GROWTH PERFORMANCE AND SURVIVAL OF *Clarias gariepinus* FRY REARED UNDER PERIODIC APPLICATION OF SALT AND WASHING OF NURSERY TANKS

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ABSTRACT
The study investigates the growth performance and survival of an induced bred population of Clarias gariepinus by salting and periodic washing of nursery tanks. 15,000 fry were obtained and randomly distributed into four treatments with three replicates each. The fry were stocked at 1000 fish/tank (0.6 x 0.25 x 0.5m3). T1 has no salting nor washing, T2 salting only, T3 was a tank with washing only while T4 was a tank with salting and washing. The results showed the fish reared in T3 performed much better than those in T2. The fish in T4 has the highest final body weight (FBW), mean weight gain (MWG), specific growth rate (SGR), percentage survival and daily growth rate (DGR). All the values of the growth parameters measured in T4 were significantly different (p<0.05) from values obtained in other treatment groups. The FBW, MWG, SGR and DGR of fish in T2 were not significantly different (p>0.05) compared with fish in T1 but significantly (p<0.05) lower than those recorded in T3. It could be concluded that the addition of salt and periodic washing of the nursery tank will positively affect the growth performance and survival of Clarias gariepinus in the hatchery.
Keywords: Growth parameters, aquaculture, Hatchery operations, Clarias fry,

INTRODUCTION

World aquaculture has developed immensely during the past 20 years to becoming an economically essential industry (Subasinghe *et al*., 2009). According to FAO (2007), aquaculture develops more swiftly than all other animal food-producing sectors, with a mean worldwide growth rate of 8.8% per annum ever since 1970, while capture fisheries has a growth rate of 1.2% per annum. In intensive fish production, high quantity is produced in a unit area but without an effective production of fish seed (Adekoya *et al*., 2004).

In Africa, not many countries apart from Nigeria and Egypt, are producing more than 1,000 tonnes of fish per year (Zakariah *et al*., 2016). In 2010, the highest producer of aquaculture fish was Egypt followed by Nigeria producing 919,585 tonnes and 200,535 tonnes of total Africa production respectively (FAO, 2012). Though the aquaculture output in Nigeria increased significantly in 2010 compared to 2009, the country remains in the second position in Africa (Zakariah *et al*., 2016).

Production of fish seed (fry, fingerlings, and juveniles) remains a crucial phase of aquaculture which has been accorded continuous research to increase and sustain fish production (Onada and Ogunola, 2017). The main methods used for providing the right quality and quantity of fish seed in enclosures like ponds, tanks, reservoirs, and lakes are termed "artificial fish propagation" (Charo and Oirere, 2000).

However, the issue at stake is how to ensure high fry survival. After 3–4 days, when about two-thirds of the yolk sac has been absorbed, the larvae (about 2–3 mg) begin to swim vigorously in a fish-like manner and are very fragile. Larval rearing has long been identified as a major problem in African catfish production. There are several unpublished cases of high losses in hatcheries especially in Nigeria (Diyaolu, 2015). While several efforts had been geared toward addressing numerous issues relating to African catfish larval culture during the last decade (Britz and Hecht, 1987, Goos and Kichter, 1996, Hecht *et al*., 1996, Appelbaum and Kamler, 2000), many facts remain obscure regarding mass mortalities of catfish larvae in the hatchery. The objective of this study is to evaluate the mortality and survival of induced bred population of *Clarias gariepinus* by salting and periodic washing of nursery tanks.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Hatchery Unit of Motherhood Freshwater Fish Farms, Obantoko, Abeokuta, Ogun State, Nigeria.

Experimental Design

Fifteen thousand (15,000) fry were obtained from an induced bred population of *Clarias gariepinus* carried out at the Hatchery Unit of Motherhood Freshwater Fish Farms, Obantoko, Abeokuta, Ogun State, Nigeria. Using a broodstock ratio 1male: 1female of weight 2kg:2.5kg respectively. The fry were randomly distributed into twelve (12) experimental tanks (four treatments and three replicates each) of 0.6 x 0.25 x 0.5m3 with 1000 fry per tank. The fish were distributed into four groups (treatments) as shown below.

Treatment 1 = tanks with no salting nor washing throughout the experimental period

Treatment 2 = application of salt only to the tank during the experimental period

Treatment 3 = periodic washing of tanks only during the experimental period

Treatment 4 = application of salt and periodic washing of tanks in the course of the experiment

Each treatment was replicated thrice and the fish were reared under a flow-through water system for 60 days. In the treatments (2 and 4) involving salting, salt application was carried out daily at a rate of 2g/litre. And in the treatments (3 and 4) involving tank washing, washing of the perimeter walls and the bottom of the rearing plastic tanks was carried out every five (5) days with foam. The fry were fed to satiation with 0.5mm, 1mm and 2mm copens feed, adjusted as they grow bigger. The weights of the hatchlings were determined using sensitive electronic balance (METTLER TOLEDO, PB602). During the experiment, leftover feed and wastes were siphoned out twice daily, in the morning (7.00 hr) and the evening (16.00 hr). Dead fish in each of the tanks were recorded.

Survival and Mortality rates

Percentage mortality and survival rates were determined with the formula described by Bagenal, (1978) and adopted by Yisa *et al*. (2010):

Percentage Mortality = $\frac{Cumulative\ Mortality}{Total\ number\ stocked}\ x\ 100$ Percentage Survival = $\frac{Cumulative\ Survival}{Total\ number\ stocked}\ x\ 100$

Growth parameters

Mean weight gain

The fish were sampled every 10 days. The average weight in grammes was used to calculate the Mean Weight Gain as follows:

Weight gain (w) = Final weight (W2) – Initial weight of fish (W1)

Specific Growth rate

The specific growth rate was calculated according to formulae described by Ricker, (1975)

Specific growth rate (SGR, % per day = $\frac{Loge\ Wi - Loge\ Wt\ x\ 100}{D}$

Where Wi and Wt are the initial and final mean weight respectively and 'd' represents the number of feeding days

Water parameters

Water quality parameters including temperature, dissolved oxygen, pH and conductivity were monitored and maintained at optimum level. Water temperature, pH and dissolved oxygen (DO) were measured daily at 6.30 am with mercury in-glass thermometer, pH meter model WTW Ph 330 and DO meter (Model MW600), respectively. Other water quality parameters such as NO and NO were tested with Merck test kits 2/3 days per week.

Statistical Analysis

The data were analysed for significant differences (P<0.05) by Analysis of Variance (ANOVA) using computer Statistical Package for Social Sciences (IBM SPSS version 20). The differences among the means were separated using Duncan Multiple Range Test (DMRT).

RESULT

The growth pattern of *Clarias gariepinus* fry in the different treatments shown in figure 1 indicated that the fish reared in tanks treated with salt and regular washing (T4) performs better than the other treatment groups. The fish reared in tanks with regular washing only performed a little better than those with tanks treated with salt only. While the fish (T1) reared in tanks that receive neither washing nor salting have the least performance.

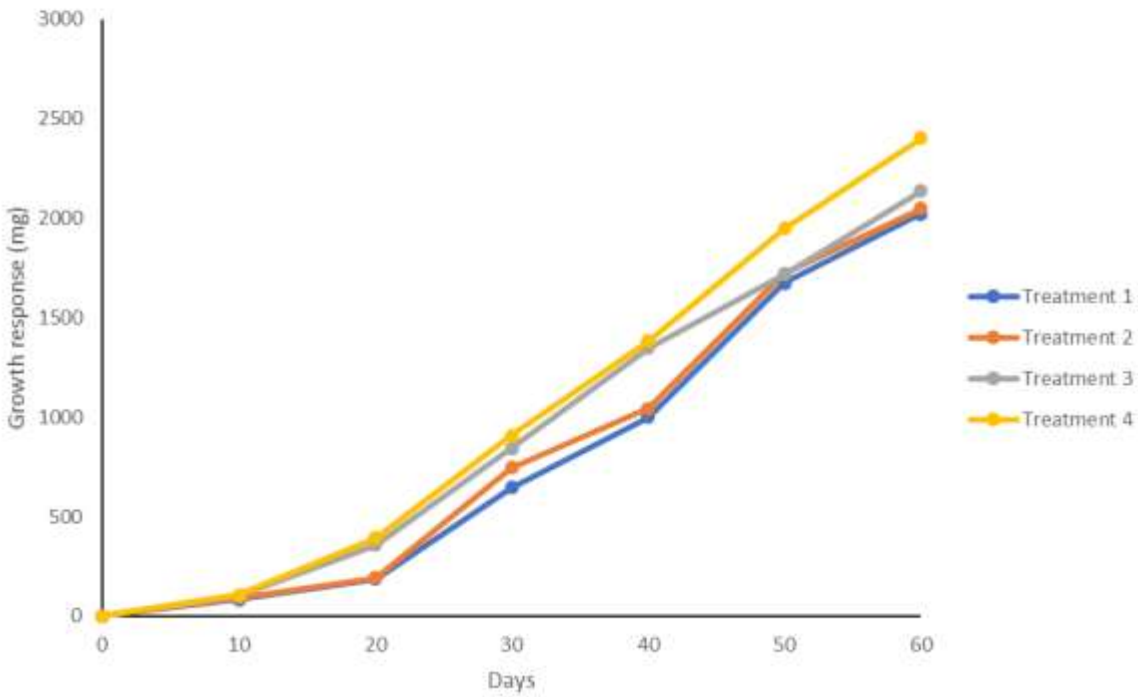

Figure 1: Growth Response of Clarias gariepinus Fry Reared in Different Treatments

The growth response is presented in Table 1. The fish reared in tanks treated with salt and washing (T4) has the highest final body weight, mean weight gain, specific growth rate, percentage survival and daily growth rate. While the least values of all the growth parameters measured were recorded in fish reared in tanks with neither salt nor washing (T1). All the values of growth parameters measured in T4 were significantly ($p<0.05$) better than the values obtained in the other treatment groups. The final weight, mean weight gain, specific growth rate and daily weight gain of fish in tanks treated with salt only (T2) were not significantly different ($p>0.05$) from the fish reared in tanks with neither salt nor washing (T1), but the values are significantly lower than the value recorded for fish in T3.

Table 1: The Growth Response of *Clarias gariepinus* Fry in Different Treatments

Parameters	T1	T2	T3	T4
Initial Weight (mg)	1.41±0.01	1.42±0.01	1.40±0.01	1.41±0.00
Final Weight (mg)	2022.53±15.22 ^{c}	2049.67±17.65 ^{c}	2138.11±29.84 ^{b}	2403.09±3.78 ^{a}
Mean weight gain (mg)	2021.13±15.21 ^{c}	2048.26±17.64 ^{c}	2136.71±29.84 ^{b}	2401.69±3.78 ^{a}
Specific growth rate (%)	12.12±0.01 ^{c}	12.13±0.02 ^{c}	12.22±0.02 ^{b}	12.41±0.01 ^{a}
Survival (%)	14.73±1.87 ^{c}	48.67±0.96 ^{b}	52.33±0.85 ^{b}	65.83±1.93 ^{a}
DGR (%)	23.95±0.16 ^{c}	24.10±0.27 ^{c}	25.50±0.34 ^{b}	28.46±0.11 ^{a}

Means with the same superscript within the same row are not significantly different ($p>0.05$)

The percentage survival of *Clarias gariepinus* fry in the different treatments is shown in Figure 2. The value of percentage survival measured was significantly higher in T4 compared to other treatments. There was no significant difference in the value of percentage survival of T2 and T3 but they were statistically different ($p<0.05$) from fish in T1. The fish survival from the beginning of the experiment to the end was shown in Figure 2. The figure revealed that the fish in T4 has the highest number of fish that survived, followed by T3 and T2 while T1 has the least.

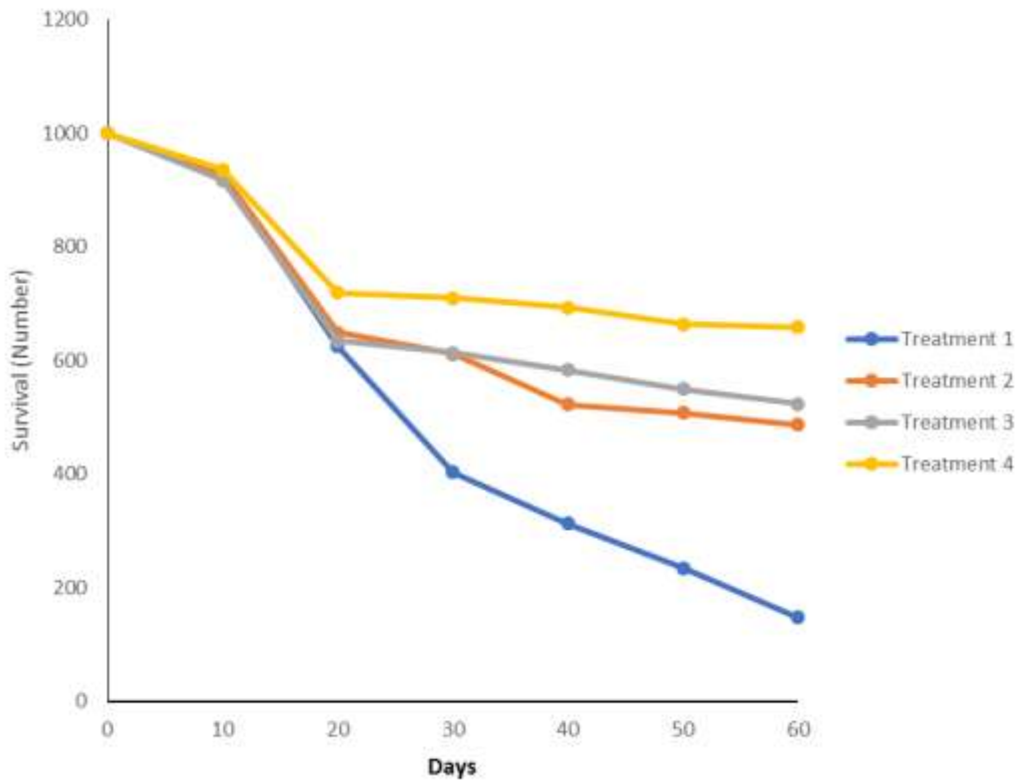

Figure 2: Survival of Clarias gariepinus reared in the different treatments

The mean cumulative Mortality and Survival Rates for *Clarias gariepinus* fry in the different treatments are presented in Tables 2 to 5. In treatment 1 where there was no salting and no washing, the percentage mortality increased geometrically from day 10 to 40 and later increased at a reducing rate. At the end of the experiment, the percentage mortality in T1 was higher (85.27%) than the percentage survival (14.73%). In treatment 2 where there was application of salt to the water, the percentage mortality at the end of the experiment was 51.33% which indicates that the variation was not as large as those stocked in T1. The percentage survival in this treatment group was 48.67% which also has less percentage mortality. It was observed that the highest mortality was recorded between day 10 and 20. The percentage cumulative survival in fish stocked in treatment 3 (washing of tanks) was 52.33% which is higher compared to T2. The percentage cumulative mortality in T3 (47.67%) at the end of the experiment was lower than the value (52.33%) of percentage cumulative survival. The percentage cumulative mortality in treatment 4 (salting and washing) was lower (34.17% compared to percentage cumulative survival (65.83%), which shows better performance compared to the other treatment groups.

Table 2: Mean cumulative mortality and survival rates of *Clarias gariepinus* fry reared in tanks that has no salting nor washing for 60 days

Period (Day)	Mortality	% Cumulative Mortality	Survival	% Cumulative Survival
10	71.00	7.10	929	92.90
20	375.33	37.53	624.67	62.47
30	597.33	59.73	402.67	40.27
40	687.33	68.73	312.67	31.27
50	765.67	76.57	234.33	23.43
60	852.67	85.27	147.33	14.73

Table 3: Mean cumulative mortality and survival rates for *Clarias gariepinus* fry reared in tanks that has application of salt only and reared for 60 days

Period (Day)	Mortality	% Cumulative Mortality	Survival	% Cumulative Survival
10	72.33	7.23	927.67	92.77
20	351.00	35.10	649	64.90
30	388.33	38.83	611.67	61.17
40	478.00	47.80	522	52.20
50	492.33	49.23	507.67	50.77
60	513.33	51.33	486.67	48.67

Table 4: Mean cumulative mortality and survival rates for *Clarias gariepinus* fry reared in tanks that was washed and reared for 60 days

Period (Day)	Mortality	% Cumulative Mortality	Survival	% Cumulative Survival
10	82.33	8.23	917.67	91.77
20	365.67	36.57	634.33	63.43
30	386.33	38.63	613.67	61.37
40	417.33	41.73	582.67	58.27
50	450.67	45.07	549.33	54.93
60	476.67	47.67	523.33	52.33

Table 5: Mean cumulative mortality and survival rates for *Clarias gariepinus* fry reared in tanks that salt application and washing for 60 days

Period (Day)	Mortality	% Cumulative Mortality	Survival	% Cumulative Survival
10	64.00	6.40	936	93.60
20	280.67	28.07	719.33	71.93
30	289.67	28.97	710.33	71.03
40	306.33	30.63	693.67	69.37
50	335.67	33.57	664.33	66.43
60	341.67	34.17	658.33	65.83

The mean water quality parameters (pH, temperature, dissolved oxygen, ammonia; nitrite and nitrate) of the various concentrations did not vary significantly ($P < 0.05$) among the treatments. The mean value recorded for the various treatment levels were within the same range as shown in Table 6. The mean value of temperature recorded in all the treatments was 28±2.5 while the mean values of pH, dissolved oxygen and turbidity were 7.2±0.8, 6.4±0.62 and 5.04±0.1 respectively.

Table 6: The mean water quality parameters in the different treatments

Parameters	T1	T2	T3	T4
Temperature (°C)	29±2.5	28±2.2	27±2.6	27±2.2
pH value	7.3±0.6	7.2±0.8	7.0±0.9	7.1±0.8
Dissolved Oxygen(mg/l)	5.9±0.62	6.0±0.56	6.3±0.52	6.2±0.86
Ammonia NH4(mg/l)	0.5±0.04	0.5±0.02	0.5±0.01	0.5±0.02
Nitrate, NO2(mg/l)	0.05±0.00	0.05±0.00	0.05±0.00	0.05±0.00
Turbidity (NYU)	5.40±0.2	5.00±0.3	5.00±0.1	5.00±0.3
Total solids (mg/l)	262±13.5	259±10.5	255±9.5	259±10.5
Chlorides (ppm)	33±10.8	32±10.6	30±11.8	30±10.6
Nitrite, NO3	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00
Ammonium, NH3	0.02±0.00	0.02±0.00	0.02±0.00	0.02±0.00

DISCUSSION

The water quality parameters observed in this study were within the tolerable range reported by Viveen *et al*. (1985) as ideal requirement for African catfishes and there was no significant difference ($p < 0.05$) among treatments. All the values were within the tolerable ranges of warm water fish species (Boyd, 1979; Adeniji and Ovie, 1989). This mean that the water quality did not negatively affects the test fish in this study.

One of the most important environmental factors applying pressures on aquatic organisms is salinity. Organisms respond to varying salinity by either spending their life cycle in an environment where salinity is "stable or variable"; while others undergo ontogenic migrations with successive stages based on salinity regimes (Varsamos *et al*., 2005).

The capability of each ontogenic stage to endure with salinity centred on the ability to osmoregulate. Brett (1979) observed that best growth rates of many fish species relative to salinity is around $0 – 10 \pm 2.00$ or 28 – 35 ppt. These groups correspond to three ecological classifications: freshwater, stenohaline anadromous species; euryhaline and stenohaline marine species. In this study, treatments 2 and 4 involving salting, salt application was carried out at a rate of 2g/litre which is within the tolerable limit of *Clarias gariepinus*. Gabriel *et al*. (2012) reported optimum tolerance range of *Clarias gariepinus* larvae to salinity to 2 – 4 and 2– 6 ppt for 14 and 21 day-old respectively, indicating that the tolerance ranges were very narrow. He concluded that in the natural environment with the vagaries in physico-chemical and other environmental factors the optimum range may be greatly influenced.

The result obtained in this study shows that the fry reared in tanks treated with salt and regular washing (T4) performed better than those in other treatment groups. Also, the fry reared in tanks with regular washing only performed much better than those in tanks treated with salt only. The fry (T1) reared in tanks that receive neither washing nor salting performed the least. This indicated that the application of salt and regular washing of the tank for Clarias larvae can improve the hatchery output.

The fish reared in tanks treated with salt and washing (T4) has the highest final body weight, mean weight gain, specific growth rate, percentage survival and daily growth rate, while the least values for all these growth parameters were recorded in fish reared in tanks with neither salt nor washing (T1). This means that salt treatment with adequate washing of tanks will improve the growth performance of Clarias larvae. The values for percentage survivals measured were significantly ($p<0.05$) higher in T4 compared to the other treatment groups. This also indicates that the application of salt coupled with washing favoured the survival of Clarias larvae in hatchery condition.

CONCLUSION

To increase the production of *Clarias gariepinus* fingerlings in order to meet the demand of fish farmers in Nigeria, there is need to make use of effective and efficient rearing methods. From this study, it could be concluded that the addition of salt and periodic washing of the nursery tank will not only positively affect the growth performance of *Clarias gariepinus* but will also improve their survival and invariably reduce mortality of the fish in the hatchery.

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