TABLE 6

Quantity of feed given per day for fish cultured in fiberglass tanks

Period	F_I		F_{II}		F_{III}		F_{IV}	
(Days)/ % b.w.	Fish wt (g)/*SD less mortality	Feed(kg)/ day	Fish wt (g)/*SD less mortality	Feed(kg /day	Fish wt (g)/*SD less mortality	Feed(kg) /day	Fish wt (g)/*SD less mortality	Feed(kg)/ day
1	4.0		4.6		4.4		4.6	
*(5%)	1000	0.22	1000	0.23	1000	0.22	1000	0.23
14	6.0		6.0		6.0		6.0	
(5%)	986	0.29	981	0.29	978	0.29	989	0.30
28	45.06		32.82		38.14		32.90	
(3%)	948	1.28	943	0.92	962	1.10	980	0.96
42	66.84		86.60		80.4		75.70	
(3%)	936	1.80	924	2.45	954	2.30	975	2.21
70	117.9		174.2		159.6		123.3	
(2.5%)	925	2.72	900	3.91	933	3.7	953	3.00
84	316.8		347.4		336.8		371.4	
(1.5%)	909	4.31	892	4.60	927	4.68	943	5.25
140	816.0		812.0		726.0		710.0	
(1.5%)	855	10.46	842	10.25	866	9.43	888	9.45
168	1130.0		1170		1158.0		1196.0	
(1.5%)	838	14.20	823	14.60	851	14.78	870	15.50
Total feed kg/ tank		647.78		688.1		664.8		683.34

Summary of results in concrete and fiberglass tanks

Table 7 gives a summary of results of the effect of feed and stocking density in concrete and fiberglass tanks. The final weight of fish stocked at 318 fingerlings/m^2 (1163g) was significantly higher than 1088g of 96 fingerlings/m^2 at 0.1% significance level. The condition factor (wellness of the fish) in fibreglass tanks was significantly ($P<0.001$) higher than those in concrete tanks. Likewise, the Food Conversion Rate and Protein Efficiency Ratio were significantly greater at $p=0.05$ and $p=0.01$ respectively in both culture systems. The daily weight gains, the Specific growth rates, Feed efficiency and survival rates weren't significantly ($p>0.05$) different from each other.

TABLE 7

Summary of result of maximizing production of *C. gariepinus* in concrete (96 fingerlings/m^2) and fiberglass tanks (316 fingerlings/m^2)

	Concrete tank (96 fingerlings/m^2	Fiberglass tank (318 fingerlings/m^2)	Statistics
Initial weight (g)	4.9 ± 0.23	4.5 ± 0.05	
Initial C.F	0.879 ± 0.002	0.856 ± 0.003	
Finial weight (g)	1089 ± 42.68	1163 ± 13.69	Sig. @ 0.1%
Final C. F.	0.928 ± 0.001	0.943 ± 0.001	P < 0.001
Daily weight gain (DW) (g/day)	6.45 ± 0.002	6.895 ± 0.08	NS P > 0.05
Specific growth Rate (SGR) (%)	3.212 ± 0.05	3.34 ± 0.02	NS P > 0.05
Food Conversion Ratio (FCR)	0.675 ± 0.05	0.695 ± 0.01	Sig. @ 5%
Protein Efficiency Ratio (PER)	3.32 ± 0.23	3.165 ± 0.05	Sig. @ 1%
Feed Efficiency (FE)	1.49 ± 0.01	1.41 ± 0.02	NS P < 0.05
Survival Rate (%)	74.9	84.82	NS P > 0.01

DISCUSSION

The critical factors that affect production of *Clarias gariepinus* are temperature, feed quality and ration. The Dissolved Oxygen values were however lower than recommended ranges (Boyd, 1981; APHA 1999; Ajayi, 2008; Ajah, 2017) but was compensated for by the use of aerators and shower heads. The water parameters monitored on the 1^{st}, 2^{nd} and 3^{rd} day of culture before a change of water was effected in the culture water were within acceptable ranges for *C. gariepinus* as recommended (Boyd, 1981; Hogendoom *et al* 1983; APHA 1999; Ajayi, 2008; Ajah, 2017). In this experiment, the effect of two stocking densities, 96 fingerlings/m^2 in concrete tanks and 318 fingerlings in fiberglass tanks on growth (SGR and DW) and feed utilisation parameters (FCR, PER and FE) were compared.

The SGR (3.34 $\pm$ 0.02%) and DW (6.895 ± 0.089/day) were higher in tanks stocked at 318 fingerlings /m^2 than in tanks stocked at 96 fingerlings/m^2 (3.212 $\pm$ 0.05% and 6.45 $\pm$ 0.002g/day respectively). The value of FCR was also higher in tanks stocked at 318 fingerlings/m^2 (0.695 $\pm$ 0.01) than those of 96 fingerlings/m^2 (0.695 $\pm$ 0.05). It therefore means that 0.695 and 0.675 unit/kg of feed were used to produce 1 unit/kg of fresh fish in the fiberglass and concrete tanks respectively. According to New (1987) the higher the value of FCR, the less efficient the feed. Invariably, the FCR values in both tanks being below 1.0 show that the commercial feed was highly efficient and capable of producing 1 kg of fish for 0.695 kg and 0.675kg feed at the two culture systems.

The higher value of FCR in the tanks stocked at 318 fingerlings/m^2 can be attributed to higher densities due to higher survival rates coupled with the feeding behaviours of the fish under crowded conditions. Under conditions of high density, catfish react faster to presence of food and consume a meal faster than under low density condition. Though at extremely high densities, the tendency is that aggression and severe competition sets in leading to the weaker ones feeding on the leftovers while the stronger and more aggressive feed more voraciously and grow faster resulting to ‘jumpers’. Fish in low density tanks leisurely select pellets from the floor of the tank. However, under high density condition, catfish typically go into “feeding frenzy” as soon as food is detected. This finding does support the work of Bjoernsson, (1999) who said that under crowded condition of higher stocking densities, fish suffer stress as a result of aggressive feeding interaction and eat less, resulting in growth retardation. The concrete tank had lower stocking density and lower percent survival than those of fibreglass tanks, hence, better feeding and consequently reduced competition and aggression, resulting to lower FCR and Condition factor. So, there is bound to be a limit to stocking densities for optimal growth which most probably revolve around 96 and 318 fingerlings/m^2 and any further increase far above the upper limit will most likely adversely affect the growth of the fish. The condition factor (CF) was significantly ($p<0.001$) affected by stocking density. The wellness of fish in the lower stocked (concrete) tanks were significantly better than those in very highly stocked (fibreglass) tank. Consequently, the robustness of the fish at the two stocking densities differing could be as a result of the varying stocking densities, the genetic makeup and the type of culture system. .

The protein efficiency ratio (PER) and feed efficiency (FE) were similarly higher in concrete tanks stocked at 96 fingerlings/m^2 (3.32 $\pm$ 0.23 and 1.49 $\pm$ 0.01) than in fibreglass tanks stocked at 318 fingerlings/m^2 (3.165$\pm$ 0.05 and 1.41$\pm$ 0.02). Although Marimuthu *et al*. (2011) had earlier stated that feed management such as optimization of feeding rate is crucial in both marine and freshwater fish cultures, we see here that the lesser the density, the lower the competitiveness and the more efficient feed is utilized. Since there was no shortage in supply of feed, crowdedness is the most probable reason for the slight edge in performance in the 96 fingerlings/m^2 over the fibreglass tanks of 318 fingerlings/m^2 aside genetic factors. The PER determines how efficient the protein in the feed has been utilized. With increasing dietary protein contents, the weight gain and food conversion ratios improve as a rule, while the PER declines (Steffens, 1997). It can then be inferred that the high stocking density reduced feeding efficency. Similar results have been reported in *Chrysichthys nigrodigitatus* larvae (Pangni *et al*, 2008); *Cyprinus carpio* larvae (Jha and Barat, 2005), and *Tor putuitora* larvae (Rahman *et al*, 2005). With 35% crude protein and 18% fat in semi-synthetic diet of young rainbow trout, it was possible to achieve PER values of 3.3. The value implies that from less than 2000g dietary feed protein, it was possible to produce 1000g trout protein. Advantageous protein efficiencies are not as a rule achieved commercially using industrially produced feeds. During the production of marketable trout, a PER of 2.04 was obtained (Steffens and Albrect, 1975). In experiments with young carp and a feed consisting of 32% protein, a PER of 3.5 was realised (Takeuchi *et al,* 1979). Similar PER of 3.32 and 3.167 respectively for concrete and fibreglass culture systems were realised using 45% and 55 % protein.

A lower mean final weight (1089$\pm$42.48g) in tanks stocked at 96 fingerlings/m^2 as against higher mean final weight (11635$\pm$13.69g) in tanks stocked at 318 fingerlings/m^2 might be due to less frenzy acquisition of food by the fish at lower stocking densities. The fish were all fed to satiation level following a recommendation by a study carried out by Southern Regional Aquaculture Center (SRAC,1998) 'Restricted Feeding Regimes increased Production efficiency in channel catfish fed to apparent satiation'. The study showed that fishes fed to satiation level gained more weight than those restricted in feed. Our experiment showed that best growth does not necessarily have to come from larger quantity of feed. For instance, the tank (C_1) with the lowest quantity of feed among the concrete tanks had the highest fish growth. Even in the fibreglass tanks, tank F_{iv} with the highest fish mean weight was not fed with the highest quantity of feed.

A survival rate of 74.9% was achieved in tanks stocked at 96 fingerlings/m^2 while 84.82% was achieved in tanks stocked at 318 fingerlings/m^2. Timmons *et al*.

(2002) opined that stocking density is one of the main criteria for consideration when designing a Recirculatory Aquaculture System because it will define the feeding rate from which the specification of technical components is determined. Ajah (2017) stated that survival in earthen ponds increased with decrease in stocking density contrary to this findings. Ajah (2017) lower survivors may equally have been as a result of more predators in higher density earthen ponds and not necessarily due to high stocking density. The higher survival in the fibreglass tanks may be due to the smoother surface and highly reduced abrasions compared with the concrete tank. Okoye *et al* (2007) observed lower survival in higher densities and attributed same to handling stress. The causes of mortalities in both tanks were sibling's cannibalism; jumping out of the tanks especially at night and infection arising from wounds on the fish. Sibling cannibalism accounted for majority of the mortalities. Most dead fishes were either completely eaten or half eaten. Jumping out of the tanks was particularly common in the fiber glass tanks. Fishes that jumped out normally crawled and hid under the tank or some other hideous places and were picked up the next day either weak or dead.

Conclusion

Intensive production of *Clarias gariepinus* (96 fingerlings/m^2 and 318 fingerlings/m^2) was carried out indoor using concrete and fiberglass tanks with the aim of ascertaining which of the two stocking densities and culture systems will produce higher fish yield measured by final weight, daily weight gain, Specific Growth rate (SGR), food conversion Ratio (FCR), Protein efficiency ratio (PER), and feed Efficiency (FE) and survival rates. The highest final individual mean weight (1163.5 ±13.69g) after 168 days (24 weeks) was recorded in tanks stocked at 318 fingerlings/m^2 while in tanks stocked 96 fingerlings/m^2 were 1089±42.68g. There were significant differences between the two final weights at 1% probability levels. Daily weight gain and Specific growth rate (SGR) were highest in group B tanks (318 fingerlings/m^2). The FCR between the two stocking densities was significant at 5% level of significance. The PER and FE were highest in tanks stocked at 98 fingerlings/m^2 while the survival rate was highest in tanks stocked at 318 fingerlings/m^2. High feed application does not always amount to high yield. Other factors like stocking densities, feed type, proper water management, predators and genetic makeup do affect yield. High stocking densities with daily change of culture water is therefore recommended for intensive culture of *Clarias gariepinus* in indoor tanks.

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