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EFFECTS OF THE SHAPE OF CULTURE TANKS ON PRODUCTION OF THE AFRICAN CATFISH *Clarias gariepinus* JUVENILES

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ABSTRACT

An 84-day laboratory experiment was conducted to determine the effects of different tank sections on production of the African catfish Clarias gariepinus juveniles of average weight (10.65 ± 0.07g). Three culture tank shapes (circular, rectangular and square) made of plastic material, having the same surface area and volume were used. The fish were fed 45% CP floating pellets at 3% body weight twice daily throughout the experimental period. Weight gain, percentage weight gain, feed conversion ratio, specific growth rate, profit index and gross profit were used to determine growth and cost of production. There was no significant difference (P > 0.05) in growth parameters of the fish in all the treatments. However, the highest weight gain, specific growth rate, profit index and gross profit were obtained in circular tank compared to other tank shapes. Similarly, circular tank gave the least cost of production and has many advantages for fish culture compared to other shapes.

Key words: Tanks, Shapes, Harvest, Catfish, Production.

INTRODUCTION

Wide range of production systems have been exploited for culturing fish. These systems include: cages, raceways, tanks and ponds. Culture in earthen ponds remains the dominant production system in Nigeria. With increased urbanization and the attendant increase in fish demand, large expanse of land required for intensive aquaculture in earthen pond is becoming seemingly unavailable in many areas. Similarly, earthen pond system of production is characterized with low productivity. Therefore, for Nigeria to make significant contribution in aquaculture at global level and meet her Millennium Development Goals (MDGs) of increasing fish production by over 250% by 2015, efforts need to be geared towards achieving higher production intensities. One way of achieving this is through the encouraging of urban aquaculture system. This system of production makes use of varieties of water and culture facilities that provide needed environment for the growth of the fish.

Many researchers have studied the effects of tank volumes in relation to growth performance of fish {Kolkovski *et al.* (1995), Gonzales *et al.* (1995)}. However, effects of tanks configuration on the performance of the fish have not been adequately investigated. The fact that a vessel holds water does not necessarily make it a good fish-rearing habitat. This paper reports a study aimed at determining the effects of different tank shapes on the growth and production cost of African catfish (*Clarias gariepinus*) juveniles.

MATERIALS AND METHODS

Culture tank with different shapes

Three different culture tanks shape namely; rectangular, circular and square shape were constructed using plastic material. Each of these tank sections served as experimental treatment. There were three replicates per treatment. Thus, a total number of nine tanks were used for the experiment. Water level of 20cm deep was maintained in each of the tanks throughout the 12 weeks experimental period. Thus the volume of water in each tank was approximately 32 litres. The tank sections were configured such that the surface area and volume were the same for all the experimental treatments, and were 1593cm^2 and 31860cm^3 respectively. The rectangular tank shape was dimensioned: length = 54cm, width = 29.5cm and depth = 20cm. The square shaped tank was 39.9cm. The circular shaped tank had dimensions of 45cm in diameter and 20cm in depth. The component parts of each tank were firmly glued together using clear sealant. All prepared tanks were tested for leakages before the commencement of the experiment.

Water supply to the culture tanks was sourced from a borehole which was aerated for 24 hours before the fish were stocked. To prevent pollution, the water in each tank was replaced with freshwater at two days interval after cleaning the tanks.

Fish stocking and experimental design

Clarias gariepinus juveniles of average body weight (10.65 ± 0.07g) were acclimatized to experimental condition for 14 days before they were randomly distributed into the tanks. Twenty-nine (29) *Clarias gariepinus* juveniles with average mean weight of 10.65 ± 0.07g were randomly stocked in the culture tanks. The treatments were replicated thrice at equivalent stocking density of 900 fish/m^3. Aeration was facilitated by the use of aquarium pump (Farrari® model CTB-308).

Floating pelleted catfish feed of 45% crude protein (CP) was used to feed the fish throughout the experimental period. The fish were fed manually at 3% body weight per day in two equal rations at 12 hours interval. Weekly feed adjustment was based on respective weekly biomass measurement (in weight).

Sampling growth and water quality parameters

The fish were sampled weekly between 8.00a.m. and 9.00a.m. to determine their increase in length and weight gain. Measuring board and electronic weighing balance were used to determine the standard length and weight in centimetre and gramme respectively. The values of the fish weekly weights changes were used to assess the growth performance of the fish as described by Olvera-Novoa *et al.*(1990) as follows:

i. Weight Gain:
This was determined at the end of each week as final weight – initial weight.

ii. Percentage Weight Gain:
Percentage weight gain was determined as the difference between the final weight and initial weight of the experimental fish using the formula

$$\% \text{ Weight gain} = \frac{\text{Final weight} - \text{initial weight}}{\text{Initial weight}} \times 100\%$$

iii. Specific Growth Rate:
This was represented by;

$$SGR = \frac{\log_e \text{(final weight)} - \log_e \text{(initial weight)}}{\text{Time period [days]}} \times 100\%$$

iv Survival Rate (%):
This was determined at the end of the culture period using the formula

$$\frac{\text{Initial Number of Fish Stocked} - \text{Mortality}}{\text{Initial no. of fish stocked}} \times 100\%$$

v. Feed Conversion Ratio:
This was calculated using the formula

$$F.C.R. = \frac{\text{Feed fed [dry weight]g}}{\text{Weight gain [Fresh weight] g.}}$$

Water sampling was carried out early in the morning between 8.00 – 9.00 a.m. at every two-week interval throughout the 12 weeks experimental period using sampling bottles of 75cl capacity. The water samples were transferred immediately to laboratory for analysis. However, the water sample for Dissolved Oxygen (DO) analysis was done separately using Dissolved Oxygen (DO) bottles to ensure that the oxygen was intact. The water quality parameters were measured bi-weekly; between 8.00 – 9.00 a.m. The water temperature and pH were measured using the Hanna® pH 211 Micro Processor pH and Temperature meter. The Dissolved Oxygen (DO), unionized ammonia nitrate and total dissolved solids (TDS) were analyzed using the standard methods (APHA, 1995).

Opercular respiratory rate
This was determined weekly between 9.00a.m. and 10.00a.m. by direct observation method using stop-watch at every two-week interval throughout the 12 weeks experimental period. The fish was held in a transparent plastic container of height 19cm and 15cm in diameter. Water level of 5cm was maintained throughout the period. Two (2) fish were selected at random from each tank one at a time. The fish were allowed to recover from stress incurred during handling before the opercular respiratory beat was counted individually per minute. Opercular respiratory rate was calculated using the formula:

$$O.R.R. = \frac{\text{Opercular beat}}{\text{time (minute)}}$$

Cost benefit evaluation
The production cost was assessed based on this following procedures and assumptions

i. That the full crop was harvestable

ii. The price of one kilogram of fish and experimental diet were N400.00 and N250.00 respectively

iii. All costs are based on current prices in Nigeria as at November 2010

iv The profit index was based on the following:

$$\text{Profit index} = \frac{\text{Value of fish (Catfish) cropped at N400/kg}}{\text{Cost of feed}}$$

v. Incidence of cost (r) was based on the formula described by Vineke,(1969)

$$\text{Incidence of cost (r)} = \frac{\text{cost of Tanks \& accessories}}{\text{Kg of fish produced}}$$

Data analysis

One-way analysis of variance (ANOVA) was used to test for differences among the culture tank sections in term of growth and water quality parameters. Correlation and regression analyses were used to investigate the association and relationship between growth and opercular respiratory rate, while descriptive statistics was used to summarize the various data obtained using SPSS 2003 (ver 2.1).

RESULTS AND DISCUSSION

Growth and water quality parameters

The result of growth performance of the African catfish *Clarias gariepinus* juveniles among the treatments is presented in Table 1. There was no significant difference ($P > 0.05$) in weight gain, specific growth rate (SGR), length increment and feed conversion ratio (FCR). Highest values of weight gain, percentage weight gain, specific growth rate (SGR) and length increment were recorded in circular tank while lowest values were recorded from the square tanks. Feed conversion ratio was the same in all the treatments.

Table 1: Growth Performance of African Catfish (*Clarias gariepinus*) Juveniles Reared under Different Culture Tank Shapes

Parameters	**Circular**	**Rectangular**	**Square**
Initial mean weight (g)	10.67 ± 0.03*	10.62 ± 0.04	10.65 ± 0.06
Final mean weight (g)	147.93 ± 6.60	143.43 ± 6.89	140.61 ± 7.25
Initial mean length (cm)	11.50 ± 0.0	11.50 ± 0.0	11.50 ± 0.0
Final mean length (cm)	28.90 ± 0.76	28.92 ± 0.37	28.75 ± 0.11
Mean weight gain (g)	137.27 ± 8.11	132.80 ± 8.44	123.78 ± 4.93
Mean length increment (cm)	17.55 ± 0.05	17.42 ± 0.37	17.25 ± 0.11
Weight gain (%)	1286.93 ± 77.23	1250.10 ± 99.95	1161.78 ± 39.89
Specific growth rate (g)	3.13 ± 0.07	3.10 ± 0.07	3.07 ± 0.08
Feed conversion ratio (FCR)	0.61 ± 0.07	0.61 ± 0.03	0.61 ± 0.02
Survival (%)	87.36 ± 3.25	87.36 ± 4.29	86.21 ± 4.88

*values are Mean±SD of three replicates

The mean water quality parameters in the different tank sections of the experimental tanks are presented in table 2. The temperature ranged from 24.93 – 25.93^{0}C in circular tank, 25.03 – 26.13^{0}C in rectangular tank and 24.97 – 26.23^{0}C in square tank. Circular tank had the lowest range while square tank recorded the highest. The temperature in all the tank sections fell within the range recommended by Akinyemi (1988) who recorded temperatures between 22 – 35^{o}C for catfish culture. Ammonia-Nitrogen values in all treatments were within tolerable range for African catfish culture.

Table 2: Mean Water Quality Parameters in the Different Tanks taken Fortnightly

Tanks	Parameters	wk.2	wk.4	wk.6	wk.8	wk.10	wk.12
Circular	Temp	25.6	25.47	25.93	25.30	25.93	24.93
	pH	7.52	6.95	6.95	5.93	6.62	6.34
	DO(mg/l)	6.3	7.13	6.37	9.23	4.01	3.67
	TSS	233	193	271	276	387	431
	(NH_3-N) (mg/l)	0.05	0.01	0.05	0.05	0.07	0.04
Rectangular	Temp	25.6	25.83	26.13	25.6	25.57	25.03
	pH	7.56	6.94	6.98	5.92	6.52	6.49
	DO(mg/l)	7.53	6.90	6.20	8.37	4.13	3.9
	TSS	253	226	253	290	411	444
	(NH_3-N) (mg/l)	0.02	0.04	0.02	0.4	0.05	0.04
Square	Temp	25.4	26.23	26.07	25.3	25.57	24.97
	pH	7.46	6.02	6.89	5.92	6.55	6.27
	DO(mg/l)	5.93	6.8	5.87	9.57	4.03	11.50
	TSS	286	199	258	285	432	487
	(NH_3-N) (mg/l)	0.03	0.04	0.03	0.06	0.06	0.04

The dissolved oxygen (DO) in circular tanks, rectangular tanks and square tanks ranged from 3.67 – 9.23mg/l, 3.9 – 8.37mg/l and 4.03 – 11.50mg/l respectively. The least range was recorded in circular tank while square tank had the highest value. DO range of 3 – 8 mg/l is generally considered suitable for fresh water fish culture. The range obtained in this study was slightly higher than recommended. This may be attributed to constant aeration and changing of water in all the experimental tanks. The pH ranged from 5.93 – 7.52 in the circular tanks, 5.92 – 7.56 in the rectangular and 5.92 – 7.46 in the square tank. The highest range was observed in rectangular tank and least in square tanks. pH value of 6.5 – 8.0 is recommended for catfish culture. The values obtained in this study were within the range recommended. Pinosa et. al., (1995), and Timmons and Summerfelt (2001) reported that circular tank has many advantages for fish production compared to other shapes. Circular tank provide cleaner rearing condition for fish culture, as wastes tend to concentrate at the centre of the tank for easy removal. The relatively low TSS values recorded in circular shaped tank treatment as compared to other tank shapes in table 2 further illustrate this assertion. Circular shaped tanks provide uniform water quality condition that enables the fish to grow to larger size (Rankocy, 1989).

Opercular respiratory rate

The mean opercular respiratory rate of African Catfish juveniles taken fortnightly in the different culture tank sections is shown in table 3. Circular tank ranged between 52 – 64.00 beats/min. Rectangular tank was between 53.83 – 63.83 beats/min and square tank ranged between 48.17 – 79.00 beats/min. Fafioye (2001) recorded opercular respiratory rate of 53.00 beats/ min for *C.gariepinus* adult fish not exposed to toxicants.

Table 3: Mean Opercular Respiratory Rate (beats/ min) of the African Catfish Juveniles reared in Different Tank Shapes

Week **Tanks**	**wk.2**	**wk.4**	**wk.6**	**wk.8**	**wk.10**	**wk.12**
Circular	64.00	62.67	62.83	57.17	55.00	52.00
Rectangular	63.83	59.67	59.33	53.83	54.17	53.83
Square	79.00	59.17	60.33	58.17	53.33	48.17

However, the result obtained in this study was a bit higher. This could be attributed to size of the fish since fish activity depends on the size. Ross et. al.,(1981) submitted that there is physiologic correlation of fish activity and opercular respiratory rate .Findings in this study supported the assertion and indicates that opercular respiratory rate decreases with increase in growth .

Production cost evaluation

The breakdown of total cost of production and gross profit index are presented in Table 4. Circular tank had the least cost of production and square tank, the highest. The result obtained in this study showed that circular tank was 15% and 21% cheaper than rectangular and square tanks respectively. This supported the report of Scholz (1983) that circular tank was 10% cheaper compared to other tank shapes. Similarly the result revealed that circular tank had the highest profit index and rectangular tank had the least.

Table 4: Cost-Benefit evaluation* of production of African Catfish (*Clarias gariepinus*) Juveniles Reared under Different Culture Tank Shapes

	Treatments		
	Circular Tank	**Rectangular Tank**	**Square Tank**
Production Period (days)	84	84	84
No of fish stocked	29	29	29
Net production (kg/tank/)	11.2424	10.8904	10.5183
Value of fish (@ N400/kg)	4496.96	4356.16	4207.32
Feed input (kg)	6.99	6.67	6.4
Cost of feed (@ N250/kg)	1697.50	1667.50	1600.00
Cost of procurement of tanks (₦)	750.00	2100.00	2800.00
Cost of repair of tanks (₦)	-	641.67	858.33
Cost of accessory @ N80/yard (mosquito net)	240	240	240

Total cost (Tanks, feed and accessory)	2687.5	4649.17	5498.33
Profit index	2.65	2.61	2.63
Incidence of cost	150.99	153.12	152.12
Gross profit (₦)	1809.46	-293.01	-1291.01

***Cost-Benefit evaluation excluded cost of labour and space for fish culture*.

Since total costs incurred remains one of the most important factor in the evaluation of most capital investments, gross profit made at the end of particular fish culture operation was considered sufficient as an index of assessment. Therefore using profit as an index, circular tank gave the best economic returns, followed by square tank and the least rectangular tank. This low returns, could be attributed to higher costs of procurement and repair of both rectangular and square tanks. The procurement and repair costs incurred for the rectangular and square shaped tanks are ₦ 2100.00 and ₦ 641.67, and ₦ 2800.00 and ₦ 858.33 respectively (table 4). This study confirms the assertion by Scholz (1983) that circular tank has lowest installed costs compared to other tank shapes.

CONCLUSION

This study shows that circular tank gave the optimum growth performance for African catfish juveniles and has many advantages in fish production compared to other tank shapes. Similarly, In terms of cost of production, the study revealed that circular tanks gave the least cost of production compared to other shapes .It was also noted that there was correlation between fish size and opercular respiratory rate (ORR). The study showed that opercular respiratory rate (ORR) decreases with increase in fish size.

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