Effect of Different Stocking Density on Nutrient Utilization, Growth Performance and Survival of African Catfish (*Clarias gariepinus*, Burchell, 1822) Fry in Recirculatory System

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ABSTRACT

Management of *C. gariepinus* fry in recirculating tank is one modern technique applied for fish culture in Nigeria. Since, this system is gaining popularity nationwide there is a need to investigate appropriate stocking density as already established for both concrete tanks and earthen pond system. *Clarias gariepinus* fry (0.14±0.01 g) were reared in indoor recirculating tanks (60.5 m³) at three different stocking rates 5000, 8000 and 12000 fry/tank as treatment LD, MD and HD respectively for a period of eight weeks. The experiment was duplicated and fish were fed 45% crude protein diet at 5% in four installments daily. The mean body weight gain and SGR decreased with increasing stocking density. The best growth performance (weight gain, length gain and SGR) was achieved in treatment LD. The lowest FCR (1.04±0.01) value was obtained in HD but show no significant difference (p>0.05) to other treatments. Percentage survival of the fish was significantly (p<0.05) affected by the stocking density with the highest value recorded in LD (86.8%). Water-quality parameters were within the recommended ranges throughout the experimental period. From this study, the stocking density of 5000 fry m⁻³ is recommended for efficient feed utilization, optimum growth performance and survival in a re-circulatory culture system.

Key words: Recirculating system, fish seed, growth performance, stocking density

INTRODUCTION

Fish represents an important food source on our planet as it complements the food supply made available largely by land based agriculture. It enriches the diet with animal protein and essential amino acids. As, the possibility of fish supplies from capture fisheries is fast depleting, improvement in fish availability could only be achieved through aquaculture. Though, aquaculture in Nigeria has a history of at least five decades it is amazing that it is still under-developed. One of the major problems identified as hindering the promotion and development of aquaculture in Nigeria had been traced to scarcity of fish fingerlings (Atanda, 2006). Studies have shown that if only 20% of land and swamp available for aquaculture in Nigeria is to be cultivated, at least 3.4 billion fingerlings will be required to stock the ponds at a very low stocking density of 1 fish m⁻³ (Ayinla, 1991). While, the present total production and supply from all sources is less than 50 million fingerlings, the requirement in the short term is at least 500 million annually (Atanda, 2006). The existing hatcheries in Nigeria cannot as at now cope with this demand. Although, fish seed could also be collected from the wild, the system is seasonal, unreliable and laborious and above all the viability of such seed could not be assured.
Therefore, the future development of aquaculture will be severely constrained by availability of fish seed. This had continued to spur interest in research and technology of which recirculatory system is one of the developed strategies to address the problem of seed supply and fish production. This is because the production of fast growing fingerlings within limited resources like land and water is very crucial to boost aquaculture in Nigeria. This study therefore aimed to determine the appropriate stocking density for efficient nutrient utilization, optimum growth performance and survival of *Clarias gariepinus* fry in recirculatory tank culture.

**MATERIALS AND METHODS**

During the peak of the season, massive induced breeding from mature African catfish *C. gariepinus* broodstocks (1750±0.30 g) were carried-out using Ovaprim® at 0.5 mL kg⁻¹ of fish. The eggs were artificially stripped, inseminated and incubated in aerated concrete tanks (2.0×2.0×1.7 m³) at 0.2 m water depth and managed as described by Viveen *et al.* (1985). After three days, the hatchlings were fed to satiation with *Artemia* nauplii at intervals of 3 h for 5 days and later fed with commercial feed (0.2 mm) for 3 days.

Fifty thousand of eight-day-old hatchery-raised fry were randomly distributed in a recirculating system composed of six, square, indoor plastic tanks (2.5×2.2×1.1 m³, L×W×H) connected to a common biofilter and settling tank. Water was recirculated between the filter and the tanks using submersible pumps. Aeration was provided via a regenerative blower and submerged air diffusers (50 KA, Koi Air pump). Oxygen concentration, pH and water temperature were monitored in each tank using LaMotte freshwater aquaculture test kit (Model AQ-2/AQ-3). Three treatments with two replicate tanks per treatment were established: (1) Low density (LD: 5000 fry/tank), (2) Medium density (MD: 8000 fry/tank) and (3) High density (HD: 12000 fry/tank) (Van de Nieuwegiessen *et al.*, 2008). The fry were fed, under similar hatchery condition, four times daily (morning: 08:00 and 12:00 h and evening: 16:00 and 20:00 h) in split-rations at 5% body weight of 45% crude protein for eight weeks. The entire plastic tanks were screened with mosquito nets to prevent fish from jumping out.

Feeding began a day after stocking the fry, experimental fish were fed 0.3 mm commercial pellet feeds (Coppens™). During the 8 week experiment, random samples of 20 fish were measured and weighed weekly from each tank. Fish were weighed using electronic digital balance (METLER TOLEDO AB54, CAPACITY Max. 51 g; Min. 10 mg) and total length taken in centimeters using meter rule, after being scooped out with a hand net and drained. The initial mean weight and length of the *C. gariepinus* fry were 0.14±0.01 g and 1.10±0.00 cm, respectively. Food Conversion Ratio (FCR), Mean Growth Rate (MGR), Specific Growth Rate (SGR) and Mean Live-Weight Gain (MWG) were calculated as in Pechsiri and Yakupitiyage (2005):

\[
\text{MGR} = \frac{W_2 - W_1}{0.5d(W_1 W_2)} \times \frac{100}{\text{day}}
\]

where, \( W_1 = \) Initial weight, \( W_2 = \) Final weight, \( d = \) stock density, 0.5 = Constant.

\[
\text{SGR (\% / day)} = \frac{(\log_e W_2 - \log_e W_1)}{T_2 - T_1} \times 100
\]

where, \( W_2 \) and \( W_1 \) represent final and initial weight of fish, \( T_1 \) and \( T_2 \) represent final and initial time (days), \( \log_e \) represent Natural log to base e.
The growth and survival data between treatments was analyzed using one-way ANOVA and Duncan's Multiple Range Test, DMRT and significance levels set at p<0.05 (Zar, 1999).

RESULTS AND DISCUSSIONS

The result of growth performance and survival of *Clarias gariepinus* fry reared in recirculatory system at different stocking rates in indoor plastic tanks is presented in Table 1. The results reveal that the stocking density at which fish were cultured significantly (p<0.05) affected the mean final length, final body weight, Mean Growth Rate (MGR), Specific Growth Rate (SGR) and final Weight Gain (MWG), except Food Conversion Ratio (FCR). Fish kept at low stocking density had a greater absolute growth (2.56±0.04 g) in comparison to others. The mean final weight gain for fish was found to be highest (2.42±0.04 g) in treatment LD followed by fish in treatment MD (1.94±0.06 g) and treatment HD (1.35±0.06), respectively. A related phenomenon was reported by Sahoo et al. (2004), who found that high stocking density negatively affected the mean body weight, final mean total length, SGR and weight gain of *Clarias batrachus* fry.

The specific growth rates were also significantly different amongst treatment (p<0.05). Treatment LD with the least stocking densities (5000 fry/tank) had a SGR of 0.95±0.01%/fish while, treatment HD with (12000 fry/tank) stocking density had the least specific growth rate of 0.66±0.02%/fish. Mean final length gain was significantly lower in treatment HD as compared to other treatments. The highest mean final growth rate (0.040±0.00 g day⁻¹) was however, observed in treatment LD. There was no significant difference (p>0.05) in food conversion ratio among treatments, although low density was relatively higher. The mean number of fast growers was found to be highest in treatment HD while, treatment LD recorded the least. At the end of the study, significantly high survival was recorded in 5000 and 8000 fry/tank groups. This is

| Stocking densities | LD | MD | HD |
|--------------------|----|----|----|
| Initial mean weight (g) | 0.14±0.01a | 0.14±0.01a | 0.14±0.01a |
| Mean final weight (g) | 2.56±0.04c | 2.08±0.06b | 1.49±0.06a |
| Mean final weight gain (g) | 2.42±0.04c | 1.94±0.06b | 1.35±0.06a |
| Initial mean length (cm) | 1.10±0.05a | 1.10±0.05a | 1.10±0.05a |
| Mean final length (cm) | 2.70±0.05b | 2.80±0.05b | 2.20±0.05a |
| Mean final length gain (cm) | 1.60±0.10b | 1.70±0.00b | 1.10±0.00a |
| Mean final growth rate (g day⁻¹) | 0.04±0.00b | 0.027±0.00a | 0.018±0.00a |
| Mean final specific growth rate (%/fish) | 0.95±0.01a | 0.84±0.02b | 0.66±0.02a |
| Mean final food conversion ratio | 1.72±0.03a | 1.58±0.05a | 1.53±0.07a |
| Mean final survival (%) | 86.80±1.20f | 71.15±0.35f | 49.55±1.35f |

Values are mean of 3 replicates±SD, Means across the same row differently superscripted differ significantly (p<0.05), LD: Law density, MD: Medium density, HD: High density.
Fig. 1: Water quality parameters of African catfish fry (*Clarias gariepinus*) raised in RAS consistent with the finding of Hossain *et al*. (1998) who recorded a negative correlation of fish survival with stocking density. Water-quality parameters remained relatively stable throughout the experiment (Fig. 1). Water temperature averaged 27.5±0.12°C (Mean±SE). Dissolved oxygen was 5.47±0.21 mg L\(^{-1}\). pH of the culture water was 7.7±0.06 (Mean±SE). The recorded water parameters values were within the acceptable limits for catfish growth and health (Omitoyin, 2007).

**CONCLUSION**

The results from this study indicate that fry management expressed by stocking density significantly impacts the growth performance and survival of *C. gariepinus* in recirculating tank. The best results i.e. highest weight gain, good growth rate and maximum survival were recorded in 5000 fry/tank. Hence, 5000 fry/tank is regarded as the appropriate stocking density for the intensive tank culture of *C. gariepinus* fry management.

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