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REPRODUCTIVE INDICES AND GROWTH PERFORMANCE OF *Clarias gariepinus* (BURCHELL, 1822), *Heterobranchus bidorsalis* (GEOFFREY SAINT-HILAIRE, 1809) AND THEIR HYBRIDS IN AN INDOOR TANKS

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ABSTRACT

Hybridization is significant in producing higher breeds, it produces new breeds and strain and reduce inbreed. The study examined the percentage fertilization, hatchability, heterosis and survival of the hatchlings in a complete randomized design. The cross established high fertilization rate across the hybrids. *Clarias gariepinus* male ($Cl\sigma$) x *Heterobranchus bidorsalis* female ($Hb\phi$) recorded the highest fertilization (100%), $Hb\sigma$ x $Cl\phi$ and $Hb\sigma$ x $Hb\phi$ had (90 %), and the least was in $Cl\sigma$ x $Cl\phi$ (60%), respectively. Pure strain $Hb\sigma$ x $Hb\phi$ performed significantly higher ($p < 0.05$) in final weight ($234.7 \pm 0.0577g$) and length ($119.7 \pm 0.374mm$) in all the trials from the onset of exogenous feeding with Blue Crown feed for 56 days. The best and least specific growth rate (SGR) 3.64 and 3.55 were recorded in $Hb\sigma$ x $Cl\phi$ and $Hb\sigma$ x $Hb\phi$ respectively. $Hb\sigma$ x $Cl\phi$ and $Hb\sigma$ x $Hb\phi$ survived 90% followed by $Cl\sigma$ x $Hb\phi$ with 80% but the least survival was in $Cl\sigma$ x $Cl\phi$ (30%). The growth of the hybrids revealed a hope for aquaculture improvement in Nigeria, and a means of promoting the availability of fish all year round if employed in the farm.

Key words: Growth, Pure breeds, hybrids, *Clarias gariepinus*, *Heterobranchus bidorsalis*

INTRODUCTION

Fish is an essential source of animal protein. However, inadequate supply and low availability makes the consumption rate low (Idris *et al.*, 2018), Idris *et al.* (2018) reported that, the low availability of fish, with high demand can result to increase in the price. Adewolu *et al.* (2008) conveyed that the scarcity of the parent stock, and fingerlings of the desired cultured species are one of the major hindrance in the promotion and development of aquaculture in the country. If one million tons of fish as speculated by Food and Agricultural Organization, FAO (2004) were to be realized at a semi-intensive culture level of fingerlings production, then at least two billion fingerlings would be required annually from all sources to meet the demand of the populace (Atanda, 2007). Aquaculture requires deliberate human intervention for improved productivity, management and yields which can augment those from the capture fisheries. Aquaculture genetics shows immense potential for enhancing production. The application of genetic tools is Onyia *et al.* (2018) recount that aquaculture requires human input, labor, time and energy to

known to have increase fish production (Akinwande *et al.*, 2009). The African catfish is an excellent species for aquaculture as it is omnivorous, majorly available in all farms, grows fast, and tolerates relatively poor water quality (Ochokwu *et al.*, 2019).

The desire of a fish farmer is to produce table size fish within the shortest possible time (Ekelemu, 2010). However, achieving the above aim and having an all- year round supply depends on the availability of the broodstock and the ability of the farmer to control the entire life cycle of the fish (Ekelemu, 2010). In many parts of the world, several people depend wholly or partly on the fisheries sector for their food and livelihood (FAO 2018). The demand for fish and fishery products has increased tremendously all over the world due to population explosion and nutritional benefit from fish over meat from livestock (Gupta and Acosta, 2004; FAO 2018). Fish and fishery products are source of nutrients, micronutrients, including vitamins, several minerals and omega-6 and 3 fatty acid (FAO, 2018).

improve yield and productivity through manipulation of the rate of growth, mortality and

reproduction, which tremendously exceeds those from the natural environment. They are also capable of reproducing in captivity and grow to a size of 7.0 kg. They are efficient feed converters especially the males (Nweke and Ugwumba, 2005).

Idodo- Umeh, (2003) reported that, *Heterobranchus sp* are capable of attaining 14.0 kg, but are not hardy as *Clarias sp*. Harnessing the qualities of these two species by cross breeding produce hybrids which are hardy and grow to a large size (Miller 2003; Keremah and Green, 2005).

Potentials of aquaculture industry are threatened because of inadequate fish seed. Dependence on natural propagation create a gap to manage the aquaculture industry making it difficult to meet the demand for fish. In order to ensure the continual growth of Aquaculture industry, there is need to increase fish artificial propagation, hybridization, selection and genetic manipulation (Ochokwu *et al.*, 2016). Aluko and Ali (2001) carried out intergeneric hybridization between African Clariids and produced fast growing generation hybrid, (Ochokwu, *et al.*, 2016) crossed between Katsina and Ibadan, Sanda *et al.* (2015) crossed *C. anguillaris* and *H. bidorsalis*. This research focused on the cross between *H. bidorsalis* and *C. gariepinus*, to examine the fecundity, the fertility and hatchability rate, and compare the growth of the pure breed and their hybrids.

MATERIALS AND METHODS

Study Area

The research was done in the Department of Fisheries, Modibbo Adama University of Technology, Yola (of Adamawa State located at 9°13'48"N and 12°27'36"E, situated 10 km north of the city on the road to Mubi), from April, 2019 to June, 2019.

Broodstock Selection

Eight matured brooders (4 males and 4 females) of *Clarias gariepinus* and *Heterobranchus bidorsalis* were obtained from a reputable fish farm in Yola, Adamawa State. The fish were taken to the Research Farm. The selection was randomly carried out based on age and size; swelling of the lower abdomen in female containing ripped and matured eggs; while in male, a slightly swollen and pinkish urogenital papillae was observed (Ngugi *et al.*, 2007). The broodstock were induced with Ovaprim at 0.5ml/kg weight of fish and allowed for a latency period of 12hours (Onyia *et al.*, 2015). The fish were kept separately

in mesh protected plastic bowls filled with quality and well aerated water during the latency period.

Collection of Milt and Eggs

The milt was collected by incapacitating the male and using a dissector to remove testes from the gonad. Incision was done on the two lobes of the creamy colored testes to allow squeezing of the testicle sacs which was washed with saline water. Egg were stripped by gently pressing the abdomen. The fertilized eggs were incubated for hatching.

Experimental Design

Two hundred and forty (240) fish larvae of two weeks old, a pre- fingerlings were obtained from the experimental crosses (pure breed Hb x Hb; Cg x Cg and hybrids Hb x Cg and Cg x Hb). Using a Completely Randomized Design (CRD), progeny of the different cross were distributed to four (4) treatments in replicate and stocked with twenty fish seed each. Fish were contained in an indoor culture tanks, and were fed three (3) times daily *ad libitum* for a period of 56 days (8 weeks) (Sanda *et al.*, 2015; Ochokwu *et al.*, 2016).

Fry Rearing

The larvae were reared and monitored under good management practices. They were kept in good and well aerated water to enhance growth and development (weight and length). Hatchlings were fed to satiation with *Artemia nauplii* at 3 hours intervals for 10days.

The fry were randomly distributed into three plastic bowls of 20 liters capacity in three replicates, stocked at 20 fish for the 56 days. Water parameters such as dissolved oxygen, temperature and pH were recorded on daily basis.

Fertilization rate (%) = $\frac{\text{No.of fertilized eggs}}{\text{Total No of incubated eggs}} \times 100$, Onyia *et al.* (2015)

Hatchability (%) = $\frac{\text{Number of hatched eggs}}{\text{Total eggs incubated}} \times 100$, Ochokwu *et al.* (2016)

Specific growth rate (SGR) % = $\frac{\text{Log-Log}W_2 - \text{Log-Log}W_1}{T} \times \frac{100}{1}$, Ochokwu *et al.* (2014)

Where: W_1 (initial weight); W_2 (Final weight); T- Time

Feed Conversion Ratio (FCR) = $\frac{\text{feed consumed}}{\text{weight gain (g)}}$

Ochokwu *et al.* (2020)

Weight Gain (g) = Final weight – Initial weight

Survival Rate (%) = $\frac{\text{Total number of fingerlings after 56 days}}{\text{Number of stocked fish}} \times 100$, Onyia *et al.* (2021)

Condition Factor (K) = $\frac{100 \times \text{final weight}}{L^3}$, Ochokwu *et al.* (2014)

L= Total length (cm).

Statistical Analysis

Data obtained from the experiment was subjected to line graph and one- way analysis of variance (ANOVA) using statistical software SPSS version 20. The difference among means were determined using least significant differences (LSD) at 95% confidence level ($P < 0.05$).

RESULTS

Reproductive indices vary in weight, size and season. Table 1 display the eggs and sperm

performance in relation to the weight of both male and female broodstock. The weight of female *Clarias gariepinus* is 1.0 kg and the egg weight 193.0g. While 1g of egg was 831, the fecundity was 160,383. In *H. bidorsalis* female, the weight of the fish (8.5kg), the weight of the egg 700.0g, 1g of egg gave 762 number, and the fecundity was 533,400. The egg diameter of both parent stock ranged from 1.1 mm in *C. gariepinus* and 1.3 mm in *H. bidorsalis*.

Table 1: Reproductive indices of *Clarias gariepinus* and *Heterobranchus bidorsalis*

Parameter	<i>Clarias gariepinus</i>	<i>Heterobranchus bidorsalis</i>
Weight of female (♀) (kg)	1.0 ^b	8.5 ^a
Weight of eggs (g)	193.0 ^b	700.0 ^a
Number of eggs in 1g	831	762
Total number of eggs (g)	160,383 ^b	533,400 ^a
Weight of male (♂) (kg)	2.0 ^b	4.2 ^a
Egg diameter	1.1	1.3
Weight of right lobe of testes (g)	9.27 ^a	1.02 ^b
Weight of left lobe of testes (g)	6.72 ^a	0.86 ^b
Length of right lobe of testes (cm)	5.5	6.5
Length of left lobe of testes (cm)	5.8 ^b	7.0 ^a
Milt volume (ml)	7.5 ^a	2.2 ^b

Means with different superscripts in the same row are significantly different ($p < 0.05$).

Figure 1 revealed the percentage fertilization and hatchability of *C. gariepinus* and *H. bidorsalis*. The hybrid ($Cl♂ \times Hb♀$) had the highest percentage fertilization (100) and hatchability (90), followed by ($Hb♂ \times Cl♀$) and pure breed *H. bidorsalis* (90%); while the least was observed in pure breed *C. gariepinus* ($Cl♂ \times Cl♀$) with 60% fertilization rate. There was significant difference ($p < 0.05$) in the hatchability rate. Hybrids ($Cl♂ \times Hb♀$ 90% and $Hb♂ \times Cl♀$ 80%) had the highest hatchability rate while the pure breeds had the least hatchability rate.

The percentage survival of *C. gariepinus* and *H. bidorsalis* is presented in figure 2. The highest (90%) and the least (30%) survival rate were observed in ($Hb♂ \times Hb♀$; $Hb♂ \times Cl♀$) and ($Cl♂ \times Cl♀$) crosses respectively. The hybrid of ($Cl♂ \times Hb♀$) had 80% survival rate.

The growth performance in terms of weight and length differential is presented in Table 2. The highest weight 234.1 ± 0.577^a was in pure breed ($Hb♂ \times Hb♀$) and the least was in ($Cl♂ \times Hb♀$) 54.1 ± 0.577 . ($Hb♂ \times Cl♀$) had 168.1 ± 0.577 and ($Cl♂ \times Cl♀$) 58.1 ± 0.577 . The highest performance in relation to length was 137.00 ± 1.374 in ($Hb♂ \times Hb♀$) pure line. The least length attained was 52.33 ± 0.783 recorded in ($Cl♂ \times Hb♀$), respectively.

The temperature, dissolved Oxygen level and pH were monitored. Water temperature varied from 30.6°C to 32.6°C (Table 4). The dissolved Oxygen level range from 3.98 to 4.73. Water pH of the culture were more or less similar in the different treatment but, later as the experimental days progresses there was a slight rise of the pH to 8.5, respectively.

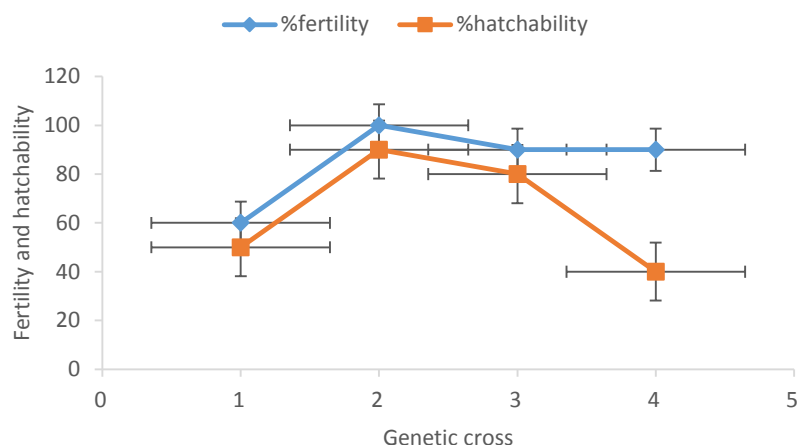


Figure 1: The percentage fertilization and hatchability

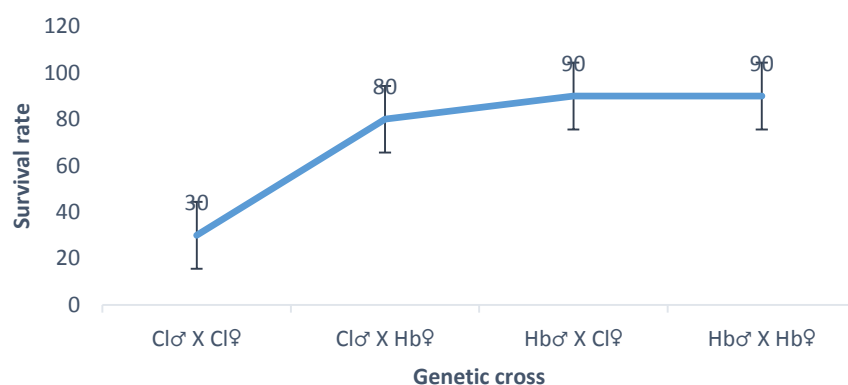


Figure 2: The percentage survival.

Table 2: Mean Growth Performance of Pure Strains and their Hybrids

Parameters	Cl♂x Cl♀	Cl♂ x Hb♀	Hb♂ x Cl♀	Hb♂x Hb♀
Initial Weight of Fingerling (mg)	1.30 ^b	1.30 ^b	1.50 ^b	2.40 ^a
Final Weight of fingerling (g)	58.10 ^c	54.10 ^d	168.10 ^b	234.10 ^a
Mean weight gain (g)	56.8 ^c	52.7 ^d	166.6 ^b	231.7 ^a
Initial Length of Fingerling (mm)	8.7 ^c	9.33 ^{bc}	15.0 ^b	17.33 ^a
Final Length of Fingerling (mm)	57.0 ^c	52.3 ^{cd}	81.0 ^b	137.0 ^a
Mean length gain (mm)	48.3 ^d	52.0 ^c	66.0 ^b	119.7 ^a
Specific growth rate (%/day)	2.94 ^c	2.89 ^c	3.64 ^a	3.55 ^a
Feed conversion ratio	0.15 ^a	0.40 ^b	0.45 ^b	0.45 ^b
Survival (%)	30 ^c	80 ^b	90 ^a	90 ^a
Condition factor (K)	0.51 ^c	0.68 ^a	0.58 ^b	0.14 ^d

Means with different superscripts in the same row are significantly different (P<0.05)

Table 3: Mean Water Quality Variables

Cross	Water Temperature (°C)	Dissolved Oxygen(mg/lt)	pH
D1 Cl♂ X Cl♀	31.1	4.73	7.6
D2 Cl♂ X Hb♀	32.6	4.31	7.8
D3 Hb♂ X Cl♀	30.8	4.11	8.5
D4 Hb♂ X Hb♀	30.6	3.98	8.5

DISCUSSION

Egg and sperm quality is an important factor in aquaculture development and major resource in fish breeding and hybridization (Ochokwu *et al.*, 2015). This research revealed high fecundity in both *Clarias gariepinus* (160,383) and *Heterobranchus bidorsalis* (533,400). The result obtained agreed with the findings of Ochokwu *et al.* (2016). *C. gariepinus* displayed significant increase in the sperm weight and milt volume more than that of *H. bidorsalis*. This concur with Onyia *et al.* (2018).

The fertilization and hatchability rate was higher among the (F1) hybrids. The highest fertilization rate obtained among the F1 generation agreed with Owodeinde *et al.* (2011), however, the high hatchability rate obtained in this research among the F1 disagreed with Owodeinde *et al.* (2011) who reported high hatchability in the P1. The major causes of poor fertility and hatchability during hybridization are the gamete quality such as viability of the sperm and egg, age of the fish, pH, Dissolve Oxygen, Temperature, Total dissolved solid and water Turbidity, incubation of more than one layer of eggs, wrong latency period and high stocking density. All these factors must be considered for a better fertility and hatchability. In Nigeria poor hatchability and ability of the hatchlings to survive to fingerlings stage have been one of the major problems incurred among farmers (Ochokwu *et al.*, 2016). These have necessitated researchers to engross on hybridization and cross breeding among species to improve the rate of hatchability in catfish.

There was increase in the weight of the F1 when compared with P1 *Cl x Cl*. Among the cross P1 *Hb x Hb* had the highest weight and length during the rearing period. However, the cross improved the growth in weight and length of F1 generations. Diyaware and Onyia (2014) recorded increase in the F1 generation in a cross between *C. anguillaris* and *H. bidorsalis* within the period of eight months. Same trend was detailed in (Owodeinde *et al.*, 2011). The hybrids showed positive heterosis in growth rate. Oguguah *et al.* (2011) revealed that fish growth correlates with its feed intake, however, other factors such as genetic makeup of the parent, hormones, hereditary, Temperature (which have effects in fish metabolism), water quality, and internal physiological status (stress, stocking density, health and reproductive status) equally determines the growth rate of the fish (Ochokwu *et al.*, 2020).

The FCR reported in this research revealed that the pure breeds and the F1 effectively utilized the

given feed for growth. The P1 *Cl x Cl* had the least value which signify that it effectively maximized the feed for growth. However, the condition factor which is the relative robustness of the fish, was less than 1. It revealed that the fish was in good condition within the culture period. Survival among the genetic cross was high in F1 generation when compared with the parent, meanwhile P1 *Cl x Cl* had the least percentage survival, this research disagreed with Yisa *et al.* (2011) who recorded poor survival across the F1 with high mortality; Solomon and Okomoda, (2013) also recorded poor survival with P1 *Cg x Cg* having the highest survival rate. However, Diyaware and Onyia, (2014) recorded high survival across the intergeneric cross. The high survival recorded in this research can be attributed to the management practices during the process of rearing of the fingerlings this include monitoring of the pH, dissolve oxygen, temperature, siphoning of the uneaten feeds and waste (Diyaware and Onyia, 2014).

CONCLUSION

The result showed that the hybrids performed better than the purebreed interms of fertility, hatchability and in growth performance. It inferred that the growth and survival needed by the farmers can be achieved through hybridization and intergeneric cross. This is therefore essential and acceptable as more *Heterobranchus bidorsalis* and its hybrids can be produced to augment the scarcity of fish. It is evident that there are potentials in hybridization for commercial purpose in two African Catfishes which can sustain and maintain fish seed multiplication as well as adequate supply to fish farmers across Nigeria, owing to the facts that this synergistic improvement in growth performance are not widely practiced.

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Prof. Onyia, L.U X.X; Ochokwu, I.J Y.Y; and Edward, V Z.Z

conceptualization, X.X. and Y.Y.; methodology, Y.Y. and Z.Z; data analysis, Y.Y. and X.X; validation, X.X., Y.Y. and Z.Z.; formal analysis, X.X. and Y.Y; investigation, X.X. Y.Y and Z.Z; resources, X.X. and Z.Z; data curation, X.X. and Y.Y; writing—original draft preparation, X.X. and Y.Y; writing—review and editing, X.X. and Y.Y and Z.Z; visualization, X.X.; supervision, X.X. and Y.Y; project administration, X.X.; funding acquisition, X.X. and Y.Y.”,

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