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Comparison of Fertiliztion, Hatchability, Growth and Survival of Clarias Gariepinus from Adamawa and Katsina States

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Abstract
Studies of intra – specific hybridization between *Clarias gariepinus* from two ecological zones namely Adamawa and Katsina states in North west and North eastern Nigeria, was carried out at fisheries departmental farm of Modibbo Adama University Yola for the period of 3 weeks, to determine the percentage fertilization, hatchability, survival rate and growth performance of hatchlings from the different crosses. Four intra – specific progenies were obtained from the crosses of the two strains of C. *gariepinus*. Hatchlings were fed with Artemia free cyst and Coppens for the 3 weeks. The results showed that purebred from Katsina had better fecundity (240,800 eggs) than Yola (125,625 eggs). There was a significant difference ($p<0.05$) in the weight of right and left lobes of testes (4.5g and 2.7g) and in the length of the right and left lobes of the broodstock from the different strains. KT x KT had the highest percentage fertility (97.7%) followed by YY x YY (97.2%), ♀YY X ♂KT (96%) and the least in ♀KT x ♂YY (93.6%). KT x KT had the highest percentage hatchability (97.3%) followed by ♀YY x ♂KT (96%), ♀KT x ♀YY (95%) and the least was YY x YY (87%). There was a significant difference ($p<0.05\%$) in the fertility and hatchability between purebreds and hybrids. At the end of 3 weeks survival rate was higher in YY x YY (95%) followed by KT x KT (90%), ♀YY x ♂KT (80%) and ♀KT x ♂YY (75%).

Keywords: Strain, Fertilization, Hatchability and survival, *Clarias gariepinus*

INTRODUCTION

With global population expansion, the demand for high- quality protein especially from aquatic source is rising dramatically. Increase in aquaculture production is clearly needed to meet this demand in the third millennium, because capture fisheries are at low capacity or showing precipitous declines due to over-fishing, pollution and habitat destruction. Further increases in capture fishes are not anticipated under the current global conditions (Dunham *et al.*, 2001).

Fish production was recently realized when it became obvious that our fish requirement cannot be met. The aquaculture sector expansion began in the 1970s stimulated by advances in hatchery technology and pond husbandry (FAO 2007). According to the FAO (2007), aquaculture continues to grow more rapidly than all other animal food producing sectors. The contribution of aquaculture to global supplies of fish, crustaceans, molluscs and other aquatic animals, increased from 3.9% of total production by weight in 1970 to 27.1% in 2000 and 32.4% in 2004. This growth is however impeded by lack of adequate attention to genetic and selective breeding, leading to stagnating yield (Consultative Group on International Agricultural Research, 2006).

Strain is a subgroup of a species of organism distinguished by specific characteristics, sometimes often developed by breeders for those characteristics, or a line of ancestral or group of descendants from group common ancestors (Dunham, 1995). According to Dunham (1995) a strain within species is a population with common origin and history that possess a unique trait that distinguishes it from other strains. Universally, almost all domesticated strains of fish exhibit better growth performance than the wild strains in aquaculture environment, for example, Chappel (1979) reported that channel catfish strains originating from different geographic locations within United States differ in growth and domestic strains grow faster than wild strains. The easiest methods to genetically improve an aquaculture stock or initiates a genetic improvement program is to evaluate the performance of strains to choose or utilize the best available strains to initiate or replace fish stock.
Research has been carried out on intra-specific hybridization. Legendre et al. (1992) reported the cross between *Clarias gariepinus* and *Heterobranchus longifilis* to produce viable reciprocal hybrids with their survival rates being similar to those found in the maternal species, (Diyaware and Onyia, 2014) reported high growth rate in cross between *Clarias anguillaris* and *Heterobranchus bidorsalis*. While (Omeji *et al.*, 2013) reported Intra-specific hybridization of local and exotic *Clarias gariepinus*, where survival and fecundity was improved. (Tilahun *et al.*, 2016) had a better fertilization and hatchability rate in the hybrids when he assessed the reproductive performance, growth and survival of hybrids of African catfish (*C. gariepinus*) and Indian catfish (*Clarias batrachus*) compared to their parental line cross. The growth performance of intraspecific hybridization of wild strains of Clarias gariepinus from Nigeria water was investigated by Megbowon *et al.* (2014) The objectives of this study were to evaluate the milt volume, sperm length, fertility rate, hatchability, and survival

of *Clarias gariepinus* strains from Adamawa (North West) and Katsina (North West) Nigeria

MATERIAL AND METHODS

Study Area

The experiment was carried out in the hatchery unit of Fisheries Department of Modibbo Adama University of Technology, Yola, Adamawa State. MAUTECH is situated in Girei LGA of Adamawa State, located about 10km north of Yola city on Yola- Mubi road. The research farm is located at the outskirt of the MAUTECH staff quarters and close to the school orchard. Adamawa state is located on latitude 9.20 -9.33^0N longitude12.30–12.50^0E. An altitude of 185.9 m, it has an average annual rainfall of about 759mm with maximum temperature of 39.7^0C. October. The raining season run from May through October, while the dry season commences in November and end in April. The driest mouths of the year are January and February when relative humidity drops to 13% (Canback Global Distribution Database,

Source and selection of Broodstock

The broodstock were sourced from hatchery unit of Modibdo Adama University of Technology, Yola Adamawa and from Songhai farm Dutsima Local Government Area, Katsina State respectively. The broodstock were transported to the fish hatchery unit of the Department Fisheries, Modibbo Adama University of Technology Yola, and Adamawa State in Jute bags and placed into a 50 liters capacity jerry-can cut horizontally and which was filled with 30 liters of water. Broodstock selection was based on maturity, the females were selected based on swollen, well distended soft abdomen, round and reddish vent while the Matured males were selected from each group based on their reddish, pointed genital papilla.

The male and female broodstock were separated in concrete tanks for 24 – 48 hours for them to be acclimatized to the environment. The weight (in gram) and length (in cm) for each broodstock was taken and recorded. The broodstock were fed with Coppens commercial feed at 3% of their body weight, following the procedure of Dada *et al.* (2010).

Crossbreeding Design of the Different Strains of *Clarias gariepinus*

♂ \ ♀	STRAIN	**KT**	**YY**
	KT	**KT x KT**	KT x YY
	YY	YY x KT	**YY x YY**

Key:
KT = Katsina broodstock ♀ Female
YY = Yola broodstock ♂ Male

Hormone Injection

The broodstock were weighed separately using a 10kg Camry premium table weighing balance. The broodstock were injected with synthetic ovaprim spawning hormone based on their body weight. Ovaprim spawning hormone was administered intramuscularly above the lateral line, towards the tail at recommended dose of 0.5 ml per kg of female fish, and half dose for the male fish (i.e. 0.25ml per kg). The injected fish were placed back into the concrete tanks for a period of 10 – 12 hours for ovulation and maturation of gonads.

Milt and Egg Collection

After the latency period of 10-12 hours testes were collected by sacrificing the males. The male were dissected using forceps. The two lobes of each testis were removed from each male either from Katsina or Adamawa, cleaned with tissue paper in order to remove blood and was placed into a labeled petri- dish. The female were stripped with a gentle application of pressure on the abdomen to release the eggs. The eggs were collected in dry and well labeled bowls. The broodstock were weighed before and after removing the gonads and stripping of eggs.

Spawning Fecundity

The total number of stripped (spawned) eggs was estimated using gravimetric method by counting number of eggs in 1g of eggs and multiplied by the weight of the stripped eggs according to (Onyia, *et al* 2010).

Stripping percentage was calculated as follows: (Joseph, 2013)

$$\text{Stripping Percentage} = \frac{\text{Weight of stripped eggs}}{\text{Body weight}} \text{x} 100$$

Relative Fecundity

This was calculated as described by (Joseph, 2013) as follows:

$$\text{Relative Fecundity} = \frac{\text{Number of Stripped eggs}}{\text{Total number of egss counted}} \times 100$$

Artificial Fertilization

The testes were macerated with care in order to squeeze out the milt, 0.9% of saline solution (NaCl) was added to the milt. Thereafter, egg for each cross was fertilized with the milt labeled bowls and mixed properly with the aid of a feather. Proper mixing of milt and eggs enhances increased fertilization. The translucent eggs containing embryonic eggs at the time of polar cap formation 10-20 minutes after fertilization were considered fertilized. The percentage fertilization was calculated. (Adebayo and Popoola, 2008).

$$\% \text{ fertilization} = \frac{\text{Number of fertilized eggs}}{\text{total number of eggs}} \text{ x } 100$$

One hundred and fifty fertilized eggs were incubated using egg collectors in 30 litre containers, after 24 -48 hours depending on the room temperature there after hatchability were calculated (Akinwande *et al*., 2012). %

$$\text{Hatchability} = \frac{\text{Number of Hatchlings}}{\text{Number of incubated eggs}} \text{ x } 100$$

Stocking of Hatchlings

Twenty hatchlings were randomly stocked in bowls according to the treatment and in triplicates, i.e. KT x KT, ♀KT x ♂YY, YY x YY and ♀YY x ♂ KT. The hatchlings (larvae) were fed with Artemia for three weeks after three days when all yolk had been reabsorb. Before stocking and throughout the period of the experiment, the weight and length of the fry were recorded weekly. At the end of the first three weeks, the survival rate was calculated. (Akinwande *et al*, 2012).

$$\text{Survival} = \frac{\text{No.of hatchlings at the end of th eexperiment}}{\text{No.of hatchling stocked}} \text{ x } 100$$

RESULTS

Table 1 shows the body weight, length and reproductive performance of different strains of female Clarias gariepinus The result revealed that both the female fishes had the same weight of 750g, Katsina female had high fecundity rate (240,800), compared to the broodstock obtained from Yola (`27.659). There was significant ($P<0.05$) difference in the weight of the ovary between Katsina and Yola

The Mean Body Weight, Length and weight of Testes from Katsina and Yola strains are shown in Table 2. Katsina male lobes had a total weight of 4.5g with right and left lobes weighing 2.5g and 2.0g each. The total weight of lobes from Yola strain was 2.7g with right and left lobes weighing 1.2g and 1.7g respectively. Milt volume of Katsina and Yola were 4.2ml and 4.4ml respectively. The result shows that there was significant difference ($P< 0.05$) in the weight of testes and milt volume in males from Katsina and Yola strain

Table 3 shows the fertilization and hatchability rate of C. gariepinus purelines and their reciprocals. The highest fertilization (97.7%) and hatchability (97.3%) were recorded in parent broodstock from Katsina, followed by the hybrids ♀YY x ♂KT which had highest fertilization (96%) and hatchability (96.7%). There was significant ($P<0.05$) differences between the fertilization rate and hatchability among the pure lines and the hybrids.

The survival in all the genetic crosses for a period of 3 weeks under controlled hatchery conditions is shown in table 4. From the overall performance in the survival rate, ♀YY x ♂KT had the highest (100%). There were significant differences ($p<0.05$) in the survival rate between purebreds and hybrids while there was no significant differences ($p<0.05$) among ♀YY x ♂KT and ♀KT x ♂YY.

Table 1: Body weight and Reproductive Performance of Different Strains of Female *Clarias gariepinus* From Katsina and Yola

Parameters	Strains	
	KT♀	YY ♀
Body weight (g)	750[a]	750[a]
Length of fish (cm)	44.4[b]	44.8[a]
Weight after stripping	550[b]	625[a]
Weight of stripped eggs	200[a]	125[b]
Number of eggs in 1g	1204[a]	1021[b]
Nature of eggs ovulated	Matured brown	Matured golden green
Spawning fecundity	240,800[a]	127,625[b]
Stripping percentage	26.666[a]	16.666[b]
Relative percentage	32,106.67[a]	17,016.67[b]

Means with different superscript are significantly different (P <0.05)

Table 2: Mean Body Weight, Length and Weight of Testes from different Males of *Clarias gariepinus*.

Parameters	Strains	
	KT ♂	YY ♂
Body weight (g)	1000[a]	1000 [a]
Body length (cm)	55[b]	55.5[a]
Weight of testes (g)	4.5[a]	2.7 [b]
Weight of right lobe (g)	2.5 [a]	1.2 [b]
Weight of left lobe (g)	2.0 [a]	1.5 [b]
Length of right lobe (cm)	4.5 [b]	5.5 [a]
Length of left lobe (cm)	6.o [a]	5.3[b]
Milt volume (ml)	4.2 [b]	4.4 [a]

Means with different superscript are significantly different (P <0.05)

Table 3: Percentage Fertilization and Hatchability of *Clarias gariepinus* Purelines and their Reciprocals

Genetic groups	No of eggs treated	No of eggs not fertilized	No of eggs fertilized	No of hatched eggs	Percentage fertilization	Percentage hatchability
Purelines						
KT × KT	150	3[d]	147[a]	143[a]	97[a]	97[a]
YY × YY	150	5[c]	145[b]	123[d]	97[a]	87[d]
Hybrids						
KT × YY	150	15[b]	135[d]	130[c]	93[c]	95[c]
YY × KT	150	11[a]	139[c]	136[b]	96[b]	96[b]

Mean with different superscripts are significantly different (p < 0.05)

Table 4: Mean Survival, Growth Performance and Feed utilization of Purebreds and their Reciprocals for 3 Weeks

Parameters	KT X KT	YY X YY	KT X YY	YY X KT
Initial weight	0.967 ± 0.033[a]	0.933± 0.066[b]	0.855 ± 0.034[d]	0.911 ± 0.027[c]
Initial length	0.667 ± 0.167[a]	0.644 ± 0.22[b]	0.589 ± 0.132[d]	0.600± 0.123[c]
Final weight	2.022 ± 0.139[c]	2.078± 0.161[b]	1.677 ± 0.176[d]	2.967± 0.52[a]
Final length	2.100± 0.158[b]	1.944 ± 0.050[c]	1.800 ± 0.180[d]	2.889 ± 0.218[a]
Weight gained	1.055[c]	1.145[b]	0.822[d]	2.056[a]
Length gained	1.433[b]	1.3[c]	1.211[d]	2.289[a]
Specific growth rate	1.525[c]	1.656[b]	1.393	2.442[a]
Relative growth rate	109.100[c]	122.722[b]	96.140[d]	225.686[a]
Condition factor	35.848[c]	52.117[a]	46.284[b]	17.143[d]
Protein efficiency ratio (PER)	0.019[c]	0.020[b]	0.015[d]	0.037[a]
% survival	75[d]	80[c]	90[b]	95[a]

Means along the column with different superscripts are significantly different (p < 0.05)

Keys:
KT × KT = Katsina Strain
YY × YY = Yola Strain
KT × YY = Katsina Strain x Yola Strain
YY × KT = Yola Strain x Katsina Srain

Table 5: Mean Water Quality Parameters of experimental set up

Treatments	pH(mol/L)	Dissolved oxygen (mg/l)	Temperature (^{O}C)
Purelines			
KT x KT	7.0 ± 0.6 [b]	5.2 ± 1.3 [a]	28.6 ± 1.4[a]
YY x YY	7.1 ± 0.7 [a]	5.1 ± 12 [b]	28.4 ± 1.3[c]
Hybrids			
KT x YY	7.1 ± 0.5 [a]	5.1 ± 1.3 [b]	28.5 ± 1.4[b]
YY x KT	7.0 ± 0.6[b]	5.2 ± 1.2[a]	28.5 ± 1.5[b]

Means with different superscripts are significantly different ($p<0.05$)

DISSCUSION

The reproductive performances and survival of *C.gariepinus* from two ecological zones and their reciprocals under controlled hatchery conditions have been examined in this study. Spawning fecundity and stripping percentage were higher in Katsina strain (240,800) and 26.666% Yola strain (127,625) and (16.666%). The higher fecundity recorded in this research work agree with the work of Sahoo *et al.* (2005) and Khan *et al.* (2006) that recorded high fecundity in *Clarias gariepinus.* The difference in the spawning fecundity may be due to differences in environment, food supply, Bagenal (1978) or egg sizes (Beach and Murray, 1993).

Yola male had higher length (55.5cm) followed by Katsina male (55cm). This study agree with the work of Ochokwu *et al.* (2015) that carried out intra-specific hybridization between Ibadan and Katsina strains and recorded lower length value in Katsina strain of *Clarias gareipinu*. The two strains had the same weight (1000g).Yola male had milt volume of (4.4ml) with right lobe length measured (5.5cm) and left lobe measured (1.2cm) when compared with Katsina male which had milt volume of (4.2ml) with right and left lobes measured (4.5cm and 6.0cm respectively). The differences could be attributed to the length of Yola male (55.5cm) compared to Katsina (55cm). Variation in milt quality may be due to sex ratio, stocking density, age, size, nutrition, and feeding regime. (Tahoun *et al*, 2008). Studies have shown that qualitative parameters of the milt (milt volume, sperm lobe length, mortality) can be influenced by several factors such as quality of the feed (Cerovsky *et al*, 2009), environmental factors, variations between individual age, weight length of the fish Ochokwu *et al*. (2015), season of the year (Habirazaee *et al*, 2010).

The percentage fertilization was highest in Katsina strain among the parental crosses while ♀KT x ♂YY was the highest among the hybrids. The overall result revealed that purebreds had highest percentage fertility than the hybrids; however this study agrees with the findings of Omeji *et al.* (2013) that had higher percentage fertility among the purebreds and lower among the hybrids, after crossing between exotic and local *Clarias gariepinus.* Shah *et al*, (2011) also reported higher fertility in purebreds (95%) and had lower fertility (86% - 89%) in hybrids. The reason for the lower fertilization rate in the crosses can be due to differences in their population. The highest percentage hatchability was recorded in Katsina strain (97%). However, the trend in hatchability observed in the research favoured the parental crosses. The high hatching success obtained in the study among the purebreds and lower among the hybrids agree with the observations of routine reports from fish hatcheries in Nigeria (Olufeagba *et al*., 2015; Tilahun *et al.*,2016; Sayeed, 2015). It is however important to acknowledge that differences that arise from breeding history, may be affected by water quality and age of the fish especially the hatching rates. Variations in seasons can also lead to differences in hatching rates, as rightly observed Shah *et al*., (2011) ; (Ochokwu *et al*., 2015)

Parental crosses Yola strain of *Clarias gariepinus* had highest survival rate (95%) closely followed by Katsina strain (90%) and among the hybrids had (80%) and (75%) respectively for YY x KT and KT x YY as the survival rate recorded. These results showed that the performance of the purebreds was better than that of hybrids. This could be due to the fact that the purebreds observed in this study have better heterosis for survival than hybrids. The higher survival rate obtained in this study is incongruent with the findings of (Olurin and Aderibigbe, 2006; Akinwande *et al*., 2012) that had similar result after crossing *H. longifillis* and female *C. anguillaris.* The lower values recorded for hybrids in this study is in agreement with the work of Abubakar *et al*., (2013); Akinwande *et al*., (2012) who obtained lower survival rate of (35.9 ± 4.32, and 70%) for *Clarias gariepinus* hybrids. The lower survival rate in this study can be attributed to mortality resulting from weekly sampling stress since the fry were very fragile at this stage.

CONCLUSION

From this study to identify the best strain of *Clarias gariepinus* from the two ecological zones of Nigeria, the hybrid YY x KT had the best percentage fertilization, hatchability, growth and survival among the reciprocal hybrids. Therefore, the hybrid could be used further by hatchery managers to raise fingerlings and maximize profit in their business. Furthermore, researchers could explore the genetic traits of this strain to develop improved broodstock at the second filial generation.

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