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Full Length Research Paper

Effects of feeding levels on growth performance, feed utilization and body composition of African catfish (*Clarias gariepinus,* Burchell 1822)

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Effect of feeding levels on growth performance, feed utilization and economic viability of *Clarias gariepinus* fingerlings was studied under natural photoperiods of 12/12 h light/dark cycle using a complete random design. Triplicate group of 10 fish with average initial mean weight of 3.5 ± 0.3 g per tank (measuring 1 m × 1 m × 1 m) was formed. A commercial feed (Coppens®, Holland) with crude protein of 42% was fed for 12 weeks over five feeding levels studied (3, 4, 5, 6 and 7%). Mean weight gain was all significantly different (P < 0.05) across feeding levels except at T2 and T4. T3, 3.80±0.01, has the highest specific growth in the feeding trials. Feed conversion ratio was increasing from T1 - T5. Although net profit value was not significantly different, the investment cost analysis and the gross profit between fish fed with 4 and 5% body weight were equally not significantly (P > 0.05) different. The results of this experiment indicate that fish could be fed 5% body weight twice a day with maximum growth and profit.

Key words: Feeding rate, feed utilization, growth, *Clarias gariepinus.*

INTRODUCTION

Fish makes a vital contribution to the survival and health of a significant portion of the world's population. Fish is especially important in the nutrition of the developing world. In some part of the world, people derive as much as 75% of their daily protein from fish. The growing need for fish supply and increase awareness of aquaculture in Nigeria has led to remarkable investment in aquaculture in recent years. However, the growing population in the country posed a challenge, which requires more investment to fill in the supply gap of 1.6 million metric tons (Fishnetwork, 2009). Fish is still the cheapest and most available source of animal protein in Nigeria, though the high cost of fish today is attributed to low supply caused by low productivity from the water bodies that are already over-exploited due to reckless fishing methods (Adesulu, 2004). Therefore, research cannot but continues on how to salvage fishing pressure on our water bodies. A better alternative is to ensure availability of fast growing fish seeds for people in the area for aquaculture. Fish like any other valuable natural resources require good management. *Clarias gariepinus* (Burchell, 1822) is a highly valued commercial fish widely cultured in Nigeria and has been cultured at subsistence level from fingerlings sourced from the wild (Sydenham, 1997). The development of a reliable method for the production of *C. gariepinus* fingerlings was one of the priorities of aquaculture research in Africa and the success in intensive fingerling production today is based on such works. Feeding of the larvae, fry and fingerlings

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of the catfish have been mostly studied and may influence growth and survival of the fish. Good nutrition in animal production systems is essential to economically produce a healthy and high quality product. In fish farming, nutrition is critical because feed represents 40-50% of the production costs. Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health. Feeding rate is one important consideration as it can affect growth, survival and fillet composition as well as water quality. Feeding also at the optimum rate can result in tremendous savings in feed cost (Davies et al., 2006).

The amount of the daily feed intake and presentation of the predetermined ration are the key factors of feed management strategies, influencing the growth and feed conversion (Jobling, 1995; Goddard, 1995). Optimal feeding frequency may vary depending on species, age, size, environmental factors, husbandry and feed quality (Goddard, 1995). The objectives of this study are:

(a) To determine the optimum and maintenance feeding level and the effects of feeding rate on growth performance, feed utilization and body composition of nutrients for fingerlings of *C. gariepinus* over a range of 3 to 4.0% body weight (bw) day-^{1}.
b. To establish the effect of feeding levels on the economy of fingerlings production of *C. gariepinus.*

MATERIALS AND METHODS

Experimental fish, diet and husbandry conditions

This experiment was carried out in the University of Agriculture, Abeokuta, Ogun State, Nigeria. African catfish *C. gariepinus* fingerlings (with average weight of 3.5 ± 0.3 g) were obtained from a local hatchery in Odeda Local Government Area of Ogun State, Nigeria and transported to the experimental unit in aerated polyethylene bags. Fish were acclimatized to laboratory conditions for two weeks in 2,500 L capacity tank fitted to a flow through system and fed a maintenance diet containing 42% crude protein and 12% lipid for 2 weeks. After this period, each fish was randomly distributed to partitioned concrete tanks of 1 m × 1 m × 1 m. The tank was filled up to about 2/3 of its volume with water supplied from a bore hole. Trial conditions included ten fish per tank and five feeding frequencies, with each feeding level being experimentally tested in triplicate. Fish were kept under natural photoperiod of approximately 12/12 h light/dark cycle and fed a popular commercial catfish feed (Coppens®, Holland). The fish were fed at 3, 4, 5, 6, and 7% body weight per treatment at 10:00am and 6:00pm for 12 weeks.

The treatments were designated T1, T2, T3, T4 and T5 respectively based on the feeding level. Fish tanks were cleaned daily by siphoning out residual feed and faecal matter, though the water in the tanks were changed twice weekly and feed consumption was monitored weekly. Water quality parameters (temperature, dissolved oxygen and pH) were monitored twice weekly; temperature with Mercury-in-glass thermometer calibrated in degree centigrade (°C), dissolved oxygen (DO) was determined by using the Winkler's solution and pH was determined with a pH meter, to ensure they were within tolerant limits expected for the studied species. During the experiment, water temperature, pH and dissolved oxygen (DO) were within 26 - 29°C, 5.4 - 8.0 and 4.5 - 4.8 mg l-1 respectively, and were controlled through the source of water supplied and regular water changing.

All fish were weighed individually at the beginning and end of the experiment while batch weighing per tank using electronic sensitive scale model AJ5303 (capacity 6000 g; readability 0.2 g) was performed weekly to monitor growth performance.

Economic analysis

The economic analysis was performed to estimate the cost of feed required to raise a kilogram of fish fed the popular commercial feed while being cultured under controlled conditions. The cost of feed and fish were the only economic criteria under consideration in this case and were based on the current market cost of the commercial feed and market value of a kilogram of fresh fish in Nigeria at the time of the experiment.

The economic evaluations were calculated based on the method of New (1989) as follows:

Estimated investment cost analysis = Cost of feeding (N) + Cost of fingerling stocked (N).
Profit index = Value of fish (N)/ Cost of feed (N).
Net profit = Sales – Expenditure.

Calculations and statistical analysis

The following formula were applied to the data:

Specific growth rate (SGR %/day) = $[(\ln Wf - \ln Wi)/T] \times 100$.
Feed conversion ratio (FCR) = total feed intake (g)/total wet weight gain (g).
Where *Wf* refers to the mean final weight, *Wi* is the mean initial weight of fish and *T* is the feeding trial period in days.
Protein Efficiency Ratio (PER) = wet weight gain (g)/total protein intake.

Statistical analysis

The data collected were analysed using one way analysis of variance (ANOVA). Duncan's Multiple Range Test was used to compare the mean differences, which were deemed significant at $P < 0.05$.

Table 1. Growth and feed utilization parameters of *Clarias gariepinus* fed with different % body weight.

Treatment	T1 (3%)	T2 (4%)	T3 (5%)	T4 (6%)	T5 (7%)
Initial weight (g)	3.40±0.04	3.10±0.03	3.30±0.03	2.90±0.03	3.13±0.02
Final weight (g)	56.23±3.21[c]	63.64±2.91[b]	79.83±3.38[a]	65.07±3.10[b]	51.61±2.15[d]
Weight gain (g)	52.83±1.28[c]	60.54±0.58[b]	76.53±0.37[a]	62.17±2.42[b]	48.48±2.23[d]
Specific growth rate	3.34±0.03[c]	3.60±0.02[b]	3.80±0.01[a]	3.69±0.07[b]	3.34±0.05[c]
Feed intake (g)	57.30±0.01[c]	71.06±0.02[b]	87.51±0.02[b]	93.97±0.01[a]	101.7±0.02[a]
Protein intake	24.06	29.84	36.75	39.46	42.71
Feed conversion ratio	1.08±0.06[c]	1.17±0.06[c]	1.14±0.01[c]	1.51±0.04[b]	2.09±0.03[a]
Protein efficiency ratio	2.19±0.05[a]	2.06±0.04[b]	2.08±0.04[b]	1.58±0.03[c]	1.14±0.02[c]
Survival (%)	93.33±6.67[a]	90.00±5.77[b]	93.33±6.67[a]	90.00±5.77[b]	86.67±3.33[c]
Net profit value (N/Kg)	18.21[a]	18.10[a]	18.29[a]	18.08[a]	18.39[a]
Investment cost analysis (N)	86.34[c]	90.21[b]	93.14[a]	90.01[b]	84.13[c]
Gross profit (N)	66.62[c]	69.0[ab]	71.07[a]	69.4[ab]	62.43[d]

Source: Field survey (2011).
Mean values (mean ± standard error) in the same row with different superscript are significantly different (p<0.05).

Table 2. Water quality parameters.

Treatment	Temp (°C)	pH	TDS (ppt)	Conductivity (m/S)	DO (mg/l)
T1 (3%)	26.7±1.00	7.44±0.14	1.71±0.11	2.93±0.32	7.44±0.11
T2 (4%)	27.0±0.26	7.56±0.17	1.86±0.15	2.71±0.09	7.63±0.03
T3 (5%)	28.0±0.25	7.07±0.11	2.02±0.26	2.65±0.17	7.92±0.07
T4 (6%)	26.9±0.28	6.91±0.18	2.01±0.21	2.29±0.32	7.90±0.04
T5 (7%)	27.10±0.27	7.10±0.12	2.02±0.13	2.72±0.361	7.81±0.03

Source: Field survey (2011).

RESULTS

Entries in Table 1 showed the weekly average weight of the experimental fish. The initial mean weight of the fingerlings used was not significantly different for each respective group. The weekly mean weight ranged from 3.40±0.04 - 56.23±3.21 g, 3.10±0.03 - 63.64±2.91 g, 3.30±0.03 - 79.83±3.38 g, 2.90±0.03 - 65.07±3.10 g, and 3.13±0.02 - 51.61±2.15 g for treatment T1, T2, T3, T4 and T5 respectively. The highest mean weight, 79.83±3.38 g, was observed in T1 while T5 has the least weight of 51.61±2.15 g. Table 1 also showed the Analysis of Variance and Duncan Multiple Range Test. Analysis of variance indicated a significant difference with T3 (5%) superior to others (p<0.05). The final body weight varied from 51.61±2.15 in treatment 5 to 79.83±3.38 in T3. The varying effect of percentage body weight had significant effect (p<0.05) on the weight gain of the experimental fish with T3 being significantly higher than others. The growth responses are shown in Table 1 and graphically in Figure 1. T3 has the highest mean weight gain of 76.53±0.37 g followed by T2 with 60.54±0.58 g, while T5 has the least value of 48.48±2.23 g. Treatment 1 was significantly higher (p<0.05) than others in response to weight gain. T3 has the highest specific growth rate of 3.80±0.01 while T1 and T5 have the least specific growth rate of 3.34±0.03. The food conversion ratio (FCR) varied from 1.08±0.06 in T1 to 2.09±0.03 in T5. The varying level of different percent body weight has significant effect on the food conversion ratio with T1 being lowest followed by T3. Economic parameters like investment cost analysis and gross profit varied significantly with levels of feeding.

Water quality parameters

Water qualitative parameters in each partition during the experimental period are presented in Table 2. The values observed were within the tolerable range of *C. gariepinus* conductivity which ranged from 2.29 - 2.93, pH was from 6.91 - 7.56, TDS ranged from 1.71 - 2.02, dissolve oxygen (DO) ranged from 7.44 - 7.92, while temperature ranged from 26.7 - 28.0 (°C).

DISCUSSION AND CONCLUSION

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;

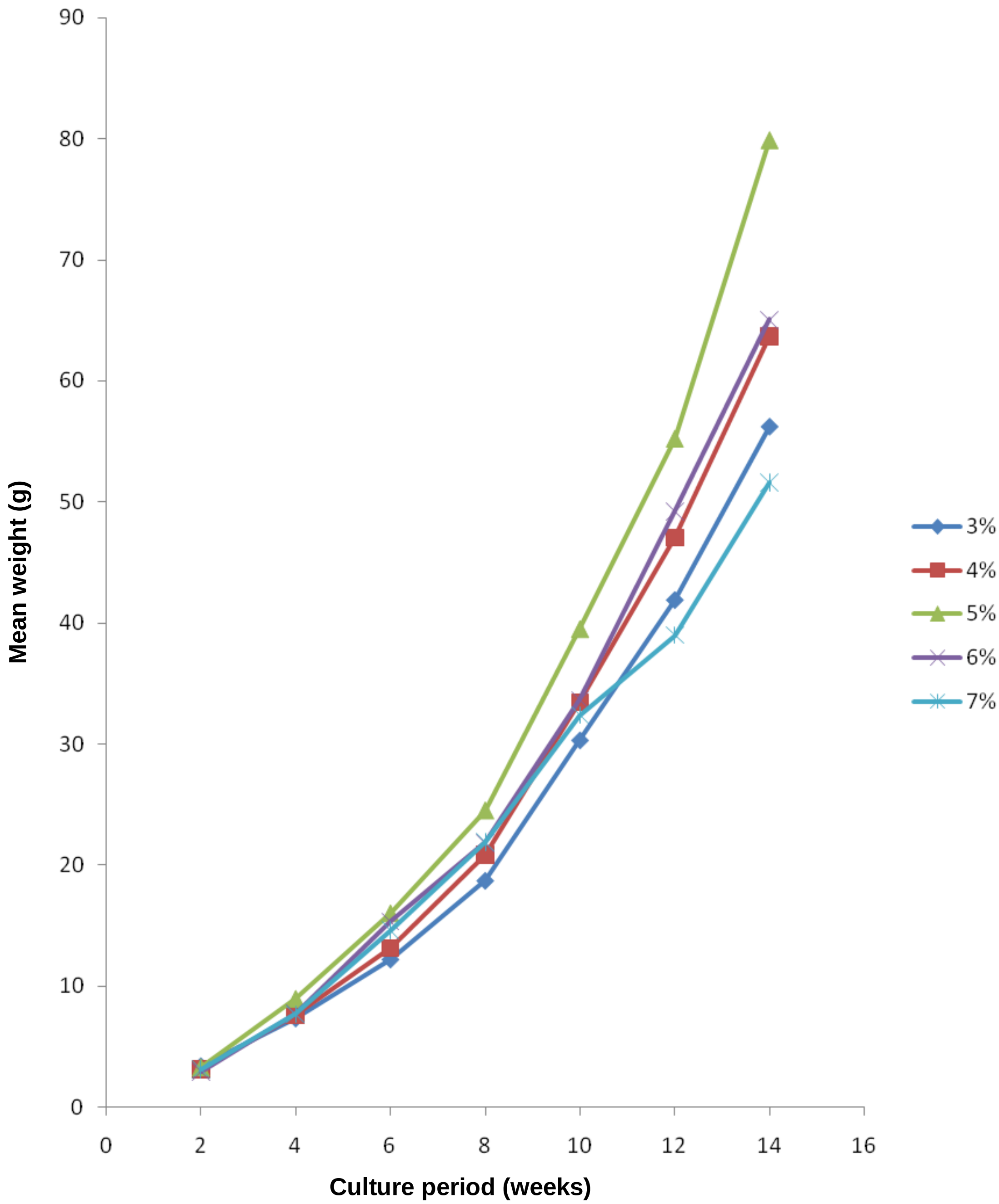

Figure 1. Weight gain of *Clarias gariepinus* fed with different % body weight.

Bascinar et al., 2007). This is in agreement with our findings in this study that feeding level/frequency had a significant effect on feed consumption and growth of *C. gariepinus*. Feed consumption and growth rates appeared to increase with increase in feeding level up to T3, though further increase in feeding level did not result in significant increase. Feed conversion ratio is high at T5 although there is no significant difference between T1, T2 and T3 in terms of food conversion ration. 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 supports the hypothesis that more higher 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. The same author equally stresses the need to determine different feeding frequency for each species and different sizes of the same species, under varying culture condition. The lack of difference in feed conversion rate among the treatments was consistent with the argument that the effect of feeding level on feed conversion is usually small (Hepher, 1988). This indicated that fish which were fed more percent body weight and consumed more food, utilized that food as efficiently as the fish that were fed less body weight and that food consumption and not food conversion efficiency was the growth-limiting factor (Wang et al., 1998). The ability of an organism to utilize nutrients especially protein will positively influence its growth rate (Sogbesan and Ugwumba, 2008). This is justified by the highest PER and low FCR in treatments fed 3% body weight followed by 4 and 5% body weight respectively. This suggested that fish must have efficiently converted feed consumed to growth. *C. gariepinus* is commonly produced in Nigeria because of its fast growth rate and profitability. Efficient production and growth of fish depend on feeding the best possible diets at levels not exceeding the dietary needs (Charles et al., 1984). 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% body weight has been found to be sufficient for maximum growth of a number of different fish species (Yuan et al., 2008). This generally agrees with the result of this study as depicted by the net and gross profit value obtained alongside other parameters already mentioned.

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