Intra-specific hybridization of local and exotic *Clarias gariepinus*

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**ABSTRACT**

Preliminary study on the intra-specific hybridization of *Clarias gariepinus* and its reciprocal crosses was carried out to evaluate its hatching, survival and growth performance. Pure strains of *C. gariepinus* (exotic and local) and their reciprocal were reproduced artificially through induced breeding and reared for 6 weeks indoor in a plastic bowl. Pure strain exotic *C. gariepinus* had a higher hatchability of 52.1% than local *C. gariepinus* (46.19%) and their reciprocal crosses but were not significantly different. After 2 weeks, pure strain local *C. gariepinus* recorded the highest survival rate of 92% followed by reciprocal cross ♀LCG × ♂ECG (71%). While reciprocal cross ♀LCG × ♂ECG recorded the least percentage survival (62.67%). However, there was a significant difference between the treatments after 6 weeks as pure strain local *C. gariepinus* still maintained its highest survival rate (72.10%) and exotic *C. gariepinus* had the least (38.46%). Mean weight gain of 0.215±0.02 g and specific growth rate of 9.64±0.14 g recorded in 6 weeks was the highest for pure strain exotic *C. gariepinus* while the least of 0.172±0.00 g and 9.18±0.03 g was recorded for pure strain local *C. gariepinus*. There was no significant difference between the treatments in respect to fecundity of the strains of *C. gariepinus* hatched and reared indoor for 6 weeks.

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**INTRODUCTION**

With global population expansion, the demand for high quality protein especially from aquatic source is rising dramatically. Increased aquaculture production is clearly needed to meet this demand. In the third millennium, because capture fishes are at capacity or showing precipitous declines due to over-fishing, habitat destruction and increasing population, increase in capture fishes are not anticipated under the global condition (Dunham et al., 2001).

Aquaculture is a fast growing sector in Nigeria, although presently contributing only 5% per year (Moses, 2006). Fish production was recently realized when it became obvious that our fish requirement cannot be met from capture fish alone. However, fish farming industry is faced with various problems, prominent among which are insufficient production of fish seeds and fingerlings, lack of sufficient balanced feed for fish culture, insufficient number of earth moving equipment with subsequent liming rate and poor water quality.

In aquaculture, fish production can be improved upon by genetically improved fishes. The usual traditional method of growing genetically improved fishes has been through hybridization and selective breeding. In selection, the target could be qualitative and quantitative traits, there is therefore a need to boost its fingerlings production and increase its growth performance hence, one of the current methods of improving growth performance of aquaculture species is through biotechnology manipulations. This could be through hybridization chromosome manipulation (Olufeagba and Aluko, 1997).
Genetic technologies can be utilized in aquaculture for a variety of reasons, not just to improve production but also marketability, cultural benefits, and the conservation of natural resources (Moses et al., 2005). Biotechnology has opened a new window for development of genetic resources in aquaculture. However, the application of biotechnology and genetics to aquaculture in Africa has been constrained by various factors (Mugabe, 2002; Changadaya et al., 2003). Various concerns about its safety has limit its application hence there is need to rely on selective breeding and hybridization for the improvement of genetic resources in aquaculture.

Hybridization between some species of tilapia such as Oreochromis niloticus × Oreochromis aureus results in the production of predominantly male offspring and reduces unwanted natural reproduction in grow-out ponds (Rosenstein and Hulata, 1993). Hybridization of the African catfishes Clarias gariepinus, Heterobranchus bidorsalis and/or Heterobranchus longifilis have been reported by Nwadukwe (1995), Nlewadim et al. (2004) and Salami et al. (1993). The African catfish × Thai catfish hybrid (C. gariepinus × C. macrocephalus) is preferred to the Thai catfish because it has the desired flesh quality of the Thai catfish and the fast growth of the African type (Bartley et al., 1997).

Legendre et al. (1992) investigated hybridization of the two African catfishes: C. gariepinus and H. longifilis and reported viability in reciprocal hybrids with their survival rates being similar to those found in the maternal species. Hybrid morphology was intermediate to that of the parents and no difference in external morphology was observed between the reciprocal hybrids. Both reciprocal hybrids and parental species displayed an equilibrated sex ratio.

The detrimental effects of inbreeding are well documented and can result in a decrease of 30% or greater in growth production, survival and reproduction (Dunham et al., 2001). Hybrid line cannot be maintained by allowing hybrids to reproduce. They must be produced from parental lines in every generation.

Fast growing species obtained from the act of crossing are often cherished by most farmers. Inter-generic hybrids will be generated when parents from two different genera are crossed. Inter-specific hybrids are often sterile and usually do not display hybrid vigour. Intra-specific hybridization is the crossing or mating of fish of the same species and genus but different localities, regions and ecological zones. The motive behind is a search for improved quality since hybrids among fishes are sterile and the primary goal of intra-specific hybridization is to produce top cross hybrids for species of different genotypes exclusively for production.

With the determination of growth parameter of pure breed line and cross breed, selection of fish for culture becomes easier especially with emergence of highly intensive culture systems and ever increasing demand for fingerlings to be stocked. Sourcing of Clarias fingerlings from the wide does not guarantee good quality; moreover, it leads to rapid depletion of juvenile of fish stock of this fish in the wide. Little work has been done on the phenomenon of jumpers. Since the aim of the fish culturist is to produce fish that grows to table size using the most minimal of inputs, it is necessary to know which cluster of fingerlings to pick as brood stock for the production of fast growing fry and fingerlings and also avoid cannibalism in the hatchery. There is need for sustained fingerlings production as well as avoidance of mortality above profitable level for fish farmers. Therefore, this study investigated the hatchability and survival rate of local and exotic C. gariepinus and their reciprocal crosses. The growth performance of the strains of local and exotic C. gariepinus and their reciprocal crosses was also investigated.

**MATERIALS AND METHODS**

**Experimental site**

The project work was carried out in the hatchery unit of the University of Agriculture, North-core, Makurdi, Benue State, Nigeria. Makurdi the capital of Benue State lies between longitude 8° and 9° east at Greenwich meridian and 7° and 8° of the equator (Kowal and Knabe, 1972).

**Source of breeds**

The broodstock of local C. gariepinus were purchased from local fish monger at Wadata market while gravid/mature exotic C. gariepinus were obtained from Aqua-haven Fish farms, North-bank, both in Makurdi, Benue State, Nigeria and these breeds were taken to the fish hatchery of University of Agriculture, where they were acclimatized in concrete holding tanks for 24 h before artificially induced breeding was carried out.

**Broodstock selection**

The mature gravid females were selected based on swollen well distended soft abdomen, reddish vent, and gentle extraction of few eggs by depressing of the fish abdomen using the finger. Females with sharp golden coloured eggs were selected for local C. gariepinus while those with sharp greenish coloured eggs were selected for exotic C. gariepinus. Matured males were also selected based on their reddish pointed genital papillae.

**Hormone injection**

The fish were sexed and separated into males and females based on examination of their genital papillae.
and they were kept separately in four labeled plastic bowls containing water. It was covered with chicken wire mesh and a heavy weight was placed on each of the bowls in other to ensure that the fishes did not jump out from the bowls. The male and female fishes were weighed separately using a 10 kg Camry Premium Table weighing balance. The fishes were injected based on their weight using synthetic hormone (Ovaprim). Ovaprim was administered intramuscularly (above the lateral line, towards the tail) at the recommended rate of 0.5 ml per kg of female fish, and 0.25 ml per kg of male fish. After the injection the fishes were kept back into the plastic bowl covered with chicken mesh for 12 h of latent period.

Milt and egg collection

After the 12 h latency period, the milt was collected by sacrificing the male. The two testes lobes of the males were removed, well cleaned with tissue paper and kept in a labeled Petri dish for weighing and measurement. The abdomen of the females were well cleaned with tissue paper to avoid contact between the eggs and water, and then stripped of its eggs by a gentle application of pressure on the abdomen to release the eggs. The eggs were covered in the dry, labeled Petri dish and kept with labels.

Artificial fertilization

The testes of the male were cut open using scissors and the milt was squeezed out, and then 0.9% saline solution (NaCl) was added to the milt to facilitate fertilization after which the milt was used to fertilize the already stripped eggs.

Experimental crosses

The following generic combinations were carried out:

Parental crosses

<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local <em>C. gariepinus</em></td>
<td>Local <em>C. gariepinus</em></td>
</tr>
<tr>
<td>Exotic <em>C. gariepinus</em></td>
<td>Exotic <em>C. gariepinus</em></td>
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</table>

Intra-specific crosses

<table>
<thead>
<tr>
<th>Local <em>C. gariepinus</em></th>
<th>Exotic <em>C. gariepinus</em></th>
</tr>
</thead>
</table>

| Exotic *C. gariepinus* | Local *C. gariepinus* |

Incubation and hatching of eggs

Incubation and hatching of eggs were carried in eight (8) aerated bowls containing clean kakabans (substrate attachment of eggs). Both the parental and the intra-specific crosses were replicated. The fertilized eggs were then evenly spread on the kakaban in the tank at temperatures between 26–27°C. At hatching, all the live larva were counted in each replicate. Percentage hatchability of each cross was calculated using the formula:

\[
\text{Percent hatchability} = \frac{\text{Total number of hatched eggs}}{\text{Total number of fertilized eggs}} \times 100
\]

Setting of indoor experiment and daily survival of hatching

The treatment was duplicated having 100 hatchlings each after taking the pool weight and both were collected and stored in the aerated bowls. The survival of fry in each bowl per treatment were taken on a daily basis for 14 days, while pooled weight, pooled length and final survival were taken on the 14th day.

Feeding of larvae

Three days after the hatching, when all yolk reserve had been re-absorbed, feeding of the new hatchlings with Artemia was started exogenously.

Setting the out-door experiment and feeding the fry

The four crosses were duplicated and stocked in eight concrete tanks at 100 fry per tank. The fry were fed with Coppen’s feed of 0.2–0.3 mm for 1 week and 0.3–0.5 mm for another 4 weeks. Hatchlings were fed twice daily (morning and evening). Sampling for pooled weight and length were done biweekly for 2 weeks.

Statistical analyses

Data collected during the study was analysed using Minitab 14 software for descriptive statistics and Genstat Discovery edition 4 for analysis of variance (ANOVA). Breeding performance was analysed using one way ANOVA.

RESULTS

Results of the percentage hatchability, mean weight gain, specific growth rate (SGR), fecundity and percentage survival (2 weeks and 6 weeks) of fingerlings of the local
and exotic C. gariepinus strain reared indoor for 6 weeks and the daily percentage survival of the fry of local, exotic and crosses of both strains of C. gariepinus for 2 weeks (14 days) in indoor plastic bowls are as shown in Table 1. The highest percentage hatchability (52.1%) was recorded in pure line exotic C. gariepinus (ECG × ECG) strain and the lowest (46.19%) in local C. gariepinus (LCG × LCG) strain. However, there was no significant differences between the treatments (P<0.05).

The highest survival value of 92% was recorded in local C. gariepinus (LCG × LCG), followed by LCG × ECG (71%), (female local C. gariepinus crossed with male exotic C. gariepinus) and the least percentage survival rate of 62.67% was recorded in ECG × LCG (female exotic C. gariepinus crossed with male local C. gariepinus). While local strain of C. gariepinus (LCG × LCG) still maintained the highest survival rate (72.10%) after 6 weeks of rearing, pure strain exotic C. gariepinus recorded the least value (38.46%).

The mean weight gain of fingerlings of the four strains of C. gariepinus reared indoor for 6 weeks is also presented in Table 1. The highest mean weight gain of 0.215 g was recorded in pure the strain of exotic C. gariepinus and the least of 0.172 g recorded in pure strain local C. gariepinus. The results of the statistical analyses showed that the difference between the treatments were significant (P<0.05).

SGR of the individual strains reared indoor for 6 weeks follows the same trend as that of mean weight gain. Pure strain of exotic C. gariepinus recorded the highest (9.64) while local C. gariepinus strain recorded the lowest (9.18) SGR. There was no significant difference between the treatments in respect to fecundity of the strains of C. gariepinus hatched and reared indoor for 6 weeks.

Based on the record obtained from the study, there was no statistical difference between the strains of C. gariepinus in all the treatments in respect to fecundity and hatchability. Results of weekly increase of crosses in weight are presented in Figure 1. It was observed that, after 2 weeks, there was a significant increase in weight gain in all treatments. The results showed that pure strain exotic C. gariepinus (ECG × ECG) had the highest weight gain (0.215) and the least was recorded for pure strain of local C. gariepinus (LCG × LCG), (0.172).

Figure 2 shows the results of the weekly increase in length of crosses. The results also followed the same trend as pure strain exotic C. gariepinus (ECG × ECG) had the highest length gain and the least was recorded for pure strain local C. gariepinus (LCG × LCG), while there was no significant difference in length between the crosses of ECG × LCG and LCG × ECG.

**DISCUSSION**

The feasibility of crosses of exotic and local C. gariepinus and its reciprocal cross-breeding was demonstrated in the present study. The high hatching percentage (52.1%) observed in pure strain exotic C. gariepinus might be attributed to the genetic improvement through selective breeding. The hybrids were viable and their survival was strongly influenced by their maternal parent. This agrees with the reported work of Moses et al. (2005) who reported 59.1% and 28.40% hatching percentage in exotic and local C. gariepinus.

Lower hatching rate has been reported for C. gariepinus by Macharia et al. (2005) who reported a rate as low as 4% for C. gariepinus eggs incubated on a nylon substrate, which is very low compared to the present result (46.19%), even though nylon net was used as hatching substrate. It is however important to acknowledge that differences that arise from breeding history, age and water quality can affect hatching rates. Variations in seasons can also lead to differences in hatching rates, as rightly observed by de Graaf et al. (1995). So long as fecundity does not drop, hatching rates and survival rates of larvae remain the key to viable and economically beneficial production of catfish fry and fingerlings.

The high survival rate (92%) of local strain C. gariepinus during larval rearing may be related to its hardiness and adaptation to environment. This is in agreement with de Graaf et al. (1995) and Olufeagba and Aluko (1997) who reported high survival rate of local

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**Table 1. Hatchability, survival and growth parameters of four (4) strains of C. gariepinus reared in plastic bowls.**

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>♀ECG × ♀ECG</th>
<th>♀ECG × ♀LCG</th>
<th>♀LCG × ♀ECG</th>
<th>♀LCG × ♀LCG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecundity</td>
<td>9186±354a</td>
<td>10810±230a</td>
<td>9540±354a</td>
<td>10580±230a</td>
</tr>
<tr>
<td>Hatchability (%)</td>
<td>52.10±12.6</td>
<td>50.24±4.21</td>
<td>49.50±11.4</td>
<td>46.19±3.14</td>
</tr>
<tr>
<td>Survival (2 weeks) (%)</td>
<td>69.33±4.06b</td>
<td>62.67±3.84b</td>
<td>71.00±4.00b</td>
<td>92.00±1.73a</td>
</tr>
<tr>
<td>Survival (6 weeks) (%)</td>
<td>38.46±1.45c</td>
<td>49.50±2.07b</td>
<td>41.60±1.31c</td>
<td>72.10±1.99a</td>
</tr>
<tr>
<td>SGR</td>
<td>9.64±0.14a</td>
<td>9.38±0.03b</td>
<td>9.34±0.08b</td>
<td>9.18±0.03b</td>
</tr>
<tr>
<td>Mean weight gain (MWG)</td>
<td>0.215±0.002a</td>
<td>0.200±0.002b</td>
<td>0.201±0.002b</td>
<td>0.172±0.003c</td>
</tr>
</tbody>
</table>

Means in the same column followed by different superscripts differ significantly (P<0.05).
Figure 1. Weekly weight increase of crosses.

Figure 2. Weekly length increase of crosses.
C. gariepinus reared under a medium stocking density for a short duration in protected tanks. During the outdoor trial, survival of C. gariepinus (72.10%) was also much higher than that of exotic local C. gariepinus (♂ECG × ♀ECG) (38.46%) and their reciprocal crosses. This could be due to high adaptability of local C. gariepinus (♂LCG × ♀LCG) to outdoor environmental condition while the low percentage survival of pure strain exotic C. gariepinus (♂ECG × ♀ECG) might be as a result of climatic and environmental differences.

The mean weight gain of the four genetic groups under study for 6 weeks ranged from 0.21–0.17 g. The pure strain exotic C. gariepinus cross (♂ECG × ♀ECG) showed the highest final mean weight gain of 0.21 g. This is significantly lower than the values of 2250 mg reported for the same cross by Nlewadim et al. (2004). However, the final mean weight value of 0.21 g recorded is comparable to the value of 1950 mg as reported by Nlewadim et al. (2004). There was significant difference (P<0.05) in values obtained for the treatments.

The high SGR recorded for pure strain exotic C. gariepinus (♂ECG × ♀ECG) in this study agrees with the report of Ataguba et al. (2009); and de Graaf et al. (1995) for C. gariepinus reared for a short period after hatching. This also followed the same trend as that of the mean weight gain. Pure strain exotic C. gariepinus (♂ECG × ♀ECG) recorded the highest (9.64) while the least in local strain C. gariepinus. De Graaf et al. (1995) reported a specific growth rate of 6.9% day⁻¹ for C. gariepinus stocked at a low stocking rate and reared for a long period (≥51 days). This is similar to the value of 9.64 observed in the present study. The SGR of 9.64 reported in the present study for the pure exotic C. gariepinus cross is significantly higher than that of the local C. gariepinus (♂LCG × ♀LCG) and their reciprocal crosses. The least SGR (9.18) was recorded for the pure strain local C. gariepinus (♀ECG × ♂ECG) cross.

The results obtained from the study showed that there were no significant differences between the crosses of exotic and local C. gariepinus and their reciprocal crosses in respect to fecundity and hatchability. All the strains of C. gariepinus used for the study recorded high fecundity. Reciprocal cross between exotic and local C. gariepinus (♂ECG × ♀LCG) recorded the highest (10810) while exotic strain C. gariepinus recorded the least (9186). High fecundity of the local strain breed was not recorded.

**Conclusion**

Intra-specific hybridization studies were carried out in exotic and local C. gariepinus with the aim of determining the best fecundity, percentage hatchability, survival rate and growth performance. The highest fecundity of 10810 was recorded for reciprocal cross (♀ECG × ♂LCG) and the least (9186) for exotic (♀ECG × ♂ECG). The highest percentage hatchability of 52.10% was recorded for pure strain of exotic C. gariepinus (♀ECG × ♂ECG). While the least of 46.19% was recorded for pure strain C. gariepinus (♀ECG × ♂LCG). Highest survival value of 9.20% and 74.5% were recorded for local pure strain C. gariepinus (♂LCG × ♀LCG) after 2 weeks indoor and 6 weeks outdoor, respectively. However, the least percentage survival reared indoor after 2 weeks was 62.67% for reciprocal cross (♀ECG × ♂LCG) while for the outdoor, pure strain exotic C. gariepinus (♂ECG × ♀ECG) recorded the least of 38.46%. The best growth performance after 6 weeks (9.64) was recorded for pure strain exotic C. gariepinus (♂ECG × ♀ECG), while the least of 9.18 was recorded for pure strain local C. gariepinus (♀LCG × ♂LCG).

**RECOMMENDATION**

From the above findings, it is recommended that intra-specific cross of female exotic C. gariepinus and male local strain C. gariepinus (♀ECG × ♂ECG) be practiced for optimum performance. This will ensure high hatchability and survival rate. This result should therefore be used as baseline information that is extended to hatchery operators. Application of selective breeding for the improvement of our local C. gariepinus is also recommended because of its adaptation to local environment as revealed by its survival rate.

**REFERENCES**


