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DETERMINATION OF NUTRITIVE COMPOSITION AND EFFECT OF INCLUSION LEVEL OF FISH OFFAL COMPOSITE IN THE DIET OF *Heterobranchus bidorsalis* FINGERLINGS

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ABSTRACT

This experiment was conducted to determine the nutritive composition and effect of inclusion level of composite fish offal in diets of Heterobranchus bidosalis fingerlings. Five diets of T1(0%), T2(25%), T3(50%), T4(75%) and T5(100%) levels of composite fish offal substitutions were formulated to contain 40% crude protein and similar energy levels. The feeding trial was carried out for period of 56 days. A total of 150 fingerlings was randomly distributed into three replicates of five experimental groups in a 35liters capacity plastic bowl using Completely Randomized Design (CRD). Each replicate consists of 10 fish with a mean weight of 4.00±0.2g. At the end of the experiment, results showed that Weight Gain (WG), Survival Rate (SR), Feed Conversion Ratio (FCR) and Feed Efficiency (FE) of T1 were observed to be statistically P>0.05 similar with T2 and T3. The water quality parameters showed that the culture medium was within the optimal level. The study showed that diets with inclusion rate of 25% to 50% composite fish offal gave similar result as that fed with control diet. Therefore, it was concluded that fish composite with inclusion rate of 25% to 50% could be fed to H. bidorsalis catfish without any negative effects on the growth and survival.

Keywords: Hetrobranchus bidorsalis, Fingerlings, Feeding, Growth, Survival, Composites

Introduction

Aquaculture is one of the fastest growing food production sectors in the world and provides significant supplement and substitute to wild fishes (Adebayo and Quadri, 2005). Fish are cultivated for food and are sources of revenue for the growing human population, restocking of streams, lakes, and rivers to curb the shortage due to the decline in the wild capture and for sport fishing (FAO, 2000). Aquaculture aims at production of fish to provide protein in the diet (Sugunan, 2002). Fish is easily digestible and has ability to prevent and manage heart disorders and neurological diseases (Tan *et al.*, 2007).

Fish is the cheapest source of animal protein and account for about 40% of the total protein intake by the average Nigerian (Atanda, 2007). The dynamics of Nigeria's demographic figure is in favor of perpetual increase with the attendant challenge on food security vis-à-vis increasing demand for dietary protein. This is

evident in the rising consumption of fish which aquaculture now provides a substantial quantity of the fish protein consumed (FAO, 2016). Sustainability of the consistent expansion of Aquaculture industries depends on development of fish culture techniques in order to obtain the most efficient, safe and cost-effective methods for producing aqua products (Sadiku, 2003)

Feed accounts for about 50-80% of fish production cost (Craig and Helfrich, 2009). The implications of high cost of feed are universal to both the fish culturists whose concerns are the production levels, operational costs and sustainability of their ventures and the consumers whose consideration is meeting their fish protein per capita within their convenient budgets. Dietary protein and energy are responsible for the high cost of feed for both fish and livestock (Khattab, *et al.*, 2004; Medugu *et al.*, 2011). These have prompted researches into possible reduction of feed cost through utilization of cheaper alternative sources of dietary protein, reduction in the dietary protein levels and utilizing the available dietary protein and energy efficiently with assured improvement in the desired performance of the cultured fish (Lovell, 1989 and Abowei and Ekubo, 2011; De Silva *et al.*, 2016).

The use of fish offal whose composite include fish gut/intestine has been successfully used in fish nutrition to reduce cost of feeding. Tilapia offal has been reportedly used in aquaculture diets to feed fish (Fagbenro and Jauncey, 1994). In their study, Hossain *et al.*, (2003) replaced fishmeal with broiler offal in broiler diet at lowest feed cost per kg and observed a significant growth performance. More so, Lien and Ly (2001) reported that the use of fish silage with molasses could replace fishmeal in the diet for growing pigs. Fermented fish silage produced by addition of lactic acid, bacteria and a carbohydrate source was produced from Tilapia offal and subsequently used in aquaculture diets to feed fish and significant growth performance was recorded (Fagbenro and Jauncey 1994).

One of the major problems facing the aquaculture industries today is the high cost of fish feed, which contributes more than 50% of the total cost of production in intensive culture systems (Ali *et al*, 2005). According to Omitoyin (2005) and Adeyemi *et al.*, *(*2004), majority of feed ingredients required for animal feeds can be met by using agro-industrial products, which are considered as wastes. The cost of feeding fish on artificial feed is very high, only very few farmers can afford it. This problem has been attributed to high cost of fish meal and irregular supply of conventional fish feed ingredients. The method to reduce feed cost of fish meal with alternative cheaper protein sources is by substitution. However, composite of fish offal is readily available and economical. The use of composite of fish offal may allow greater flexibility in diet formulation without loss of fish performance.

The use of non-conventional animal feed ingredients to replace conventional type such as fishmeal as animal protein source in diets for cultured species had been explored widely by various researchers including maggot meal (Adewolu, 2010), poultry by-product meal (Turker *et al* 2005) and feather meal (Adewolu, 2010), among others. The high cost of feed ingredients makes it too expensive for an average farmer, and hence most fish farmers use agricultural waste as a fish feed (Devendra, 1988). Conventional feed stuff for feeding fishes is scarce and expensive, hence this resulted to the need to improve the production of the fish in captivity using cheap and available unconventional feed ingredients such as composite of fish offal which is usually sold to farmers at cheaper prices compared to fish. The study aimed to evaluate the growth performance and survival of *Heterobranchus bidosalis* fingerlings fed with

diets containing various percentages of fish offal composite and determine the optimum level of composite of fish offal inclusion in diets of *H. bidorsalis*.

Materials and Methods

Experimental Site

The experiment was carried out at Fisheries Laboratory, Department of Forestry and Fisheries, Kebbi State University of Science and Technology, Aliero, located on latitude 110 7.91N and longitude 70 45.59 1E.

Experimental Materials and Equipment

The materials and equipment that were used during the experimental period were 35liters plastic bowls, thermometer, sensitive weighing balance (Model: XY300-2C), siphoning tubes, pH meter and aerator.

Sample Collection

The sample of the fish composite (offal) was obtained from fish seller at Jega market, Jega Local Government Area of Kebbi State. The composites contain (intestine, liver, eggs, barbel, gill rakers, etc) and they were removed with aid of knife and hand. The collected sample was subjected to 50ºC temperature electric oven for 10 hours until the moisture content and fat content was reduced and was room dried. The dried sample was grinded into meal and combined with the experimental diet ingredients included in fish feed at 25%, 50%, 75% and 100% respectively.

Experimental Fish

A total number of 150 fingerlings of *Heterobranchus bidorsalis* were purchased from Abdulsalam Fish Farm New Bussa, Niger State, Nigeria. The fish were sorted into uniform average size (4.0 ± 0.2g) using sensitive weighing scale (Model: XY300-2C) and were allocated randomly into 15 plastic bowls having 10 fingerlings each. The fish were acclimatized for 7 days in plastic bowl during this period they were fed with commercial diet of 40% crude protein.

Experimental Design

Fifteen (15) of 35liters capacity plastic bowls were used for this study, which contain five treatments replicated three times in a Completely Randomize Design (CRD). Ten (10) fingerlings were stocked per bowl and each diet were fed to three replication bowls. The initial weight of the fingerlings was measured before commencement of the feeding trial.

Experimental Diets

Five experimental diets of T1(0%), T2(25%), T3(50%), T4(75%) and T5(100%) percentage level of inclusion of fish composite were formulated at 40% crude protein and prepared for experiment.

Proximate composition

The collected sample and experimental diets were subjected to proximate analysis at the Agricultural physical laboratory in Faculty of Agriculture Usmanu Danfodio University Sokoto, Nigeria. The analysis includes Moisture content, Ash content, Crude fiber, Crude lipid, Crude protein and Nitrogen Free Extract (NFE) determination using standard methods (AOAC, 2000).

Feeding and Sampling

The experimental diets were randomly assigned to each treatment in triplicate. The fingerlings were fed to satiation at 3% body weight three times daily for 8 weeks. The sampling was done weekly.

Determination of Water Quality Parameters

The water quality parameters that were monitored during the experiment include: Temperature (ºC) which was determined using mercury thermometer. Dissolve Oxygen (DO) was determined using Winkler's method. The

Hydrogen concentration (pH) was determined using pH indicator paper.

Fish Performance Indices

1. Weight Gain (WG)

This was calculated as

Weight gain = $W_2 - W_1$

Where, W_1 = initial weight

W_2 = final weight

2. Feed Conversion Ratio (FCR)

FCR is the ratio between the weights of the food consumed divided by the weight gain by the fish.

$$FCR = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

3. Survival Rate (SR %)

$$SR\ \% = \frac{Nt}{N0} X\ 100$$

Where, Nt = Number of fish that survived

N0 = Total number of fish stocked

4. Feed Efficiency (FE)

$$FE = \frac{\text{Weight gain (g)}}{\text{Feed intake (g)}}$$

Statistical Analysis

The data obtained from the growth and water quality parameters was analyzed using Statistical Package of Social Sciences (SPSS Version 25.0). One-way analysis of variance (ANOVA) was used to calculate the mean. The differences in means were compared using Duncan multiple range test at ($P<0.05$) level of significance.

Results

Proximate composition of composite of fish offal and experimental diet

Result from Table 1 showed that composite of fish offal was found to have CP of 64.56% which is relatively similar to CP of fish meal (65.5%), moisture content (4.38%), ether extract level o(11.95%), crude fiber (2.21%), ash content (6.40%) and NFE (8.50%). The proximate composition of the experimental diet from the result shows that the Moisture content has high value in T3 (9.80%) and low in T2 (9.60%). Crude protein was highest in T2 (41.55%) and least in T5 (39.98%). The ether extract level in the diets has high value in T1 (13.70%) and low value in T2 (10.66%). The crude fiber level is higher in T5 (9.12%) and low in T1 (7.96%). The Ash content in all treatments but T4 (21.85%) has higher value and T1 (10.12%) has least value.

Table 1. Proximate Composition of the Sample and Fish meal

PARAMETERS	Composite of Fish Offal	Fish Meal
Moisture content	8.38	9.75
Crude protein (CP)	64.56	65.20
Crude fiber	2.21	1.96
Ether extract	10.35	9.89
Ash content	6.34	7.12
Nitrogen Free Extract	8.16	6.08

Growth performance of H. bidorsalis fed with composite of fish offal.

The survival of the fingerlings was high in the T1 (86.63%) and low in T5 (53.33%). Generally, the survival was good in all the treatments. This could be attributed due to proper handling during the whole experimental period. At the end of the experiment the result in Table 1 shows that there is significant difference ($p<0.05$) in WG but T1 (6.20±1.00), T2 (5.94±0.87) and T3 (4.82 ±0.34) have the highest value and least in T4 (2.58±0.74) and T5 (1.24±0.54). The result further shows that FCR in all treatments was significantly different ($p<0.05$) having high value in T5 (3.29±0.06) and low in T1 (2.48±0.06). T. The FE in all treatments was significantly different ($p<0.05$) where T1 (0.15±0.01) has high value and T5 (0.03l±0.01) has low value.

Table 2: Growth performance of H. bidorsalis fed with composite of fish offal.

TRT	IW (g)	FW (g)	WG (g)	SR (%)	FCR	FE
T1	4.00 ± 0.2^{a}	10.20 ± 0.45^{a}	6.20 ± 1.00^{a}	86.67 ± 0.6^{a}	2.48 ± 0.06^{b}	0.15 ± 0.01^{a}
T2	3.98 ± 0.2^{a}	9.92 ± 0.52^{a}	5.94 ± 0.87^{a}	80.00 ± 0.6^{a}	2.72 ± 0.06^{a}	0.10 ± 0.01^{b}
T3	4.00 ± 0.2^{a}	8.82 ± 0.32^{a}	$4.82^{a} \pm 0.34^{a}$	73.33 ± 0.6^{a}	2.87 ± 0.06^{b}	0.08 ± 0.01^{b}
T4	3.99 ± 0.2^{a}	6.57 ± 0.27^{b}	2.58 ± 0.74^{b}	63.33 ± 0.6^{a}	3.14 ± 0.06^{c}	0.04 ± 0.01^{c}
T5	3.97 ± 0.2^{a}	5.22 ± 0.21^{b}	1.24 ± 0.54^{b}	53.33 ± 0.6^{a}	3.29 ± 0.06^{a}	0.03 ± 0.01^{c}

Mean values on the same column with the same superscripts are not significantly different ($P>0.05$)

TRT = Treatment, IW = Initial Weight, FW = Final Weight, WG = Weight Gain, SR = Survival Rate, FCR = Feed Conversion Rate, FE = Feed Efficiency.

Water quality parameters monitored during the experimental period

Table 3 shows that the water quality parameters analyzed during the experiment were within the acceptable range recommended for *H. bidosalis* and are not significantly different ($P<0.05$) in all treatments. The D.O(mg/l) has higher value in T5 (8.67±0.00) and least in T1 (7.00±0.00). The Temperature (^{0}C) was higher in T5 (25.00±0.00), T2, T3 and T4 has (24.67±0.00) while least value in T1 (24.33±0.00). Similarly, pH has high value in T2, T3, T4, T5 (6.67±0.00) and low value in T1 (6.33±0.00).

Table 3: Water quality parameters monitored during the experimental period

Treatment	DO (mg/l)	Temperature (^{O}C)	pH
T1	7.00±0.00^{a}	24.33±0.00^{a}	6.33±0.00^{a}
T2	7.67±0.00^{a}	24.67±0.00^{a}	6.67±0.00^{a}
T3	8.00±0.00^{a}	24.67±0.00^{a}	6.67±0.00^{a}
T4	8.33±0.00^{a}	24.67±0.00^{a}	6.67±0.00^{a}
T5	8.67±0.00^{a}	25.00±0.00^{a}	6.67±0.00^{a}

Means with the same superscript are not significantly different (P>0.05)
Key: DO = Dissolved Oxygen

Discussion

The crude protein contents of the experimental diets (39.98 – 42.05%) were within the range recommended in *H. bidorslis* formulated test diets and it met the protein requirements (30 - 40%) recommended as being optimum for growth in the *H. bidorslis* (Faturoti, 2000). This research shows that fish offal can replace fishmeal up to about 50% without any negative effect on growth. This is similar to the findings of Soltan *et al.* (2002) and Tegene *et al.,* (2018) who stated that fish offal meal represented a good protein source due to its high content of the essential amino acids which can replace the conventional diets of *O. niloticus*. This result agrees with the findings of Farahiyah *et al.*, (2015) who stated that commercial feed might contain compounds such as attractants to lure fish to consume more of the feed thus gaining weight, however the efficiency in converting the feed to meat and the efficiency of utilizing the protein content in the feed was not significantly different with fish fed with diet based on 100% fish offal meal inclusion.

Feed conversion ratio (FCR), feed per unit of body weight gain, is an important indicator of the quality of fish diets, a lower FCR indicate better utilization of the fish feed (Mary *et al.*, 2015). According to research by Tegene *et al.*, (2018), fishes fed with soybean meal, poultry litter and fish offal had an FCR which were not significantly different from each other which may imply that the experimental diets had comparative nutritional value to control diet. FCR recorded in this research is similar to those reported by Tegene *et al.,* (2018), Stickney and McGeachin (1984). In addition, the PER of all the fish fed in this experiment was observed not to be significantly different. This result suggests that protein sources other than fishmeal could be used to partially supplement for fish meal in fish diets.

The specific growth rate and relative growth rate recorded for fish fed three times daily in this study were also observed by Gabriel *et al.*, 2000 for *Heterobranchus bidorsalis* fingerlings fed at 3% body weight 3 times daily. However, reports show that feeding channel catfish twice/day produced similar growth rates compared to fish fed three times/day when grown in tank (Webster et al., 1998) or in ponds (Webster et al., 1999). Robinson *et al.* (1995) reported that when channel catfish were fed once daily, time of feeding had no significant impact on growth, feed conversion or body composition. The mean weight gain and weekly weight gain recorded in this experiment were very much

lower than that reported for *Heterobranchus* and *Clarias* species in low input homestead concrete tanks and brackish water pond environment (Legendre, 1998; Egui, 1999), but similar to those observed by Gabriel *et al.* (2000).

All the water quality parameters analyzed during the experiment were within the acceptable range and considered suitable for the growth of African catfish as reported by Legendre *et al.* (2008). Minimum and maximum temperature for tropical fish ranges from 25 - 32^{0}C. Ovie and Adeniji (1990) also recommend the pH value to be 6.5 - 9.0. Survival rate in the present study was within the range reported by Webster *et al.* (2001) who observed that juvenile sunshine bass, *Morone chrysops, M. saxatifilis*, had survival percentages between 62-75%. All mortalities may be attributed to handling stress after weekly parameters handling.

Conclusion

The result obtained from this study revealed that the composite of fish offal can be used to replace fish meal partially in the diet of *Hetrobranchus bidorsalis*, where fish farmers cannot afford the high cost of fish meal. Moreover, the composite of fish offal can effectively replace fish meal to about 50%. Fish composite is readily available, affordable and economical. The use of fish composite may allow greater flexibility in diet formulation without loss of fish performance. In order to avoid excessive deposition of feed in the culture medium, replacement of up to 50% in term of weight gain and survival is therefore recommended for optimal growth performance and survival.

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