GROWTH PERFORMANCE OF HYBRID CATFISH (*Heterobranchus bidorsalis* (♀) X *Clarias gariepinus* (♂)) AT VARIOUS STOCKING DENSITIES IN VARIED CULTURE TANKS

[1]OGUGUAH, Ngozi Margaret, [2]NWADUKWE, Frank, [3]ATAMA, Chinedu Ifeanyi, [4]CHIDOBEM, Joseph Ikechukwu and [5]EYO, Joseph Effiong

[1]Department of Physical and Chemical Oceanography, Nigerian Institute for Oceanography and Marine Research, 3 Wilmot Point Road, Victoria Island, Lagos Nigeria.

[1,3,4,5]Department of Zoology, Faculty of Biological Sciences, University of Nigeria, Nsukka, Enugu State, Nigeria.

[2]Department of Animal and Environmental Biology, Delta State University, PMB 1, Abraka, Delta State, Nigeria.

Corresponding Author: Oguguah N. M. Department of Physical and Chemical Oceanography, Nigerian Institute for Oceanography and Marine Research, 3 Wilmot Point Road, Victoria Island, Lagos Nigeria. **Email:** ngozimoguguah@yahoo.com, **Phone:** +234 8032642262

ABSTRACT

Stocking density effect of Heterobranchus bidorsalis (♀) and Clarias gariepinus (♂) hybrid juveniles stocked at densities of 7, 14 and 21 catfishes m^{-2} in three varied culture tanks (concrete, metal and plastic) were studied for 20 weeks. Total length and weight of catfish juveniles were recorded every fortnight. Plastic tanks with stocking density of 7 catfishes m^{-2} had the best weight gain (4.89 ± 6.81 g) while the least weight gain (1.39 ± 2.16 g) was recorded in concrete tank with stocking density of 21 catfishes m^{-2}. There was significant difference between stocking density of 7 catfishes m^{-2} (4.13 ± 5.38 g) and 21 catfishes m^{-2} (1.82 ± 2.26 g) ($P < 0.05$). There was no significant difference in specific growth rate, feed efficiency and condition factor of catfishes in all culture tanks and stocking densities. The best total length of 12.23 ± 5.22 cm was obtained in concrete tank with stocking density of 7 catfish m^{-2}. The least mean total length (9.44 ± 4.04 cm) was recorded in plastic tank with stocking density of 21 catfishes m^{-2}. The effect of stocking density on total length was significant between stocking densities of 7 catfishes m^{-2} (11.85 ± 5.52 cm) and 21 catfishes m^{-2} (9.54 ± 4.01 cm) ($P < 0.05$).

Keywords: Growth, Hybrid catfish, *Heterobranchus bidorsalis* X *Clarias gariepinus,* Stocking densities, Culture tanks, Weight gain

INTRODUCTION

Fish provides a relatively cheap source of animal protein when compared to beef (NEPAD, 2005). The African catfish (*Clarias gariepinus* Burchell 1822) is commonly used in homestead fish culture because it takes up oxygen from the air, has a high growth rate and is often disease resistant (Eyo, 1997; Martin and de Graaf, 2001). *C. gariepinus* species are very popular with fish farmers, and command a very good commercial price in Nigerian markets (Ezenwaji, 1986; Oladosu *et al.*, 1993; Ayinla *et al.*, 1994). In the long run homestead fish pond will enable fish culturist and the entire country to be fish protein sufficient. Furthermore, excess production will be sold to non producers and income so generated will be used to meet other domestic needs. Anetekhai *et al.* (2004) observed that additional income can be generated at homes through homestead aquaculture. The future of aquaculture in Africa lies in increasing production efficiencies and intensities so as to produce more fish using less land, water and financial resources (Jamu and Ayinla, 2003). Micha (1976) reported that the growth rate of *C. gariepinus* decreased with increased stocking density. Stocking density depends largely on desired market size and varies from 2 - 10 fingerlings per square metre, which translates to a market size of approximately 500 and 200 grams respectively after 6 month rearing period (de Graaf and Janssen, 1996). Fingerlings (10 – 50g) stocking rates of about 8,500-10,000 fish per hectare (3,743 fingerlings/acre) in single harvest production and up to 24,000 fish per hectare (9,713 fish/acre) in multiple harvest production systems are reported. In net enclosures, stocking densities of 6 – 12 fingerlings per cubic metre of the cage has been practiced (Chapman, 2000). Nick (1999) reported stocking 40 fish in a 55 gallon steel drum and Carpenter (1996) recommended the stocking of channel catfish or blue catfish at 1000 fingerlings per surface acre in fed ponds; 100 fingerlings per surface acre in fertilized ponds and 50 fingerlings in unfertilized ponds. Sirikul *et al.* (1988) recommended a stocking rate of 60 – 300 fingerlings per metre for *Clarias batrachus* and *Clarias macrocephalus* and Anibeze *et al.* (2003) recommended a stocking rate of 7 fingerlings m^{-2} for *Heterobranchus longifilis* in concrete ponds based on production and economic parameters. From the forgoing the objective of this study was to evaluate the growth potentials of hybrid catfish (*Heterobranchus bidorsalis* (♀) x *Clarias gariepinus* (♂)) at various stocking densities using different type of culture tanks.

MATERIALS AND METHODS

This study was carried out at fish ponds in the Zoological garden of the Zoology Department at the University of Nigeria Nsukka in 2006.

Physico-Chemical Parameters: Some Physico-chemical parameters of pond water were determined for all the culture tanks, viz- concrete tanks, metal tanks and plastic tanks. The parameters include water temperature (determined with a mercury-in-glass thermometer), pH (determined with a portable field pH meter). Dissolved oxygen was determined by means of the Wrinkler's method, while ammonia, nitrate and nitrite were determined using total Kjeldall nitrogen method and a colorimeter (LaMotte) respectively during the five months study period.

Culture Tanks: Three types of culture were used for this study and they include nine concrete tanks (each 1 m x I m x 1m) with a volume of 1000 L, nine 1000 L plastic tanks and nine 1000 L metal tanks. All the tanks were covered with mosquito net to prevent escape of fish, as well as entry of predators and leaves from falling in from trees. The tanks were filled with tap water up to three quarters full. Each tank was fertilized with inorganic fertilizer (NPK 15:15:15) and poultry droppings (tied in jute bag) at the dosage of 5 g/m^2 and $10g/m^2$ respectively. The water was allowed to age for two weeks before introduction of fish. All tanks were continuously aerated using an air conditioner compressor.

Catfish Hybrid: The catfish hybrid fingerlings were produced in the Fisheries and Hydrobiology Wet Laboratory, Zoological Garden, University of Nigeria, Nsukka. Female *C. gariepinus* broodfish were obtained from the pond of the Fisheries and Hydrobiology Wet Laboratory, Zoological Garden, University of Nigeria, Nsukka. While the adult male *H. bidorsalis* were obtained from ADP hatchery in Agbor, Delta State. The fish were induced using the methods described by Nwadukwe (1995). The hybrid fry were transferred to tanks and reared according to the procedures used by de Graaf and Janssen (1996). They were fed with zooplankton for 21 days before being transferred to outdoor nursery system.

Diets: Proximate analysis of dietary ingredients was carried out after which the diet was compounded following the method described by Eyo (2003). The feed was run through meat mincer (National, Japan) fitted with 3 mm dye and the resulting nodules shaped strands were cut into pellets and oven dried at 50 ^{o}C for 3 hours. Catfish hybrid fingerlings were fed daily at the rate of 5 % of body weight with the pelletized diet (40.40 % crude protein) (Eyo, 2003). Daily feed was given in two rations (at 9am and 4pm). The quantity of diet administered was adjusted fortnightly using weight gain data from fish sampled bimonthly.

Experimental Design: The experimental design used was the Randomized Complete Block Design (RCBD) also called two-way classification (Obi, 2002) involving nine treatments triplicate culture tanks in treatments A, D, and G (control tanks) were stocked with 7 juveniles m^{-2} (Anibeze *et al.*, 2003). Triplicate culture tanks in treatments B, E and H were stocked with 14 juveniles m^{-2} and triplicate culture tanks in treatments C, F and I were stocked with 21 juveniles m^{-2}.

Production Parameters: All the fingerlings were harvested fortnightly and weighed using Mettler electronic balance (PC 2000) to the nearest 0.01 g.

Total length: Total length of juvenile catfish in different treatments was recorded fortnightly using fish measuring board to the nearest 0.01 cm.

Weight gain: Weight gain was calculated using $W_2 - W_1$, where W_2 is final weight and W_1 is initial weight over a sampling period.

Specific growth rate: Specific growth rate of catfish in different treatments was calculated using the formula; Instantaneous or Specific growth rate: $\ln W_2 - \ln W_1 / t_2 - t_1$ (Chiu, 1989). Where $\ln W_2 - \ln W_1$ = Natural logarithm of initial and final weight over a period t_2-t_1.

Feed efficiency: Feed efficiency for catfish in different treatments was calculated using the formula: Feed efficiency = Weight gain[b] / Feed intake[a] (Boonyaratpalin, 1989); Where [a] Feed intake = feed eaten by the fish on a matter basis; [b] weight gain = a weight increase on wet matter basis.

Condition factor (K): Condition factor of catfish in different treatments was calculated using the formula; $K = 100\ W / l^3$; Where W = weight of fish (g), L = total length of fish (cm).

Data Analysis: Data resulting from the experiment were subjected to Two Way Analysis of Variance using SPSS (Statistical Package for Social Sciences) Version 12. Tukey HSD, LSD and Tamhane were used to compare difference among individuals means at P = 0.05.

RESULTS

Physico-Chemical Parameters

Temperature: The effect of tank type on temperature revealed that concrete tanks had the highest mean temperature of 28.00 ± 6.11 °C (Table 1), followed by metal tanks (27.98 ± 5.84 °C) (Table 1) and plastic tanks had the least mean temperature of 27.61 ± 6.54 °C (Table 1).

pH: The mean effect of pH on tank type was significantly different ($P < 0.05$). The significant difference was between concrete tank (7.65 ± 1.39) (Table 2) and metal tank (7.01 ± 1.22) (Table 2) and plastic tank (6.98 ± 0.90) (Table 2).

Dissolved Oxygen: The mean effect of dissolved oxygen on tank type was statistically significant ($P < 0.05$). There was significant difference between the mean dissolved oxygen concentrations of concrete tanks (4.27 ± 0.65) and plastic tanks (3.79 ± 0.68). The mean of dissolved oxygen concentration of the metal tank (4.02 ± 0.55) was not significantly different ($P > 0.05$) (Table 3).

Ammonia: The group effect of ammonia concentration on tank type was not statistically significant ($P > 0.05$). The highest mean concentration was recorded in concrete tank (0.0001 ± 0.001) followed by metal tank (0.0001 ± 0.00009) and plastic tank (0.0001 ± 0.0009) (Table 4).

Nitrite: The groups mean effect of nitrite on tank type was significantly different ($P < 0.05$).

Table 1: Five months culture tank water temperature of *Heterobranchus bidorsalis* (♀) x *Clarias gariepiuns* (♂) hybrid juveniles grown in varied grow-out tanks and stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
			Temperature (°C)	
Concrete	1	35.17 ± 0.17	35.40 ± 0.61	35.10 ± 0.00
	2	35.03 ± 0.05	36.03 ± 0.06	35.20 ± 0.26
	3	24.00 ± 0.00	23.83 ± 1.04	23.83 ± 1.61
	4	23.50 ± 0.41	22.83 ± 1.26	22.40 ± 1.51
	5	23.00 ± 0.82	22.50 ± 0.50	22.23 ± 1.75
	Mean	28.14 ± 5.91	28.12 ± 6.48	27.75 ± 0.82
Metal	1	33.70 ± 1.57	35.43 ± 0.58	35.57 ± 0.50
	2	34.10 ± 1.05	35.43 ± 0.58	35.57 ± 0.50
	3	23.00 ± 1.00	24.00 ± 0.00	24.00 ± 0.00
	4	22.83 ± 0.76	23.67 ± 0.58	24.00 ± 0.00
	5	22.83 ± 0.29	22.50 ± 0.50	23.00 ± 1.00
	Mean	27.29 ± 5.65	28.21 ± 6.14	28.43 ± 6.06
Plastic	1	35.23 ± 0.15	35.23 ± 0.15	35.57 ± 0.50
	2	35.10 ± 0.00	35.57 ± 0.50	36.10 ± 0.00
	3	22.50 ± 0.50	23.50 ± 0.50	23.17 ± 1.04
	4	22.50 ± 0.50	23.27 ± 0.25	23.00 ± 1.00
	5	21.00 ± 0.00	21.43 ± 0.51	21.00 ± 0.50
	Mean	27.27 ± 6.71	27.80 ± 6.48	27.77 ± 6.89

Table 2: Five months culture tank water pH of *Heterobranchus bidorsalis* (♀) x *Clarias gariepiuns* (♂) hybrid juveniles grown in varied grow-out tanks and stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
			pH	
Concrete	1	6.54 ± 0.54	6.66 ± 0.15	6.70 ± 0.48
	2	8.46 ± 0.49	8.42 ± 0.81	8.28 ± 0.54
	3	9.09 ± 0.18	9.86 ± 0.27	9.58 ± 0.40
	4	6.92 ± 0.13	6.68 ± 0.26	7.00 ± 0.03
	5	7.54 ± 0.75	7.63 ± 0.95	7.44 ± 0.09
	Mean	7.51 ± 1.26	7.71 ± 1.57	7.73 ± 1.34
Metal	1	6.01 ± 0.41	6.12 ± 0.49	6.16 ± 0.44
	2	7.95 ± 0.41	7.23 ± 0.60	7.23 ± 0.54
	3	8.41 ± 0.02	8.74 ± 1.10	8.80 ± 0.67
	4	6.74 ± 0.19	6.47 ± 0.17	6.59 ± 0.08
	5	5.97 ± 0.48	6.56 ± 0.23	6.07 ± 0.07
	Mean	7.01 ± 1.19	7.04 ± 1.28	6.97 ± 1.23
Plastic	1	6.04 ± 0.18	5.84 ± 1.63	6.31 ± 0.47
	2	7.03 ± 0.12	6.74 ± 0.79	7.17 ± 0.64
	3	8.31 ± 0.01	7.71 ± 1.30	8.27 ± 0.04
	4	6.59 ± 0.14	7.07 ± 0.37	6.96 ± 0.31
	5	6.57 ± 0.06	7.05 ± 0.91	6.31 ± 0.30
	Mean	6.91 ± 0.83	7.02 ± 0.92	7.00 ± 0.97

Table 3: Five months culture tanks water dissolved oxygen levels of *Heterobranchus bidorsalis* (♀) x *Clarias gariepiuns* (♂) hybrid juveniles grown in varied grow-out tanks and stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
		Dissolved Oxygen Concentration (mg/l)		
Concrete	1	3.72 ± 0.16	4.14 ± 0.69	4.09 ± 0.17
	2	3.11 ± 0.33	3.70 ± 1.40	3.63 ± 0.43
	3	4.53 ± 0.10	4.58 ± 0.03	4.72 ± 0.21
	4	4.45 ± 0.32	4.65 ± 0.25	4.67 ± 0.57
	5	4.63 ± 0.05	4.57 ± 0.31	4.87 ± 0.21
	Mean	4.09 ± 0.65	4.33 ± 0.71	4.39 ± 0.57
Metal	1	3.49 ± 0.23	4.43 ± 0.55	3.96 ± 0.22
	2	2.93 ± 0.31	4.25 ± 0.85	4.25 ± 0.45
	3	4.05 ± 0.15	4.60 ± 0.25	3.68 ± 0.03
	4	4.20 ± 0.00	4.42 ± 0.40	3.40 ± 0.10
	5	4.18 ± 0.58	4.75 ± 0.15	3.95 ± 0.05
	Mean	3.72 ± 0.51	4.49 ± 0.46	3.85 ± 0.36
Plastic	1	3.69 ± 0.06	3.54 ± 0.46	3.65 ± 0.00
	2	3.65 ± 0.05	3.20 ± 0.33	3.20 ± 0.20
	3	3.73 ± 0.18	4.03 ± 0.73	4.10 ± 0.20
	4	2.85 ± 0.35	3.30 ± 1.30	3.85 ± 0.65
	5	4.60 ± 0.00	4.75 ± 0.15	4.68 ± 0.38
	Mean	3.70 ± 0.59	3.76 ± 0.84	3.90 ± 0.56

Table 4: Five months culture tanks water ammonia levels of *Heterobranchus bidorsalis* (♀) x *Clarias gariepiuns* (♂) hybrid juveniles grown in varied grow-out tanks and stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
		Ammonia Concentration (mg/l)		
Concrete	1	0.0014 ± 0.0009	0.0014 ± 0.0018	0.0024 ± 0.0018
	2	0.0004 ± 0.0000	0.0004 ± 0.0001	0.0004 ± 0.0001
	3	0.0006 ± 0.0006	0.0003 ± 0.0001	0.0010 ± 0.0013
	4	0.0015 ± 0.0009	0.0025 ± 0.0005	0.0022 ± 0.0001
	5	0.0027 ± 0.0009	0.0011 ± 0.0002	0.0015 ± 0.0001
	Mean	0.0001 ± 0.0001	0.0001 ± 0.0001	0.0002 ± 0.0001
Metal	1	0.0009 ± 0.0004	0.0014 ± 0.0018	0.0005 ± 0.0002
	2	0.0005 ± 0.0001	0.0003 ± 0.0002	0.0003 ± 0.0000
	3	0.0012 ± 0.0007	0.0004 ± 0.0002	0.0006 ± 0.0003
	4	0.0025 ± 0.0001	0.0023 ± 0.0003	0.0021 ± 0.0005
	5	0.0009 ± 0.0002	0.0013 ± 0.0002	0.0016 ± 0.0001
	Mean	0.0001 ± 0.0008	0.0001 ± 0.0001	0.0001 ± 0.0008
Plastic	1	0.0013 ± 0.0008	0.0007 ± 0.0002	0.0003 ± 0.0001
	2	0.0001 ± 0.0000	0.0001 ± 0.0000	0.0001 ± 0.0000
	3	0.0022 ± 0.0021	0.0013 ± 0.0004	0.0005 ± 0.0002
	4	0.0021 ± 0.0002	0.0018 ± 0.0001	0.0021 ± 0.0001
	5	0.0013 ± 0.0001	0.0015 ± 0.0002	0.0013 ± 0.0002
	Mean	0.0001 ± 0.0001	0.0001 ± 0.0007	0.0009 ± 0.0008

There were significant differences between levels of nitrite in metal tank (0.0003 ± 0.00004) and plastic tank (0.0003 ± 0.00003) and between metal tank and concrete tank (0.0003 ± 0.0004) (Table 5).

Total Length: There was significant difference in total length of catfishes at different stocking densities in the different grow out tanks ($P < 0.05$) (Table 6). Concrete tank with stocking density of 7 catfish m^{-2} gave the best mean total

Table 5: Five months culture tanks water nitrate concentrations of *Heterobranchus bidorsalis* (♀) *Clarias gariepinus* (♂) hybrid juveniles grown in varied grow-out tanks and stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
			Nitrate level	
Concrete	1	0.0002±0.00	0.0004±0.0000	0.0003±0.0000
	2	0.0001±0.00	0.0002±0.0000	0.0001±0.0000
	3	0.0001±0.00	0.0002±0.0001	0.0001±0.0000
	4	0.0005±0.00	0.0005±0.0001	0.0005±0.0000
	5	0.0003±0.00	0.0005±0.0000	0.0005±0.0001
	Mean	0.00002±0.01	0.00003±0.00001	0.00003±0.00002
Metal	1	0.0003±0.0001	0.0004±0.0001	0.0002±0.00
	2	0.0003±0.0002	0.0002±0.0001	0.0001±0.00
	3	0.0001±0.0000	0.0001±0.0000	0.0001±0.00
	4	0.0004±0.0001	0.0005±0.0000	0.0004±0.00
	5	0.0004±0.0001	0.0005±0.0001	0.0003±0.00
	Mean	0.00003±0.00001	0.00004±0.00002	0.00002±0.00
Plastic	1	0.0003±0.0001	0.0004±0.0001	0.0004±0.0001
	2	0.0001±0.0000	0.0004±0.0002	0.0002±0.0001
	3	0.0001±0.0000	0.0001±0.0000	0.0001±0.0000
	4	0.0005±0.0001	0.0005±0.0002	0.0005±0.0001
	5	0.0004±0.0001	0.0004±0.0001	0.0005±0.0001
	Mean	0.00003±0.00002	0.00004±0.00002	0.00003±0.00002

Table 6: Five months length increment of *Heterobranchus bidorsalis* (♀) x *Clarias gariepinus* (♂) hybrid juveniles grown in varied culture tanks at different stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
			Length (cm)	
Concrete	1	2.01 ± 0.01	2.11 ± 0.15	2.09 ± 0.01
	2	8.32 ± 1.45	7.18 ± 0.50	7.23 ± 0.65
	3	11.05 ± 1.90	8.87 ± 1.01	8.43 ± 0.79
	4	12.74 ± 1.08	11.32 ± 0.80	9.42 ± 0.64
	5	16.98 ± 0.36	15.08 ± 0.50	13.83 ± 0.87
	Mean	12.23 ± 5.22	10.92 ± 4.56	9.62 ± 3.83
Metal	1	1.94±0.08	2.17±0.13	2.03±0.07
	2	6.86±0.12	6.93±0.67	6.37±0.25
	3	9.95±0.17	8.84±0.24	8.30±0.82
	4	12.06±0.68	10.18±0.70	9.30±0.32
	5	17.57±0.75	14.22±0.96	14.07±0.09
	Mean	11.49±5.60	9.91±4.19	9.57±4.27
Plastic	1	2.22±0.09	2.39±0.37	2.17±0.13
	2	7.63±0.23	7.37±0.83	6.40±0.22
	3	9.83±0.60	9.14±0.74	8.30±0.32
	4	11.75±0.62	11.66±0.50	9.80±0.28
	5	17.33±1.53	14.87±0.77	13.44±0.18
	Mean	11.83±5.87	10.57±4.55	9.44±4.04

length of 12.23 ± 5.22 cm. This was followed by 11.83 ± 5.87cm in plastic tank with similar stocking density. The least mean total length of 9.44 ± 4.04cm was recorded in plastic tank with stocking density of 21 catfish m^{-2}. The mean effect of stocking density on total length differed significantly ($P < 0.05$). The main effect of stocking density was significant only between stocking density of 7 catfishes m^{-2} (11.85 ± 5.52cm) and stocking density of 21 catfishes m^{-2} (9.54 ± 4.01cm). The mean total length for stocking density of 14 catfishes m^{-2} (10.47 ± 4.41) was not statistically significant from stocking densities of 7 and 21 catfishes m^{-2}.

Weight Gain: There was significant difference in weight gain of catfishes at different stocking densities in the different grow out tanks ($P < 0.05$) (Table 7). Metal tanks with stocking density of 7 catfishes m^{-2} gave the best weight gain of 17.06 ± 17.41g. This was followed by 16.75 ± 19.25g in plastic tank with similar stocking density. The least weight gain of 6.91 ± 5.81g was recorded in concrete tank stocked with 21 catfishes m^{-2}. These values were statistically different ($P < 0.05$). The mean effect of stocking density regardless of tank type on weight gain differed significantly ($P < 0.05$). Stocking density of 7 catfishes m^{-2} had the best weight gain of 4.12 ± 5.38g followed by stocking density of 14 catfishes m^{-2} (2.19 ± 3.81g) and stocking density 21 catfishes m^{-2} (1.82 ± 2.27g).

Specific Growth Rate (SGR): There was no significant difference ($P > 0.05$) in specific growth rate of *H. bidorsalis* (♀) x *C. gariepinus* (♂) hybrid grown for 20 weeks in varied culture tanks at different stocking densities (Table 8). Concrete tank with stocking density of 7 catfish m^{-2} had the same mean specific growth rate as concrete tank with 14 catfishes m^{-2} (0.06 ± 0.04 and 0.06 ± 0.05 respectively). Furthermore, concrete tank with stocking density of 21 catfishes m^{-2}, metal tank with stocking density of 7 and 21 catfishes m^{-2} and plastic tank with stocking density of 14 catfish m^{-2} all had the same mean specific growth rate (0.05 ± 0.03). The mean effect of stocking density on specific growth rate was best in stocking density of 7 catfishes m^{-2} (0.06 ± 0.09) followed by stocking density of 14 catfishes m^{-2} (0.05 ± 0.04 and the least was recorded in stocking density of 21 catfishes m^{-2} (0.04 ± 0.03).

Feed Efficiency: The highest mean feed efficiency was in concrete tank with 14 catfishes m^{-2} (3.01 ± 9.66) and the least mean feed efficiency was recorded in plastic tank with stocking density of 21 catfishes m^{-2} (1.26 ± 2.54) (Table 9). These mean feed efficiencies were not statistically different. The mean effect of stocking density regardless of tank type on feed efficiency did not differ statistically ($P > 0.05$). Stocking density of 14 catfish m^{-2} had the best mean feed efficiency (2.02 ± 6.12) while the least was stocking of density 21 catfishes m^{-2} (1.40 ± 3.00).

Condition Factor: There was no significant difference in the condition factor of catfishes at different stocking densities in the varied culture tanks ($P > 0.05$) (Table 10). Plastic tanks with stocking density of 7 catfishes m^{-2} had the best condition factor of 0.80 ± 0.56, this was followed by metal tank with stocking density of 7 catfishes m^{-2} (0.77 ± 0.29) and the least was recorded in concrete tank with stocking density of 21 fish m^{-2} (0.67 ± 0.22).

The best mean effect of stocking density on condition factor was recorded in stocking density of 7 catfishes m^{-2} (0.74 ± 0.38), this was followed by stocking density of 14 catfishes m^{-2} (0.70 ± 0.31). The least mean condition factor obtained was from stocking density of 21 catfishes m^{-2} (0.67 ± 0.29).

DISCUSSION

Growth in fish depends on food intake and a host of intrinsic factors (Eyo, 2003). Regardless of tank type, stocking density of 7 catfishes m^{-2} had the best weight gain of 4.12g ± 5.38g followed by stocking density of 14 catfishes m^{-2} (2.19 ± 3.87g) and stocking density of 21 catfishes m^{-2} (1.82g ± 2.27g). This finding was similar to that of Anibeze *et al*. (2003) and Egwui (1987) who observed an inverse relationship between stocking density and daily average increase in weight of *C. gariepinus*.

Table 7: Five months weight gain of *Heterobranchus bidorsalis* (♀) *Clarias gariepinus* (♂) hybrid juveniles grown in varied grow-out tanks and stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
		Weight gain (g)		
Concrete	1	4.27 ± 2.15	1.97 ± 0.31	2.33 ± 0.50
	2	8.10 ± 3.02	4.00 ± 0.49	3.26 ± 0.48
	3	11.98 ± 1.70	7.77 ± 1.31	5.36 ± 0.49
	4	27.40 ± 2.49	17.60 ± 2.45	12.79 ± 0.29
	5	37.37 ± 2.79	24.88 ± 3.73	15.45 ± 4.70
	Mean	15.41 ± 13.36	9.89 ± 8.59	6.91 ± 5.81
Metal	1	2.21 ± 0.21	2.64 ± 0.71	1.51 ± 0.72
	2	6.79 ± 0.36	4.74 ± 0.67	2.93 ± 0.83
	3	11.43 ± 2.29	7.43 ± 2.00	5.04 ± 0.54
	4	34.39 ± 6.11	17.32 ± 3.11	14.68 ± 1.39
	5	45.29 ± 7.96	20.12 ± 2.48	21.73 ± 0.20
	Mean	17.06 ± 17.41	9.00 ± 7.83	7.78 ± 7.77
Plastic	1	2.50 ± 0.17	2.79 ± 0.79	1.95 ± 0.25
	2	6.17 ± 0.50	4.86 ± 1.14	3.40 ± 0.30
	3	9.67 ± 1.00	7.31 ± 1.07	5.93 ± 0.63
	4	29.00 ± 9.13	19.14 ± 3.14	16.64 ± 0.86
	5	54.00 ± 18.00	27.93 ±4.93	23.37 ± 0.93
	Mean	16.75 ± 19.25	10.54 ± 9.83	8.52 ± 8.45

Table 8: Five months specific growth rate of *Heterobranchus bidorsalis* (♀) x *Clarias gariepinus* (♂) hybrid juveniles grown in varied culture tanks at different stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
		Specific growth rate (%)		
Concrete	1	0.15 ± 0.00	0.16 ± 0.02	0.12 ± 0.02
	2	0.07 ± 0.03	0.07 ± 0.02	0.08 ± 0.03
	3	0.05 ± 0.00	0.04 ± 0.00	0.04 ± 0.01
	4	0.04 ± 0.00	0.04 ± 0.00	0.04 ± 0.01
	5	0.04 ± 0.00	0.03 ± 0.00	0.03 ± 0.01
	Mean	0.06 ± 0.04	0.06 ± 0.05	0.05 ± 0.03
Metal	1	0.11 ± 0.03	0.11 ± 0.02	0.11 ± 0.03
	2	0.07 ± 0.01	0.06 ± 0.01	0.06 ± 0.02
	3	0.05 ± 0.00	0.04 ± 0.00	0.04 ± 0.01
	4	0.04 ± 0.01	0.04 ± 0.00	0.04 ± 0.01
	5	0.04 ± 0.00	0.03 ± 0.00	0.03 ± 0.00
	Mean	0.05 ± 0.03	0.05 ± 0.03	0.04 ± 0.03
Plastic	1	0.43 ± 0.37	0.15 ± 0.06	0.08 ± 0.03
	2	0.06 ± 0.01	0.06 ± 0.01	0.05 ± 0.02
	3	0.04 ± 0.01	0.04 ± 0.00	0.04 ± 0.01
	4	0.04 ± 0.00	0.04 ± 0.00	0.04 ± 0.01
	5	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.01
	Mean	0.07 ± 0.15	0.05 ± 0.04	0.04 ± 0.02

Table 9: Five months feed efficiency of *Heterobranchus bidorsalis* (♀) *Clarias gariepinus* (♂) hybrid juveniles grown in varied grow-out tanks and stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
			Feed efficiency	
Concrete	1	16.98 ± 12.39	29.17 ± 19.09	10.03 ± 8.17
	2	1.15 ± 0.14	0.64 ± 0.14	0.80 ± 0.10
	3	0.44 ± 0.04	0.42 ± 0.04	0.41 ± 0.01
	4	0.43 ± 0.07	0.44 ± 0.01	0.43 ± 0.02
	5	0.32 ± 0.02	0.23 ± 0.07	0.31 ± 0.01
	Mean	2.01 ± 6.87	3.01 ± 9.66	1.37 ± 3.47
Metal	1	8.99 ± 13.87	8.09 ± 6.01	10.74 ± 5.59
	2	1.55 ± 0.06	3.30 ± 3.72	1.33 ± 0.22
	3	0.59 ± 0.42	3.61 ± 4.76	0.29 ± 0.00
	4	0.51 ± 0.01	3.93 ± 6.02	0.59 ± 0.38
	5	0.34 ± 0.01	5.26 ± 8.59	0.35 ± 0.02
	Mean	1.50 ± 4.29	1.58 ± 3.12	1.56 ± 3.30
Plastic	1	7.31 ± 6.21	10.85 ± 3.58	6.48 ± 4.10
	2	1.44 ± 0.20	0.86 ± 0.13	1.07 ± 0.27
	3	0.50 ± 0.03	0.38 ± 0.05	0.48 ± 0.02
	4	0.44 ± 0.01	0.45 ± 0.02	0.50 ± 0.03
	5	0.43 ± 0.06	0.33 ± 0.02	0.34 ± 0.01
	Mean	1.30 ± 2.54	1.48 ± 3.17	1.26 ± 2.54

Table 10: Five months condition factor of *Heterobranchus bidorsalis* (♀) *Clarias gariepinus* (♂) hybrid juveniles grown in varied grow-out tanks and stocking densities

Tank types	Months	SD 7 fingerlings per sq m	SD 14 fingerlings per sq m	SD 21 fingerlings per sq m
			condition factor	
Concrete	1	1.08 ± 0.33	1.70 ± 0.84	1.25 ± 0.17
	2	0.67 ± 0.06	0.53 ± 0.03	0.61 ± 0.03
	3	0.58 ± 0.07	0.59 ± 0.13	0.50 ± 0.04
	4	0.58 ± 0.06	0.53 ± 0.02	0.70 ± 0.24
	5	0.56 ± 0.02	0.50 ± 0.03	0.47 ± 0.06
	Mean	0.65 ± 0.19	0.65 ± 0.40	0.67 ± 0.22
Metal	1	1.52 ± 0.40	1.25 ± 0.40	1.00 ± 0.21
	2	0.68 ± 0.10	0.78 ± 0.02	0.57 ± 0.21
	3	0.69 ± 0.00	0.68 ± 0.04	0.50 ± 0.01
	4	0.65 ± 0.02	0.70 ± 0.16	0.63 ± 0.01
	5	0.63 ± 0.04	0.60 ± 0.02	0.56 ± 0.06
	Mean	0.77 ± 0.29	0.72 ± 0.22	0.62 ± 0.18
Plastic	1	2.31 ± 0.89	1.32 ± 0.37	1.58 ± 1.21
	2	0.57 ± 0.09	0.70 ± 0.05	0.83 ± 0.14
	3	0.73 ± 0.20	0.63 ± 0.01	0.59 ± 0.02
	4	0.60 ± 0.04	0.52 ± 0.07	0.53 ± 0.16
	5	0.55 ± 0.05	0.58 ± 0.01	0.69 ± 0.01
	Mean	0.80 ± 0.56	0.72 ± 0.29	0.74 ± 0.42

Furthermore, in an earlier study, Hengsawat *et al*. (1997) observed that the mean fish weights per cage were higher at the lowest density. Olivier and Kaiser (1997) and Hossain *et al*. (1998) also observed that increasing stocking rates resulted in significant reduction of in weight. Sahoo *et al.* (2004) observed that increase in stocking density resulted in increased growth and survival of *C. batrachus* larvae and fry during hatchery rearing.

There was no significant difference (P > 0.05) in specific growth rate (SGR) of *H. bidorsalis* (♀) x *C. gariepinus* (♂) grown for 20 weeks in varied culture tanks at different stocking densities. The mean effect of stocking density on specific growth rate (SGR) regardless of tank type was highest in stocking density of 14 catfishes m^{-2} (0.05 ± 0.04) and the least was stocking density of 21 catfishes m^{-2} (0.04 ± 0.03). Bomboe *et al.* (2002) observed that fish reared at lower densities had significantly higher SGR than fish reared at higher densities, this contrasts with this work where there was no observed significant difference (P > 0.05) in the SGR values.

The mean effect of feed efficiency on stocking density did not differ significantly (P > 0.05). Stocking density of 14 catfishes m^{-2} (2.02 ± 6.12) was the highest and the least was stocking density 21 catfishes m^{-2} (1.40 ± 3.00). Many fish culture operations have poor feed efficiency (weight gain feed given) and this contributes to the high cost of production and often results in significant water pollution (Bureau and Cho, 2004).

There was no significant difference (P > 0.05) in the condition factor of catfishes at different stocking densities in the varied culture tanks (Table 8). The best mean effect stocking density effect on condition factor was in stocking density of 7 catfishes m^{-2} (0.74 ± 0.38) this is because the fish has a lot of space as a result of low stocking density, followed by stocking density of 14 catfishes m^{-2} (0.70 ± 0.39) and stocking density of 21 catfishes m^{-2} (0.67 ± 0.29). This is lower than the values reported by Anibeze (2000) who observed relative condition mean of 1.29 ± 0.19 SE and 1.07 ± 0.18 SE for female and male *H. longifilis* respectively. North *et al.* (2006) observed that rainbow trout stocked at 10 kgm^{-3} had a significantly lower mean body condition factor and an increased size variation at the end of the study.

The mean effect of stocking density on total length differed significantly (P < 0.05). The mean effect of stocking density on total length was significant only between stocking density of 7 catfishes m^{-2} (11. 85 ± 5.52 cm) and stocking density of 21 catfishes m^{-2} (9.54 ± 4.01 cm). The mean effect of stocking density on total length of 14 catfishes m^{-2} (10.47 ± 4.41 cm) was not statistically significant. Our findings was in agreement with Olivier and Kaiser (1997) and Hossain *et al*. (1998) that reported increased stocking densities resulted in significant reduction of in total length of fish.

Conclusion: From the foregoing it is clear that stocking density is a limiting factor in fish production and stocking density of 7 catfishes m^{-2} is gave the best result and so it is recommended. Tank culture is recommended for cat fish because of their high tolerance to water quality extremes, their ability to breathe air and their omnivorous habits (Yaakob and Ali, 1994).

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