FORMULATION, PRODUCTION AND EVALUATION OF FLOATING CATFISH FEED

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ABSTRACT

This trial was carried out to compare the performance of catfish fed with four experimental diets; a reference foreign diet (Multifeed) and three isonitrogenous and isoenergetic locally formulated diets with different palm oil contents (1, 2 and 3 liters) coded as Feed 1, Feed 2, Feed 3 and Feed 4 respectively. The growth trial which lasted for six months was conducted in rectangular concrete tanks of 2.5m x 0.7m x 0.58m with water volume maintained at 0.17 m level. A total of 1800 catfish, *Clarias gariepinus,* juveniles with an average weight of 40.18± 0.51g were randomly allotted (at the rate of 150 juveniles per tank) into each of the 12 experimental concrete tanks. The result indicated significant variation in all the treatments in terms of final body weight, weight gain, daily weight gain and specific growth rate of the fish at harvest ($p>0.05$). The data generated also showed that the reference diet and the three formulated feeds had no significant influence on catfish in terms of food conversion ratio, protein efficiency ratio, protein intake, feed intake/fish and survival ratio. Feed 3 (containing 2 litres of oil) was observed to be the best treatment among the locally formulated diets as it resulted in significantly ($P \leq 0.05$) high final bodyweight (229.4g), weight gain (213.3g), daily weight gain (1.78g/fish/day) and specific growth rate (2.19g) of catfish that was statistically comparable to those of fish fed with the foreign control feed. The result of the present study suggest that a locally formulated floating feed containing 33.25% crude protein, 2.58 k/cal and 1 liter palm oil is comparable to foreign expensive feed in terms of cat fish yield and production.

Keywords: Aquaculture, catfish, protein source and fish feed

INTRODUCTION

Fish farming contribute significantly towards meeting Nigeria's animal protein requirements as the aquaculture industry is expanding to satisfy increasing demand for affordable, safe and high-quality fish and seafood products (Craig and Helfrich, 2009). On a global scale, fish, crustaceans and molluscs production has increased from 3.9 percent of total production by weight in 1970 to 27.1 percent in 2000 and to 32.4 percent in 2004 (FAO, 2006). Nigeria's contribution to these global figures remains, largely, insignificant and more needs to be done to bridge the gap. Catfish, family Clariidae, is very popular in Nigeria due to its culture characteristic, which has endeared it to many fish farmers with about ninety percent of the catfish supply in sub-Saharan Africa in the year 2000 reported to emanate from the country (FAO, 2004). Catfish (*Clarias gariepinus*) is appreciated by consumers for the quality of its meat (Pruszyński, 2003) and is mostly smoked and used in soups. Furthermore, the fish are widely cultured owing to their high market price, fast growth rate and ability to withstand adverse pond conditions especially low oxygen content (Oladosu, et. al. 1993).

In animal production systems, good nutrition is essential for maximum yield and economic return. Similarly, in catfish farming, nutrition is critical because feed represents 40-50% of the production cost. Although natural food organisms may provide certain nutrients (particularly micronutrients such as vitamins and fatty acids), the contribution of pond organisms to the nutrition of intensively cultured catfish is generally considered to be small (Robinson and Li 1996). Thus, the nutritional requirements

of cultured catfish are met by using a complete feed, that is, a feed formulated to provide all required nutrients in the proper proportions necessary for rapid weight gain, high feed efficiency, and a desirable composition of gain. Catfish feeds have generally been based on a fixed formula with little use of a least-cost approach as is used in other animal industries. In the past, fixed formulas were used because of the lack of sufficient nutritional information (Robinson and Li, 1996). Presently, nutritional data are available to allow the nutritionist to formulate catfish feeds on a least-cost basis. The primary constraint limiting the use of least-cost programs for formulating catfish feeds is that relatively few feedstuffs are available that can be used in catfish feeds. Many feedstuffs are unsuitable for use in catfish feeds because of their poor nutritional content or because of manufacturing constraints.

Feeding is an important consideration in catfish production as feed cost is reported to represents about one-half of variable production costs in catfish culture (Green et. al., 1995). Foreign catfish feed are the major diets utilized by farmers in catfish production. However, prices for this imported feed have increased dramatically in recent years. In addition economic efficiency in Catfish culture requires that the fish should be fed to near satiation without feed wastage and without adversely affecting water quality. Nevertheless, feeding to satiation is highly subjective since it is difficult to determine when the fish are satiated. Thus, it is easy to overfeed, which results in wasted feed that increases production cost and may have deleterious effects on water quality. Considerable interest has been shown in finding less expensive, alternative feedstuffs for use in catfish diets. Low-cost floating catfish feed formulated from locally available ingredients should be nutritionally comparable with good quality commercial or imported catfish feed to maintain productivity. Identifying locally available ingredients to formulate floating catfish feed that is nutritious but cheaper than existing commercial feeds promises productivity, health and environmental benefits by minimizing feed wastage and pond pollution. The formulation and production of a less expensive local floating catfish feed in comparison to the imported feed would reduce feed cost for catfish production. This research is a systematic study to come up with an alternative to commercial floating catfish feeds using locally available ingredients.

MATERIALS AND METHODS

This experiment on growth performance and feed utilisation was conducted at a private fish farm in Rigasa district Igabi Local Government Area of Kaduna State.

Experimental Treatments

The experimental treatments were composed of one reference diet (a foreign fish feed containing 32% crude protein and 2.70 kcal/kg) coded as Feed 1 and three in-house diets formulated from locally available feed ingredients that differ in their palm oil (1, 2, and 3 liters) contents and coded Feed 2, Feed 3 and Feed 4 respectively. The proximate chemical composition of the feed ingredients used in the feed development is shown in Table 1. All experimental diets were formulated to meet or exceed all known dietary requirements for catfish (NRC 2011) and manufactured as floating pellets. The four treatments were replicated three times and laid out in a simple randomize complete design (Steel et al. 1997), Fingerling of catfish *(Clarias gariepinus)* were stocked into twelve experimental ponds.

Feed Preparation

The experimental feedstuff (soybean meal, wheat bran, maize bran, GNC, rice bran, palm oil and fish meal), salt, vitamin mix, methionine and lysine were ground into powdery form using a corn mill. The feed was produced by careful mixing of the dry ingredients together by hand before adding palm oil and distilled water. The pellet feed was made using an electronic meat grinder (Quoc Hung Company, Vietnam) with diameter and length of pelleted feed in the range 1-2 mm. All diets were sun-dried for 2-3 days, and then weighed and stored in sealed plastic bags in small portions at 5 ºC until use. New batches of experimental feeds were made biweekly. The fish were fed three times daily manually to apparent satiety, at a fixed rate of 30% body weight, dry feed per day.

Experimental Procedure

The experiments were carried out in 12 rectangular concrete tanks of 2.5m x 0.7m x 0.58m with water volume maintained at 0.17 m level. A total of 1800 catfish, *Clarias gariepinus*, and juveniles with an average weight of 40.18± 0.51g were randomly allotted (at the rate of 150 juveniles per tank) into each of the 12 experimental concrete tanks. Fingerling of catfish *(Clarias gariepinus)* were sourced, stocked in ponds, and quarantined for two weeks to alleviate stresses during transportation and to be adapted to new conditions. During this period, the fish were fed the control diet containing 30 % crude protein. The fish were then selected randomly, weighed and then transferred to each experimental pond for one week before the experiment commenced. After the adaption period the catfish were hand fed with the four treatment diets three times (at 6.00am, 2.00pm and 10.00pm) daily to apparent satiation at a rate of 30 % of live body weight. This feeding regime was maintained throughout the experimental period. The fish were measured and weighed every 2 weeks and the food consumed in this period was recorded. In addition, the subsequent amounts of the feed required per treatment were readjusted according to the actual body weight. The ponds were cleaned and disinfected periodically, while the dead fish were recorded daily and removed. The fish were individually sampled, weighed and their lengths were measured. Furthermore, fish were sampled for processing and the remaining fish from each pond were harvested (approximately 180 days after stocking), counted and weighed. Due to the relatively large number of fish used in the study, not all of them were counted. Instead, a 45-fish sample was randomly collected and group-weighed to estimate weight gain of individual fish.

Data Collection and Analysis

At the end of the diet evaluation study, 30 fish from each pond were selected to determine processed yield. Fillets (one fillet per fish, 10 fish per pond) were stored at -4°F for proximate analyses. After sampling, all fish from each pond were harvested, counted, and weighed. Data collected included total feed fed, net yield, weight gain, feed conversion ratio, survival and dressed yield. Protein, fat, and moisture were analyzed according to standard methods (AOAC 2000). Similarly, the proximate chemical composition of feed ingredients were estimated by the methods described by the Association of Official Analytical Chemists (AOAC, 2000), to determine the crude protein content, moisture, fat, ash etc. The calculations on the growth performance and feed utilization that were made during the experiment include: specific growth rate (SGR%), daily weight gain (DWG), survival rate (SR%), protein efficiency ratio (PER), protein intake (PI), total feed intake (FI), feed conversion ratio (FCR) and mortality. Water quality parameters in each experiment were recorded twice a month during the experiment. Chloride concentration was maintained at 50 ppm or more to alleviate possible nitrite toxicity. Water quality was maintained in ranges considered adequate for optimum fish performance (Tucker et. al. 1979). Dead fish were removed from ponds, weighed, and recorded for correction of feed conversion ratio. Data collected were subjected to ANOVA and the Fisher's protected LSD procedure (Steel et al. 1997; Gomez and Gomez, 1984) using Statistical Analysis System version 8.0 software (SAS Institute, Inc., Cary, North Carolina). A significance level of $P \leq 0.05$ was used. Differences were subjected to Duncan s (1955) Multiple Range – test.

RESULTS

Ingredient Composition Test Diets

Ingredient composition of the three experimental diets containing varying quantities (1, 2 and 3 liters) of palm oil to aid in their floatability were labeled as Feed 2, Feed 3 and Feed 4 respectively and presented in Table 1. Fishmeal and soybean meal were used as sources of animal and plant protein sources, respectively, wheat milling by product, groundnut cake, rice bran and maize bran were added in all the experimental diets as energy sources.

Table 1: Ingredient Composition (g/100g) of the experimental diets with varying inclusions of oil formulated to meet requirements' for catfish

Ingredient	Experimental Diets (Crud protein/Kcal)		
	FEED 2 34% /2.44 k/cal	FEED 3 33.25% /2.58 k/cal	FEED 4 30%/2.70 k/cal
Maize bran	23.00	20.00	15.00
Wheat bran	20.00	27.00	20.00
Soya beans meal	12.00	12.00	22.00
GNC	25.00	23.00	20.00
Fish meal	15.00	15.00	17.00
Rice bran	03.20	03.00	03.00
Salt	00.25	00.25	00.25
Vit. Premix	00.25	00.15	00.25
Methionine	00.15	00.15	00.15
Lysine	00.15	00.25	00.15
Palm oil	01.00	02.00	03.00

Growth Performance and Feed Utilization

Table 2 showed the result of the growth performance and feed utilisation of catfish (*Clarias gariepinus*) fingerlings fed the reference diet (RD) and the test diets at three months. Out of all the variables evaluated in this experiment only body weight and weight gain were observed to be significantly (P>0.05) affected by all the treatments at three months. The highest body weight was recorded by fish fed with the reference diet and feed 3 that were higher but statistically at per with body weight of catfish fed with feed 4. Fish fed feed 2 recorded statistically lower body weight compared to the fish fed the other diets except feed 4 that was statistically comparable. For the test diets, fish fed with feed 3 had significantly higher body weight than those fed with feed 2 that did not differ statistically with the body weight of fish treated with feed 4.

Catfish fed with the foreign diet gain significantly higher weight than all the fish fed with the test diets except for fish fed with feed 3 that gain statistically comparable weight. The lowest daily weight gain was observed with Fish fed with feed 2 that was comparable with fish fed feed 4. The results further indicates that there were no statistically significant variation in daily weight gain, specific growth rate, food conversion ratio, protein efficiency ratio, protein intake, feed intake/fish and survival ratio among the fish regardless of the diet.

Table 2: Growth performance and feed utilization of catfish (*Clarias gariepinus*) fingerlings fed the reference diet (RD) and the test diets at three months

Variable	Feed 1	Feed 2	Feed 3	Feed 4	SEM	P-Value
Body weight	61.8a	42.7b	56.7a	51.9ab	0.08	0.11
Weight gain	45.4a	26.2c	40.5ab	35.5bc	5.12	0.04
Daily weight gain	0.4a	0.2a	0.3a	0.3a	5.15	0.03
Specific growth rate	1.1a	0.8a	1.0a	0.9a	0.04	0.23
Food conversion ratio	1.8a	2.3a	1.8a	1.9a	0.07	0.22
Protein efficiency ratio	2.1a	1.2a	1.4a	1.5a	0.20	0.22
Protein intake	0.22ab	0.22a	0.22ab	0.22ab	0.24	0.13
Feed intake/fish	97.3a	96.8a	97.6a	98.6a	0.002	0.16
Survival ratio	97.8a	93.3a	97.2a	94.4a	0.77	0.52

Means followed by the same letter within same row are not statistically different

The data on the growth performance and feed utilisation of catfish (*Clarias gariepinus*) fingerlings fed the reference diet and the test diets at harvest months are presented in Table 3. The result indicated significant variation in all the treatments in terms of final body weight, weight gain, daily weight gain and specific growth rate of the fish in the experiment. For the aforementioned variables fish fed with foreign diet performed significantly higher than fish fed feed 2 and feed 4 and was statistically comparable in performance to fish administered feed 3. For the same variable with respect to the test feed, the data indicated that the performance of fish fed with feed 2 was significantly lower than that observed for fish fed feed 3 and feed 4 that were statistically at par. It is noteworthy that the reference diet and three formulated feeds had no significant influence on catfish in terms of food conversion ratio, protein efficiency ratio, protein intake, feed intake/fish and survival ratio.

Table 3. growth performance and feed utilization of catfish fingerlings fed the reference diet (RD) and the test diets at harvest.

Variable	Feed 1	Feed 2	Feed 3	Feed 4	SEM	P-Value
Body weight (g)	257.00a	177.9c	229.4ab	219.0b	0.85	0.61
Weight gain (g)	240.80a	161.7c	213.3ab	202.1b	6.91	0.01
Daily weight gain (g)	2.01a	1.35c	1.78ab	1.69b	0.07	0.02
Specific growth rate	2.29a	1.96c	2.19ab	2.13b	0.04	0.03
Food conversion ratio	1.3c	1.6bc	1.3c	1.6c	0.05	0.05
Protein efficiency ratio	3.2a	2.4a	3.2a	2.9a	0.12	0.01
Protein intake	0.77a	0.56ab	0.59ab	0.74a	0.04	0.03
Feed intake/fish	340.0a	347.3a	326.1a	320.8a	1.22	0.14
Survival ratio	95.0a	90.5a	95.2a	93.2a	0.74	0.62

Means followed by the same letter within same row are not statistically different

DISCUSION

Feeds and feeding are critical factors in the growth, yield and production of fish. It was observed from the result of this research that none of the experimental feeds exhibited any significant differences in the entire catfish growth variables evaluated except body weight and total weight gain at three months after stocking (Table 2). This may be attributed to the fact that catfish growth in response to the application of these experimental feeds was slow during this period or it may be because the pelleted fish ration, was probably consumed inefficiently by the fish during the initial 90 days. The poor performance of catfish under the foreign feed control and the formulated floating feed treatments may have most likely resulted from the inability of the young fish to consume these fish feed pellet, rather than the quality of feed. The small quantity of feed initially offered to fish may have been of little value even as fertilizer to stimulate natural productivity, so fish growth was limited by food availability. On the other hand, the response of catfish with respect to the variables observed at six months (Table 3) could be attributed to the value of the feeds in maintaining fast fish growth during the first two months of grow-out and accelerating this growth afterwards up till harvest. The control foreign Multifeed diet was observed to be significantly higher in all catfish performance index compared with all the other feeds under study. This result agrees well with data from other studies with catfish fingerlings (Li *et al.* 2006; Kop and Korkut, 2010). This could be attributed to its floatability and high nutrient content. All the three test diets were formulated to meet or exceed the nutrient and energy requirements for catfish (NRC 2011; Robinson *et al.* 2001). This could be the reason for the appreciable performance of fish fed with feed 3 and feed 4 compared to fish fed with the control diet in terms of growth attributes under study.

The data generated from this trial indicates that catfish fed with locally formulated catfish feed 4 (containing 3 liters of palm oil) has performed significantly well in comparison to the foreign control

diet. However, this performance was marginally lower compared to that of fish fed with feed 3. The high palm oil content of feed 4 compared to the oil in the two other formulated catfish feed may have been unnecessary or may even be detrimental to catfish due to pond contamination and pollution thus resulting in lower fish performance in terms of growth compared to feed 3. This implies that the diet containing a moderate quantity of palm oil like feed 3 would be a reliable substitute.

Furthermore, the lower palm oil content in locally formulated feed 3 and possibly higher digestible energy levels in diet could likely account for the improved body weight, weight gain, daily weight gain and specific growth rate of fish fed this diet because all the experimental diets contained an excess of digestible energy. In the present investigation, inclusion of palm oil in the locally formulated catfish feed did not reduce the growth rate but rather gave the best weight gain in *Clarias gariepinus* juveniles. Various workers on have shown that inclusion of palm oil in fish diets can improve its floatability and support growth (Ritcher *et. al.*, 2003; Santiago *et. al.*, 1988; Afuang *et. al.*, 2003). The growth performances of the fish (Table 1) agree with those of the earlier workers (Ritcher *et. al.*, 2003). The maize content of the locally formulated catfish feed has also contributed to its floatability in addition to the palm oil it contained. Since according to Rad *et. al.* (2003) a typical commercial catfish diet contains 15–25% corn grain to ensure good pellet quality and that the pellets float on the water surface. In this study, though no difference was found between the feed types in terms of especially food conversion ratio, protein efficiency ratio, protein intake, feed intake/fish and survival ratio values, these values are at the acceptable level in nutrition of catfish species ($p<0.05$). It has been suggests that 1.2-1.4 feed conversion rate in tanks is sufficient for carnivore fish production. A very small percentage of mortality was recoded throughout the period of the experiment; this could indicate that the diets did not have any deleterious effects on the fish. The data from this study agree in general with that of similar studies (Li *et al.* 2004, 2006).

CONCLUSION

The study demonstrates that inclusion of palm oil in the formulation and production of local floating catfish feed has significantly enhance its dietary value. In addition, the nutritional contents of these local feeds combined with their floatability have contributed significantly to their performance. The present experiments has also showed that catfish formulated with 1 liters of palm oil was statistically comparable to the foreign Multi feed in promoting growth and performance in cat fish. It is therefore concluded that locally formulated catfish feed (33.25% Cp and 2.58 k/cal) containing one liter of oil could be used successfully for feeding catfish without any adverse effects on their productive performance as it increased weight and growth of the fish.

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