THE EFFECT OF STOCKING DENSITY ON THE GROWTH PERFORMANCE AND FEED UTILIZATION OF ALBINO *Clarias gariepinus* REARED IN COLLAPSIBLE TARPULIN TANKS

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ABSTRACT

Background: Stocking density refers to the weight of fish per unit volume or the number of fish stocked at the beginning of an experiment. Available space and adequate water for exchange are two factors which could greatly affect the productivity of aquaculture in conjunction with the target species, hence, must be optimally utilized. **Objectives:** African Sharptooth catfish, albino *Clarias gariepinus* was cultured at four different densities in collapsible tanks to evaluate the effect of stocking density on growth response, survival rate and feed utilization. **Materials and methods:** Two hundred and seventy (270) fish with initial weight of 1.09g, 0.80g, 0.61g, 0.71g were stocked at 15/m^2, 20/m^2, 25/m^2 and 30/m^2 respectively. The experiment lasted for 140 days. The experimental fish were fed 6% of their body biomass daily and the weight and length were taken biweekly while the physico-chemical parameters were recorded weekly. **Results:** The final mean weights of the fish stocked at stocking densities of 15/m^2, 20/m^2, 25/m^2 and 30/m^2 were 104.21 ±10.38g, 106.65 ± 11.04g, 110.23 ± 23.68g and 78.88 ± 7.58g respectively. The corresponding mean values of specific growth rate were 0.03, 0.04, 0.03, 0.03. The feed conversion Ratio (FCR) was 1.62, 1.06, 1.36, 1.29 and survival rates were calculated to be 82.22%, 85%, 45.67% and 60% accordingly. At the end of the experiment the result showed that the survival rate of the stocking densities of 15/m^2, 20/m^2 and 30/m^2 were not significantly different (P>0.05) but stocking density 25m^2 was significantly different (P<0.05) from stocking densities 15/m^2, 20/m^2 and similar to stocking density 30/m^2, stocking density 25/m^2 had the highest mean weight gain (110.23g ± 23.68) compared to the other treatments which was the best. **Conclusion:** It was concluded from the results that high stocking densities had negative impacts on the growth performance and feed utilization of the albino *Clarias gariepinus*.

Keyword: *aquaculture, fish, survival rate, proximate composition*

1. INTRODUCTION

Aquaculture refers to the breeding, rearing and harvesting of plants and animals in all types of water environments including ponds, rivers, lakes and the oceans [1]. Fish culture being an integral subset of Aquaculture is fundamentally important for reliable generation of fish to meet human nutritional needs. Fish provides a relatively cheap source of animal protein when compared to beef [2]. Fish has long remained an important source of quality protein consumed by the world's population [3]. The endeavour to satisfy the high demand for fish in view of its health benefits and the deficiency of the natural waters to efficiently meet such fish demands have generated a perennially increasing interests in aquaculture. These interests have consequently lead to mounting pressures on certain cardinal factors of production. Available space and adequate water for exchange are two factors which could greatly affect the productivity of aquaculture in conjunction with the target species, hence, must be optimally utilized. Many species of fish have been tried in aquaculture. The African aquaculture has been dominated by the farming of the *Clariid* fishes of which the African sharptooth catfish (*Clarias gariepinus*) is the most popular and of great economic importance as food fish [4,5]. The species, *Clarias gariepinus* attracts good prices in Nigerian markets [6,7], due to its tasty flesh devoid of sharp bones. It is hardy, exhibiting great tolerance for high stocking density even in low oxygen waters, good growth rate, efficient food conversion and excellent nutritional profile, and medicinally valuable [8,9,10].

Like many other vertebrates [11], the African sharptooth catfish (*Clarias gariepinus*), has a synonymous strain, albino *C. gariepinus* [12,13]*.* The albino has pinkish or yellowish body colouration, white belly and red eyes [14]. Albinism is a genetic abnormally caused by an autosomal recessive gene in the homozygous state resulting in deficit melanin production [15,16]. According to these authors, it can also be induced artificially by exposing the eggs or brood stocks to heavy metals such as arsenic, cadmium, copper, mercury, selenium, or zinc. Three types of albinism have been identified namely: true (total or complete) albinism, marked by total absence of melanin, normal skin and eye pigmentation; leucism, in which exists abnormal skin pigmentation but normal eye colour; and partial albinism recognized by restricted normal skin colour but normal eye colour [15-14-17,18,19]. While the other authors regarded leucism as partial albinism, Miller (2005) classified them as distinct. The albino fishes are prominent as ornamental fishes due to their striking appearance [18].

The future of aquaculture in Africa lies in producing more fish using less land, water and financial resources [20]. In aquaculture, fish growth rate determines fish size and production which affect the price of fish [21]. Most fish culturists cultivate their fish in high stocking densities in order to maximize productivity [22]. Stocking density refers to the weight of fish per unit volume [23] or the number of fish stocked at the beginning of an experiment [24].

The much research interest on stocking density seeks to provide information regarding the fish welfare [25,26,27]. Papst et al. (1992) remarked that in intensive aquaculture the stocking density is a crucial factor that suggests the economic viability of the production system [28]. Fish growth performances, physiology and fish behavior are believed to be moderated by stocking density [29,30,31-25]. In high stocking density, usually fish exhibit aggressive behaviour, especially when food availability is limited. This condition could lead to fish stress and poor health hence; food availability is very important when it concerns fish density [29]. Knowing the appropriate stocking density to apply is considered essential to increasing the fish production to meet the rising fish demand and maintain profitability and economic sustainability of aquaculture venture [32].

The albino *Clarias gariepinus* is not commonly reared as food fish in Nigeria hence, it becomes necessary to find out the appropriate density that it could be stocked for optimum productivity as table fish by evaluating the growth performance, feed utilization and survival in collapsible tanks. The objective of the study was based on this.

2. MATERIALS AND METHODS

2.1 Study Area: The experiment was conducted in a private fish farm (Saekufre fish farm) with coordinates 4°68'0 N and 7°53'0 E located in Obio Nsit, Nsit Ibom L.G.A, Akwa Ibom State, Nigeria. The experiment lasted for 140 days (20 weeks) and were carried out in 12 collapsible tanks of 1 M^3 volume.

2.2 Experimental Fish and Design: The albino *Clarias gariepinus* fingerlings of four weeks' old were purchased from the Institute of Oceanography and Marine Research, University of Calabar and brought to Uyo in a modified 50 litre Jerry can. At the experimental site, the fish were kept in a 1m×1m×1m collapsible tarpaulin tank for two weeks to acclimate. 1.2mm – 1.5mm particle sized commercial catfish feed (Coppens) containing 50% crude protein was used in feeding the fish during this period. They were fed to satisfaction twice daily (7:30 – 8:00hrs and 18:00- 18:30hrs) till the commencement of the experiment. Twelve tarpaulin tanks each measuring 1mx1mx1m were used for this experiment. The tanks were grouped into four sets and each assigned a separate stocking density (treatment) 30, 25, 20 and 15 fish per $1m^2$ respectively. Each treatment had three replicates. At the commencement of the experiment, the fish were weighed with Mettler Toledo (Model PB602) weighing balance (0.01g) and the total length taken with a measuring board. Ten (10) fingerlings of the albino *Clarias gariepinus* were used for the analysis of proximate composition employing the official method of AOAC (2005) [33].

2.3 Routine Feeding and Measurement: The fish in each tank were fed twice daily at 3% biomass per meal that equals 6% biomass per day using 42% crude protein based commercial feed. Feeding took place daily except on the days of weighing and measuring. Water level in each tank was maintained at 60cm while the water was changed weekly.

2.4 Water Quality Management: The physico-chemical properties of the water were checked weekly. Dissolved oxygen and temperature of the water were measured with Hanna multi-parameter kit (Model H19828) and pH using pH pen meter (Model 009 111).

2.5 Data Collection: Both the weight and length of fish in each tank were measured every two (2) weeks after which the feeds for the succeeding two weeks were adjusted to 6% of the new body weight. At the termination of the experiment, the final weight and length were measured. A sample of fish from each replicate was taken out for proximate analysis [33]. Growth and feed utilization parameters as well as survival rate were determined as follows.

Mean weight gain (g) (MWG), [34], $MWG = W2 - W1$ (1)

Where
W_2 = Final weight
W_1 = Initial weight

Mean growth rate (MGR), [35], $MGR = \frac{W2-W1}{0.5\,(W1+W2)} \times \frac{100/t}{1}$ (2)

Where
W_2 = Final weight
W_1 = Initial weight
t = Feeding period

Specific Growth rate (SGR) [36], $SGR = \frac{100 \times InW2 - InW1}{Rearing\ period\ in\ days}$ (3)

Where
In W_2 = Natural Logarithm of final weight
In W_1 = Natural Logarithm of initial weight

Survival rate (SR) [37], $SR = \frac{Total\ no.of\ fish\ harvested}{Total\ no.of\ fish\ stocked} \times 100$ (4)

Feed Conversion Efficiency (FCE) [38], $FCE = \frac{weight\ gain\ (g)}{feed\ intake\ (g)} \times \frac{100}{1}$ (5)

Feed conversion Rate (FCR) [39], $PER = \frac{Weight\ gain\ (g)}{Protein\ intake\ (g)}$ (6)

Where, Protein intake, $Protein\ intake = \frac{\%\,protein\ in\ feed \times total\ diet\ conusumed}{100}$ (7)

Protein Production Value (PPV) [40], $PPV = \frac{100 \times protein\ gain\ (g)}{protein\ intake\ (g)}$ (8)

2.6 Statistical Analysis: The results obtained were statistically analyzed with One-way Analysis of Variance (ANOVA) for significant differences at 0.05 level of probability and the means separated with Fitcher Least Significance difference, using Statistical Package for Social Sciences (SPSS) Version 19.

3. RESULTS

3.1 Water Quality Analysis

The prevailing physico-chemical properties of the culture water during the period were as shown in Table 1 indicating both the maximum and minimum values. They were within ranges tolerable for cultured species

Table 1: The table shows the mean water quality parameters recorded during the experiment (Mean ± SE)

Parameters	Temperature (^oC)	Dissolved oxygen (mg/L)	pH
Maximum	27.73 ± 0.01	10.83 ± 0.01	8.26 ± 0.32
Minimum	20.01 ± 0.01	6.62 ± 0.09	6.78 ± 0.22

3.2 Proximate Composition

The results of body composition of albino catfish during the study is presented in Table 2. The results have shown that the mean nutrient profile of the fish tissue between the commencement and the end of the experiment had increased drastically in all parameters examined except nitrogen free extract which produced a stupendous decline. They also varied among the different stocking densities studied. The mean protein deposition in fish stocked at 15 fish/m^2 was the highest, though not significantly different from stocking density (SD) 25 fish/m^2 ($p>0.05$). It however, differed from SD 20 and 30 fish/m^2 ($p<0.05$). Fat accumulation was however highest in SD 30 fish/m^2 and lowest in SD 15 fish/m^2. SD15 was significantly different ($p>0.05$) from all others. Stocking densities 20 fish/m^2 and 30 fish/m^2 were similar ($p>0.05$) but differed significantly ($p<0.05$) from SD 25 fish m^2. Crude fiber was highest in SD 15 fish/m^2 and differed from all others ($p<0.05$), which incidentally were all similar ($p>0.05$). The values of Nitrogen free extract (NFE) and muscle energy level were highest in fish stocked at 30/m^2, though not significantly different ($p> 0.05$) from those stocked at 20 and 25/m^2 but differed significantly from fish in stocking density of 15/m^2 ($p< 0.05$) which yielded the lowest values. Trend was only observed in the NFE and muscle energy among all the parameters examined (increasing in ascending order of stocking densities). Ash value was highest in fish of density 15fish/m^2 and least in 25fish/m^2. SD 15 fish/m^2 exhibited significant difference ($P<0.05$) from all others which however, did not differ significantly.

Table 2: The table presents the mean proximate composition of carcass of albino *Clarias gariepinus* reared under different stocking densities in tarpaulin tanks for 20 weeks (Mean ± SE).

Parameters	Initial	Final			
		15	20	25	30
Crude protein (%)	23.69	48.63 ± 0.24^a	47.58 ± 0.20^b	47.85 ± 0.16^{ab}	45.63 ± 0.48^c
Crude fat (%)	1.98	9.45 ± 0.17^c	13.33 ± 0.23^a	11.48 ± 0.57^b	14.13 ± 0.17^a
Crude fibre (%)	1.73	11.37 ± 0.80^a	8.95 ± 0.31^b	9.68 ± 0.19^b	9.44 ± 0.16^b
NFE (%)	64.31	13.76 ± 0.73^b	17.25 ± 0.14^a	17.89 ± 0.81^a	18.39 ± 0.32^a
ASH (%)	8.29	16.37 ± 0.27^a	12.82 ± 0.17^b	12.45 ± 0.19^b	13.53 ± 0.56^b
Energy value (Kcal)	369.82	334.62 ± 0.91^b	378.95 ± 3.00^a	367.95 ± 4.27^a	374.79 ± 5.84^a

Means with the same superscripts along the rows are not significantly different ($p>0.05$).

3.3 Growth Performance Indices

Mean growth performance of albino *C. gariepinus* during the study is represented in Table 3 and Figure 1. The best mean weight gain (MWG) was recorded in stocking density (SD) 25 fish/m^2 followed by stocking density 15 fish/m^2 while SD 30 fish/m^2 was the least. The differences among all the treatments were just marginal without significance ($p>0.05$). SD 20 fish/m^2 gave better and significant ($p<0.05$). Specific growth rate compared to all others which were insignificant. Mean gain in length (MLG) was highest and significant ($p<0.05$) in SD 25 fish/m^2, and lowest in SD 30 fish/m^2. Similarities were found among SD 15, 20 and 30 fish/m^2 ($p>0.05$), and also between SD 25 and 15 fish/m^2. The lowest mean survival rate was obtained in SD 25 fish/m^2 and the highest in 20 fish/m^2, both of which were significant ($p<0.05$). SD 15, 20 and 30 fish/m^2 were not significantly different, and likewise 25 and 30 fish/m^2 ($p> 0.05$).

Table 3: The table shows the mean growth performance indices of albino *Clarias gariepinus* reared under different stocking densities in tarpaulin tanks for 20 weeks (Mean ± SE).

Parameters	**Stocking densities (fish/m^2)**			
	15	**20**	**25**	**30**
Initial mean weight(g)	1.09	0.8	0.61	0.71
Final mean weight(g)	117.45	107.45	110.84	79.54
Initial mean total length (cm)	1.68	1.23	0.94	1.09
Final mean total length (cm)	23.66	23.55	26.19	21.08
Mean length gain (g)	22.77 ± 0.94^{ab}	22.32 ± 0.31^{b}	25.25 ± 1.41^{a}	20.40 ± 0.07^{b}
Mean weight gain (g)	108.38 ± 10.39^{a}	106.65 ± 11.34^{a}	110.23 ± 23.68^{a}	78.83 ± 7.58^{a}
Mean growth rate (%/day)	1.68 ± 0.01^{a}	1.40 ± 0.00^{b}	1.19 ± 0.00^{c}	1.18 ± 0.00^{c}
Mean specific growth rate (%/day)	0.03 ± 0.00^{b}	0.04 ± 0.00^{a}	0.03 ± 0.00^{b}	0.03 ± 0.00^{b}
Mean survival rate (%)	82.23 ± 8.01^{a}	85.00 ± 0.00^{a}	46.67 ± 5.81^{b}	60.00 ± 9.64^{ab}

Means with the same superscript along the rows are not significantly different (P>0.05)

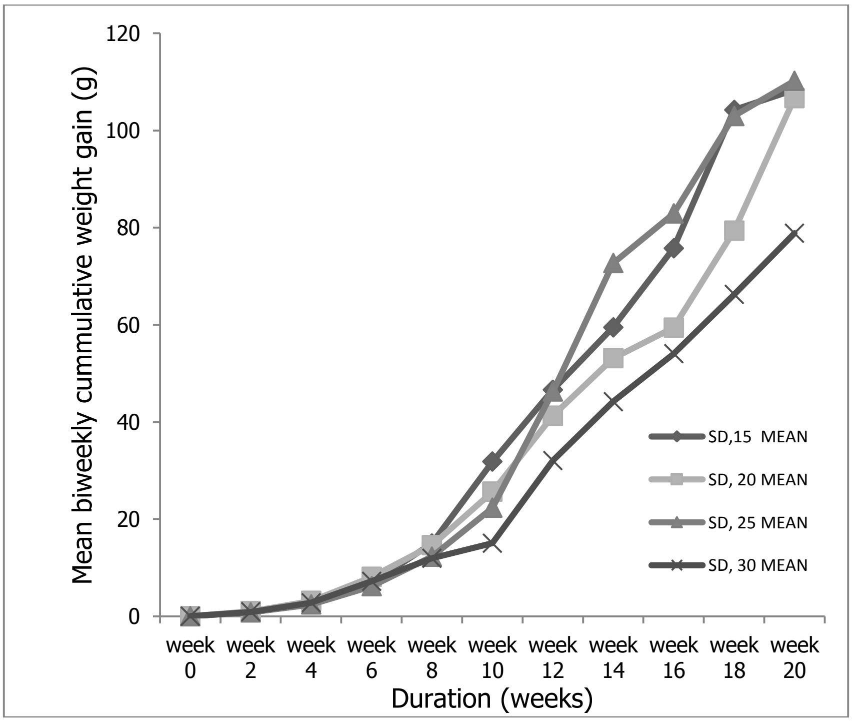

Figure 1: Mean biweekly cumulative weight gain of *Clarias gariepinus* "Albino" reared under different stocking densities in tarpaulin tanks for 20 weeks.

3.4 Feed utilization indices

Table 4 shows the feed utilization indices of albino *C. gariepinus* during the study. The largest quantity of feed and dietary crude protein were consumed in SD 25 fish/m^2 while the lowest were in SD 15 fish/m^2. The feed as well as crude protein consumed in all treatments were not significantly different ($p>0.05$). Feed conversion efficiency (FCE) and food conversion ratio (FCR) were best at SD 20 fish/m^2 and significantly different from the worst values at SD 15fish/m^2. Both indices remained insignificantly different ($p>0.05$) in their respective values among SD 20, 25 and 30 fish/m^2. SD 20 fish/m^2 also ranked highest in protein efficiency ratio (PER) though not significant ($p>0.05$) when viewed against SD 25 fish/m^2, but significantly different ($p<0.05$) from SD 15 fish/m^2 (lowest) and 30fish/m^2, both of which were similar ($p>0.05$). Protein productive value (PPV) was significant ($p<0.05$) between SD 15 fish/m^2 and all others which incidentally had no significance differences among their means ($p>0.05$).

Table 4: The table shows the mean feed utilization indices of albino *Clarias gariepinus* reared at different stocking densities in tarpaulin tanks for 20 weeks (Mean ± SE).

Parameters	Stocking densities (fish/m^2)			
	15	**20**	**25**	**30**
Feed consumed (g)	70.15 ± 68.79^a	110.11 ± 2.16^a	153.64 ± 51.66^a	99.94 ± 1.23^a
Protein consumed (g)	27.82 ± 27.84^a	44.73 ± 0.87^a	47.50 ± 4.61^a	40.60 ± 0.49^a
Feed conversion efficiency	61.28 ± 0.42^b	97.00 ± 10.02^a	76.51 ± 10.37^{ab}	79.24 ± 8.45^{ab}
Feed conversion ratio	1.62 ± 0.01^a	1.06 ± 0.12^b	1.36 ± 0.19^{ab}	1.29 ± 0.15^{ab}
Protein efficiency ratio	1.52 ± 0.01^b	2.38 ± 0.25 ^{a}	2.31 ± 0.25 ^{ab}	1.95 ± 0.21 ^{b}
Protein productive value	35.58 ± 2.62^b	53. 08 ± 1.71^a	51.70 ± 4.29^a	54.08 ± 1.71^a

Means with the same superscripts along the rows are not significantly different at ($P>0.05$)

4. DISCUSSION

The mean water quality indices prevalent during the 20 weeks experimental period were within the safe range for the survival, growth and reproduction of warm water fishes.

The growth performance of the albino *Clarias gariepinus* at the end of this experiment was generally fair across all stocking densities. Though the general performance of the fish did not exhibit any significant difference among the treatment, the empirical result however, revealed that stocking density of 30 fish/m^2 gave the worst result in the mean weight gain (MWG) (78.83±7.58) and mean growth rate (MGR) (1.180±0.00). The highest or best growth performance was seemingly found in SD 25 fish/m^2 with respect to MWG (110.23±23.676). However, considering the mean number of fish (11.67) that survived in SD 25 fish/m^2 (46.667 ± 5.812) as compared to the mean number (12.3) that survived in SD 15fish/m^2 (82.223±8.011), it is obvious that SD 25 fish/m^2 was actually slightly lower than SD 15 fish/m^2 apparently from week 12. The mean survival growth rate was best and significant at stocking density of 20 fish/m^2. The survival rates at SD 15 fish/m^2, 20 fish/m^2 and 30 fish/m^2 were not significant, but SD 25 fish/m^2 was significantly different from SD 15 fish/m^{2}and 20 fish/m^2, and similar to SD 30 fish/m^2. The numerical values of the survival rates and their statistical inferences were in favour of better survival at lower than at higher densities.

The general results therefore seem to reflect the moderating effects of stocking densities on the growth performance of the albino *C. gariepinus* in line with the observations of various authors on diverse species of fish. Jamabo and Keremah (2009) and Dasuki et al. (2013) had observed depreciation in growth performance and feed utilization with increasing stocking density in *C. gariepinus* [41,42]. Boujard et al. (2002), Ellis et al. (2002), Wallat et al. (2004) and Rasmussen et al. (2007) studied the trout and observed the influence of stocking density on the growth performance of the fish [38-25-43,44]. Ellis et al. (2002) noted that the growth rate and food conversion ratio got poorer with increasing stocking density [25]. Sirakov and Ivancheva (2008) observed better growth rate and feed conversion ratio in brown trout at lower density than at high density [27]. Irwin et al. (1999) and Aksungur et al. (2007) similarly reported a negative effect of high stocking densities on the growth performance, survival and food conversion ratio of turbot (*Psetta maxima*) [45,46]. The negative correlation of the growth performance, feed utilization and survival of some fishes to high stocking densities are often linked to increased stress [47,48]; high susceptibility to disease [49]; aggressive behaviour and cannibalism leading to physical injuries and even death [50-26-51]; poor body condition [25]; reduced feed intake probably due to competition [25] and poor water quality [27].

In this study the most noticeable cause of poor survival were aggressive and cannibalistic tendencies of the albino *C. gariepinus*. These tendencies related more to the hierarchical behavior [51] of some bigger ones resulting from differential growth especially in SD 25 fish/m^2 than competition for food which was ample at the 6% biomass supplied to the fish. Size variation still appears to be remarkable among the albino individuals as in the normal pigmented strain of *C. gariepinus* This may be supported by the assertion of Miller (2005) that the albinos have the characteristics of other members of the species saves the absence of melanin to manufacture dark colour in their skin, scales and the eyes [18]. Also, deterioration of water quality could relate more to the metabolites than feed management and other physical parameters of the water.

5. CONCLUSION

Stocking density is considered an important factor to take into account when ranking families or progeny groups for growth performance. Despite the enormous studies conducted on stocking densities, obtaining precise information on better stocking densities for each species is still challenging [52]. Different culture system and fish age have been identified as factors which could be considered while contemplating ideal stocking densities. The growth performance and survival of the albino *C. gariepinus* in this experiment had been found to be negatively affected by a higher stocking density. The performance and survival of this, fish could perhaps differ from what was obtained in this experiment if such condition as type of culture facility were different, but under similar conditions as prevailed in this experiment, stocking densities not beyond 20 fish per a square meter are recommended for the production of table sized albino *C. gariepinus.*

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