

## PRELIMINARY REPORTS ON SELECTIVE BREEDING OF THE AFRICAN CATFISH (*Clarias gariepinus* BURCHELL, 1822) UNDER SEMI-ARID CONDITION OF NIGERIA

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### ABSTRACT

Selective breeding response and growth of *Clarias gariepinus* were investigated. A total of 24 paired gravid *C. gariepinus* collected from River Benue, Numan and Gubi Dam, Bauchi crossed as following: *C. gariepinus* River Benue x *C. gariepinus* River Benue (RBxRB), *C. gariepinus* River Benue x *C. gariepinus* Gubi Dam Bauchi (RBxGD), *C. gariepinus* Gubi Dam x *C. gariepinus* Gubi Dam (GDxGD), and *C. gariepinus* Gubi Dam x *C. gariepinus* River Benue (GDxRB) in a completely randomized design. Females are mentioned first. Seven days old fry were reared for 6 weeks in 30 litres capacity plastic trough according to the crosses. Six weeks old fish were further reared at 10fish/m<sup>2</sup> for 90 days in net 2m<sup>2</sup> hapa installed in 7 x 5x1.2m polyethylene-line pond. The result shows that fertilization rates were higher in GDxGD, while hatching rates were better in GDxRB F<sub>1</sub> hybrids. Fry final weight, weight gain, specific growth rate, survival and heterosis for survival were higher in RBxGD progenies in F<sub>1</sub> progenies. The final weight, weight gain, and heterosis for growth were better in GDxRB hybrids. The GDxRB proved to have better growth and survival. This study revealed the potentials for selective breeding of *Clarias gariepinus* in North-East Nigeria.

**Keywords:** *Clarias gariepinus*, selective breeding, growth, semi-arid condition

### INTRODUCTION

Fish is an important source of protein for the large teeming population of Nigeria. It provides 40% of the dietary intake of animal protein to the average Nigerian. According to Adekoye and Miller (2004), fish and fish products constitute more than 60% of the total protein in adults, especially in rural areas.

The deteriorating performance of domesticated *Clarias* species with the decline in growth and reproduction and appearance of deformities is raising concern among fish farmers. *Clarias gariepinus* (Claridae) is very popular with fish farmers for the highest market price, fast growth rate, good food conversion ratio, and resistance to diseases, infection, and ability to withstand adverse pond conditions especially low oxygen content and high turbidity. The culture of *C. gariepinus* fry as seed for fish production is increasingly becoming essential since fish contributes to the food abundance and nutritional benefit to family health, income generation and employment opportunities (Bamidele, 2007). *Clarias gariepinus* which is widely considered to be one of the most important tropical catfish species has an almost Pan-African distribution, from the Nile to West Africa and from Algeria to southern Africa (de-Graaf and Janssen, 1996). They are found throughout Africa and the middle-east and live in freshwater lakes, rivers, and swamps, as well as man-made habitats. In Nigeria, they are found in Rivers Benue, Niger, Lakes Kainji, Lake Chad (Teugels *et al.* (1992), Jebba, Geriyo, Alau, Hawul, etc. They are also found in Kiri, Tiga, and Gubi Dams, etc.

Selection (mass and family), intraspecific crossing, Interspecific, and intergeneric

hybridization have been the major breeding strategies to improve fish for culture (Nguenga *et al.*, 2000). Successes have been achieved in interspecific of *Clarias* species. Yisa *et al.* (2017) reported interspecific hybridization between strains of *C. anguillaris* from Onitsha (Rain forest), Makurdi (Guinea Savanna) and Maiduguri (Sahel Savanna), and Akinwande *et al.*, (2009) crossed between *C. gariepinus* x *H. longifilis* and *C. gariepinus* and *H. bidorsalis*, while intergeneric hybridization between *C. gariepinus* x *H. bidorsalis* have been documented by Ataguba *et al.* (2010), Diyaware *et al.*, (2010) and Diyaware and Onyia (2014) reported hybridization between *C. anguillaris* and *H. bidorsalis*. Megbowon *et al.* (2013) reported the growth performance of intraspecific hybridization between *C. gariepinus* strains from Kogi, Adamawa, Kebbi, Oyo, Anambra, and Delta States. Similarly, Megbowon *et al.* (2014), Olufeagba and Okomoda (2015) conducted intraspecific hybridization between Nassarawa (NS), Kainji and Ajase Ipo, (SW) strain of *Heterobranchus longifilis*. Ochoku *et al.* (2016) crossbred between *C. gariepinus* strains from Ibadan and Katsina in the South-west and North-western, Iwalewa *et al.* (2017) from Lokoja, Makurdi, Agenebode, and Onitsha.

Aluko and Ali (2001) observed over 98% hatching rate in the parent species and more than 90% in the hybrid group during the intergeneric hybridization of four African catfish *C. gariepinus*, *C. anguillaris*, *H. bidorsalis*, and *H. longifilis* to produce eight hybrids. Nguenga *et al.* (2010) reported high fertilization and hatching rate for

crosses of various strains of *H. longifilis* ranging from 87.10 to 95.2%.

Ataguba *et al.* (2010) reported negative heterosis for growth in hybrid of *Clarias gariepinus* x *Heterobranchus longifilis*. Akinwande *et al.* (2011) reported positive heterosis for weight gain and survival in hybrids and negative value for the specific growth rate. Diyaware *et al.* (2012) noticed positive heterosis in the growth of hybrid of *C. anguillaris* x *H. bidorsalis* in the semi-arid zone of Nigeria.

The development of fish farming in North-east Nigeria is very slow due unavailability of quality and low-cost fingerlings. Most fingerlings for culture in North-east Nigeria are usually obtained from the Southern part of the country. *Clarias gariepinus* is found in almost every water body in the region, yet there is no information on the selective breeding program from the region, in an attempt to solve the high cost of the Clariids fingerlings. The objective of the study, therefore, is to develop fish strains that could grow faster and adaptable to the semi-arid condition of North-East Nigeria through selective breeding.

## MATERIALS AND METHODS

### Study Area

The study was conducted in the Fish hatchery complex of the Department of Fisheries, University of Maiduguri situated between latitude 11° 48' 51.45" N and longitude 13° 11' 48.116" E and at an altitude of 375mm above sea level (Google map 2018). The mean rainfall of the study area is 600mm per annum with hot season between March to July and Harmattan from November to February while the raining season starts from June and ends in October.

### Experimental Fish

Gravid males and females *Clarias gariepinus* were collected from Gubi Dam in Bauchi

- i) Fertilization rate (%) =  $\frac{\text{No. of fertilized eggs}}{\text{No estimated eggs}} \times 100$
- ii) Hatchability (%) =  $\frac{\text{Total No. of hatched eggs}}{\text{Total No. of fertilized eggs}} \times 100$
- iii) Survival (%) =  $\frac{\text{Total no. of larvae} - \text{No. of dead larvae}}{\text{Total no. of larvae}} \times 100 \%$

### Growth Performance of Fry to Fingerlings

One hundred and fifty pieces of seven days fry of *C. gariepinus* from Rive Benue, Gubi Dam, and their hybrids were stocked in 30 litres capacity plastic trough in triplicates indoors. The fry were fed with Coppens diet – this name may not be mentioned (0.2mm-0.3mm, 0.3mm - 0.5mm, 0.5mm – 0.8mm and 1mm) at 5% body weight 3 times per day. The fry were reared for 6 weeks. At the end of 6 weeks rearing, a total of twenty (20) fingerlings from each treatment were stocked in 2 x 2 x 1.5m net hapa installed in 7 x 5 x 1.2m polyethylene line fish and further reared for 90 days to ascertain their growth

States situated between latitude 10°42'N and longitude 9° 87'E and River Benue in Numan, Adamawa State situated between latitude at 9°28' N and longitude 12°26' East. The fish were transported to the hatchery unit of the Department of Fisheries in 25Litres Jerrycan cut one quarter horizontally. The fish were acclimatized for 2 weeks in 7 x 5 x 1.2 m polyethylene lined fish pond strain wise.

## Experimental Design

### Induced breeding

Six females and males broodstock (1100±132.29- 623 ± 25.17g) were used for the experiment. The female broodstock were induced with Ovaprim hormone at 0.5ml/kg of the fish via intramuscular injection. After ten hours of the latency period, milt was collected from males, according to the method described by Diyaware *et al.* (2010a). The induced female fish were stripped into receptacles and fertilized based on the following cross combinations: Female *C. gariepinus* River Benue x Male *C. gariepinus* River Benue (RB x RB), Female *Clarias gariepinus* River Benue x Male *C. gariepinus* Gubi Dam (RB x GD), female *C. gariepinus* Gubi Dam x male *C. gariepinus* Gubi Dam (GD x GD, and female *Clarias gariepinus* Bauchi x male *Clarias gariepinus* River Benue (GD x RB) as treatments 1, 2, 3 and 4, respectively. The cross combinations (treatments) were replicated three times in a Complete Randomized Design (CRD) manner.

### Estimation of Fertilization and Hatching rate

After twelve hours of fertilization, the translucent eggs containing embryonic eyes were considered as fertilized eggs, while opaque eggs were counted as unfertilized or dead eggs. The fertilized eggs were allowed to hatch. Fertilization, hatching and larval survival rates were estimated using the following formulae:

performance. During the cultured period, the fingerlings were fed two times morning and evening with Coppens commercial diet (40% crude protein). At the end of the rearing period, final weight, final length, survival rate, and quantity of feed consumed were recorded. Growth indices were estimated using the formula below:

(i) Weight gain =  $W_1 - W_0$ , where  $W_1$  = final weigh (g),  $W_0$  = initial weight (g).

(ii) Mean Weight gain (g) =  $\frac{W_0 - W_1}{t}$ , where final weigh,  $W_0$  = initial weight (g), and t = culture period.

$$(iii) \text{ Specific Growth rate (SGR \% /day)} = \frac{\text{LogWo} - \text{LogW1}}{t} \times 100$$

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

$$(vi) \text{ Condition Factor} = \frac{W}{L^3} \times 100, \text{ where } W = \text{live fish weight, } L = \text{live length}$$

$$(vii) \text{ Survival (\%)} = \frac{N_t \times 100}{N_i}$$

### Heterosis

The heterosis for growth and survival of the fish at different growth stages were estimated following Nguenga *et al.* (2000) formula: Heterosis (%) =  $[(H_1 + H_2)/2 - (P_1 + P_2)/2] \div P_1 + P_2/2 \times 100$ , where  $H_1$  and  $H_2$  are the mean weight (or survival) of the crosses and  $P_1$  and  $P_2$  and mean weight (or survival) of the purebreds.

### Water Quality Parameter

Water quality parameters such as temperature, pH and Dissolved Oxygen (DO) were recorded for both indoors and outdoors rearing using digital EC/TDS/pH meter, (Model: EC500 meter SANXIN-China) and DO meter (Model: JPB-608 Shanghai REX) respectively every week.

### Statistical Analysis

Data obtained were subjected to one-way Analysis of Variance (ANOVA) while di t between the mean was determined using Fisher Least Significant Difference (LSD) at 5% confidence level ( $P \leq 0.05$ ) with the aid of Statistics 8.0.

## RESULTS AND DISCUSSIONS

### Fertilization and Hatching Rate of *C. gariiepinus* strains from River Benue, Gubi Dam, and their hybrids

Table 2 shows fertilization and hatching rates of *C. gariiepinus* strains from River Benue, Gubi Dam, and their hybrids. Higher fertilization (79.23%) was recorded in parental crosses of GD followed by that of the reciprocal hybrid of GD x RB with 65.90 % fertilization. The hybrid of RB x GD had 61.00% fertilization rates, while the RB X RB

strain had 50.00%. There were significant differences ( $p > 0.05$ ) between the fertilization values of GD strain, GD x RB compared to RB x GD and RBX RB strains. The higher egg fertilization values recorded in this study were lower than those reported by Diyaware *et al.* (2010a) for hybrids between *Heterobranchus bidorsalis* x *Clarias anguillaris* in a semi-arid zone, and Diyaware *et al.* (2010b) after milt collection through ablation, Ochokwu *et al.* (2016) for Ibadan, Katsina strains and the hybrid of *C. gariiepinus*.

Hatching rate was significantly ( $p < 0.05$ ) better (72.40%) in reciprocal hybrids GD x RB compared to GB strain. However, there were no significant ( $P > 0.05$ ) variations between the hatching rates of GD x RB compared to those of RB x RB and RB x GD. The best hatching rate values recorded in this study were lower than 94.2% reported by Olufeagba and Okomoda for crosses between Kano strains of *H. longifilis*, 82.27% recorded by Diyaware *et al.* (2010b) after milt collection through ablation, and 82 -89% recorded by Nguenga *et al.* (2000) for *H. longifilis* strains from Layo and Noun, Cameroun. The number of fertilized eggs, the number of dead eggs, percentage fertilization and the number of hatchlings observed in this study are higher than those reported by Sahoo *et al.* (2003). However, Aluko and Ali (2001) observed 90% hatching rates in the hybrids of four (4) African catfish *C. gariiepinus*, *C. anguillaris*, *H. bidorsalis* and *H. longifilis* that produced eight hybrids. Omeji *et al.* (2013) reported a 46 – 52% hatching rate after crossing Nigeria (local) *C. gariiepinus* with so-called exotic *C. gariiepinus*.

**Table 2: Fertilization and Hatching rates of *C. gariiepinus* strains from River Benue, Gubi Dam, and their hybrids**

Parameters	Cross Combination			
	RB	RB×GD	GD	GD×RB
NFE	120.67±1504.7 <sup>ab</sup>	122.67±602.3 <sup>ab</sup>	140.67±834.3 <sup>a</sup>	87.00±219.0 <sup>a</sup>
NDE	113.00±388.0 <sup>a</sup>	147.33±3861.3 <sup>a</sup>	38.00±47.00 <sup>b</sup>	86.67±790.3 <sup>ab</sup>
FR (%)	50.77±17.85 <sup>c</sup>	61.43±120.56 <sup>bc</sup>	79.23±1.5633 <sup>a</sup>	65.93±104.0 <sup>ab</sup>
NH	70.33±426 <sup>a</sup>	73.67±592.3 <sup>a</sup>	46.00±158.3 <sup>a</sup>	62.00±48.00 <sup>a</sup>
HR (%)	58.63±2.56 <sup>ab</sup>	59.37±104.0 <sup>ab</sup>	36.00±403.0 <sup>b</sup>	72.40±136.7 <sup>a</sup>

Mean in the column having similar superscript are not significantly different ( $p < 0.05$ ).

**Key:** RB= F<sub>1</sub> of Pure line *C. gariiepinus* River Benue, RB x GD = F<sub>1</sub> hybrid of *C. gariiepinus* River Benue x *C. gariiepinus* Gubi Dam, GD= F<sub>1</sub> of Pure line *C. gariiepinus* Gubi Dam, GD x RB = F<sub>1</sub> hybrid of *C. gariiepinus* Gubi Dam x *C. gariiepinus* River Benue, RB= *C. gariiepinus* River Benue, GD = *C. gariiepinus* Gubi Dam. NFE= No. Fertilized eggs, NDE= No. Dead eggs, FR= Fertilization Rate (%), NH = No. of hatchlings, HR= Hatching Rate (%),

### Growth Performance Fry of *C. gariepinus* strain from River Benue and Gubi Dam and their hybrids

Table 3 shows the mean growth performance of fry of *C. gariepinus* from River Benue and Gubi and their hybrids reared for six weeks. Fry final weight, average weight gain, mean daily weight gain and specific growth rates were significantly ( $P < 0.05$ ) higher in RB  $\times$  GD. No significant ( $P > 0.05$ ) variation was observed in the survival of the fry among the entire cross combinations. Deformed larvae were recorded in

both hybrids. The numbers of deformed hybrid larvae recorded in this study are higher than those reported by Diyaware *et al.* (2010b) in intergeneric hybrids between *C. anguillaris*  $\times$  *H. bidorsalis* in the semi-arid zone. However, Sahoo *et al.* (2003) reported as high as 30% deformed larvae in both the hybrids and the pure line progenies after hybridization between *C. gariepinus* and *C. batrachus*. The deformation in the hybrid could be due to the hybridization effect as suggested by Sahoo *et al.* (2003).

**Table 3: Mean ( $\pm$ SEM) Growth Performance of Fry of *C. gariepinus* strain from River Benue and Gubi Dam and their hybrids reared for 6 weeks**

Parameters	Crossing Combination			
	RB $\times$ RB	RB $\times$ GD	GD $\times$ GD	GD $\times$ RB
FW(g)	1.92 $\pm$ 0.19 <sup>b</sup>	15.53 $\pm$ 2.47 <sup>a</sup>	4.93 $\pm$ 0.38 <sup>b</sup>	6.37 $\pm$ 1.46 <sup>b</sup>
AWG (g)	1.70 $\pm$ 0.16 <sup>b</sup>	15.15 $\pm$ 2.65 <sup>a</sup>	4.74 $\pm$ 0.40 <sup>b</sup>	6.14 $\pm$ 1.47 <sup>a</sup>
FL (cm)	3.02 $\pm$ 0.21 <sup>ab</sup>	3.77 $\pm$ 0.41 <sup>a</sup>	2.57 $\pm$ 0.12 <sup>b</sup>	2.75 $\pm$ 0.10 <sup>a</sup>
MDWG	0.28 $\pm$ 0.03 <sup>b</sup>	2.54 $\pm$ 0.45 <sup>a</sup>	0.80 $\pm$ 0.07 <sup>b</sup>	1.03 $\pm$ 0.25 <sup>b</sup>
SGR	2.21 $\pm$ 0.04 <sup>c</sup>	4.59 $\pm$ 0.24 <sup>a</sup>	3.24 $\pm$ 0.10 <sup>b</sup>	3.54 $\pm$ 0.38 <sup>b</sup>
S (%)	23.33 $\pm$ 1.17	51.00 $\pm$ 11.06	25.33 $\pm$ 3.76	51.33 $\pm$ 13.68
DL	30.00 $\pm$ 4.51	26.00 $\pm$ 6.00	20.67 $\pm$ 5.2	17.33 $\pm$ 6.06
DLA	0.00	1.67 $\pm$ 0.8 <sup>a</sup>	0.00	1.33 $\pm$ 0.33 <sup>ab</sup>

Mean in the same column having similar superscript are not significantly different ( $p > 0.05$ ).

**Keys:** RB  $\times$  RB = *C. gariepinus* River Benue  $\times$  ♂ *C. gariepinus* River Benue, RB  $\times$  GD = F1 hybrid of *C. gariepinus* river Benue  $\times$  *C. gariepinus* Gubi Dam, GD  $\times$  GD = *C. gariepinus* Gubi Dam  $\times$  *C. gariepinus* Gubi Dam, GD  $\times$  RB = F1 hybrid of *C. gariepinus* Gubi Dam  $\times$  *C. Gariepinus* River Benue. FW = Final weight, AWG = Average Weight Gain, FL = Final Length, MDWG = Mean Daily Weight Gain, S = Survival, SGR = Specific Growth Rate, DL = Dead larvae, DLa = Deformed Larvae.

### Growth Performance Fingerlings of *C. gariepinus* strains from River Benue, Gubi Dam, and their hybrids

The F<sub>1</sub> hybrids of GD  $\times$  RB attain greater (331.93g) significant ( $p < 0.05$ ) final body weight, weight gain, mean daily weight gain compared to the rest of the cross combinations. However, there were no significant ( $p > 0.05$ ) variations among the final weights of RB  $\times$  RB, RB  $\times$  GD, and GD  $\times$  GD. The higher final weight recorded in this study is lower than 408g when Kainji  $\times$  Jos strains were crossed, 431- 466g after crossing between Kainji  $\times$  Onisha by Yisa *et al.* (2006), 550.7 and 341g for hybrids of *C. batrachus* with *C. gariepinus* hybrids (Sahoo *et al.* (2003), 1124g reported by Yisa *et al.* (2017) for crosses between *C. anguillaris* strains from Omisha, Makurdi and Maiduguri strains. However, the final weight and weight gain observed in this study are lower than (126-204g) those reported by Megbowon *et al.* (2015) from crosses between same species of fish from the six (6) states (Adamawa, Delta, Kebbi, Kogi and Oyo) of Nigeria. The differences in the

final weights might be due to differences in the strain of the fish as suggested by Barasa *et al.* (2017) that geographical location contributes to genetic variation in fish.

In terms of specific growth rates, no significant differences ( $P < 0.05$ ) were observed among the crossing combinations. The specific growth rate observed in this study was lower than 9 – 934 %/day reported by Omeji *et al.* (2013). Diyaware *et al.* (2010b) reported lower (0.54 – 0.76%/day) for intergeneric hybrids of *C. anguillaris*, *H. bidorsalis*, and their intergeneric hybrids.

The feed conversion ratio and condition factor in all cross combinations did not vary statistically ( $P > 0.0$ ), except for significantly ( $P < 0.05$ ) lower FCR observed in GD  $\times$  RB. Similarly, no significant difference was observed among the cross combination in terms of survival rate. The survival rates noticed in this study were very low, compared to those reported by Diyaware *et al.* (2010b) and Sahoo *et al.* (2003).

**Table 4: Growth performance of *Clarias gariepinus* strains from River Benue and Gubi Dam and their hybrid reared for 3 months**

Parameter	Crossing Combination				SEM
	RB × RB	RB × GD	GD × GD	GD × RB	
IW (g)	0.23 <sup>a</sup>	0.18 <sup>a</sup>	0.20 <sup>a</sup>	0.23 <sup>a</sup>	0.03 <sup>ns</sup>
FW (g)	242.60 <sup>b</sup>	230.70 <sup>b</sup>	248.27 <sup>b</sup>	331.93	30.50*
WG (g)	242.7 <sup>a</sup>	230.5 <sup>b</sup>	246.07 <sup>b</sup>	331.71 <sup>a</sup>	30.49*
MDWG (g/day)	9.61 <sup>b</sup>	9.70 <sup>b</sup>	10.35 <sup>b</sup>	13.17 <sup>a</sup>	1.40*
SGR (%/day)	0.02 <sup>a</sup>	1.17 <sup>a</sup>	0.01 <sup>a</sup>	0.02 <sup>a</sup>	0.01 <sup>ns</sup>
CF (K)	0.02 <sup>a</sup>	0.01 <sup>a</sup>	0.02 <sup>a</sup>	0.02 <sup>a</sup>	8.64 <sup>ns</sup>
FCR	0.70 <sup>a</sup>	0.77 <sup>a</sup>	0.67 <sup>a</sup>	0.50 <sup>b</sup>	0.08*
S (%)	53.33 <sup>a</sup>	63.30 <sup>a</sup>	63.33 <sup>a</sup>	63.33 <sup>a</sup>	11.79 <sup>ns</sup>

Mean in the column having similar superscript are not significantly different ( $p < 0.05$ ).

**Keys:** RB × RB= Pure line *C. gariepinus* River Benue, RB × GD = F1 hybrid *C. gariepinus* River Benue × *C. gariepinus* Gubi Dam, GD×GD= Pure line *C. gariepinus* Gubi Dam, GD×RB = F1 hybrid *C. gariepinus* Gubi Dam × *C. gariepinus* River Benue. FW=Final Weight, IW = initial weight, IL = initial length, FW = final weight, FL = final length, WG = weight gain, SGR = specific growth rate, CF = Condition factor, FCR = food conversion ratio, S = survival.

#### Heterosis

Table 5 shows heterosis for the growth and survival of the hybrids of *C. gariepinus* strains from River Benue and Gubi Dam in relation to their growth stages. All the genetic crosses showed positive heterosis for both growth and survival at all stages of growth. No significant ( $p > 0.05$ ) variations ( $P < 0.05$ ) were observed between the heterosis for both growth and survival among the entire crosses. The positive heterosis observed at both stages of

development in this study differed from the findings of Ngeunga *et al.* (2000) who reported negative heterosis for the survival of larval and fry stages in strains of *H. longifilis*. Ataguba *et al.* (2010) reported negative heterosis for survival at the fry stage and growth at fingerling stages in hybrids between *Clarias gariepinus* and *Heterobranchus longifilis*. Ngeunga *et al.* (2000) observed 85.5% heterosis for growth at the juvenile stage for *H. longifilis*.

**Table 5: Heterosis for Growth and Survival of the hybrids of *Clarias gariepinus* strains of River Benue and Gubi Dam in relation to developmental stages**

Heterosis (%)	Crossing combination			
	Fry to fingerlings		Fingerling to post fingerlings	
	RB× GD	GD ×RB	RB× GD	GD ×RB
Growth	6.70 <sup>a</sup>	9.77 <sup>a</sup>	31.00 <sup>a</sup>	11.96 <sup>a</sup>
Survival	59.58 <sup>a</sup>	23.33 <sup>a</sup>	21.96 <sup>a</sup>	45.23 <sup>a</sup>

Means within the same row with different superscripts differ significantly ( $P < 0.05$ ).

**Key:** CgRB × CgRB = Pure line *C. gariepinus* River Benue, RB × GD = F1 hybrid *C. gariepinus* River Benue × *C. gariepinus* Gubi Dam, GD×GD = Pure line *C. gariepinus* Gubi Dam, GD×RN = F1 hybrid *C. gariepinus* Gubi Dam × *C. gariepinus* River Benue

#### Water Quality Parameters

Dissolved oxygen (DO), temperature and pH during the study were between 4.80 – 4.85, 25.10 – 27.20, 7.50 – 7.68, respectively in the indoors, while outdoor DO was 4.03 – 4.07, Temperature 25.25-

28.04°C and pH 7.91-87.77 (Table 6). All the water quality parameters recorded during the study were within the recommended values of fish culture by Viveen *et al.* (1984).

**Table 6: Water Quality Parameters**

Crossing combination	Fry rearing indoors			Fingerling outdoors		
	DO mg/l	T (°C)	pH	DO mg/l	T(°C)	pH
RB x RB	4.82	27.13	7.68	4.03	25.25	7.78
RB xGD	4.85	27.20	7.68	4.05	27.42	7.91
GD x GD	4.80	25.17	7.51	4.05	28.04	7.86
GD x RB	4.83	27.10	7.50	4.07	26.72	7.77

Key: D.O = dissolved oxygen, T = temperature, CgRB x CgRB = Pure line *Clarias gariepinus* River Benue, RB x GD = F1 hybrid *Clarias gariepinus* River Benue x *C. gariepinus* Gubi Dam, GD x GD = Pure line *C. gariepinus* Gubi Dam, GD x RB = F1 hybrid *C. gariepinus* Gubi Dam x *Clarias gariepinus* River Benue

## Conclusion

The Gubi dam strain crossed with River Benue strain proved to have better growth and survival rates. The outcome of this study revealed the potentials of selective breeding programs for *C. gariepinus* in North-East Nigeria. This indicates the potentialities of exploiting hybrids African catfish strain within the North-Eastern Nigeria.

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