a week. The treatment 1 (DT1) was for maggot meal treatment while treatment 2 (DT2), the control, was for the fish meal treatment. Sixty African catfish (*Clarias gariepinus*) juveniles, with average weight of 10 g were purchased from a local fish farm in Ibadan, Oyo State. The fish were transferred in 25 litres plastic container partially opened at the top for exchange of gas. The fish were acclimatized for five days in the previously prepared plastic tanks in the laboratory. The fish were fed commercial pellet of 40% CP and 2 mm size during acclimation.

Maggot meal processing and diet formulation

Maggots were collected from the layers chicken production units at University of Ibadan Teaching and Research Farm Ibadan, Nigeria. The maggots collected were washed properly so as to remove dirty materials (like faecal dropping of the poultry birds, feather etc.) and then put inside plastic containers. The maggots were covered inside containers for over two hours until they all died, after which they were dried by spreading on aluminium trays under the sun for 7 days. The dried maggots were then pulverized with an electric blender. The powdered maggot meal was kept in a clean, air tight plastic container. The diet was formulated by using the following ingredients, soybean, fish oil, bone meal, vitamin premix, groundnut cake, corn bran, wheat bran and starch (Table 1) except for substitution of fishmeal for maggot meal weight for weight. The maggot meal based diet contained 30% maggot meal while the fish meal based diet contained 30% fish meal. The various ingredients were grinded into fine powdery form and thoroughly mixed in a bowl to form a homogenous mixture. Premix, warm water and starch were added to the ingredients and were thoroughly mixed together. The feed was then pelletized using grinding machine enhanced with 2 mm die. The pellets were sundried, labelled and packaged in an air tight bag. Samples of the two diets were taken to the laboratory for proximate analysis following standard methods (AOAC, 2012)

Table 1: Gross composition of the experimental diets per 100 g

Ingredients (g)	DT1 (maggot meal based diet)	DT2 (fish meal based diet)
Fish meal (72%)	-	30
Maggot meal	30	-
Soybean	20.3	20.3
GNC	20.3	20.3
Corn bran	12.4	12.4
Wheat bran	12.4	12.4
Bone meal	1.0	1.0
Fish oil	1.0	1.0
Premix	1.0	1.0
Common salt	1.0	1.0
Starch	0.6	0.6
Total	100	100

Experimental procedure

There were two treatments DT_1 (maggot meal based treatment) and DT_2 (fishmeal based treatment), and the design used was completely randomized design (CRD). Each tank was stocked with 10 fish (average weight of 10 g) each making a total of 60 fish used for the experiment. The juvenile were fed twice daily (morning and evening) at 5% body weight, the amount of feed supply are adjusted weekly based on the change in weight observed during weekly sampling. Water quality parameters were measured weekly. The selected physico-chemical parameters were pH, ammonia, nitrite, nitrate, temperature and dissolved oxygen. The water quality parameters were measured following procedures described by Dauda *et al*. (2014).

Growth performance, nutrient utilization, survival and body indices evaluation

The length and weight of fish in each tank were measured weekly, and the amount of feed per week was also evaluated. Data obtained were used to calculate various performance evaluation parameters using the equations below as described by Akinwole *et al*. (2014) and Dauda *et al*. (2018b):

Weight gain

WG (g) = final weight (g) – initial weight (g)

Mean Weight gain

MWG (g) = Weight gain (g)/Number of fish

Specific growth rate

SGR (%/day) = $(\text{Ln } W_2 - \text{Ln } W_1) \times 100/\text{Number of Culture days}$

Where W_1 = initial weight

W_2 = final weight

Ln = Natural logarithms

Feed conversion ratio

FCR = Dry weight of feed consumed (g)/Wet weight gain (g)

Protein intake

PI (g) = %protein content of the feed x total feed intake (g)

Protein efficiency ratio

PER= wet weight gain (g)/ protein intake (g)

Lipid intake

Lipid intake (g) = % lipid in feed x amount of feed consumed (g)

Lipid efficiency ratio

Lipid efficiency ratio = wet weight gain of fish/lipid intake of the fish

Condition factor (k)

$K = w \times 100/L^3$

Where w= weight of fish

L= standard length of fish

Survival

% Survival =Total number of fish harvested x 100/Total number of fish stocked

Hepatosomatic index

HSI (%) = Liver weight (g) x 100/Body weight (g)

Statistical Analysis

The mean value (±standard deviation) for each growth parameters, nutrient utilization, body indices and water quality parameters were determined using descriptive statistics. Independent sample t-test was used to establish the significant differences between the two treatments for each of the parameters measured at 95% confidence interval.

RESULTS

The results of the proximate analysis of the experimental diets are shown in Table 2, crude protein, lipid and ash were higher in fish meal based treatment, 34.65%, 7.33% and 18.03% respectively, while 28.70%, 7.20% and 11.01% were recorded in maggot meal based diet. The crude fibre was slightly higher in maggot meal based diet.

Table 2: Proximate analysis (%) of the experimental diets

Parameters	DT1 (Maggot meal based treatment)	DT2 (Fish meal based treatment
Crude protein	28.70	34.65
Crude fibre	3.90	3.30
Crude ash	11.01	18.03
Crude lipid	7.20	7.33
Dry matter	91.39	91.05

The results of the selected water quality parameters are presented in Table 3. The water quality parameters were generally similar between the two treatments with only slight differences in some of the parameters, but the differences were not significant (P>0.05) for any of the parameters. Nitrate-nitrogen and nitrite-nitrite-nitrogen were below level of detection. The dissolved oxygen and ammonia-nitrogen were slightly higher in DT2.

Table 3: Mean (±SD) selected water quality parameters of fish culture with different diets

Parameters	DT1 (Maggot meal based treatment)	DT2 (Fish meal based treatment
Dissolved oxygen(mg/L)	2.76±0.10	2.92±0.09
pH	6.70±0.02	6.72±0.02
Nitrate-nitrogen (mg/L)	0.00±0.00	0.00±0.00
Nitrite-nitrogen (mg/L)	0.00±0.00	0.00±0.00
Ammonia-nitrogen(mg/L)	2.00±0.00	2.1±0.11
Temperature (°C)	25.22±0.10	25.28±0.14

The results of the growth and nutrients utilization performance of the fish cultured with the two diets are presented in Table 4. All the growth performance indices; final biomass, weight gain, mean weight gain, mean daily weight gain and specific growth rate were significantly higher (P<0.05) in fish meal based treatment compared to maggot meal based treatment. While the feed conversion ratio was significantly lower (P<0.05) in the fish meal based treatment, other nutrient utilization parameters, including total feed intake, protein intake, protein efficiency ratio, lipid intake and lipid efficiency ratio were higher significantly in fish meal based treatment. No mortality was experienced in any of the treatments throughout the experimental period. The condition factor and hepatosomatic index were significantly not different (P>0.05) between the two treatments.

Table 4: Growth performance, nutrient utilization and body indices of *Clarias gariepinus* fed with Maggot meal based and fish meal based diets

Parameters	DT1 (Maggot meal based treatment)	DT2 (Fish meal based treatment)
Duration of study (days)	42	42
Initial biomass (g)	100.00±0.03	100.00±0.04
Final biomass (g)	227.00±3.53[b]	272.50±7.00[a]
Weight gain (g)	127.00±3.54[b]	172.50±7.00[a]
Mean weight gain (g)	12.70±0.35[b]	17.25±0.70[a]
Mean daily weight gain (g/day)	0.30±0.01[b]	0.41±0.02[a]
Specific growth rate (%/day)	1.95±0.04[b]	2.39±0.06[a]
Total feed fed intake (g)	299.55±9.97[b]	332.77±4.41[a]
Feed conversion ratio	2.36±0.01[a]	1.93±0.06[b]
Protein intake (g)	85.97±2.86[b]	95.50±1.27[a]
Protein efficiency ratio	1.48±0.01[b]	1.81±0.06[a]
Lipid intake (g)	21.57±0.72[b]	23.96±0.32[a]
Lipid efficiency ratio	5.89±0.03[b]	7.20±0.24[a]
Survival rate (%)	100.00±0.00	100.00±0.00
Condition factor	1.15±0.01	1.17±0.03
Hepatosomatic index (%)	1.70±0.47	0.97±0.43

[+]Values are Mean of three readings (±SD), different superscripts in each row indicate significant difference ($P<0.05$)

DISCUSSION

The success of aquaculture practices largely depend on ability to make quality feed with appropriate nutrient values available to cultured fish. *C. gariepinus* is an omnivorous fish with relatively high protein requirements. Several researchers have reported the nutrients requirements of African catfish fingerlings/juveniles with variations. While pioneer research reports suggested 40% crude protein as optimum crude protein requirements (Faturoti *et al*., 1986; Degani *et al*., 1989). Recent research reports have reported as low as 30 and 25% crude protein in the diet of African catfish without negative consequences (Abu Bakar *et al*., 2015; Mwangi *et al*., 2018). The crude protein of 28.70 and 34.65 % in DT1 and DT2 respectively in this research are within the previously reported range and should be able to support the efficient growth of the fish cultured. Higher lipid and ash content in DT2 which already has higher crude protein content may be giving the diet advantages ahead of DT1. The water quality parameters are not influenced by the different diets, as this is evident in the similarities of the selected water quality parameters. All the water quality parameters are within the range for safe culture of tropical fish species like *C. gariepinus* and discharge into the environment without negative consequences (Dauda *et al*., 2014; Dauda *et al*., 2018b). The growth and nutrient utilization parameters were better in the fish meal based diet. This may not only be due to the higher crude protein and lipid but also the quality of the crude protein and fatty acid composition. However, the protein quality, amino acid and fatty acid composition were not examined in this study. 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 the research are similar to that of total replacement of fish meal with sun-dried maggot meal by Fasakin *et al*. (2003). Michael and Sogbesan (2015) also 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. The hepatosomatic index was not different significantly between the treatments and it is within the same range previously observed for *C. gariepinus* (Dauda *et al*., 2017; Dauda *et al*., 2018b). The similarity in hepatosomatic index is an indication that the fish were not stressed and that the livers are in good condition. So it is sufficient to say that both the water quality and feeds experimented are adequate for fish culture. Survival rate and condition factor were also similar between the two treatments, further indicating that total replacement of fish meal with maggot meal tends not to affect the well-being of the fish.

CONCLUSION

It can be established from this research that maggot meal that can be readily available without any threat of over exploitation of natural resources like the case of fish meal and perhaps at cheaper cost can be used as a source of protein in fish feed. However, it may be better for partial replacement and not total replacement of fish meal. A further research to establish the optimum replacement level is therefore recommended.

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