Influence of Stocking Density on Growth and Survival of Post Fry of the African Mud Catfish, *Clarias gariepinus*

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Abstract

The effect of stocking density on growth and survival of post fry of the African mud catfish, *Clarias gariepinus*, was investigated. *C. gariepinus* post fry were stocked at the rate of 5, 10, 15, 20, and 25 post fry/litre of water. The post fry were fed to satiation four times daily with crumbles of a commercial catfish feed. The survival, mean total length, mean body weight, condition factor, specific growth rate and performance index were found to be density dependent. Survival rate ranged from 29.7 ± 7.4 to 56.6 ± 33.3%, while specific growth rate was between 0.00143 ± 0.0014 to 0.00702 ± 0.0044. Optimum growth and survival rates were recorded at stocking densities of 5, 10, 15 post fry/litre of water. However, the determined optimum stocking density for rearing of *C. gariepinus* post fry in tanks is 15 post fry/litre of water. It is concluded that increased density impacts on growth and survival of the fish, a consequence of increased activity (frequent surfacing, feeding and swimming) and aggressiveness.

Keywords: Aquaculture; Fish consumption; Demand-supply; Retardation; Food security

Introduction

The production of fast-growing fry is vital to the development of a viable aquaculture venture for enhanced protein security [1]. In Nigeria, aquaculture production has increased tremendously due to increasing demand for fish protein. The Federal Department of Fisheries [2] estimated that over 1.6 million tonnes of both fin and shell fish were required to meet the animal protein need of the country's population in 2004. It was also noted [3] that about 50% of the fish supply in Nigeria comes from importation. The current national fish consumption figure has been put at about 2.66 million tonnes per annum and with an annual fish import figure of about 750,000 metric tons [4]. Nigeria is thus the highest importer of fish in Africa. This means that a huge sum of money is expended on fish importation annually. It is estimated that about 100 billion is spent on fish importation annually in Nigeria [5].

Aquaculture is considered key for bridging the national fish demand-supply gap. No doubt, the increasing demand for fish protein can be met when capture fisheries is supplemented by aquaculture. The Nigerian aquaculture industry has grown considerably, contributing to the production of about 20,475 metric tonnes of fish per year in the 1990s (Olaniyi, 2005) to about 85,087 metric tonnes per year in 2007 [5].

African walking mud catfish, *Clarias gariepinus,* is the most successful aquaculture species in Nigeria. The fish is widely cultured by both trained and untrained smallholder, medium and large-scale farmers. Other attributes that make *C. gariepinus* a first 'choice' farming fish and highly relished by consumers include biological (high food conversion ratio, fast growth rate, readily accepting artificial feeds, ease of artificial propagation, disease resistance), social (good market price, good table food quality) and ecological reasons (tolerance to wide range of environmental conditions) [6-8].

Rearing of the early life history stages of fish (fry and post fry) is the most critical aspect of aquaculture [9,10]. This is essentially because fish at these stages are very sensitive to the various factors or determinants of production. High mortality during fish seed production is common and is a major challenge confronting fish farmers. The import of this scenario is aptly captured by Brain and Amy [11] who noted that economically productive aquaculture is greatly dependent on adequate supply and management of fish seed with which to stock rearing enclosures. Appropriate management practices are, therefore, considered strategic in order to stem this trend. Stocking density has been highlighted as an important aspect of aquaculture practice, generally associated with problems such as reduction in feed conversion efficiency, condition factor and growth [12,13]. Information on stocking density, defined as the weight of fish per unit volume or per unit volume in unit time of water flowing through or contained in the holding environment [14] and its effect on the early life stages of *C. gariepinus* is scarcely available. The available data are skewed to fingerlings [15,16].

The effect of post fry stocking density on survival, growth and performance index of *C. gariepinus* was, therefore, investigated. It is envisaged that the result would provide information capable of aiding the design of appropriate protocols for fish seed production, especially early life history stages of *Clarias gariepinus*.

Materials and Method

Experimental procedure

C. gariepinus post fry were obtained from the University of Port Harcourt Faculty of Agriculture demonstration farm. The fry were acclimated for one week prior to the experiment and fed with commercial catfish diet (*Coppens*). Four thousand and fifty post fry (mean weight 0.68 ± 0.10 g; mean total length 4.03 ± 0.10 cm) *Clarias gariepinus* were counted and transferred to fifteen 20-litre rectangular plastic containers (30 cm width × 40 cm length × 26 cm depth). The fish were stocked at five densities: (5 fry/litre T1, 10 fry/litre T2, 15 fry/litre T3, 20 fry/litre T4, 25 fry/litre T5). Three replicate tanks were used for

each stocking density. Using a water flow through fish culture system, water depth was maintained at 20 cm (i.e. 18 litres) level daily. The post fry were fed to satiation 4 times (7 am, 10 am, 1 pm and 4 pm) daily with the commercial catfish feed.

During the experiment, leftover feed and wastes were siphoned out twice daily, in the morning (6.30 am) and in the evening (3.30 pm). Dead fish in the tanks were recorded. 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. At weekly intervals, 10 larvae were randomly sampled from each tank, weighed individually and total length measured. After 21 days of rearing, all the surviving larvae were collected from each tank. For each individual, total length and body weight were measured and recorded. The survival rate (SR), specific growth rate (SGR), mean daily weight gain (MDWG) and Fulton's condition factor (K) were calculated as follows:

$$SR\ (\%) = 100 \times \frac{Final\ number\ of\ larvae}{Initial\ number\ of\ larvae}$$

$$SGR\ (\%\ day) = 100 \times \frac{In(Final\ body\ weight) - In(initial\ body\ weight)}{Duration\ of\ rearing\ period\ (days)}$$

$$K = \frac{Final\ mean\ body\ weight\ (mg)}{L^3\ (cm)} \times 100$$

$$MDWG\ (mg/day) = \frac{Final\ mean\ body\ weight\ (mg) - initial\ body\ weight\ (mg)}{duration\ of\ rearing\ (days)} \times 100$$

To evaluate the effect of stocking density on production performance with more precision, the performance index (PI) was calculated [17,18]. This index was calculated by combining two responses such as growth and survival.

$$PI = Survival\ rate\ \times \frac{Final\ mean\ body\ weight\ (mg) - initial\ body\ weight\ (mg)}{duration\ of\ rearing\ (days)}$$

Statistical analysis

The experiment adopted the completely randomized design. Analysis of variance (ANOVA) and least significant difference (LSD) were determined to find out the effect of stocking densities on the growth and survival rate of *C. gariepinus* post fry, at 5% level of significance.

Results

Physico-chemical quality of the test media monitored throughout the study period is summarized in Table 1. Water temperature ranged between 30.7°C and 30.9°C.

The pH mean values in all tanks ranged from 6.4 to 7.1 and decreased with increasing stocking density. Values of dissolved oxygen were comparatively lower in higher density media (T_4 and T_5).

The results of Specific Growth Rate (SGR) and performance index PI show higher stocking densities resulted in lower SGR and PI; the best values were obtained in T_1, T_2 and T_3 (Table 2 and Figure 1). At the end of the experiment, the condition factor (K) of post fry was lower in T_4 and T_5 (p>0.05). Length and weight followed the same pattern (Table 2, Figures 2 and 3). But K was similar for post fry reared at stocking densities T_1, T_2 and T_3.

Survival rate was also significantly (p<0.05) affected by the stocking density. This decreased with increasing stocking density. The mean survival rates are summarized in Table 2. In all the treatments, post fry did not exhibit discernible cannibalism.

Discussion

Post fry stocking density influenced environmental conditions in culture tanks, which, in turn undermined growth and survival of the fish. High accumulation of faeces or excreta and metabolic wastes arising from higher density of post fry led to significant concentrations of nitrogen compounds and simultaneously lowered oxygen in T_4 and T_5. Low levels of dissolved oxygen and pH are considered limiting factors in intensive fish culture. For example, low levels of dissolved oxygen have been attributed to decreasing growth in channel catfish (*Ictalurus punctatus*) larvae reared in tanks [19] (Brazil and Wolters). In general, poor growth performance of cultured species takes place at pH <6.5 [20].

Growth is the manifestation of the net outcome of energy gains and losses within a framework of abiotic and biotic conditions. The effect of stocking density on growth (SGR and MDWG) and Performance Index (PI) was highly significant at higher stocking densities (T_4 and T_5), while there was no significant variation among SGR, MDWG and PI, at T_1, T_2, and T_3. This implies that yield would be higher at T_1, T_2, and T_3 stocking densities than at T_4 and T_5. Under crowded conditions, fish suffer stress as a result of aggressive feeding interaction and eat less, resulting in growth retardation [21]. The results indicate that post fry *C. gariepinus* stocking densities above 15 individuals/litre will compromise growth. In a study on the effect of stocking density on growth and survival of *C. batrachus* larvae reared in tanks, Sahoo et al. [22] reported similar effects of high stocking densities on growth and SGR.

Parameters	T_1	T_2	T_3	T_4	T_5
Temperature °C	30.70	30.80	30.9	30.7	30.8
pH	7.1	7.0	6.6	6.4	6.6
DO (mg/l)	6.20	5.90	5.66	4.82	4.37

Table 1: Mean values of water quality parameters measured in the rearing tanks.

Parameters	T_1	T_2	T_3	T_4	T_5
Length	4.08 ± 0.2[a]	4.05 ± 0.13[a]	3.98 ± 0.23[a]	3.64 ± 0.49[b]	3.58 ± 0.46[b]
Weight	0.82 ± 0.23[a]	0.73 ± 0.24[a]	0.70 ± 0.03[b]	0.66 ± 0.12[b]	0.61 ± 0.10[c]
Specific Growth Rate (SGR)%	0.0070 ± 0.004[a]	0.0052 ± 0.002[a]	0.0026 ± 0.002[b]	0.0017 ± 0.0009[b]	0.0014 ± 0.00[c]
Condition Factor (k)	1.93 ± 0.24	1.81 ± 0.48	1.72 ± 0.23	1.65 ± 0.13	1.54 ± 0.06
Mean Daily Weight Gain (MDWG)	0.06 ± 0.007[a]	0.059 ± 0.02[a]	0.051 ± 0.002[a]	0.049 ± 0.005[b]	0.044 ± 0.008[c]
Survival Rate (SR)	56.66 ± 33.30[a]	44.44 ± 10.30[a]	36.04 ± 5.50[b]	31.85 ± 3.80[c]	29.70 ± 7.40[c]
Performance index (PI)	2.80 ± 1.13[a]	2.50 ± 0.51[a]	2.19 ± 0.09[b]	1.46 ± 0.32[c]	1.42 ± 0.15[c]

Table 2: Growth, survival and performance index of *C. gariepinus* post fry reared at different stocking densities.
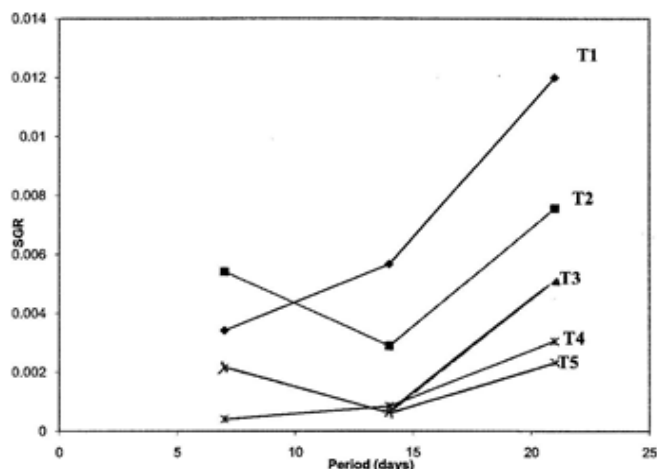
Figure 1: Specific growth rate of *C. gariepinus* at five stocking densities in tanks.
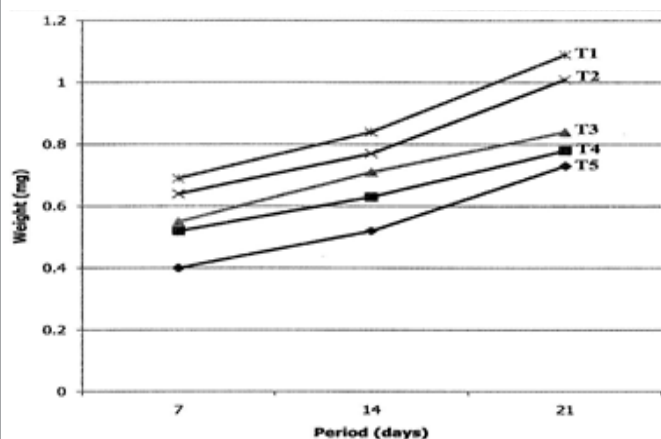

Figure 2: Total body weight of *C. gariepinus* fry cultured at five densities in tanks for 21 days.
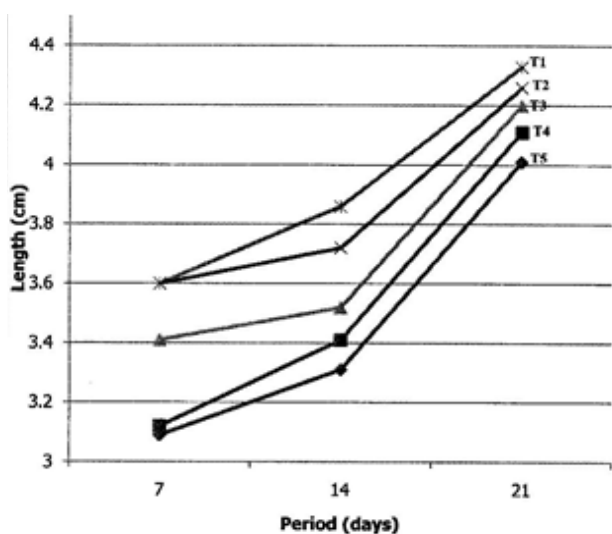

Figure 3: Total body length of *C. gariepinus* fry cultured at five densities in tanks for 21 days.

The condition factor of post fry *C. gariepinus* also decreased at higher stocking densities. At lower stocking densities, the post fry ate well and maximally converted ingested feeds to biomass. Mortality of the post fry was higher at high stocking densities and generally, dead individuals removed from the tanks were relatively of smaller sizes with flattened abdomen; a sign of empty stomach. It is conceivable that the smaller individuals were denied access to food, as they could not have competed favourably with relatively bigger individuals. The effect of stocking density on fry survival depends on the species. For the fry of *Rachycentron canadum* [22-24] reared in tanks, survival rate decreased as stocking density increased. On the other hand, Haylor [25] reported that stocking density did not affect survival of *C. gariepinus* fry reared in floating cages. However, Jamabo et al. [15] reported that survival rate, mean body weight, mean total length and specific growth rate were stocking density dependent for *C. gariepinus* fingerlings, which corroborates the findings of the present study.

For optimum productivity, profitability and good biological conditions (growth and survival), *C. gariepinus* post fry stocking density in tanks should be 15 individuals/litre.

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