GROWTH PERFORMANCE, PROXIMATE COMPOSITION AND PROFITABILITY OF *Heterobranchus longifilis* GROW-OUT USING DIFFERENT COMMERCIAL FEEDS

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ABSTRACT
The effect of two commercial feeds and a farm-made feed on growth, body composition and economics of Heterobranchus longifilis grow-out were assessed. Triplicate groups of H. longifilis fingerlings mean weight 36 g ± 0.04 were fed commercial feeds in treatments 1 and 2 and a farm-made feed in treatment 3. Feeds were of 42% crude protein content. Feeding was at 1% body weight thrice daily. After 154 days, mean weight of 350 ± 29 g, 342 ± 40 g and 118 ± 7 g were obtained in treatments 1, 2, and 3 respectively. Feed conversion ratio, specific growth rate, and protein efficiency ratio for treatments 1, 2, and 3 were 1.33 ± 0.04, 1.44 ± 0.13, and 1.79 ± 0.03; 1.25 ± 0.14, 1.48 ± 0.07, and 1.94 ± 0.1; 2.32 ± 0.01, 0.76 ± 0.02, and 1.1 ± 0.08; respectively. Economic conversion ratio was significantly lower in treatment 2 than treatment 1 ($P < 0.008$). Economic weight gain and cost:benefit over feed cost in treatments 1, 2, and 3 were 513 ± 6, 1:1.37; 478 ± 15, 1:1.47; 852 ± 67, 1:0.82 respectively. Cost items in order of magnitude were water, feed and fingerlings. Inclusive of cost of water, cost:benefit becomes 1:1.16, 1:1.2, and 1:0.6 in treatments 1, 2, and 3 respectively. The lower priced and less preferred feed in treatment 2 had a higher growth performance than treatment 1, indicating a strong need for a fish feed advisory.
Keywords: pelleted feed, aquaculture, growth indices, African catfish, water cost

INTRODUCTION

Urban and peri-urban aquaculture in Nigeria is an emergent phenomenon (Miller and Atanda, 2011). Information on aquaculture production under this setting is scarce. By definition, urban conditions are characterized by lack of space. This is often compounded for aquaculture, by problems of inadequate municipal services including electricity and water supply. Because of these conditions, the emergent urban and peri-urban aquaculture has intensive characteristics, in terms of nutrient provision and stocking density (Tacon and De Silva, 1997). The inadequacy of municipal water supply services makes it necessary, for aquaculture practitioners in most of Nigeria to incur relatively heavy cost by supplying own water. *Heterobranchus longifilis* copes well with high density culture and is well accepted by the market. As with its close relative *Clarias gariepinus*, it needs relatively high dietary protein levels (Degani *et al*., 1989), and therefore expensive pelleted feed for successful culture. Intensive culture systems are characterized by high stocking densities and a heavy reliance on pelleted feed (Tacon and De Silva, 1997), causing even incremental reductions in cost of feeding individual fish to have a huge multiplier effect on total feed cost. There are various brands of commercial pelleted feeds available to farmers in Nigeria. Some brands are simply regarded as being of superior quality to others. Thus feeds are not rated on the basis of empirically determined levels of biological and economic performance, leading to various degrees of artificially high pricing. Farmers alternate commercial pellets in the first few months of culture, with farm-made feeds for the rest of the culture period (Akinwole and Faturoti, 2007), due to the high cost of commercial pellets. As far as the authors know, there is no advisory to farmers in Nigeria, on the expected benefit from the use of specific feed brands in order to make an informed decision on choice of feed. The profitability of this form of aquaculture is affected by inadequate provision of municipal services like power and water (Miller and Atanda, 2011), yet, rarely are these cost items included in its cost-benefit analyses.

This study fills these gaps by determining and comparing the effect of two differently priced but locally available and widely-used commercial pellets, on growth, proximate composition, and grow-out economics of *H. longifilis* under urban and peri-urban conditions in Nigeria. Because of inadequate record keeping, profits may be over-stated due to hidden costs. Since it is still at an early stage, there is a need to empirically assess the profitability of urban and peri-urban aquaculture. This study provides information on the economics of catfish grow-out under prevailing urban conditions characterized by inadequate space and a selected municipal service.

MATERIALS AND METHODS

Pre-study Survey

Prior to the feeding trials, 15 fish farmers in various parts of Abia State in southeast Nigeria were randomly selected. This number is estimated to be 30% of the functional fish farms in the state. They were presented with a list of the brand names of five separate pelleted fish feeds. These included Coppens feed®, Dizengof feed®, Excel feeds®, Multi feed®, and Vital feed®. They were asked to rank them in order of preference. The best and second-best ranked feeds were selected for the feeding trials in this study. The third feed used was a farm-made feed, processed and formulated according to prevailing local practices.

The experiment was conducted in the laboratories of the Department of Fisheries and Aquatic Resources Management, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Experimental fish were *H. longifilis* fingerlings obtained following standard procedures of hypophysation and stripping of wild-sourced brood stock. The fish were raised on shell-free *Artemia*. They were then fed to satiation with the top ranked feed, up to the commencement of the experiment.

Experimental design

Experimental units were circular 70 l plastic containers filled to the 50 l mark, placed in-doors in the laboratory. Five *H. longifilis* of mean weight 36 g ± 0.04 and eight weeks old were stocked in each container. The containers were then randomly assigned treatments. Three iso-nitrogenous feeds of 42% crude protein content were used. In treatment 1, the fish were fed diet 1, which was the top-ranked brand of commercial pelleted feed. In treatment 2, the fish were fed diet 2, which was the brand of commercial pelleted feed ranked second. The fish in treatment 3 was fed a farm-made feed. Each treatment was replicated thrice. Feeding in all cases was at the rate of 1% fresh body weight thrice daily at about 8:00, 13:00 and 18:00 hours. The experiment lasted for 154 days.

Ingredient processing and farm-made feed preparation

Fresh blood was boiled, sun-dried, ground into powder, and sieved through a 0.63 mm mesh size sieve to obtain blood meal. Soybeans were boiled, sun-dried, and ground. Maize was ground to powder before use. Cassava tubers were peeled, sliced into bits, dried and ground. The ingredients were mixed in hot water and pelleted using a meat mincer of 2 mm die producing a 2 mm pellet size feed. The product was sundried before usage.

Procedure

On a two-weekly basis, the fish were weighed to obtain feed data. Feed quantity was adjusted monthly, according to standard practice, and recorded. Every three days, the water was changed. pH and temperature were measured with La motte pH plus Direct pH meter. Dissolved oxygen was measured using a dissolved oxygen meter Hanna Instrument (model HI 9142). Ammonia and nitrite levels were determined using HACH Spectrophotometer (Model DR 2000 USA). The amount of water used throughout the period was noted. Proximate analysis was carried out on the feed ingredients after processing, before feed preparation. Before being distributed to the respective experimental units, a sample was taken from the pool of fish to determine initial levels of moisture, ash, ether extract, crude protein and nitrogen free extract respectively. At the end of the experiment, fish in the various units were analyzed to detect final levels of the variables. Both analyses were done according to A.O.A.C. (1984).

Growth and feed performance indices

The following growth parameters were calculated: specific growth rate (SGR) (% day^{-1}), feed conversion ratio (FCR), protein efficiency ratio (PER), and percentage weight gain (Ridha and Cruz, 2001). They were computed as follows:

$$SGR = \frac{\ln W2 - \ln W1}{\text{Culture period (Days)}} \times 100$$

Where W2 = final weigh, W1 = initial weight, T2=end of culture period (days), T1=beginning of culture period (days).

$$FCR = \frac{\text{Total weight of dry feed given (g)}}{\text{Total weight gain of fish (g)}}$$

$$PER = \frac{\text{Live weight gain (g)}}{\text{Weight protein fed (g)}}$$

$$\text{Percentage weight gain} = \frac{\text{Gain in weight (g)}}{\text{Initial weight (g)}} \times 100$$

Survival rate was calculated by expressing number surviving as a percentage of number stocked.

Economic indices

Economic weight gain (EWG) was calculated as

$$EWG(\text{Naira kg}^{-1}) = \frac{\text{Financial cost of feed (Naira)}}{\text{Body weight (kg)}}$$

Economic conversion ratio (ECR) (after Martinez-Lorens *et al.*, 2007) was calculated as:

$$ECR(\text{Naira kg}^{-1}) = \frac{\text{Feed offered (kg) x feed cost (Naira kg}^{-1})}{\text{Weight gain (kg)}}$$

A partial budget analysis was done to determine the profitability of the treatments according to Ofor (2007). The following factors were used to calculate expenditure (1USD=145 Naira):

(1) Official state minimum wage in Abia State, of 5, 500 Naira/month, and an 8 hour workday.

(2) Cost of feed amounting to 650.00 Naira (treatment 1). Cost of feed ingredients (treatments 1 and 2) amounting to 506.00 Naira, and 190.00 Naira respectively.

(3) Transportation cost of 27 Naira

(4) Labour cost of 151.00 Naira in treatments 1 and 2, and 168.00 Naira in treatment 3.
(5) Cost of utensils and materials for feed preparation in treatment 3 = 110 Naira
(6) Cost of fingerling = 150 Naira
(7) Water used amounting to 5906 litres at the cost of 1723 Naira. The price of *H. longifilis* was based on the farm gate price, and this was used to compute revenue.

Statistical analysis

Data on *H. longifilis* growth parameters, proximate composition of the fish flesh and water quality parameters were analyzed using the two-way ANOVA in the generalized linear models procedure of the SAS (SAS Inc. 1995) and also using the t-test in the T Test procedure of the SAS (SAS Inc. 1995).

RESULTS

Effect of feed on growth

The proximate composition of the various feeds is given in Table 1. Data on growth and feed performance indices of fish is given in Table 2. Final mean weight and mean weight gain were not significantly different between treatments 1 and 2, but were significantly different for treatment 3 ($P < 0.05$). FCR was lower in treatment 2 (1.25) than treatment 1 (1.33). Though the difference between FCR in treatments 1 and 2 were not significantly different ($P > 0.05$), treatment 3 was significantly higher (2.32) ($P < 0.05$). SGR was higher in treatment 2 than 3, but not significantly ($P > 0.05$). PER was significantly higher in treatment 2 than in treatment 1 ($P < 0.05$). Treatment had the highest effect on SGR ($P < 0.001$), and the least in mean weight gain at harvest (%) ($P < 0.05$). Treatment effect on PER, mean weight and harvest mean weight gain was significant at $P < 0.01$. The pattern of mean weight variation throughout the study is shown in Fig. 1.

Effect of feed on body composition

Data on proximate composition of fish flesh is shown (Table 3). There were significant differences ($P < 0.05$) between the initial body moisture content and the final moisture content of the fish flesh with respect to treatment 2 and 3, with treatment 3 having the highest moisture content of 77.67% which was significantly higher than in the rest of the treatments ($P < 0.05$). There were no significant differences ($P > 0.05$) between the initial and final moisture content in treatment 1. This was also true of percentage dry matter. The percent protein content for treatment 1 was higher than for treatment 2, but not significantly ($P > 0.05$). Both treatments had significantly higher levels than treatment 3. All treatments recorded significantly higher fat levels than the initial ($P < 0.05$). There were no significant differences ($P > 0.05$) in the final fat content of the various treatments.

Effect of feed on physico-chemical parameters

There were no significant differences ($P > 0.05$) amongst the treatments in the levels of the various physico-chemical parameters (Table 4). The ammonia and nitrite levels were not significantly affected by number of days from last change of water change ($P > 0.05$) (Table 5).

Economic analysis

A partial budget of the three feeds is given in Table 6. A selling price of 700 Naira per kilogram of fish was used to compute revenue. Water cost accounted for 63.8%, 67.4% and 72.6% of sum of costs (total costs), feed cost accounted for 31%, 27%, and 21%, while fingerlings accounted for 5.5%, 5.9% and 6.3% in treatments 1, 2, and 3 respectively. When the cost of water is excluded, cost:benefit is lowest in treatment 2. This is also the case when the ratio is calculated on the basis of feed only. But when the cost of water is included, all treatments run at a loss.

DISCUSSION

As the feeds were iso-nitrogenous, the source of differences between them and their effect on growth and proximate composition could be due to the ingredients from which they are composed, especially the source of protein, and the percentage of animal protein (fishmeal) incorporated in the feeds. There was lower final protein content in comparison with the initial in all treatments. The fish were fed to satiation, prior to the commencement of the experiment, with the higher-ranked feed of treatment 1. Reduced feeding rate during the experiment may have been low enough to induce protein but not fat loss. The change of feed when feeding commenced may have increased this effect in treatments 2 and 3. The fish samples taken for analysis were not homogenized with respect to sex composition. According to Rubbi *et al* (1985), there are sex-based differences in proximate composition of fish flesh. Protein levels were higher in juvenile fish than in adults, while fat levels were lower in juveniles than in adults. Despite the identical feed crude protein levels, protein content of flesh and PER of fish in treatment 2 was higher than in treatment 1, but not significantly. This indicates that the protein in treatment 2 may have been more digestible and utilizable than is the case in treatment 1. According to De Silva and Anderson (1995) PER is a measure of the extent of the protein sources in a diet to provide the essential amino acid requirements of the fish fed. On the other hand, treatment 3 was compounded with soybeans and blood meal as the protein source. The low methionine content of soybeans is well known. This is compounded by its relative low digestibility, which is exacerbated by the local, on-farm processing methods which includes not removing the testa. The relative low performance of the fishes fed treatment 3 diets, maybe as a result of the feed itself. Being low in some essential amino acids (Eyo, 2001), 25% (Otubusin, 1987) and 50% (Eyo, 1991) inclusion levels of blood meal in diets for *Oreochromis niloticus* and *Clarias anguillaris* respectively, resulted in reduced growth rate for both species. Olatunde and Eyo (2000) found a combination of high levels of bloodmeal and soybeans to cause a low growth in fish, due to leucine toxicity to fish (Tacon, 1992).

The most expensive cost item across treatments was water, followed distantly by feed and fingerling costs. Water cost is often an ignored but important cost component in aquaculture. In this study, water was very expensive, accounting for a huge proportion of total cost, drastically reducing profit. This cost item therefore needs to be adequately exposed to analysis *ab initio*, in order to properly guide prospective investors. The market price used to calculate revenue is at the upper part of the range of prices for the species. The treatments therefore cannot absorb any more increases in price. The cost of these items therefore needs to be reduced to accommodate other items that will be included in a total budget to enable complete analysis of the system. The report of the effect of inordinately high feed cost has been made by Jantrarotai *et al*. (1993), Ahmed (2007) and Ofor (2007), who suggested a target selling price of 30 Naira per kilogram of fish feed. Similarly, the relatively high cost of fingerlings has been mentioned by Omondi *et al.* (2001), Moehl *et al.* (2005) and Ofor (2007) who suggested a sale price of 10.00 Naira per catfish fingerling for profitable culture. Azim *et al*. (2002) by contrast, obtained lower cost ratios of fingerlings for a 3 species polyculture of carp.

The impression of the economic and biological performance of the feeds is at variance with findings in this study. The higher price of fish in treatment 1was not matched by higher biological and economic yields. For this reason, there is a need for a commercial fish feed advisory, to enable farmers make an informed choice of feed. EWG is the total financial cost of ingredients eaten per unit weight gained. Ingredients of minimum EWG will yield the most economical feed and vice-versa. It therefore follows that diet 2 is most economical and diet 3 the most uneconomical. Madu and Akilo (2001) reported a low EWG when artificial diets were fed to *C. anguillaris.* Despite the high cost:benefit and EWG, treatment 3 had the least feed cost, indicating a high potential. If properly processed, the potential may be realized, and combination feeding with commercial feed and farm-made feeds may be recommended as a culture practice. Such a mixed feeding practice will have higher profitability than either commercial or farm-made feed because it will be productive (attribute of treatments 1 and 2) and incur less feed cost (attribute of treatment 3).

CONCLUSION

The range of values for the parameters of water quality in the various treatments fell within the range recommended by Boyd and Tucker (1998) for warm water fishes. Water quality was affected more by length of time from last change than by feed type. This points to the fact that farm-made feeds can be processed to attain sufficient water stability to minimize pollution via this route. Though exhibiting progressive deterioration with time of culture, even on the third day, the water quality parameters were still within recommended range for fish culture. This should serve as a guide to indoor fish culture practitioners, where water is changed at intervals. Especially in urban and peri-urban areas, where water is expensive, as shown in this study, water should be changed in accordance with the practice in this study, to reduce its cost.

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