Effect of Different Feeding Levels on The Production of *Heterobranchus longifilis* Raised in Indoor Aquarium Tanks

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***ABSTRACT*:** As the culture of *Heterobranchus longifilis* becomes more intensive, there is need to determine the optimum feeding level for its production as sufficient consumption of feed is essential for increased yield and profitability. This research therefore aimed at determining the effect of different feeding levels on the production of *H. longifilis* with the views to establishing the best feeding level. Ninety (10 per tank) *H. longifilis* (10.65 ± 0.23 g) were fed at four feeding levels (5%, 15%, 25% and 35% fresh body weight) with Coppen for 56 days and designated as A1, A2, A3 and A4 respectively. These were replicated thrice. Fish growth parameters measured showed that fish fed 5% of their fresh body weight had best result in weight gain (8.61 ± 0.11), specific growth rate (SGR) (1.35 ± 0.23) and mean growth rate (MGR) (10.61 ± 0.1) and these were significantly different ($P<0.05$) from fish fed at other feeding levels. Food utilization indices also favoured fish fed at 5% of their body weight. Feed conversion ratio (FCR) (0.32 ± 0.01) and feed conversion efficiency (FCE) (359.01 ± 53.35) were also better in A1. *Heterobranchus longifilis* is commonly produced in Nigeria because of its fast growth rate and profitability. Efficient production and growth depend on feeding the best possible diets at levels not exceeding 5% fresh body weight.

***Keywords* – Overfeeding, starvation, optimum, nutrient, profitability, yield.**

INTRODUCTION

Admittedly, fish landings globally are declining steadily and prices of animal proteins are rising, accompanied by a rise of living standard. Worldwide aquaculture has gained importance due to an increasing demand for fish to feed the worlds increasing human population. In Nigeria for example, population increase at the rate of 3.2 percent and stands at over 170 million (NPC, 2011) which leads to a rising demand for protein. Unfortunately, food production is not commensurable to increase in world population. This has resulted in food crisis which necessitates urgent need for increase food production within the nation.

The growth of aquaculture in Nigeria now is largely being boosted by a steady rise in catfish culture. *Heterobranchus longifilis* is an economically important food fish cultured primarily in fresh water ponds in tropical countries. It exhibits many qualities which makes it suitable for commercial culture. These include hardiness, high disease resistance, rapid growth, high yield potential, high fecundity, air breathing characteristics and good market potential (Madu and Olurebi, 1987; Ofor, 2011). *Heterobranchus longifilis* is highly priced in Nigeria along with other African catfish species due to good taste and flavor.

The Nigerian fish farmers have not been able to meet the populace demand for this species due to high cost of feeding. Fish feed account for about 70% of aquaculture operation (FAO, 1983). Thus, overfeeding would deteriorate water quality (leaching of nutrient). This poor water quality will increase disease susceptibility. It could also increase the need for water changes which will in turn stress the fish. On the other hand, underfeeding may suppress growth as a result of starvation (Seenappa and Deveraj, 1991).

As the culture of *H. longifilis* becomes more intensive there is need to determine the best feeding level of *H. longifilis* as sufficient consumption of feed is essential for increased yield and profitability. Feeding at the optimum feeding level can result in tremendous savings in feed cost. There exist conflicting views in the literature. Some suggests 1% FBW (Ofor and Afia, 2015), others 1% (Davies, 2006), and many 5%. There is therefore the need to also check higher feeding levels. This research therefore aimed at determining the effect of higher feeding levels on the production of *H. longifilis* raised in in-door aquaria in order to establish the best feeding level for this important fish species.

MATERIALS AND METHODS

Description of The Study Location (Cross River State, Nigeria)

The study location for this research work is the Institute of Oceanography fish in the University of Calabar, Calabar, Cross River State of Nigeria. It is located at latitude $40^{0}55'$N and Longitude $08^{o}26'$E along the coastal plain of Nigeria bordering the Gulf of Guinea which is 2 km above sea level. The climate of the study area is characterized by a long period of wet season from April to

October and a dry season from November to March. A short period of drought (no rain) occurs in the wet season around August/September which is known as August break. Mean annual rainfall is about 700 m (Akpan and Ofem, 1993). There is usually an harmattan season (could dry dusty period) between December and January. Temperature ranges, generally, between 22º in the wet season and 35ºC in dry season. Relative humidity is generally above 60% at all seasons with values close to 90% during the wet season. The study area's vegetation is a rainforest close to the mangrove belt. The mangrove species that are found in the study area include *Rhizophora racennia Auinniannia africana*, *Laguncularia racemosa* and *Nypa friutcans*. The human activities in this area include farming, hunting, fishing, boat building and sand mining (Holzlohner, *et al*., 1998).

Experimental Design

The setup took the form of completely randomized design (CRD). The experiment which lasted for 8 weeks was carried out in the University of Calabar Hatchery complex, Calabar. Twelve glass aquarium tanks (97x55x30 cm^3) were used for this experiment. These were grouped into four treatments with three replicates. Fish in Treatments 1, 2, 3, 4 were fed 5, 15, 25 and 35% fresh body weight and were designated A1, A2, A3 and A4 respectively. Each experimental unit was filled with water up to a height of 25 cm, which was maintained throughout the experimental period. Prior to starting the experiment, the mean initial length and weight of fish were taken using a meter rule. Thereafter, it was measured fortnightly (every 2 weeks). Also, the fingerlings stocked in each aquarium were weighed using an electronic weighing balance before starting the experiment. The fingerlings were weighed every two weeks (i.e. fortnightly).

Source of Fingerlings

The experimental fish for the research work (*H. longifilis*) was obtained from the hatchery unit of the African Regional Aquaculture Centre (ARAC), Aluu, Port Harcourt and was transported in a 20 litres rubber container with water and an opening on the topmost part for oxygen to penetrate. These were brought to the experimental site with no transport mortality incurred. They were then acclimated for two weeks in the hatchery unit of the fish farm. During this period the fish were fed *ad libitum* (as we chose) with diet of 45 percent crude protein.

Tank Preparation, Stocking and Feeding

Prior to stocking, the tanks were washed and dried. Water was supplied from the bore-hole through tap by the hose. Each aquarium tank was stocked with ten post fingerlings (10.95±0.25 g) each. Fish were fed twice a day at 8.00 and 20.00 hours for 8 weeks. Sampling was done fortnightly using hand net. The feeding rate was adjusted accordingly during each sampling date. Commercial floating diet containing 40% crude protein formulated and prepared by ARAC was used.

Measurement of Physico-Chemical Parameters

Physico-chemical parameters were recorded weekly, where there was fluctuation, 10% of the cultured water was replaced with fresh water from the reserviour. Dissolved oxygen concentration (DO), water temperature and pH were measured in situ in each pond using a calibrated JENWAY 3405 electrochemical analyser (Barloword Scientific Ltd, Essex, UK), with independent probes for each variable. Portions of the water samples were filtered through a Glass microfiber GF/C 2-micron filter paper and a Technicon II Autoanalyzer was used to determine total ammonia using spectrophotometric methods described by Golterman (1978) for total ammonia. The analyses were carried out at Soil Science Labouratory, University of Calabar-Nigeria following the standard analytical procedures detailed in APHA (1998).

Sampling and Data Collection

Data on fish growth were recorded weekly. The weight of fish was taken using electronic sensitive weighing balance (Model JY10S-01, China). The experimental tanks were inspected daily to remove dead fish, if any. Fish daily weight gain, feed conversion ratio, specific growth rate and survival were determined as follows:

Daily Weight Gain

Daily weight gain (g) is calculated as the difference between the initial and final mean weight values of the fish divided to the number of days the experiment was conducted.

$$DWG = FE\text{-}IW/N$$

Where:

DWG= daily weight gain

FW=final weight of fish

IW=Initial weight of fish

N=number of days the fish were culture

Specific Growth Rate (SGR)

Specific Growth Rate (SGR) was calculated according to Hepher (1990), using the formula:

$$SGR = \frac{(\text{In FBW} - \text{In IBW}) \times 100)}{\text{No. of days}}$$

Where;

FBW =Final Body Weight at each harvest,

IBW=Initial Body Weight

In=Natural logarithm

Feed Conversion Ratio (FCR)

This was calculated by dividing the total amount of feed given (feed intake) by the mean weight gain (MWG). The calculation was based on total dry weight of feed (Hepher, 1990) using the formula:

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

Feed conversion Efficiency (FCR)

This was calculated by dividing the mean weight gain (MWG) by the total protein intake (Halver, 1972,) and multiplying by 100.

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) test and the means from the various treatments were compared for significant differences (P<0.05), by means of (SPSS, 2016). Results with P ≤ 0.05 were considered significant. Where there was significant difference, *post hoc* test was conducted using Duncan Multiple Range Test (DMRT).

RESULTS

Effect of feeding level on the Physicochemical Parameters

The physico-chemical parameters of the cultured water are presented in Table 1. There was no significant difference (p<0.05) among the different treatments in the temperature, DO, pH and total ammonia nitrogen.

Table 1. Physico-chemical parameters of tank water during the 8 weeks culture period

Parameter	A1	A2	A3	A4
Temperature	30.05 ± 0.94^a	29.70 ± 0.54^a	28.85 ± 1.44^a	28.00 ± 1.24^a
Dissolved oxygen	4.2 ± 0.49^a	3.7 ± 0.24^a	3.4 ± 0.02^a	2.5 ± 0.10^a
pH	6.63 ± 1.25^a	6.54 ± 1.21^a	6.14 ± 0.22^a	6.45 ± 1.02^a
Ammonia-nitrogen	0.05 ± 0.01^a	0.07 ± 0.01^a	0.08 ± 0.01^a	0.10 ± 0.01^a

Values are mean±SD from three replicates. Mean with the same superscript letter are not significantly different (P<0.05). A_1, A_2, A_3 and A_4 =treatment 1, 2, 3, 4 respectively.

Effect of Feeding Levels on Growth Performance of *Heterobranchus longifilis*

The fortnightly weight of *H. longifilis* post-fingerlings over eight weeks and growth response are shown in Fig. 1 and Table 2 respectively. Generally, the best response was observed when fingerlings were fed 5% fresh body weight (FBW) while the worst response was observed in fingerlings fed 36% FBW. On the whole, there was no significant difference (P>0.05) among the treatments in terms of final weight and SGR. Daily weight gain was however significantly higher (P<0.05) in A1 and A2.

Effect of different feding levels on Feed Utilization of Heterobranchus longifilis

Treatment A1 has the best feed conversion ratio and feed conversion efficiency (Table 2). Diet A4 had significantly lower (P<0.05) FCR than other diets. In this study feeding levels improved the feed utilization parameters. Both feed conversion ratio and protein efficiency ratio were improved in treatments A1 and A2.

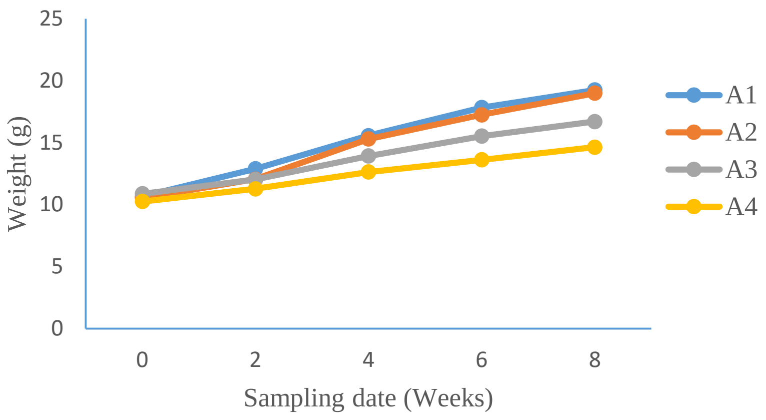

Fig. 1: Growth trend of *Heterobranchus longifilis* during the 8 weeks culture

Effect of Feeding Levels on Feed intake of *Heterobranchus longifilis*

Feed consumed during the 8 weeks study is shown in Figure 2. The trend is a reverse of the growth performance. Highest feed intake was noticed in A4 which the least was recorded in A1.

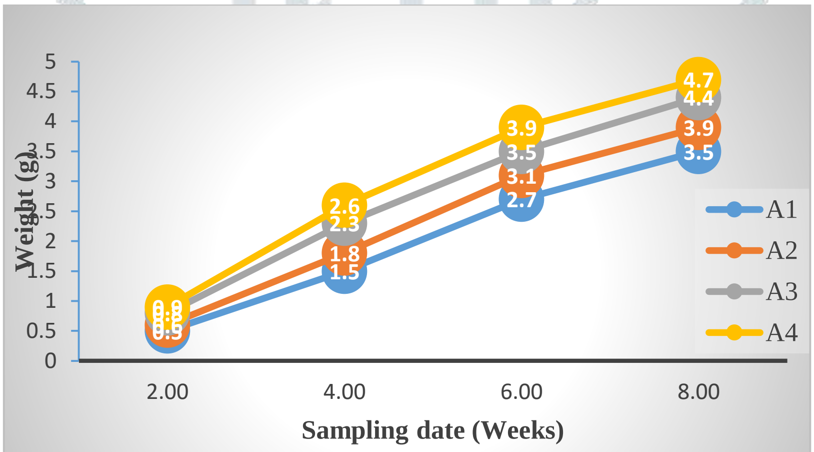

Fig. 2. Feed consumption by *Heterobranchus longifilis* during the 8 weeks culture

Table 2. Growth performance and feed utilization of *H. longifilis* fed different feeding levels for 8 weeks

	Treatments			
Parameters	A1	A2	A3	A4
Growth performance				
Initial weight (g)	10.65±0.14^{a}	10.54±0.12^{a}	10.87±0.09^{a}	10.25±0.10^{a}
Final weight (g)	19.25±92.4^{a}	18.99±1.10^{a}	16.71±4.16^{a}	14.64±3.37^{a}
Weight gain (g)	8.61±0.11^{a}	8.45±0.35^{a}	5.84±0.43^{b}	4.39±0.10^{b}
Growth rate	0.16±0.00^{a}	0.15±0.01^{a}	0.10±0.01^{a}	0.08 ±0.00^{a}
Specific growth rate	1.35±0.23^{a}	1.05±0.05^{a}	0.77±0.06^{a}	0.64 ± 0.01^{a}
Mean growth rate	10.61 ± 0.17^{a}	10.20 ± 0.46^{a}	7.510 ± 0.51^{a}	6.299 ± 0.007^{a}
Initial length (cm)	4.09 ± 0.04^{a}	4.12 ± 0.02$_{a}$	4.53 ± 0.47^{a}	4.03 ± 0.3^{a}
Final length (cm)	9.22 ± 0.10^{a}	9.06 ± 0.03^{a}	8.07 ± 0.05^{a}	7.47± 0.40^{a}
Length gain (cm)	5.13 ± 0.06^{a}	4.94 ± 0.01^{a}	3.52 ± 0.43^{a}	3. 44 ± 0.37^{a}
Feed utilization				
Feed conversion ratio	0.32 ± 0.01^{a}	0.97±0.01^{ab}	2.26 ± 0.17^{b}	3.82 ± 0.05^{c}
Feed conversion efficiency	359.01 ± 53.35^{a}	102.91 ± 3.97^{a}	44.56 ± 3.38^{bc}	26.25 ± 0.25^{c}

Values are mean±SD from three replicates. Mean with the same superscript letter are not significantly different ($P<0.05$). A1, A2, A3 and A4 = treatment 1, 2, 3, 4 respectively.

DISCUSSION

The range of physicochemical parameter during the experimental period fall between the acceptable range for fish growth and health (Boyd, 1979; Viveen *et al*., 1986; Gabriel *et al.*, 2000). Physiochemical parameter during the experimental period in Aquarium A in which fish were fed 5% body weight was better than in other aquaria. This could be attributed to the fact that less feed was introduced into Aquarium A1 while leftover feed caused degradation of the water. These variations in physiochemical parameter could be attributed to metabolism of fish in the tank or/and bacteria decomposing organic material like waste feed or underutilized feed.

Efficient aquaculture requires proper feeding for optimum fish production. Underfeeding in any case results in loss of production while overfeeding causes wastage of expensive feed and is additionally a potential cause of water pollution, a condition resulting in loss of animals or requiring expensive corrective measures. Thus, both overfeeding and underfeeding have serious economic consequences which affect the viability of the farm. In order to avoid this situation, the quantity of feed to be given to a pond or cage each day should normally be based on a percentage of the biomass present (total weight of animals). Studies conducted on other fish species have shown that feed consumption and growth generally increased with feeding level up to a given limit (Wang *et al*., 1998; Bascinar *et al*., 2007) although this increase may not correspond always with the incremental feed consumption. Weight gain continuous increase with increasing feeding rate has been recorded in white sturgeon, *Acipenser transmontanus* (Deng *et al*., 2003); European sea bass, *Dicentrarchus labrax* (Eroldogan *et al.*, 2004); olive flounder, *Paralichthys olivaceus* (Cho *et al*., 2007), blackspot seabream, *Pagellus bogaraveo* (Ozorio *et al*., 2009) and juvenile Korean rockfish, *Sebastes schlegeli* (Mizanur *et al*., 2013). In this study, feeding levels above 5% FBW was chosen to investigate whether such high levels could actually result in improved biological and morphological performance. Results shows that growth parameters continuously decrease with increasing feeding levels which resulted in much wastage and water pollution.

In this study final weight decreased with increasing feeding levels above 5% fresh body weight (FBW). In fish culture practices, studies on the amount and rate of feeding are aimed at identifying the optimum level. Increased feed digestibility and increased water quality are the benefits of using the best feeding level. About 5% FBW has been found to be sufficient for maximum growth of a number of different fish species, example Chinese sucker, *Myxocyprinus asiaticus* (Yuan *et al*., 2008), African catfish, *Clarias gariepinus* (Ashley-dejo, *et al*., 2014), African mudfish, *H. longifilis* (Davies *et al*, 2006; Ibiyo Lenient, *et al.*, 2008; Imgbian and Zarmai, 2010; Udo and John, 2015). However, Ofor and Afia (2015) posited that with appropriate stocking density, 1% FBW can be sufficient for Heteroclarias.

Mean weight gain, specific growth rate, length increment and other parameters also decreased with increasing levels above 5% FBW. The highest mean weight gain, specific growth rate and length gain recorded in this experiment for fish fed 5% FBW were not in agreement with those reported for *H. longifilis* fed 3% FBW twice daily (Davis *et al*, 2006). This shows that this rate is appropriate for the feeding of this fish species. The better growth performance obtained in fish fed 5% FBW could be attributed to better utilization of dietary protein for growth rather than for energy metabolism. This could also be attributed to high nutrient content of the feed, with a high protein (45%) value (Hillman and Cully, 1978; Falaye, 1992).

In the present study feed conversion ratio and feed efficiency ratio were better in A1, and decreased with increasing feeding rate above the optimum level. It shows that this feeding level/frequency is optimal for the condition of this trial, suggesting that both growth and feed utilization are most efficient at this level of feeding. This agrees with Ashley-dejo, *et al*., (2014) who concluded that fish could be fed 5% FBW twice a day with maximum growth and profit. Feed consumption and growth rates appeared to be optimum in treatment A1. Further increase in feeding level did not result in significant improvement of these parameters. Feeding level/frequency had a significant effect on feed consumption and growth of *H. longifilis*. This supports the hypothesis that optimum rate of feeding yields fish of more uniform sizes (Bascinar *et al*., 2001); this could arise because dominant individuals are less aggressive under such circumstances, or because more food is distributed to locations occupied by subordinates. Ibidem stresses the need to determine different feeding frequency for each species and different sizes of the same species, under varying culture condition. Feeding 5% FBW per day for a dry feed throughout the growing cycle would almost certainly result in near starvation in the early stages and gross overfeeding and water quality problems later. Feeding rates should not stay steady throughout the whole of the growing cycle to market size. They must be modified according to the size and age of the fish, and to the water conditions. This explains the reason for the shortness of the experimental duration.

CONCLUSION

Results of this research show that fish fed at optimum rate (5% FBW) and consumed more feed, utilized that feed as efficiently whereas fish fed higher rate and that food consumption and not food conversion efficiency was the growth-limiting factor. The ability of an organism to utilize nutrients especially protein will positively influence its growth rate. This is justified by the highest FER and low FCR in treatments fed 5% body weight. This suggested that fish must have efficiently converted feed consumed to growth. *Heterobranchus longifilis* is commonly produced in Nigeria because of its fast growth rate and profitability. Efficient production and growth depend on feeding the best possible diets at levels not exceeding the dietary needs.

ACKNOWLEDGMENT

The contribution of the staff of institute of Oceanography and Department of Zoology and Environmental Biology University of Calabar are greatly acknowledged.

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