EVALUATION OF HETEROSIS OF CROSSES BETWEEN *CLARIAS GARIEPINUS*, *HETEROBRANCHUS BIDORSALIS* AND THEIR HYBRIDS COLLECTED FROM MINNA METROPOLIS

ABSTRACT

Hybridization of Clarias gariepinus (Cl) and Heterobranchus bidorsalis (Ht) and determination of their growth parameters and heterosis was carried out. Four crosses were tried (♀ × ♂): Cl X Cl, Ht X Cl, Cl X Ht and Ht X Ht. Fifty 14-day old juveniles from each of the four crosses were stocked separately in triplicate plastic aquaria. Fifteen fish were selected randomly every week using a fine mesh mosquito size net and then weighed on a sensitive balance. The highest percentage fertilization (58.57%) was recorded in pure breed (Ht x Ht). The hybrid (Cl x Ht) recorded the highest percentage hatchability. The pure breeds recorded the highest condition factor (2.37) and the hybrids have the highest feed conversion ratio. The cross Cl X Cl had the highest final mean weight (1980mg) and Specific Growth Rate (SGR) 4.91%/day compared to the other three crosses. A negative heterosis for growth (-14.95%) was observed in the hybrids while survival of the hybrids showed a positive heterosis (26.56%). Poor growth of hybrids accounted for the negative heterosis. Therefore, crossbreeds survived better than purebred catfish. There was significant difference in specific growth rate among the four genetic groups studied (P>0.05).

Key words: Heterosis, Hybridization, Growth, Hybrid catfish, Weight gain

INTRODUCTION

Aquaculture is one of the fastest-growing agro-industrial activities in the last five decades and is projected to improve population growth. In the next decade, total output from both capture and aquaculture is expected to exceed that of other livestock produce (FAO, 2012).

Increased productivity of fry and fingerlings with attributes of faster growth rates and better environmental tolerance is sine qua non to ensuring fish food security in Africa. Genetic techniques are therefore needed to ensure that a faster growth rate leading to a shorter production cycle as well as a greater tolerance for poor water condition is achieved.

Hybridization is practiced to achieve favourable outcomes: this includes heterosis or hybrid vigor, which is defined in a broad sense as increased performance value of progeny above the average of the parental performance value (Ojutiku, 2008).

Legendre *et al.* (1992) investigated hybridization of the two African catfishes: *Clarias gariepinus* and *Heterobranchus longifilis*. These authors reported viability in reciprocal hybrids with their survival rates being similar to those found in the maternal species. Furthermore, Sahoo et al (2003) investigated hybridization between two clariids: *Clarias batrachus* (Linn.) x *Clarias gariepinus* (Bur.) and performance of the offspring in rearing operations. Nwadukwe (1995) reported the growth performance of *Clarias gariepinus* and *Heterobranchus longifilis* and their F1 hybrids with the reciprocal cross showing intermediate growth rate between both parents. Aluko (1995) reported that crosses between male *Heterobranchus longifilis* and female *Clarias anguillaris* were significantly heavier and longer than the reciprocal cross. The objective of this study was to test the crossbreeds of (*Clarias gariepinus* x *Heterobranchus bidorsalis*) for growth and survival heterosis.

MATERIALS AND METHODS

The broodstocks of *Clarias gariepinus* and *Heterobranchus bidorsalis* of known breeding records were obtained from the Teaching and Research Farm, Water Resources, Aquaculture and Fisheries Technology Department, Minna, Niger State.

Catfish Hybrid: The crossing of these species was carried out in the Department of Water Resources, Aquaculture and Fisheries Technology Wet Laboratory. These were labeled as: Cl X Cl (*Clarias gariepinus* X *Clarias gariepinus*), Ht X Ht (*Heterobranchus bidorsalis* X *Heterobranchus bidorsalis*), Ht X Cl (*Heterobranchus bidorsalis* X *Clarias gariepinus*) and Cl X Ht (*Clarias gariepinus* X *Heterobranchus bidorsalis*). In all the crosses the female is mentioned first (♀ × ♂).

Oocyte maturation and Ovulation: Oocyte maturation and ovulation was induced by a single intramuscular injection of Ovatide at a dose of 0.5 ml kg-1. Time between injection and ovulation was 12 hours for *Clarias gariepinus* and 15 hours for *Heterobranchus bidorsalis*. After ovulation, eggs were collected by manually pressing the abdomen towards the caudal fin into a dry clean plastic bowl. Milt was obtained by surgically removing the testes. Sperm was extended in 0.9% NaCl solution. The oocytes were fertilized by adding the extended milt mixture. The resulting mixture was stirred using a plastic spoon for one minute to ensure complete fertilization then triplicate batches of eggs from each cross were incubated in 25L plastic aquaria with flow through water system using mosquito mesh netting as substrate.

Three females and two males were used for the crosses. A control sample of eggs that were not inseminated was used to determine fertilization. The time taken for these control eggs to become opaque (dead eggs) was noted, after which the brownish/greenish eggs in the incubation tanks were termed as fertilized.

Diet: Hatchlings were fed ad libitum twice daily with dried decapsulated cysts of Artemia sp. After two weeks of feeding, the fish were introduced gradually to an artificial dry diet of Skretting (0.2mm-0.3mm) catfish feed for 2 weeks and 0.5mm-0.8mm for the remaining 4 weeks.

Experimental Design: Fifty 14-day old juveniles from each of the four crosses Cl × Cl, Ht × Ht, Ht × Cl, and Cl × Ht were stocked separately in triplicate 25L plastic aquaria with water continuously aerated and renewed totally every two days. The experiment lasted for fifty-six days and mean fish weight in each tank was determined every week beginning from the day they were stocked in the tanks. Waste removal was done by siphoning every day. For sampling, 10 fish were selected randomly using a fine mesh mosquito size net and then weighed in bulk on a sensitive balance. After the 56 days period, the surviving juveniles were counted and all fish from the tank were weighed in bulk.

Production Parameters

Total length: Total length of juvenile catfish in different treatments was recorded using fish measuring board to the nearest 0.01 cm.

Weight gain: Weight gain was calculated using W2 – W1, where W2 is final weight and W1 is initial weight over a sampling period.

% Fertilization =

$$\frac{Total\ No\ of\ Fertilized\ eggs}{Total\ No\ of\ Eggs\ stripped}\ X\ 100$$

Using NIFFR standard, 1g of fertilized eggs equals 700 pieces of eggs.

% Hatchability =

$$\frac{Total\ No\ of\ Hatched\ eggs}{Total\ No\ of\ Eggs\ fertilized}\ X\ 100$$

% Survival =

$$\frac{Cummulative\ No\ of\ survival}{Total\ No\ of\ fishes\ stocked}\ X\ 100$$

Specific growth rate: Specific growth rate of catfish in different treatments was calculated using the formula;

$$\frac{LnW_2 - LnW_1}{t} \times 100$$

Where: W_2 = Final mean body weight,

W_1 = Initial mean body weight and t = time in days.

The mean weights and surviving number of the crossbreeds and the pure breeds were used to ascertain heterosis for growth and survival, respectively.

Condition factor (K) =

$$\frac{W}{L^3}\ X\ 100$$

Where W = Weight while L = Length

Feed Conversion Ratio (FCR) =

$$\frac{Total\ Feed\ Fed(g)}{Weight\ Gain\ (g)}$$

Heterosis here refers to the performance whether growth or survival of the crossbreeds relative to that of the purebreds as expressed in percentage by the formula (Nguenga *et al* .2000).

$$\text{Heterosis} = \frac{\left(\frac{(C1+C2)}{2} - \frac{(P1+P2)}{2}\right)}{P1+P2}\ X\ 100$$

Where C1 or C2 are the mean final weight or survival of crossbreeds, and P1 or P2 are the mean final weight or survival of the purebreds.

Growth and survival rates were compared using one-way analysis of variance (ANOVA) and Fisher's LSD to determine significant differences between means. Since mean initial weights differed significantly among the genetic groups studied, the specific growth rate (SGR) of the fish were compared using Analysis of covariance with the initial weight serving as covariate.

RESULTS

Table 1 shows the fertilization, hatchability, mean initial weight, mean final weight, weight gain, specific growth rate (SGR), survival rate (SR), condition factor (K) and feed conversion ratio for pure breeds and crossbreeds of two African catfishes *Clarias gariepinus* and *Heterobranchus bidorsalis* reared under hatchery conditions in plastic aquaria for 56 days.

The pure breed (Ht X Ht) showed higher fertilization and survival rates (58.57% and 38.42% respectively) than other crosses. The hatchability rate for the cross Ht♀ X Cl♂ (85.18%) was significantly different from the other crosses ($P<0.05$). The feed conversion ratio (FCR) of the two hybrids: Ht♀ X Cl♂ and Cl♀ X Ht♂ were significantly higher than those of the pure breeds. In terms of final mean weights, the pure cross (Cl X Cl) had a significantly ($P<0.05$) higher weight (1980mg) than the other three crosses. The pure breeds recorded higher SGR, 4.91%day-1 and 2.64%day-1 for Cl X Cl and Ht X Ht respectively. The result of the condition factor (K) indicated that the pure cross (Ht X Ht) gave the highest value (2.37g/cm^3). These was significantly different from other crosses ($P>0.05$) with values of 2.17g/cm^3 for Cl♀ X Ht♂, 1.77 g/cm^3 for Ht♀ X Cl♂ and 0.87 g/cm^3 for Cl X Cl.

Table 1. Fertilization, Hatchability, Mean Growth, condition factor, feed conversion ratio and survival rates of pure lines and cross breeds of *Clarias gariepinus* and *Heterobranchus bidorsalis*.

Variables	Cl X Cl	Ht♀ X Cl♂	Cl♀ X Ht♂	Ht X Ht
Fertilization, % ±S.E.	40.29 ± 0.04^{d}	44.50 ± 0.04^{c}	48.18 ± 0.04^{b}	58.57 ± 0.04^{a}
Hatchability, % ±S.E.	53.76 ± 0.01^{c}	85.18 ± 0.01^{a}	57.57 ± 0.01^{b}	50.42 ± 0.01^{d}
Initial Weight, mg ± S.E.	100 ± 8.16^{a}	90 ± 8.16^{a}	80 ± 8.16^{a}	80 ± 8.16^{a}
Final Mean weight, mg ± S.E.	1980 ± 8.16^{a}	280 ± 8.16^{c}	250 ± 8.16^{d}	360 ± 8.16^{b}
Weight Gain, mg ± S.E.	1880 ± 8.16^{a}	190 ± 8.16^{c}	170 ± 8.16^{d}	280 ± 8.16^{b}
SGR, % day -1± S.E.	4.91 ± 0.01^{a}	2.07 ± 0.01^{c}	1.98 ± 0.01^{d}	2.64 ± 0.01^{b}
Survival Rate, % ± S.E.	12.25 ± 0.01^{b}	12.08 ± 0.01^{c}	10.88 ± 0.01^{d}	38.42 ± 0.01^{a}
Condition factor, g/cm^3 ± S.E.	0.87 ± 0.01^{d}	1.77 ± 0.01^{c}	2.17 ± 0.01^{b}	2.37 ± 0.01^{a}
FCR, ± S.E.	0.14 ± 0.01^{d}	1.11 ± 0.01^{b}	1.25 ± 0.01^{a}	0.76 ± 0.01^{c}

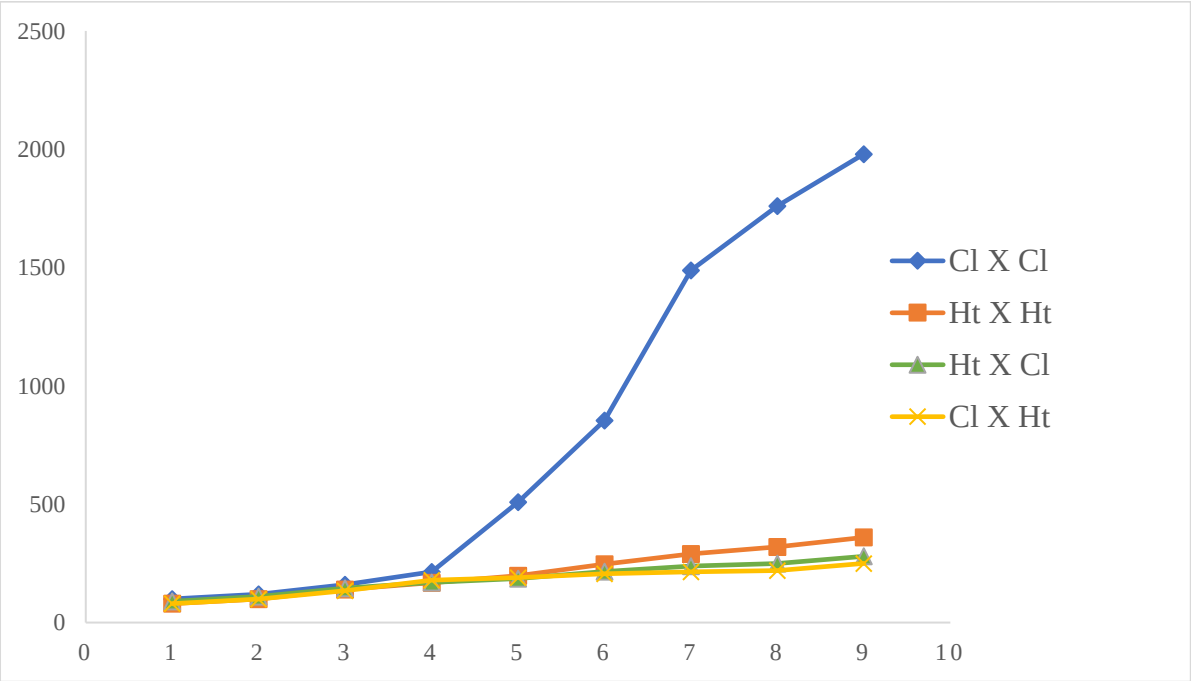
Means (n=3) in each row with same superscript were not significantly different (P>0.05)

Table 2: Heterosis for the various stages of development of progeny of the crosses.

STAGE	**GROWTH**	**SURVIVAL**
FINGERLINGS	-14.95	26.56

The hybrids displayed a negative heterosis for growth (-14.95%) due to their poor growth compared to the pure breeds after 56 days period. In terms of survival, the hybrids showed a positive heterosis (26.56%) after 56 days of rearing.

Figure 1: Growth pattern of fry from crosses of *Clarias gariepinus*, *Heterobranchus bidorsalis* and their hybrids reared for 56 days.



DISCUSSION

The highest percentage fertilization in the cross Ht X Ht was attributed to egg and milt quality and viability. This corroborates the work of Moses and Olufeagba (2005) on karyomorphology of African catfish.

The inter-generic cross between Ht♀ X Cl♂ gave the highest percentage hatchability. This was similarly to the research conducted by Madu and Ofor (2004) which revealed that fecundity and viability of eggs from smaller size brood stock of 200-599g are higher in hatchability when compared to larger brood stock of 600-799g.

The result of survival rate showed that Ht X Ht differed significantly from the other crosses ($P<0.05$). This observation differed from the study of Olurin & Aderibigbe (2006), and Akinwande et al (2012) who recorded higher values (80% and 86% respectively) for *C. gariepinus,* and 70% for hybrid crosses of male *H. longifilis* and female *C. anguillaris* (Akinwande et al 2012).

The general lower survival rate in this study can be attributed to mortalities resulting from the weekly sampling stress since the fry were very fragile at this stage.

The final mean weights of the four genetic groups under study ranged from 250mg to 1980mg. The cross Cl♀ X Ht♂ showed the least final mean weight gain with 250mg. This is significantly lower than the values of 2250mg reported for the same cross by Nlewadim et al (2004). However, the final mean weight value of 1980mg as recorded for Cl X Cl is comparable to the value of 1950mg as reported by Nlewadim et al (2004). The weight gain of these genetic groups also follows the same pattern as the final mean weights. The final mean weight of the cross Cl X Cl differed significantly from the other three genetic groups ($P<0.05$).

There was significant difference in specific growth rate among the four genetic groups studied ($P>0.05$). The SGR of 4.91 %.day-1 reported in the present study for the cross Cl X Cl is just a little bit higher than the range of 2.12%.day-1 to 3.96%.day-1 as reported for various strains of *Heterobranchus longifilis* by Nguenga et al (2000).

The specific growth rate (SGR) observed for pure strains as compared to the hybrids in this experiment, seems that the heterotic effect of hybridization (hybrid vigour) had not yet manifested at this early stage in the hybrids.

Hence this compares well with Madu et al. (1993) who explains that the superior growth characteristics of the hybrids will not be manifested until after 12 months culture period from fingerlings to adult. Nwadukwe and Nawa (2000) noted that mean weight was directly related to length of rearing period, and this also explains the relative low weight of the hybrids compared with the parent crosses.

The pure breed (Ht X Ht) and the two hybrids (Ht♀ X Cl♂ and Cl♀ X Ht♂) of this study had condition factors > 1, this support Ujjania et al. (2012) who stated that condition factor greater or equal to one is good, indicating a good level of feeding, and proper environmental condition. Bagenal and Tesch (1978) recommended K value range (2.9-4.8) as suitable for matured fresh water fish.

According to Ndome *et al.* 2011, the FCR's of 1.0-2.0 are considered good for most fish species. Therefore, the two hybrids showed the best Feed Conversion Ratio (FCR).

The crossbreeds showed a negative heterosis for growth (–14.95). This is as a

result of their poor growth but they displayed a positive heterosis for survival (26.56) after 56 days of rearing. The negative heterosis value for growth shows that a negative interaction has occurred between the parental genes found at different loci in the inter-generic hybrid genome as reported by Sheridan (1981). The phenotypic variance of a quantitative trait such as growth and survival are governed by the genetic variance, environmental variance and the interaction between the genetic and environmental variance (Tave 1993). A negative interaction between the genetic variance of the hybrid and the environment may have led to poor phenotypic expression of growth.

CONCLUSION

There is need for further research into these crosses in earthen ponds so as to determine the true commercial application of the inter-generic crosses investigated here. This is important since the crossbreeds displayed a positive heterosis for survival hence greater numbers of fry and fingerlings surviving to adult stage.

The performance of the hybrid fingerlings to adult stage in the study needs to be re-examined to confirm the performance of hybrid species.

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