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Effect of final batch size heterogeneity of *Clarias gariepinus* reared in concrete tanks on sales.

Efecto de la heterogeneidad del tamaño del lote final de *Clarias gariepinus* criadas en tanques de concreto sobre las ventas.

Anwa-Udondiah, E. P.[1, 2]*, Okoro, C. B.[1], Achilike, N. M.[1] and A. A. Awonuga[1]

[1]Nigerian Institute for Oceanography and Marine Research, Victoria Island, P.M.B. 12729, Lagos, Nigeria

[2]Federal University Dutse, Jigawa State, Nigeria

*Corresponding Author's E-mail: ekasampat@gmail.com

ABSTRACT

An evaluation of sizes at harvest following commercial production of *Clarias gariepinus* in 12 m^3 capacity indoor concrete tanks was conducted. Initial mean weight, standard length and total length of the fish averaged 8.21±0.65 g, 9.51±0.20 cm and 10.82±0.27 cm (mean±SEM) respectively. The culture period was fifteen weeks with the fish attaining various sizes ranging from 151.54 g to 1 kg. Results indicated that the three size classes (large, medium and small) generated mid culture exhibited varying survival rates and wide coefficient of variation thereby impacting sales.

Keywords: African Catfish, Size Disparity, Tanks.

RESUMEN

An evaluation of sizes at harvest following commercial production of Clarias gariepinus in 12 m3 capacity indoor concrete tanks was conducted. Initial mean weight, standard length and total length of the fish averaged 8.21±0.65 g, 9.51±0.20 cm and 10.82±0.27 cm (mean±SEM) respectively. The culture period was fifteen weeks with the fish attaining various sizes ranging from 151.54 g to 1 kg. Results indicated that the three size classes (large, medium and small) generated mid culture exhibited varying survival rates and wide coefficient of variation thereby impacting sales.

Keywords: African Catfish, Size Disparity, Tanks.

INTRODUCTION

The commercial culture of the African catfish (*Clarias gariepinus*) in concrete tanks, especially within urban areas in Nigeria, is widely adopted (Madu *et al*., 1987; Williams *et al*., 2008; Ovie and Eze, 2013). Studies by Adeogun *et al*. (2007) and Siyanbola and Adebayo (2012) show that mean percentage usage was 60% in city areas of Lagos State. However, as has been observed in various aquaculture species, such as yellowtail kingfish, Nile tilapia, Asian seabass and European seabass (Moran, 2007; Azaza *et al*., 2010; Sukumaran *et al*., 2011; Batzina *et al*., 2020), the intensive culture of the African catfish results in wide variation in sizes as growth progresses.

Abdulraheem *et al*. (2019) reported that variation in sizes of fry of the African catfish took place as early as two weeks of age, thereby encouraging cannibalism, which as noted by Ebonwu *et al*. (2009) caused a reduction in the overall survival of hatchery production of the species. Besides, even when sorting is done in subsequent weeks, growth of the newly graded set would still progress in a non-uniform manner (Abdulraheem *et al*., 2019). At harvest therefore, Nigeria's most popularly cultured fish species attains varied sizes (Hecht and Britz, 1988). This impacts on overall net income for the investor given that equal opportunity at feeding and water change was undertaken.

To this end, an evaluation of sizes obtained at harvest following commercial production of *Clarias gariepinus* was carried out and discussion on what these variable market-size fish means for a farmer is elucidated.

MATERIALS AND METHODS

Experimental Design and Set-up: Two sets of four 12 m^3 capacity indoor rectangular concrete tanks depicted in Figure 1 were utilized for this study which lasted for fifteen weeks.

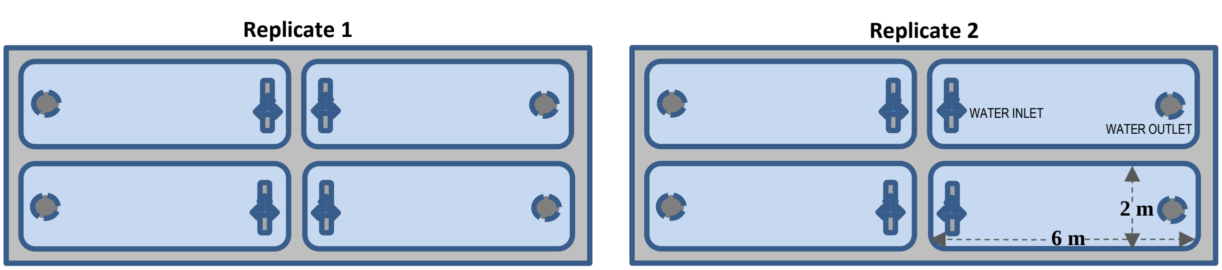

Figure 1: Schematic diagrams of duplicate sets of tanks showing inlets, outlets and dimensions

Source of Experimental Fish: Fish fingerlings numbering 2000 were obtained from a commercial producer (Ikorodu, Lagos State, Nigeria) and conveyed in two plastic containers, 1000 fish in each, to Badore Research Centre, Nigerian Institute for Oceanography and Marine Research, Lagos.

On day of collection, initial mean weight, standard length and total length averaged 8.21±0.65 g, 9.51±0.20 cm and 10.82±0.27 cm (mean±SEM) respectively. Fingerlings from the containers were left to acclimatise in two tanks (6 x 2 x 1) m^3, one in each replicate. Fish biomass was 8 kg/replicate.

Grow-out Period: Fish were sorted and counted into different tanks according to their sizes; large, medium and small. They were fed a commercially available diet of 2 mm pellet size containing 45% protein and 10% fat for the first four weeks while in the second month, they were fed 42% protein and 12% fat which were 4 mm sized pellets. In the remaining seven weeks, the fish were fed with 6 mm sized pellets containing 40% protein and 12% fat.

Water Quality Parameters: Water samples from each replicate were tested for temperature using a mercury-in-glass thermometer while pH, dissolved oxygen, ammonia, nitrite, nitrate, carbonate hardness and total hardness were analysed with Pond Lab test kit 200.

Fish Performance: Mortalities were removed and subtracted from records during the grow-out period.

Fish Samplings and Data Computation: In both replicates, fish were periodically sampled to measure body weight and length using an electronic balance and fish measuring board respectively. Data computation was done using Microsoft Excel.

Percentage survival was calculated as shown:

$$\%S = \frac{N_f}{N_i} \times 100\%$$

Where: N_f = final number of fish

N_i = initial number of fish

Size heterogeneity was computed according to this formula:

$$\frac{CV_{wi}}{CV_{wf}}$$

Where: $W_{i,f}$ = initial and final body weight

CV = coefficient of variation (100 SD/mean)

RESULTS

Mid culture size heterogeneity

In week 9, fish were re-sorted into a three-class ranking due to heterogeneous rates of growth. The fish classified as small and large were redistributed into two separate tanks within the experimental unit while the medium sized fish were split into two tanks for full utilisation of rearing system and to reduce bias as regards stocking density in each tank as pooled data indicated that about half of the population were in the medium size group; 47.5±3.54% (mean±standard deviation) as shown in the percentage component bar chart in Figure 2.

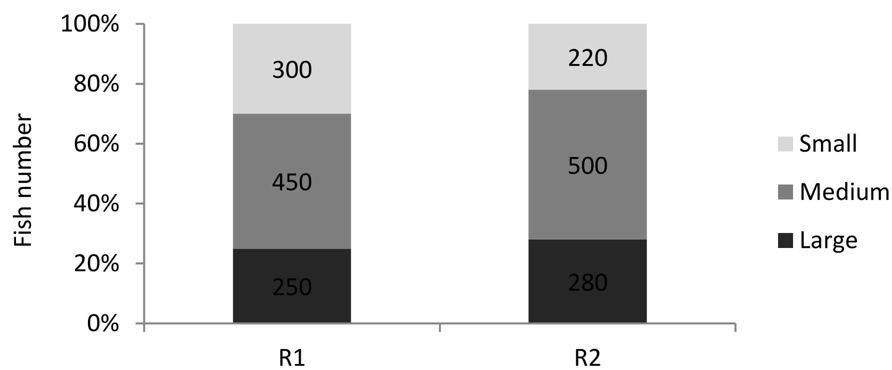

Figure 2: Re-sorted *C. gariepinus* showing mid culture size heterogeneity

Table 1 shows the pooled mean, coefficient of variation (CV) and size heterogeneity of *C. gariepinus* as the weeks progressed. The CV being a measure of relative variability indicated that in week 12, the standard deviation was 47.1% of the mean therefore the pooled data had more variation by the end of the third month of study relative to the mean.

Table 1: Size heterogeneity of *C. gariepinus* reared for 15 weeks in 12 m^3 concrete tanks

Weeks	Mean±SD (g)	Coefficient of variation (%)	Size heterogeneity
0 - Initial	8.21±2.05	24.97	---
3	32.95±8.11	24.61	0.99
6	100.98±44.82	44.39	1.78
9	222.66±85.17	38.25	1.53
12	404.16±190.36	47.10	1.89
15	609.20±202.22	33.19	1.33

Pooled data of R_1 and R_2

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Survival at termination

The mean percentage survival of *C. gariepinus* by week 15 of culture period was computed and is shown for the three size classes in Figure 3.

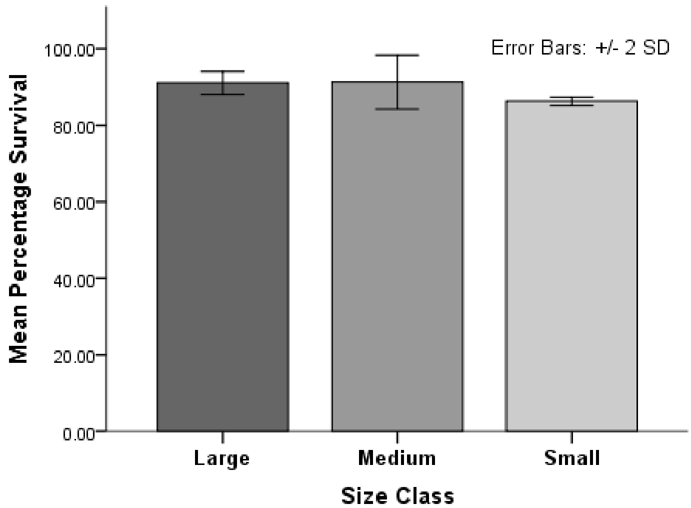

Figure 3: Mean percentage survival of the graded *C. gariepinus*

Water quality parameters

Water quality data are presented in Table 2. Temperature range and pH were 29-32 °C and 7 respectively. Dissolved oxygen (DO), ammonia, nitrate and nitrite were 2.4-3.2 mg/L, 1.0-5.0, 0 mg/L and 0.2-2.5 mg/L respectively.

Table 2: Water quality parameters of *C. gariepinus* reared in concrete tanks

Parameters	Temperature °C	DO (mg L^{-1})	pH	Ammonia (mg L^{-1})	Nitrite (mg L^{-1})	Nitrate (mg L^{-1})
Data Range	29 - 32	2.4 - 3.2	7	1.0 - 5.0	0.2 - 2.5	0.0

Pooled data of R_1 and R_2

Sale parameters

Pooled data for gross yield and fish number per class size at harvest are shown in Table 3. The impact from each class on sales is also depicted.

Table 3: Effect of final batch sizes of *C. gariepinus* reared in concrete tanks on sales

Sale Parameters	Large	Medium	Small	Total
Class Range in grams	751 - 1000	451 - 750	151 - 450	
Gross Fish Yield (kg)	346.72	472.39	148.75	967.86
Number of Fish	449	866	463	1778
Rate sold $ (₦)/kg	$2.19 (900)	$2.19 (900)	$1.95 (800)	
Sales $ (₦)	(312,048)	(425,151)	(119,000)	2,083 (856,199)

Pooled data of R_1 and R_2

DISCUSSION

Fish of initial mean weight 8.21±2.05 g (mean±SD) were sorted following acclimatisation and re-sorted again during the grow-out period at week 9 into three classes where they had attained weights averaging 222.66±85.17 g. The observation of widening disparity from initial sampling to project termination at week 15 (609.20±202.22 g) is corroborated by Kestemont *et al*. (2003) for other predatory fishes, the European seabass *Dicentrarchus labrax* and Eurasian perch *Perca fluviatilis*, where recurrent size sorting was done with results indicating that final size heterogeneity in both species were independent of their initial size heterogeneity.

Individual variation in growth for the African catfish, noted in this study, agrees with Martins, Schrama, and Verreth (2005) where *C. gariepinus* were reported to exhibit individual differences in growth of up to 52.8% CV. The authors observed consistency over time in individual growth variation, feed intake/efficiency and feeding behavior and therefore concluded that growth variation within a sibling population reared together was probably inherent. The CV of the growing fish in this study which varied between 25 to 47% between the first month of study and the end of the third month is somewhat in consonance to the range of 20 - 35% given by Gjedrem (1997) for most fish species unlike for farm animals which was observed to be 7 - 10%.

Dunham *et al*. (2016) examined the effects of stocking density, culture system, fingerling variation, grading system at harvest and genetics on body weight variability of channel catfish, *Ictalurus punctatus*, female X blue catfish, *I. furcatus*, male hybrids in commercial settings. They found that stocking density and culture system do not appear to have an impact on variability, except when stocking density is extremely high. However, genetics and a sire effect were reported as affecting body weight uniformity with the resultant CV of 30-48%. The influence of parentage is supported by Umanah (2020) who recorded increased size heterogeneity in egg sizes, which precipitate variation in hatchling sizes, with increasing maternal age of *C. gariepinus* broodstock used for induced reproduction.

On-site measurements of the water quality from replicated water samples drawn from the culture tanks were within the desirable range of 6.5 – 9.0 for pH (Bhatnagar and Devi, 2013). The temperature range which was 29-32 °C fell within the temperatures of between 25.0 and 32.0 °C, adjudged to be best for warmwater fish growth by Dupree and Huner (1984). The data range for ammonia in this study was 1.0-5.0 mg/L and aligns with previous report that catfish acclimate to high ammonia levels of 2 to 5 mg/L over time in commercial systems (Hargreaves and Tucker, 2004; Stone *et al*., 2013). Nitrate was non-existent in the fish tanks at 0 mg/L, however DO and nitrite were found to be 2.4 - 3.2 and 0.2-2.5 mg/L respectively, an indication that in the presence of low dissolved oxygen, bacteria was actively converting ammonia to nitrite via nitrification.

A single batch of African catfish production results in a wide size range of fish for harvest (Martins, Aanyu *et al*., 2005; FAO, 2021). This in turn impacts on the profit for the fish farmer which is often reduced due to discounts for smaller fish. In general, fish under 400 g may decrease the price paid to farmers. Therefore, although the fish in the present study was double-graded; following acclimatisation and also mid-study, the pooled size heterogeneity was within the approximate range of 1 and 2.

Overall, mean harvest size is dependent on a number of factors, including consumer preference for consumption or retail purposes. Customer preference in this study was for the medium and large sizes at the Institutional break-even price of $2.19 (₦900) per kg. The small-sized fish were rather bulk-sold at a lowered price of $1.95 (₦800) per kg. Consequently, production efficiency was negatively impacted as a result of the small-sized group (Table 3) because as shown in the percentage component bar chart in Figure 2, pooled data indicated that they represented a quarter of the population at 26±5.66% (mean ± SD). Conversely, in the Central African Republic, South Africa and Zambia, the desired market size ranged between 200 and 500 g (FAO, 1996).

As conclusion, size heterogeneity is commonly observed in aquaculture and affects final production and economic yield which directly impacts potential returns for the fish farmer. Although the small sized group were the second highest with regards to number of fish harvested, in terms of sales however, they had the least monetary value thereby negatively impacting gross profit.

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