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Comparative Reproductive and Growth Performance of *Clarias gariepinus* (Burchell, 1822) and Its Hybrid Induced with Synthetic Hormone and Pituitary Gland of *Clarias gariepinus*

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Abstract

A study was conducted to determine the comparative reproductive, growth performances and nutrient utilization of *Clarias gariepinus* and its hybrid "heteroclarias" using ovaprim and pituitary extract of male and female *C. gariepinus.* The experimental broodstocks consisted of 6 female *C. gariepinus* (2 each were induced separately with ovaprim, male pituitary of *C. gariepinus* and female pituitary of *C. gariepinus*), 3 male *C. gariepinus* and 3 male *Heterobranchus bidorsalis*. 2 female *C. gariepinus* induced with synthetic hormone were crossed separately with male *C. gariepinus* and male *H. bidorsalis*. A similar crossing was done for the other two sets of female *C. gariepinus* induced with male and female pituitary glands. The result shows that there was significant difference ($P<0.05$) among the treatments in all the reproductive performance, growth and nutrient utilization parameters. The highest percentage fertilization (88.44±5.74%), feed intake (27.48±7.08g), protein intake (15.39±3.96g), feed conversion ratio (1.21±0.12) and protein efficiency ratio (1.68±0.19) were recorded in pure line *C. gariepinus* induced with ovaprim. Pure breed *C. gariepinus* also had the highest values in all the reproductive performance and growth parameters. This study has shown that *C. gariepinus* induced with synthetic hormone (ovaprim) produce offspring with better qualities than those induced with pituitary.

Keywords: Catfish, Ovaprim, pituitary extract, growth parameters, nutrient utilization.

Introduction

Fish is the cheapest source of animal protein consumed by the average Nigerian, accounting for about 40% of the total protein intake (Atanda, 2007). One of the major problems identified as hindering the promotion and development of aquaculture in the country is the scarcity of fish fingerlings of the desired cultured species (Adewolu *et al*., 2008). If the potential of one million tonnes of fish as speculated by FAO (2004) were to be realized at a semi-intensive management level of fingerlings production, then at least two billion fingerlings would be required annually from all sources (Atanda, 2007).

Aquaculture unlike capture fisheries requires deliberate human intervention in the organism productivity and yields that exceeds those from the natural environment alone. Aquaculture genetics shows immense potential for enhancing production in a way that meets aquaculture development goals for the new millennium. The application of these genetic tools is known to have increase fish production (Akinwande *et al*., 2009).

C. gariepinus and *H. bidorsalis* show a seasonal gonadal maturation which is usually associated with the rainy season. The maturation processes of both species are influenced by annual changes in water temperature and photoperiodicity and the final triggering of spawning is caused by a rise in water level due to rainfall (de Graaf *et al*., 1995).

Artificial reproduction in catfish species especially *C. gariepinus* and *H. bidorsalis* have been studied by several authors (Haniffa and Sridhar, 2002; Nwokoye *et al.,* 2007; Akinwande *et al.*, 2009; Ataguba *et al.*, 2009; Owodeinde and Ndimele, 2011). There are several techniques used in artificial propagation of catfishes. In induced propagation without hormone treatment, mature breeders are reproduced artificially by simulating the events which will occur during rainy season and these trigger the mating and spawning processes. Hormone can also be administered on female broodfish to provoke the mating and spawning processes. These induced females are kept in ponds containing males for spawning and fertilisation. However, these methods cannot be used for commercial purposes because the success rate is low. The most successful method of artificial reproduction in catfish is by induced breeding through hormone treatment followed by artificial fertilization and incubation of fertilized eggs

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and the subsequent rearing to fingerlings. The hormone administered can be deoxycorticosteroid acetate (DOCA), human chorionic gonadotropin (HCG) or the pituitary glands of fish and other animals like frog (Nwokoye *et al*., 2007).

In recent years, the culture of species of the catfish belonging to the Clariidae family is fast gaining global attention. In Africa, especially Nigeria, the species mostly cultured are *Clarias gariepinus*, *Heterobranchus* sp and their hybrids (Adewolu *et al*., 2008). They are widely cultured owing to their high market price, fast growth rate and ability to withstand adverse pond conditions especially low oxygen content (Adewolu and Adeoti, 2010). Oladosu *et al*. (1993) reported that inter-specific hybrid fishes transfer desirable traits between species, combine desirable trait of two species into a single group of fishes. In Nigeria, getting fast growing fish seed have been a major problem to farmers targeting high yields. Hybrid clariid catfish has increased rapidly in the last few years and apparently market demand is still increasing (Odedeyi, 2007). Ayinla and Nwadukwe (1989) found that there are variations in the sizes of fingerlings produced from the same clariid broodstock at the same time and that the variations in sizes of the fingerlings might be related to the variations in sizes of their eggs. Among the culturable fin fish in Nigeria, catfish is the most sought after fish species, very popular with fish farmers and consumers. It commands very good commercial value in Nigerian markets (Ezenwaji, 1985; Ayinla *et al*., 1994). The catfish is very important to the sustainability of the aquaculture industry in Nigeria. The blending of high survival rate and fast growth rate into the hybrid "heteroclarias" offers higher production prospects.

This study was therefore designed to investigate the reproductive, growth and nutrient utilization performance of pure breed *C. gariepinus* and its hybrid (heteroclarias) when induced with synthetic hormone and pituitary of male and female *C. gariepinus*.

Materials and Methods

This study was carried out between April, 2010 and October, 2010 using fish hatchery facilities of the Department of Fisheries, Lagos State University, Ojo, Lagos State, Nigeria. Hatchery raised mature broodstocks were selected from Lagos State University hatchery. All broodfish were selected by consideration of external morphological characteristics, using the method of Ayinla *et al*. (1994). Female fish were also selected on the basis of ovarian biopsy (Legendre, 1986). Six females *Clarias gariepinus*, three males *Clarias gariepinus* and three males *Heterobranchus bidorsalis* (weight range of 700-1000 g) were selected. The female broodfish were kept separate from males in different tanks.

Mating was performed in the following order:

1 *C. gariepinus* ♀ x *C. gariepinus* ♂ (injected with synthetic hormone - ovaprim)

2 *C. gariepinus* ♀ x *H. bidorsalis* ♂ (injected with synthetic hormone – ovaprim)

3 *C. gariepinus* ♀ x *C. gariepinus* ♂ (injected with pituitary gland of female *Clarias gariepinus*)

4 *C. gariepinus* ♀ x *H. bidorsalis* ♂ (injected with pituitary gland of female *Clarias gariepinus*)

5 *C. gariepinus* ♀ x *C. gariepinus* ♂ (injected with pituitary gland of male *Clarias gariepinus*)

6 *C. gariepinus* ♀ x *H. bidorsalis* ♂ (injected with pituitary gland of male *Clarias gariepinus*)

Experimental Design and Artificial Spawning

Six treatments were used as indicated by the crosses above. Three hormonal materials {Synthetic hormone [ovaprim (Aqualife Syndel International Inc., Vancouver, BC, Canada)] and pituitary gland of male and female *C. gariepinus* (homoplastic hormones)} were used. Six artificial spawning trials were carried out using 6 mature females of *C. gariepinus*, three males of *C. gariepinus* and three males of *H. bidorsalis.* Pituitary glands were extracted from mature male and female *C. gariepinus* using the methods of Viveen *et al.* (1985). Each gland was then transferred into a sealed test tube containing acetone. Prior to hormone injection, vitellogenic females (female eggs were examined to confirm that they are at the stage of exogenous vitellogenesis) were randomly taken out of the tank and kept singly. Hormonal materials (synthetic and pituitary gland) were administered between 6pm and 7pm same day. Prior to homoplastic hypophysation, the weighed and stored acetone dried pituitary gland (donor fish has similar weight with recipient fish) was macerated in a porcelain mortar with a known volume (1 ml per kg body wt. of fish) of 0.6% saline solution. The pituitary suspension was drawn with 5ml hypodermic syringe with 0.6mm gauge needle. The weighed fish was then injected intramuscularly above the lateral line towards the dorsal section and pointed towards the ventral side. After withdrawal of the needle, the fish was finger-rubbed to avoid back flow of the injected fluid. Ovaprim was administered at 0.5 ml/kg body weight of female fish (Legendre, 1986). The injected fish were returned separately into their tanks containing clean water at 27°C for ovulation and maturation of gonad. Stripping of matured eggs took place 16-18 h after injection of the hormones at a mean temperature of 28°C. Six male broodfish (three *C. gariepinus* and three *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. Stripped eggs (80 g of egg per female fish) were later fertilized with milt after sperm activation was triggered by the addition of 5 ml fresh water and checked for motility by microscopic examination (Viveen *et al.*, 1985). The stripped yellowish-green eggs of *C. gariepinus* collected from three females

injected separately with ovaprim, pituitary gland of male *C. gariepinus* and pituitary gland of female *C. gariepinus* were divided into two parts (that is, each half weighs 40 g). One part of the eggs were fertilized with the milt of *C. gariepinus* - pure line, while the other part of the eggs were fertilized with the milt of *H. bidorsalis* - crossbreed. Excess milt from removed from eggs. The two sex products were then mixed with dry plastic spoon to avoid contamination of eggs by using this 0.6% saline solution. Spermatozoa from mature male were used to fertilize eggs stripped from females.

Incubation of the fertilized eggs were carried out in 6 glass tanks (70 x 45 x 35 cm), each containing a treatment or genetic cross. It was equipped with an aerator system i.e. a blower and air stones provided continual aeration. Nylon mesh (1mm) was suspended at the floor for spreading of the fertilized eggs. The eggs were spread in single layers on the suspended nylon meshed net for incubation. Hatching occurred 24 - 26h later. The larvae absorbed the yolk for three days. The nylon meshed nets were removed with the egg shells while the hatched larvae clustered at dark corners of the incubation tank. Three days from hatching, frys were fed to satiation with *Artemia naupli* for 14 days. Aeration was supplied continually; water temperature, pH and dissolved oxygen were 28±1°C, 6.76 and 4.3 mg/L respectively. Water was changed daily to avoid mortality resulting from polluted water.

Some physiochemical parameters of the water in each treatment were determined regularly. Temperatures of water in all tanks were measured daily using a thermometer. pH was measured by a Jenway model 9060 pH meter. Dissolved oxygen concentration in water was determined weekly using the methods of winkler (APHA, 1989).

Reproductive Performance Parameters

The number of eggs released was determined by subtracting the weight of the broodstock after spawning from the weight before spawning in grams and multiplying the difference by 700, (1 gm=700 eggs) (Viveen *et al*., 1985).

Fertilization rate was determined when the eggs generally reached the 4-8 celled stage of embryonic development. For calculating percent fertilisation, a sample from each replicate of each treatment were carefully collected on a petri dish containing water and the number of fertilised and unfertilised eggs were counted under a binocular microscope (x 10) (Adebayo, 2006). The fertilisation rate was then calculated by the following equation according to Adebayo (2006).

Fertilisation Rate = (Number of fertilised eggs / Total number of eggs counted) x 100

The eggs were then transferred to their original lot for hatching. After hatching, the numbers of hatchlings within each batch were carefully counted and the hatching rate was calculated using the following equation according Adebayo (2006).

Hatching Rate = (Number of eggs hatched / Total number of eggs in a batch) x 100

Survival rate was also determined as follows (Adebayo, 2006):

Survival Rate = (Number of hatchlings alive to larva stage / Total number of hatchings) x 100

Growth Experiment

After the reproductive performance, a total of five hundred and forty (540) 14-days old pure and hybrid catfish (*C. gariepinus* and *H. bidorsalis*) juveniles were used for the growth phase of the experiment. Thirty (30) juveniles were assigned to each one of the three replicates of the six treatments (genetic crosses). The treatments were randomly allocated into 18 different circular flow-through tanks. Rearing conditions were the same as described above. Each 2-m diameter tank contained about 45-L fresh water with at least 50% water exchange daily. Prior to stocking, quicklime was applied to the tank bottom at 150 g/m^2 to eliminate parasites and invertebrate predators.

Feeding Trial

Fish in each experimental unit (flow-through tank) were gradually weaned over a five-day period unto pelleted artificial diet {56% crude protein (Table 1)}. Feeding was done twice a day at 3% body weight at 09:00 – 17:00h for a period of 56 days. Feed was dispensed evenly on the water surface of each tank to allow equal feeding opportunity. Feeding in all tanks was generally completed in about 10–15 min. The mean size of the fish {weight (g) and total length (cm)} for each treatment and its replicates were measured every 2 weeks. The feeding rate was recalculated to accommodate weight changes.

The following growth and nutrient utilization parameters were determined:

Growth Parameters

Weight Gain (WTG) = $W_i - W_o$

where W_i = final mean weight (g), W_o = Initial mean weight (g)

Percentage Weight Gain (%) = $[(W_i - W_o)/ W_o] \times 100$

where W_i = final mean body weight (g), W_o = Initial mean body weight (g)

Table 1. Nutrient composition of commercial feed (Catco Fısh Concentrate – Coppens) fed to frys of pure and hybrid catfish.

Nutrient	% Composition
Crude protein	56.0
Crude fibre	10.9
Crude fat	15.0
Ash	10.9
Phosphorus	8.0
Energy	3400Kcal/kg

*Each kg of the diet contained: 300mg Vit C, 200mg Vit E, 22,500 IU Vit A, 2,500 IU vit D_3, 5mg Cu, E280 Preservatives and E324 Anti-oxidants.

Specific Growth Rate (SGR) = $[(\text{Log}_e W_i - \text{Log}_e W_o)/(T-t)] \times 100$

where W_i = final weight, W_o = Initial weight, T = Final Time (days), t = initial time (days).

Log_e = Natural logarithm.

Average Daily Growth (ADG)= $\frac{W_2 - W_1}{T}$

where W_2= mean final weight, W_1 = mean initial weight, T = rearing period (days).

Nutrient Utilization Parameters

Feed Intake (FI): Feed intake was determined as quantity of feed fed per day and was calculated as

FI= 3% body weight of fish/days

Protein Intake (PI)= feed intake (g) x % protein in the diet

Feed Conversion Ratio (FCR)= [(Weight of dry feed fed to fish (g) / Live weight gained $\{W_i - W_o\}$ (g)]

Protein Efficiency Ratio (PER)= [Gain in weight of test fish (g) / Protein consumed (g)]

Length-Weight Relationship

Parameters of the length-weight relationship of identified fish species were estimated using the equation:

$$W = aL^b \quad \text{(Rickter, 1973)} \quad (1)$$

where W = Weight of fish (g); L = Length of fish (cm); a = y-intercept or the initial growth coefficient; b = Slope or the growth coefficient.

The values of constants a and b were estimated after logarithmic transformation of equation (1) using least square linear regression (Zar, 1984) to give:

$$\log W = \log a + b \log L \quad (2)$$

In order to confirm whether b values obtained in the linear regressions were significantly different from the isometric value, t-test was applied as expressed by the equation according to Sokal and Rohlf (1995):

$t_s = (b-3) / SE$,

where t_s is the t-test value, b the slope and SE the standard error of the slope (b).

The condition factor was calculated by the formula:

Condition Factor (K) = $\frac{100\ W}{L^b}$ (Pauly, 1983)

where W = Weight of fish (g); L = Length of fish (cm); b = Slope or the growth coefficient.

Statistical Analysis

The data were analysed for significant differences ($P<0.05$) by Analysis of Variance (ANOVA) using computer Statistical Package for Social Sciences (SPSS) for windows (v. 17.0). Determined differences were partitioned by the Least Significant Difference (LSD) at P=0.05. All percentage data were transformed to arc sin values prior to analysis (Zar, 1984).

Results

Water Quality Parameters

The mean dissolved oxygen of the treatments were between 3.05-4.43 mg/L, temperature ranged between 28.51-28.84°C and the pH mean values ranged between 6.28-6.79.

Reproductive Performance

Artificial breeding of *Clarias gariepinus* and its hybrids "*Heteroclarias* (*C. gariepinus* ♀ x *H. bidorsalis* ♂)" were successfully carried out through the use of synthetic hormone (ovaprim) and pituitary extracts of male and female *C. gariepinus* to induce spawning in broodstocks.

The percentage fertilization, hatching rate and survival rate of the eggs differed significantly ($P<0.05$) in each of the experimental unit (genetic crosses) (Table 2). The highest percentage fertilization (88.44±5.74%) and percentage hatching rate (71.76±0.18%) were recorded in pure line of *C. gariepinus* (C.g ♀ x C.g ♂) induced with ovaprim, while the least for both parameters {percentage fertilization, (31.92±0.07%); percentage hatching rate, (28.48±0.48%)} were recorded in hybrid– "*heteroclarias*" (C.g ♀ x H.b ♂) induced with female

Table 2. Percentage Fertilization, Hatching Rate and Percentage Survival (14 Days Post-Hatch) of Pure Breed and Hybrid Catfish Induced with Synthetic Hormone (Ovaprim) and Pituitary of *Clarias gariepinus*

Treatment	% Fertilization (Mean±SD)	Hatching rate (Mean±SD)	% Survival (Mean±SD)
Ovaprim			
(C.g ♀ x C.g ♂)	88.44±5.74[a]	71.76±0.18[a]	47.83±2.13[a]
(C.g ♀ x H.b ♂)	63.43±2.58[b]	58.56±1.76[b]	40.00±0.58[b]
Male pituitary of *Clarias gariepinus*			
(C.g ♀ x C.g ♂)	72.19±3.36[b]	67.82±0.14[a]	73.68±3.72[c]
(C.g ♀ x H.b ♂)	60.28±0.98[b]	54.47±2.79[b]	44.44±1.78a[b]
Female pituitary of *Clarias gariepinus*			
(C.g ♀ x C.g ♂)	35.15±0.49[c]	32.31±1.02[c]	60.00±0.57[d]
(C.g ♀ x H.b ♂)	31.92±0.07[c]	28.45±0.48[c]	56.67±1.22[d]

*Values in the same column and with the same superscript are not significantly different (P>0.05)

pituitary. The highest (73.68±3.72%) and lowest (40.00±0.58%) percentage survival rate was recorded in pure line of *C. gariepinus* (C.g ♀ x C.g ♂) administered with male pituitary and hybrid-"*heteroclarias*" (C.g ♀ x H.b ♂) induced with ovaprim respectively.

Growth Parameters

The growth parameters (weight gain, percentage weight gain, average daily growth and specific growth rate) differed significantly (P<0.05) among the treatments (genetic crosses). The mean weight gain was highest (8.88±1.16g) in pure line of *C. gariepinus* (C.g ♀ X C.g ♂) induced with ovaprim while the lowest value (0.53±0.14) was recorded in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with male pituitary. The mean percentage weight gain was highest (114.25±15.65) in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with ovaprim and the lowest (30.13±2.29) was recorded in hybrid (C.g ♀ x H.b ♂) induced with male pituitary. This difference is significant (P<0.05) as shown in Table 3.

The mean average daily growth was highest (0.46±0.05g) in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with ovaprim and the lowest (0.02±0.01) in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with male pituitary. The mean specific growth rate was highest (5.01±0.58%/day) and lowest (1.14±0.17%/day) in hybrid (C.g ♀ x H.b ♂) induced with ovaprim and pure line *C. gariepinus* (C.g ♀ x C.g ♂) induced with male pituitary respectively.

Nutrient Utilization

The nutrient utilization parameters (feed intake, protein intake, feed conversion ratio and protein efficiency ratio) showed significant differences (P<0.05) among the experimental units (genetic crosses) (Table 4). The highest value for feed intake (27.48±7.08g), protein intake (15.39±3.96g), protein efficiency ratio (1.68±0.19) was in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with ovaprim while the lowest values for the three parameters {feed intake (2.38±0.57g), protein intake (1.33±0.32g), protein efficiency ratio (0.51±0.06} was recorded in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) but induced with male pituitary. The best food conversion ratio (1.21±0.12) was obtained in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with ovaprim while the least (3.95±0.39) was in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with male pituitary.

Lenght–Weight Relationship

The growth coefficient factor (b-value) of the genetic crosses showed that only pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with ovaprim had a positive allometric growth (b=3.40). The other crosses had negative allometric growth (Table 5). The result also revealed that both the pure breeds (*C. gariepinus*) and hybrid (*heteroclarias*) had condition factors (K) of less than 1.

Discussion

Weatherly (1990) described fish growth as the end product and an integrator of the reactions involving the intrinsic and extrinsic factors (including the aquatic medium) in which the fish finds itself. It has been established that specific features of the catfish environment are of primary importance in determining the growth and survival of the fish species. The dissolved oxygen of the treatments (genetic crosses) was between 3.05-4.43mg/L; temperature, 28.51-28.84°C and pH, 6.28-6.79. These values fall within the range (3-9 mg/L for dissolved oxygen), (24 - 32°C for temperature) and (6.5-9 for pH) reported by Boyd (1979) as the best for tropical fishes.

The fertilization rate of pure breed *C. gariepinus* (C.g ♀ x C.g ♂) and the hybrid (C.g ♀ x H.b ♂) induced with ovaprim and male pituitary in this study was high (88.44±5.74% and 60.28±0.98 respectively). However, percentage fertilization of pure breed *C. gariepinus* (C.g ♀ x C.g ♂) and the hybrid (C.g ♀ x H.b ♂) induced with female pituitary was low (35.15±0.49% and 31.92±0.07 respectively) (Table 2). The hatching rate followed the same trend as the fertilization rate. The result of this study shows that

Table 3. Growth of pure line and hybrid of *Clarias gariepinus* and *Heterobranchus bidorsalis* induced with synthetic hormone (Ovaprim) and pituitary glands of male and female *Clarias gariepinus*

Treatment	WG (g) (Mean±SD)	PWG (%) (Mean±SD)	ADG (g) (Mean±SD)	SGR (%/day) (Mean±SD)
Ovaprim				
(C.g ♀ x C.g ♂)	8.88±1.16^{a}	114.25±15.65^{a}	0.46±0.05^{a}	4.23±0.52^{a}
(C.g ♀ x H.b ♂)	3.68±0.73^{b}	54.45±10.27^{b}	0.20±0.03^{b}	5.01±0.58^{a}
Male pituitary of *Clarias gariepinus*				
(C.g ♀ x C.g ♂)	0.53±0.14^{c}	32.83±7.63^{b}	0.02±0.01^{c}	1.14±0.17^{b}
(C.g ♀ x H.b ♂)	0.65±0.07^{c}	30.13±2.29^{b}	0.04±0.01^{c}	1.92±0.06^{b}
Female pituitary of *Clarias gariepinus*				
(C.g ♀ x C.g ♂)	2.33±0.25^{b}	59.05±13.12^{b}	0.19±0.02^{b}	4.47±0.31^{a}
(C.g ♀ x H.b ♂)	2.93±0.34^{b}	59.23±8.09^{b}	0.19±0.01^{b}	3.88±0.17^{a}

*WG = Mean weight gain; PWG = percentage weight gain; ADG = Average daily growth; SGR = Specific growth rate.
*Values in the same column and with the same superscript are not significantly different (P>0.05).

Table 4. Nutrient utilization parameters of pure line and hybrid of *Clarias gariepinus* and *Heterobranchus bidorsalis* induced with synthetic hormone (Ovaprim) and pituitary glands of male and female *Clarias gariepinus*

Treatment	FI (g) (Mean±SD)	PI (g) (Mean±SD)	FCR (Mean±SD)	PER (Mean±SD)
Ovaprim				
(C.g ♀ x C.g ♂)	27.48±7.08^{a}	15.39±3.96^{a}	1.21±0.12^{a}	1.68±0.49^{a}
(C.g ♀ x H.b ♂)	14.66±3.38^{b}	8.20±1.89^{b}	1.75±0.08^{ab}	1.04±0.06^{b}
Male pituitary of *Clarias gariepinus*				
(C.g ♀ x C.g ♂)	2.38±0.57^{c}	1.33±0.32^{c}	3.95±0.39^{c}	0.51±0.06^{c}
(C.g ♀ x H.b ♂)	3.31±0.68^{c}	1.85±0.38^{c}	2.16±0.12^{b}	0.85±0.06^{bc}
Female pituitary of *Clarias gariepinus*				
(C.g ♀ x C.g ♂)	9.24±1.93^{bc}	5.14±1.09^{bc}	1.34±0.16^{a}	1.47±0.18^{a}
(C.g ♀ x H.b ♂)	11.06±2.45^{bc}	6.19±1.37^{bc}	1.44±0.13^{a}	1.36±0.13^{ab}

*FI = Feed intake; PI = Protein intake; FCR = Food conversion ratio; PER = Protein efficiency ratio. *Values in the same column and with the same superscript are not significantly different (P>0.05).

Table 5. Parameters of length-weight relationship of pure line and hybrid of *Clarias gariepinus* and *Heterobranchus bidorsalis* induced with synthetic hormone (Ovaprim) and pituitary glands of male and female *Clarias gariepinus*

Treatment	A	B	r^2	k
Ovaprim				
(C.g ♀ x C.g ♂)	2.557	3.40	0.872	0.041
(C.g ♀ x H.b ♂)	1.744	2.678	0.971	0.039
Male pituitary of *Clarias gariepinus*				
(C.g ♀ x C.g ♂)	0.517	1.143	0.921	0.074
(C.g ♀ x H.b ♂)	0.237	0.817	0.972	0.044
Female pituitary of *Clarias gariepinus*				
(C.g ♀ x C.g ♂)	0.449	1.384	0.998	0.051
(C.g ♀ x H.b ♂)	0.381	1.346	0.990	0.051

*A = Initial growth coefficient; B = Growth exponent; r^2 = Coefficient of determination; k = Condition factor.

pure breed of *C. gariepinus* administered synthetic hormone (ovaprim) had the highest percentage fertilization rate (88.44±5.74%) and hatching rate (71.76±0.18%) while the lowest performance in fertilization (31.92±0.07%) and hatching (28.45±0.48%) was by the hybrid "heteroclarias" induced with female pituitary extract of *C. gariepinus*. This result agrees with previous studies by Nwokoye *et al.* (2007) and Haniffa and Sridhar (2002). Nwokoye *et al.* (2007) reported percentage fertilization of 98.31% and 96.01% for *Heterobranchus bidorsalis* induced with synthetic hormone (ovaprim) and homoplastic hormone (pituitary of *Heterobranchus bidorsalis*) respectively. The difference in percentage fertilization obtained in this study and the previous ones might be due to difference in species and experimental design. Owodeinde and Ndimele (2011) also agreed that the difference could be caused by duration of the study and stress of handling. Pure breed tolerate stress more than hybrid.

The highest percentage survival rate

(73.68±3.72%) was observed in pure breed *C. gariepinus* (C.g ♀ x C.g ♂) administered with male pituitary while the lowest (40.00±0.58%) was recorded in the hybrid "*heteroclarias*" (C.g ♀ x H.b ♂) induced with ovaprim. The values are small when compared with the result of the study by Nwokoye *et al.* (2007). They reported 99.88% survival rate for *Heterobranchus bidorsalis* induced with ovaprim and 99.61% for *Heterobranchus bidorsalis* induced with pituitary of *Heterobranchus bidorsalis*. However, De Graaf *et al.* (1995) reported a survival rate of 41.5% for *C. gariepinus* reared under a medium stocking density for a short duration in protected tanks. This observed difference might have been caused by water quality management, rearing condition and species variation.

The weight gain (WG), percentage weight gain (PWG), average daily growth (ADG) and specific growth rate (SGR) of pure breed *C. gariepinus* (C.g ♀ x C.g ♂) induced with synthetic hormone (ovaprim) were significantly ($p<0.05$) higher than the other crosses. The only exception was in SGR where the highest value (5.01±0.58 %/day) was recorded in hybrid induced with ovaprim but the difference was not significant ($P>0.05$). This result is generally similar to the study by Ataguba *et al.* (2009) and Owodeinde and Ndimele (2011) where pure breed of *C. gariepinus* performed better than their hybrid in terms of growth parameters. The result also agrees with the study of Adewolu *et al.* (2008) where the hybrid (*C. gariepinus* ♀ x *H. longifilis* ♂) had the highest specific growth rate. Specific growth rate is a better measure of growth than average daily growth because the former measures growth over a long period of time while the latter measures growth on a daily basis (Odedeyi, 2007). In this study, SGR was highest in the pure line (C.g ♀ x C.g ♂) and hybrid (C.g ♀ x H.b ♂) induced with ovaprim, indicating that they had better growth performance that the pure breed and hybrid that were induced with pituitary.

There were significant differences ($p<0.05$) in the four nutrient utilization parameters {feed intake (FI), protein intake (PI), feed conversion ratio (FCR) and protein efficiency ratio (PER)} investigated. The pure breed of *C. gariepinus* (C.g ♀ x C.g ♂) induced with synthetic hormone (ovaprim) had the highest values in all the four nutrient utilization parameters examined in this study. These values are significantly ($p<0.05$) higher than the values obtained in the other treatments (genetic crosses). This further elucidate the fact that pure breed *C. gariepinus* induced with ovaprim is preferable to the pituitary-induced ones.

The coefficient of determination (r^2) for length-weight relationship for the treatments was high (0.87 –0.99) which indicates that the length increases with increase in weight of fish. The growth co-efficient (b-value) of all the treatments were negatively allometric except that of pure line *C. gariepinus* that was positively allometric (Table 5). The study also revealed that the fishes generally had condition factors (K) of less than 1. This result should however not portray the fishes as being in bad state. This is due to their allometric growth pattern, where the length increased more than the weight. This view is supported by the study of Ekelemu and Zelibe (2006). In their study on the growth patterns of four dominant fish species in Ona Lake, they opined that fishes with allometric growth patterns often have K values of less than 1.

Conclusion

This study has shown that *Clarias gariepinus* and its hybrids can be successfully bred using both synthetic hormone and pituitary of *Clarias gariepinus.* Fingerlings from the pure breed *Clarias gariepinus* induced with synthetic hormone (ovaprim) had the best performances in terms of reproductive parameters, growth parameters and nutrient utilization. Furthermore, the rigorous procedures of extracting pituitary gland of catfish like *Clarias gariepinus*, which involves sacrificing the donor catfish are eliminated. Although, the males are usually sacrificed for milt, which is a necessity for fertilization. The synthetic hormone (ovaprim) can be recommended for induced spawning since it produced better results.

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References

Adebayo, O.T. 2006. Reproductive performance of African Clariid Catfish *Clarias gariepinus* broodstock on varying maternal stress. Journal of Fisheries International, 1(1-2): 17-20. doi=jfish.2006.17.20

Adewolu, M.A. and Adeoti, A.J. 2010. Effect of mixed feeding schedules with varying dietary crude protein levels on the growth and feed utilization of *Clarias gariepinus* (Burchell, 1822) fingerlings. J. Fish. Aquat. Sci., 5: 304-310. DOI: 10.3923/jfas.2010.304.310.

Adewolu, M.A., Ogunsanmi, A.O. and Yunusa A. 2008. Studies on Growth Performance and Feed utilization of two clariid catfish and their hybrid reared under different culture systems. European Journal of Scientific Research, 23(2): 252-260.

Akinwande, A.A., Moody, F.O. and Umar, S.O. 2009. Growth performance and survival of *Heterobranchus longifilis*, *Heterobranchus bidorsalis* and their reciprocal hybrids, African Scientist, 10(1): 15-18.

APHA, 1989, American Public Health Association (APHA). 1989. American Water Works Association and Water Pollution Control Federation (1989). Standard method for the examination of water waste water (17th edition), APHA, New York U.S.A., 1268 pp.

Ataguba, G.A., Annune, P.A., and Ogbe, F. G. 2009.

Induced breeding and Early Growth of Progeny from crosses between two African Clariid fishes, *Clarias gariepinus* (Burchell) and *Heterobranchus longifilis* under hatchery conditions. Journal of Applied Biosceiences, 14:755-600. http://www.biosciences.elewa.org/JABS/2009/14/1.pdf

Atanda, A.N. 2007. Freshwater fish seed resources in Nigeria. Bondad-REanteso, M.G. (Ed.), Assessment of freshwater fish seed resources for sustainable aquaculture. FAO Fisheries Technical Paper No. 501. Rome, FAO 628P: 361-380.

Ayinla, O.A., Kayode, O.J., Idoniboye-Obu, O.I.E, Oresegun, A. and Adidu, V.E. 1994. Use of tadpole meal as subsititute for fish meal in the diet of *Heterobranchus bidorsalis* (Geoffrey St Hillarie, 1809). Journal of Aquaculture in the tropics, 9(1): 25-33.

Ayinla, O.A. and Nwadukwe, F.O. 1989. Fingerlings size variation among freshwater catfish: Effect of broodstock sizes. In: A.O. Onyia and G.N. Ajana (Eds.), Fish for food: Meeting the demand. Proceeding of a Conference, 13-17 November 1989. Fisheries Society of Nigeria: 43-47.

Boyd C.E. 1979. Water quality in warm water fish ponds. Auburn University Agricultural Experimental Station, Auburn, Alabama. 358 pp.

De Graaf, G.J., Galemoni, F. and Banzoussi, B. 1995. The Artificial Reproduction and Fingerlinging Production of the African Catfish, *Clarias gariepinus* (Burchell, 1822) in protected and unprotected ponds. Aquaculture Research, 26: 233-242. DOI: 10.1111/j.1365-2109.1995.tb00908.x

Ekelemu, J.K. and Zelibe, S.A.A. 2006. Growth pattern and condition factors of four dominant fish species in Ona Lake, Southern Nigeria. Journal of Fisheries International, 1(2): 157-162.

Ezenwaji, H.M.G. 1985. African Clarias taxonomy implication for field work. Proceedings of the 4th Annual Conference of the Fisheries Society of Nigeria (FISON) held at Port-Harcourt 26th – 29th Nov, Nigeria: 191-196.

FAO (Food and Agriculture Organisation) 2004. World aquaculture supply of catfish and tilapia. FAO Fisheries Report No 733. FAO, Rome. 46 pp.

Haniffa, M.A.K and Sridhar, S. 2002. Induced spawning of spotted murrel (*Channa punctatus*) and catfish (*Heterebranchus fossils*) using human chorionic gonadotropin and synthetic hormone (ovaprim). Veterinary Archive, 72(1): 51-56.

Legendre, M. 1986. Seasonal changes in sexual maturity and fecundity and human chorionic gonadotropin (HCG) induced breeding of the catfish, *Heterobranchus longifilis* Val (Clariidae) reared in Ebric Lagoon, Ivory Coast. Aquacul., 55: 201-213.

Nwokoye, C.O., Nwuba, L.A. and Eyo, J.E. 2007. Induced propagation of African clariid catfish, *Heterobranchus bidorsalis* (Geoffrey Saint Hillarie, 1809) using synthetic and homoplastic hormones. African Journal of Biotechnology, 6(23): 2687-2693.

Odedeyi, D.O. 2007. Survival and Growth of Hybrid (Female *Clarias gariepinus* (B) and Male *Heterobranchus longifilis* (Val.) Fingerlings: Effect of Broodstock Sizes. American-Eurasian Journal of Scientific Research, 2 (1): 19–23.

Oladosu G.A., Ayinka O.A., Adeyemo, A.A., Yakubu, A.F., and Ajani, A.A. 1993. A comparative study of the reproductive capacity of the African catfish species *Heterobranchus bidorsalis* (Geoffrey), *Clarias gariepinus* (Burchell) and their hybrid "Heteroclarias" African Regional Aquaculture Centres Technical paper 92:1-5.

Owodeinde, F.G. and Ndimele, P.E. 2011. Survival, growth and feed utilization of two clariid catfish (*Clarias gariepinus*, Burchell 1822 and *Heterobranchus bidorsalis*, Geoffroy, 1809) and their reciprocal hybrids. Journal of Applied Ichthyology, 27: 1249-1253.

Pauly, D. 1983. Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Tech. Pap. 234: 52. FAO. Rome.

Rickter, W.E. 1973. Linear regressions in fisheries research. Journal of Fisheries Research Board of Canada, 30: 409-434.

Sokal, R.R. and Rohlf, F.J. 1995. Introduction to biostatistics, 3rd Edn., Freeman Publication, New York, 887 pp.

Viveen, W.J., Richterm, C.J., Van Oodot, P.G., Janssen, J.A. and Huisman, E.A. 1985. Practical manual for the culture of the African catfish, *Clarias gariepinus.* Section for Research and Technology, Ministry for Development Cooperation, The Hague, Netherlands, 128 pp.

Weatherly, A.H. 1990. Approaches to understanding fish growth. Transactions of the American Fisheries Society, 119: 62-67.

Zar, J.H. 1984. Biostatistical analysis. Prentice Hall, New Jersey, 718 pp.