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Survival, Growth and Feed Utilization of the Reciprocal Hybrids of *Clarias gariepinus* (Burchell, 1822) and *Heterobranchus bidorsalis* (Geoffroy, 1809) in Concrete Tanks

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ABSTRACT

The production of fish seed of good quality remains one of the major challenges of modern aquaculture in Nigeria and sub-Saharan Africa. This study was conducted to determine the survival rate, fertilization rate, growth performance and feed utilization of the reciprocal hybrids of *Clarias gariepinus* and *Heterobranchus, bidorsalis*. Two genetic crosses were made: *C. gariepinus*♀×*H. bidorsalis*♂ and *H. bidorsalis*♀×*C. gariepinus*♂. The experiment was conducted in two phases; the first phase was the artificial propagation of the fish species using synthetic hormone and rearing the fry for 14 days; the second phase was rearing the 14 days old fry for 35 days. The first phase of the experiment examined the survival of frys in each experimental unit (genetic cross) while in the second phase, growth and nutrient utilization were investigated. The result showed that the highest (%) fertilization (81.32±4.76%), hatching rate (73.89±4.45) and (%) survival (78.36±4.79%) occurred in *H. bidorsalis*♀×*C. gariepinus*♂ and the differences were significant ($p<0.05$). Percentage weight gain and specific growth rate were the two growth and nutrient utilization parameters that showed significant difference ($p<0.05$) between the two reciprocal hybrids. The result of this study shows that the reciprocal hybrids of *C. gariepinus* and *H. bidorsalis* can be used for commercial aquacultural practices.

Key words: African catfish, survival rate, growth performance, feed utilization, reciprocal hybrid

INTRODUCTION

Fish is an essential source of animal protein in most parts of the globe because some competing protein sources of animal origin like beef have been implicated in heart diseases (Owodeinde *et al*., 2011). The prices of others like poultry products have risen beyond the reach of the low income group, which account for a greater percentage of the population (Owodeinde and Ndimele, 2011). Fish is an essential part of most meals in Nigeria and accounts for about 37% of Nigeria's total protein requirement (Ndimele *et al*., 2011). Fish production in Nigeria is dominated by the captured sector, especially Artisanal coastal and Artisanal inland fisheries and gives employment to a lot of the riverine population. Over 80% of total domestic production representing about 510,000 tonnes per annum is contributed by this sector. Factors such as pollution and over-exploitation of the marine fishery resources have resulted in gradual depletion of the stock from the wild. FAO (2003)

reported that Nigeria with an estimated population of over 150 million is one of the largest importers of fish in the developing world. She imports about 600,000 metric tonnes annually. In order to narrow the gap between fish supply and demand, Nigerians must be encouraged to embrace aquaculture.

Genetics is one aspect of biological sciences that have been put into beneficial use in fisheries. Various genetic techniques have been developed and used in different areas of biology to produce progenies that combines the desirable characteristics of their parents. Genetic manipulation have been used in the production all male tilapia because they grow faster and larger than the female. Hybridization of the African catfish (*Clarias gariepinus*) with the Thai catfish (*Clarias macrocephalus*) resulted in the production of offspring that had better characteristics than their parents (Ndimele *et al*., 2011). The offspring had the desired flesh quality of the Thai catfish and the fast growth of the African catfish (Bartley *et al*., 1997). Study conducted by Legendre *et al*. (1992) revealed that *Heterobranchus* species grows twice as much as *Clarias gariepinus*. However, *Clarias gariepinus* is a very hardy fish that can survive in poorly oxygenated water (Teugels, 1996). Therefore, hybridization between these two clariid catfishes could yield offspring that possess a combination of these desirable qualities.

The current growth in aquaculture in Nigeria and most parts of the world can only be sustained by the production of fish seeds with high fertilization and survival rates, high feed conversion efficiency, high growth rate, high disease resistance among other factors (Adebayo and Popoola, 2008). Genetic technology is the tool that can help to produce such fish seeds. This study investigated the fertilization, hatching and survival rates of larvae of reciprocal hybrids of two African clariid catfish (*Clarias gariepinus* and *Heterobranchus bidorsalis*) and also studied their growth performance and feed utilization.

MATERIALS AND METHODS

Experimental fish: This study was conducted in 2007. Sexually matured brood fish (550-700 g) were obtained from the hatchery complex of Department of Fisheries, Lagos State University, Nigeria. The brood fish used for the experiment were made up of two male each of *Clarias gariepinus* and *Heterobranchus bidorsalis* and two female each of this same fish species. The broodstocks were selected based on their external morphological features as described by Viveen *et al*. (1985).

Experimental procedure: The experiment was divided into two phases:

- Artificial propagation of fish species, using synthetic hormone and raising the fry for 14 days
- Rearing of 14 days old fry for another 35 days

Artificial propagation: The broodfish used for the experiment were conditioned for two weeks in holding tanks in the hatchery of Lagos State University and during this period, they were fed 40% crude protein pelleted feed at 3% b. wt. The feeding was done twice daily at 09:00 and 16:00 h.

The female broodstocks were induced by injecting them with ovaprim, a synthetic hormone (Aqualife Syndel International Inc. Vancouver, B.C. Canada) at the rate of 0.5 mL kg^{-1} b.wt. About 15-18 h after injection with the synthetic hormone, ovulation occurred and the eggs were stripped by gently applying pressure to the anterior-posterior direction on the abdomen of the

female brood fish (*C. gariepinus* and *H. bidorsalis*). The male brood fish of (*C. gariepinus* and *H. bidorsalis*) were anaesthetized, sacrificed and their testes removed. Milt was collected after dissection of the testes and immediately preserved in 0.9% sodium chloride solution. The eggs stripped from the female broodfish were later fertilized with milt after sperm activation was initiated by the addition of 5 mL fresh water and checked for motility by microscopic examination (Viveen *et al*., 1985). These are the two (2) crosses:

- *Clarias gariepinus*♀×*Heterobranchus bidorsalis*♂
- *Heterobranchus bidorsalis*♀×*Clarias gariepinus*♂

After stirring the eggs and milt for about 1 min, fertilized eggs were rinsed in fresh water to remove excess milt and treated with talcum powder for 15-30 min to inhibit adhesiveness of the egg jelly coat as well as prevent clumping and suffocation of eggs during incubation. Eggs were incubated in glass tank (70×45×35 cm^{-3}). The incubation jars was aerated continually and temperature was maintained at 28±1°C. Hatching of fertilized eggs occurred 23-26 h later. The un-hatched eggs were removed by siphoning to avoid polluting the water. The larvae were left for three days in the incubation jars to absorb their yolk.

After three days of yolk absorption, the post-larvae were fed *Artemia* nauplii for a period of 14 days. Aeration was done continually and the water temperature, pH and dissolved oxygen were 28±1°C, 6.8 and 4.8 mg L^{-1}, respectively. Water was changed daily to avoid mortality resulting from polluted water.

Growth experiment: A total of 240, 14 days old hybrid catfish (*C. gariepinus*♀×*H. bidorsalis*♂ and *H. bidorsalis*♀×*C. gariepinus*♂) juveniles were used. Forty specimens of each hybrid were randomly chosen and allocated to a circular flow-through tank. Each experimental unit (that is genetic cross) had three replicates. Therefore, there were a total of six circular flow-through tanks, three of which contained a particular genetic cross. Rearing conditions were the same as described above. The diameter of each tank was 2 m and there was at least 50% water exchange daily. Each tank contained about 50 L of fresh water.

Prior to stocking, quicklime was applied to the tank bottom at 150 g m^{-2} to eliminate parasites and invertebrate predators.

Feeding trials: The fish in each of the experimental units was fed on commercial pelleted diet (56% crude protein) (Table 1) at 3% of their body weight according to the recommendation of Viveen *et al*. (1985). The daily ration was divided into two; one part was fed at 09:00 h and the

Table 1: Nutrient composition of commercial feed (Catco fish concentrate-coppens) fed to fry of reciprocal hybrids of clariid catfish

Nutrient	Composition (%)
Crude protein	56.0
Crude fibre	10.9
Crude fat	15.0
Ash	10.9
Phosphorus	8.0
Energy	3400.0 kcal kg^{-1}

Each kg of the diet contains 300 mg Vit. C, 200 mg Vit. E, 22,500 IU Vit. A, 2,500 IU Vit. D_3, 5 mg Cu, E280 preservatives and E324 anti-oxidants

other part at 18:00 h. Feeding was completed in all tanks in about 10-15 min. Weighing of fish was done weekly throughout the period of the experiment. On weighing days, fish were not fed until the whole exercise was completed. Feeding rate was recalculated to accommodate for the weight changes. The feeding trials lasted for five weeks.

Determination of water quality parameter: Temperature of water in all tanks was measured daily using mercury-in-glass thermometer. The pH was measured by a pH meter (Jenway model 9060). Dissolved oxygen concentration in water was determined weekly using the methods of APHA (1989).

Reproductive performance parameter: The number of eggs released in each treatment unit was determined by subtracting the weight of the brood stock after stripping (W_b) in grams from the weight of the brood stock before stripping (W_a) in grams and multiplying the difference by 700 (1 g = 700 eggs) (Viveen *et al*., 1985). Fertilization rate was determined when eggs generally reached the 4-8 celled stage of embryonic development. For calculating percentage fertilization, a sample of about 50 eggs from each replicate of each treatment were carefully taken on Petri dish containing water and counted under a microscope (40 times magnification) (Adebayo, 2006). The fertilization rate was then calculated based on the total number of eggs counted.

After hatching, the numbers of larvae within each experimental unit were carefully counted and the hatching rate was calculated. Similarly, the survival rate was calculated at the end of the rearing period (49 days after hatching) based on the initial number of larvae used in the experiment.

Growth and nutrient utilization: Growth and nutrient utilization were analyzed by calculating the Weight Gain (WG) over the test period, Percent Weight Gain (PWG), Specific Growth Rate (SGR), Food Conversion Ratio (FCR) and Protein Efficiency Ratio (PER).

$$\text{Specific growth rate (SGR)} = \frac{\text{Log}_e\ W_2 - \text{Log}_e\ W_1}{T_2 - T_1} \times 100$$

where, W_2 is weight of fish at time T_2 in days; W_1 is weight of fish at time T_1 in days and Log_e is natural logarithm.

Food Conversion Ratio (FCR) as determined by Weight of dry feed fed (g) divided by live weight gain (g) and Protein Efficiency Ratio (PER) defined as gain in weight of test fish (g) divided by the amount of Protein consumed (g).

Statistical analysis: Statistical analysis was performed using the SPSS V. 15.0 package for windows. Analysis of Variance (ANOVA) was used and where significant difference was indicated, means were separated using Fishers Least Significant Difference (LSD) test at p = 0.05 significance level.

RESULTS AND DISCUSSION

The fertilization, hatching and survival rates of catfish hybrids (Clariabranchus and Heteroclarias) investigated in this study are generally high (Table 2). The percentage fertilization were 68.56±3.58 and 81.32±4.76%; hatching rate, 55.72±2.45 and 73.89±4.45% and survival rate,

60.78±1.30 and 78.36±4.79% for *C. gariepinus*♀×*H. bidorsalis*♂ and *H. bidorsalis*♀×*C. gariepinus*♂, respectively (Table 2). The values obtained in this study are similar to the values obtained in previous studies (Owodeinde and Ndimele, 2011; Owodeinde *et al*., 2011; Ndimele *et al*., 2011; Ndimele and Owodeinde, 2012). Ndimele and Owodeinde (2012) reported percentage fertilization, hatching rate and survival rate of 63.43±2.58, 58.56±1.76 and 40.00±0.58%, respectively for the hybrid, *C. gariepinus*♀×*H. bidorsalis*♂. Ndimele *et al*. (2011) reported 79.44±5.39, 70.57±1.04 and 76.11±1.59% as percentage fertilization, hatching rate and survival rate for *H. bidorsalis*♂×*C. gariepinus*♀.

However, the percentage fertilization, hatching rate and survival rate of the reciprocal hybrids of *C. gariepinus* and *H. bidorsalis* obtained in this study is lower than the values reported by Adebayo (2006) and Ataguba *et al*. (2009). The lower fertilization, hatching and survival rates recorded in this study may have been caused by differences arising from breeding history, age, water quality and season (De-Graaf *et al*., 1995; Aliu and Obasogie, 2006; Ataguba *et al*., 2009).

Table 3 shows the results of growth and nutrient utilization parameters of the two reciprocal hybrids of *C. gariepinus* and *H. bidorsalis*. Only percentage weight gain and specific growth rate of *C. gariepinus*♀×*H. bidorsalis*♂ were significantly ($p<0.05$) higher than that of *H. bidorsalis*♂×*C. gariepinus*♀ (Table 3). The percentage weight gain by *C. gariepinus*♀× *H. bidorsalis*♂ (2320±87%) and *H. bidorsalis*♂×*C. gariepinus*♀ (1345±98%) were higher than the value (122.63±38.40%) reported by Owodeinde *et al*. (2011). However, the specific growth rates for the two reciprocal hybrids (*C. gariepinus*♀×*H. bidorsalis*♂, 10.55±1.03% day^{-1}; *H. bidorsalis*♂×*C. gariepinus*♀, 7.42±0.89% day^{-1}) are similar to the value (5.01±0.58% day^{-1}) obtained by Ndimele and Owodeinde (2012). The insignificance in the differences of the values of the other growth and nutrient utilization parameters could not allow a firm conclusion to be reached. However, the results of this study have confirmed earlier studies (Owodeinde and Ndimele, 2011; Ndimele *et al*., 2011; Ataguba *et al*., 2009) that hybridization of *C. gariepinus* and *H. bidorsalis* can be done successfully.

Table 2: Percentage fertilization, hatching rate and survival rate (14 days post hatching) of reciprocal hybrids (Clariabranchus and Heteroclarias) of *C. gariepinus* and *H. bidorsalis*

	n	Fertilization (%)	Hatching rate	Survival (%)
C. gariepinus♀×*H. bidorsalis*♂	305	68.56±3.58^{a}	55.72±2.45^{a}	60.78±1.30^{a}
H. bidorsalis♀×*C. gariepinus*♂	410	81.32±4.76^{b}	73.89±4.45^{b}	78.36±4.79^{b}

Values are Mean±SE with the same superscript are not significantly different at $p>0.05$

Table 3: Growth of reciprocal hybrids of *C. gariepinus* and *H. bidorsalis* between 14th and 49th day after hatching.

Parameter	*C. gariepinus* ♀×*H. bidorsalis*♂	*H. bidorsalis* ♀×*C. gariepinus*♂
Initial weight	0.58±0.23	0.64±0.34
Mean weight gain (g)	1.43±0.11^{a}	1.25±0.13^{a}
Average daily weight gain (g)	0.06±0.02^{a}	0.05±0.01^{a}
Percentage weight gain (%)	2320.00±87.00^{a}	1345.00±98.00^{b}
SGR (% day^{-1})	10.55±1.03^{a}	7.42±0.89^{b}
FCR	0.27±0.12^{a}	0.38±0.29^{a}
PER	13.01±3.23^{a}	10.14±4.34^{a}

Values are Mean±SE with the same superscript values are not significantly different at $p>0.05$, SGR: Specific growth rate, FCR: Food conversion ratio, PER: Protein efficiency ratio

CONCLUSION

This study has confirmed earlier studies that hybridization of African clariid catfish (*Clarias gariepinus* and *Heterobranchus bidorsalis*) can be done successfully and the products of the cross breed can also be reared to adults.

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