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Reproductive Performance, Growth and Economic Evaluation of *Clarias gariepinus* Broodstocks at Different Feeding Levels

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Abstract : Several research works had been carried out to establish the best feeding rates for profit maximization of *Clarias gariepinus* but little is known on the best feeding level. In this study, thirty-six broodstocks of *C. gariepinus* with average weight of 316.66kg were stocked at the rate of 4 broodstocks per tank in triplicate and were fed at 3%, 5% and 7% Body Weight twice daily for 16 weeks with 40% crude protein balanced diet to determine the best feeding level. The lowest mean weight gain of 305.40±4.70(g) and lowest specific growth rate of 0.68±0.02% were recorded in fish fed at 7% body weight while the highest Specific Growth Rate (SGR) of 0.87% and Relative Growth Rate (RGR) of 135.25% were recorded in fish fed at 5% body weight. The Fertility rates differ significantly among the treatment ($p<0.05$) with fish fed at 5% body weight having the highest rate. The number of eggs and survival of hatchlings were highest in fish fed at 5% body weight but those fed at 3% body weight recorded the lowest values. Fish fed at 7% body weight has the highest investment cost analysis but the lowest net production value of 1351.10±0.44 and profit index of 0.21±0.03. There were no significant difference in the profit index of those fed at 3% and 5% body weight of 0.39±0.03 and 0.40±0.02 respectively. This study has shown that high growth and reproductive performance of *C. gariepinus* broodstocks can be achieved at 5% body weight feeding level.

Keywords: specific growth rate (SGR), fertility rate, survival of hatchlings, net production values (NPV), profit index (PI)

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1. Introduction

Catfish (family Claridae) have been the most commonly cultivated fishes in Nigeria due to several attributes like ability to grow fast, tolerate relatively poor water quality [1], and feed on variety of agricultural by-products (they are omnivorous). Their high tolerance to draught and resistance to diseases gave them added advantages. They also have higher price value than tilapia since they can be sold live at the market. The major priority of culturing fish is to meet the increasing demand of the human population, who depend on it as a major means of getting protein. It was reported by reference [2] that fish products are of great significance for food security, providing more than 15 % of total animal protein supplies.

The major problem facing fish culturist is the need to obtain a balance between rapid fish growth and optimum use of the supplied feed [3]. Since fish needs feeds to grow irrespective of the good health, quality or condition of their environment and if this is not adequately supplied, a malnourish condition may occur [4]. This means that nutritionally well-balanced diets with optimal feeding level

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are the main requirements for successful culture operations. Feed management in terms of optimization of feeding rate is essential in culture of marine and freshwater fishes and it has become one of the crucial areas of research in the field of aquaculture. Hence, to reduce excessive expenses, numerous studies have been focused on the feeding rate of fish species [5][6]. However, with all these progress, the best feeding level has not been established for better profit maximization of African catfish broodstocks.

There is also need to establish the effect of feeding level on reproductive performance of catfish broodstocks and the water quality. Knowledge of the effects of broodstock nutrition on egg production and quality is important because good broodstock feeding leads to successful spawning and good growth and health of the progeny [7]. This study was designed to establish the best feeding level for *Clarias gariepinus* broodstocks raised in concrete tanks for profit maximization and good reproductive performance.

2. Materials and methods

2.1. Experimental design

The experiment set-up consisted of nine concrete tanks situated in the indoor hatchery of the Department of Environmental Biology and Fisheries, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria. It was conducted for the period of 16 weeks.

2.2. Experimental fish

Thirty-six broodstocks of *C. gariepinus* of average weight of 317.23 ± 0.54 were stocked in the experimental tanks at 4 broodstocks per tank in triplicate for each treatment. The fish were weighed every two weeks using Hanna-Top Loader Scale (model 2834024) to determine the growth performance.

2.3. Fish feeding and culture

The experimental fish which was in triplicate, were fed twice daily between 8.00-9.00am and 4.00-5.00pm at 3, 5 and 7% body weight respectively throughout the experiment. They were fed with 40% crude protein diet. The diet was formulated using locally available ingredients such as fish meal (24%), soybean (23%), groundnut cake (23%), salt (0.2%), yellow maize (15%), fish premix (0.75%), bone meal (2%) and wheat bran (12%).

The ration was adjusted every two weeks for new mean weights of fish for the various experimental units. Left over feed and feaces in each tank were siphoned out every day with the water being disturbed to increase the aeration level of the water.

2.4. Monitoring of water quality

The dissolved oxygen (mg/L), Temperature (^oC), pH, Conductivity, Salinity and the Total Dissolved Solids (ppm) in each experimental tank were determined every two weeks with Hydrolab Electronic Water Probe Meter (Hanna Hi 98106 Model). Waste water was completely drained and replaced every two weeks.

2.5. Growth rate

For this study, growth was expressed as Weight gain, Relative Growth Rate, Specific Growth Rate and survival rate [8], using the following formulae:

Weight Gain (WG) = $W_i - W_o$

Where W_o = Initial Weight

W_i = Final Weight

Specific Growth Rate (SGR) =

$$\frac{L_nW_i - L_nW_o}{T} \times \frac{100}{1}$$

Where L_n = Natural Log

W_i = Mean Final Weight

W_o = Mean Initial Weight

T = Time Interval (day)

Relative Growth Rate (RGR) =

$$\frac{\text{Weight Gain by fish (g)}}{\text{Initial Body Weight (g)}} \times 100$$

Survival percentage (S) = $\frac{N_i}{N_o} \times 100$

Where N_i = Final number of fish at the end of experiment

N_o = Initial number of fish at the beginning of experiment

2.6. Production cost of the experiment

The economic evaluation in terms of Investment Cost Analysis (ICA), Net Production Value (NPV), Net Profit Value (#), Profit Index (PI), Incidence of Cost (R) and Benefit Cost Ratio (BCR) of *C. gariepinus* of the same stocking densities fed at different feeding levels were determined using the following formulae:

Investment Cost Analysis (ICA) =

Cost of feeding (#) + Cost of broodstocks (#)

Net Production Value (NPV) =

Mean Weight Gain of fish cropped (g) X Total number of survival X Cost per kg (#/kg)

Net Profit Value (#) =

Gross Profit (#) - Investment Cost Analysis

Profit Index (PI) = Net Profit Value (#)

$$\text{Incidence of Cost (R)} = \frac{\text{Cost of feeding (\#)}}{\text{Weight of fish produce (kg)}}$$

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Net Profit Value (\#)}}{\text{Investment Cost Analysis (\#)}}$$

2.7. Reproductive performance

Reference [9] shows that Hatchability rates of eggs can be determined based on the method of percentage of hatched eggs. Normal healthy hatchlings, estimated on percentage basis of dead and deformed hatchlings and gamete qualities in female *C. gariepinus*, was also determined by fecundity.

$$\text{Hatching rate} = \frac{\text{No of hatched eggs}}{\text{Total no of eggs in a batch}} \times 100$$

$$\text{Survival rate (\%)} = \frac{\text{No hatched alive up to larvae}}{\text{Total no of hatchlings}} \times 100$$

Absolute fecundity = Total number of eggs per female broodstock

2.8. Statistical analysis

All the data collected were subjected to Analysis of Variance (ANOVA), Descriptive Statistics and TukeyB test to identify differences among means.

3. Result

3.1. Water quality parameters

The mean temperature of the water ranged between 25.07 and 25.32°C, mean pH values ranged between 6.55 and 6.94 and the dissolved oxygen values of the treatments were between 4.12 and 5.06 mg/L.

3.2. Growth, economic evaluation and reproductive performance

The initial mean weights of all the experimental broodstocks were not significantly different in all the treatment groups. Mean live weight gain of the broodstocks in treatment 3%BW, 5%BW and 7%BW reached 361.57 ± 1.29, 425.33 ± 0.65 and 305.40 ± 4.70 g respectively, at the end of the trial. This translates into an Average Relative Growth Rate (%) of 135.25±0.32, 135.27±0.64 and 95.17±0.57 g respectively for the treatments over the study period (Table 1). Specific Growth Rates (SGR) for 3%BW, 5%BW and 7%BW were 0.78±0.01, 0.87±0.01 and 0.68±0.02 g respectively. The weight of spawned eggs for 3%BW, 5%BW and 7%BW were 49.27±0.80, 98.03±0.80 and 80.73±1.09 g respectively. The hatchability and survival rates were as shown in Table 2.

The Economic evaluation result of this study is presented in Table 3. The lowest profit index, 0.21±0.03, was recorded with fish fed at 7% body weight. The investment cost analyses of this study were significantly different as shown in Table 3

4. Discussion

Careful monitoring of the water quality parameters was necessary in order to maintain conditions within acceptable limit as recommended by [10]. The optimum growth of African catfish requires 28 – 30 ºC, < 5 ppt salinity, < 15 mg/l dissolved oxygen, 6.5 – 9.0 pH, and 50 – 100 mg/l hardness in the rearing water [11]. The values of water parameters for this study are within the acceptable ranges recommended for pisciculture[12]- [14] though, the dissolved oxygen level for fish fed at 7% body weight was very low, this could be as a result of over-feeding which led to pollution thereby, leading to increase in Biochemical Oxygen Demand (BOD) level. This agreed with the report of [15] that over-feeding and waste food disrupt the water quality.

The ability of an organism to utilize nutrients, especially protein, will positively influence its growth rate [16]. Reference [17] reported that the growth rate and weight gain increased progressively with dietary protein level to a maximum at 40% in *Heterobranchus bidorsalis.* Reference [18] also reported high growth in terms of live weight gain and specific growth rate in milkfish (*Chanos chanos*) fry fed at 40% protein level while the report of [19] showed that among the tested diets (23 to 40% protein) in *C. gariepinus* (10 to 12 g), high growth rate was attained when the diet contained 40% protein. In this study the broodstocks that were fed protein content (40%) of the locally made feed at 5% body weight have the highest weight gain at the end of the trial. This may be due to optimum utilization of the feed.

Table 1: Growth Indices and Survival Rates of *Clarias gariepinus* Broodstocks at Different Feeding Levels

Values	3%BW	5%BW	7%BW
Initial weight (g)	316.87±0.40[a]	317.27±0.64[a]	317.57±0.45[a]
Final weight (g)	678.97±0.15[b]	742.03±0.50[c]	619.10±1.05[a]
Weight gain (g)	361.57±1.29[b]	425.33±0.65[c]	305.40±4.70[a]
Initial number of fish	12	12	12
Final number of fish	9	12	9
Survival (%)	75	100	75
Specific Growth Rate (%)	0.78±0.01[b]	0.87±0.01[c]	0.68±0.02[a]
Relative Growth Rate (%)	135.23±0.32[b]	135.27±0.64[b]	95.17±0.57[a]

Means in the same row having different superscripts are significantly different ($p<0.05$), while values in the same row with the same superscript are not significantly different ($p>0.05$).

Table 2: Reproductive Performance of *Clarias gariepinus* Broodstocks at Different Feeding Levels

PARAMETERS	3%BW	5%BW	7%BW
Weight of Fish (g)	678.97±0.15[b]	742.03±0.50[c]	619.10±1.05[a]
Weight of eggs (g)	49.27±0.80[a]	98.03±0.80[c]	80.73±1.09[b]
No of eggs	33966.67±351.19[a]	68900±229.13[c]	56748.49±2.00[b]
Fertilization (%)	78.62±0.37[b]	88.89±0.31[c]	64.94±0.33[a]
Hatching rate (%)	78.86±0.32[a]	75.71±0.67[a]	76.05±0.35[a]
Survival rate (%)	69.65±0.61[a]	79.65±0.45[b]	69.75±0.31[a]

Means in the same row having different superscripts are significantly different ($p<0.05$), while values in the same row with the same superscript are not significantly different ($p>0.05$).

Table 3: Production Economic of *Clarias gariepinus* Broodstocks at Different Feeding Levels

ECONOMIC INDICES	3%BW	5%BW	7%BW
Cost of producing feed(#/kg)	210.00	210.00	210.00
Cost of feeding (#/kg)	3884.97±0.42[a]	6472.50±0.56[b]	9063.00±0.40[c]
Cost of broodstock (#)	1800.00	1800.00	1800.00
Investment Cost Analysis	5883.87±0.32[a]	8473.00±0.46[b]	11061.95±0.28[c]
Net Production Value	1625.00±0.30[b]	2549.97±0.45[c]	1351.10±0.44[a]
Profit Index	0.39±0.03[b]	0.40±0.02[b]	0.21±0.03[a]
Incidence of Cost	1195.05±0.40[a]	1268.73±0.25[b]	3356.08±0.39[c]
Benefit Cost Ratio	0.29±0.04[b]	0.30±0.03[b]	0.11±0.02[a]

Means in the same row having different superscripts are significantly different ($p<0.05$), while values in the same row with the same superscript are not significantly different ($p>0.05$).

With increase in the level of feeding, weight gain and feed intake per week increased. Reference [20] reported that Specific Growth Rate measures growth performance over a long period of time as against the average daily growth which is a daily effect, Specific Growth Rate would therefore be a better parameter to determine which feeding level will be the best for the optimum production of *C. gariepinus* broodstocks. The statistical analysis showed that there were significant differences in the Specific Growth Rate of the treatments. Specific Growth Rate was at best at

5% feeding level. Both feed consumption and growth rates appeared to increase with the increase in the feeding levels; further increases in feeding level above 5% body weight did not result in significant growth of the broodstocks at 7% body weight which could be as a result of stress caused by excess feed in the culture water.

Reference [7] reported that knowledge of the effects of broodstock nutrition on egg production and quality is important because good broodstock feeding leads to successful spawning and good growth and health of progeny. The fish fed at 3% body weight has the lowest weight of spawned eggs which could be due to malnutrition. Reference [4] stated that fish needs feeds to grow irrespective of the good health, quality or condition of their environment and if this is not adequately supplied, a malnourish condition may occur. Also, [21] and [22] reported that nutrition plays a major role in the reproductive performance of fish. Fish fed at 7% body weight has the lowest fertilization rate which suggests lowest quality of spawned eggs which might have resulted from the stress caused by polluted water.

Recently in the increasing popularity of aquaculture, feed constitute one of the highest operating expenditure in intensive practices. Several attempts have been made to reduce the feed cost by increasing the growth performance by employing suitable feeding strategy in order to maximize utilization of supplied nutrients to cultured fish, by mixed feeding schedule of alternating the high and low dietary protein level diet [23]-[25] and optimizing the feeding rate [5][6] and also by incorporating digestive enzymes in the diet [26]. Feeding rate is also influenced by the presence of the nutrients in the feed [27]. In this study, 7% feeding level has the highest Investment Cost Analysis and gave the lowest profit index. This means that the amount of money spent in feeding this fish was higher than the profit derived from it. Those fed at 5% Body Weight produced the highest weight gain, the highest survival and gave the best cost benefit and efficient production and growth of fish has been reported to depend on feeding the best possible diets at levels not exceeding the dietary needs [28].

5. Conclusion and recommendation

Although, fish fed at 3% body weight and 5% body weight were not significantly different in their Profit Index for production economic evaluation but the weight of spawned eggs, number of spawned egg and the survival rate of the hatchlings were very low in fish fed at 3% body weight compared to those fed at 5% body weight. It can therefore be concluded that for better profit maximization in terms of good growth performance, optimum production of fingerlings and market value, feeding level at 5% body weight for *Clarias gariepinus* broodstocks can be recommended, all other factors being equal.

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