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Review Article

Growth of Clarias gariepinus Reared in Earthen Ponds in Calabar, South south, Nigeria under Duo Nutritional Diet

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Abstract

Clarias gariepinus cultured in earthen ponds at three stocking densities-3 fingerlings/m2; 5 fingerlines/m2 and 10 fingerlings/m2 were fed both commercial and formulated diet. Each stocking density was replicated thrice per feed type. At the 8th week of culture, the daily weight gains of fish fed with commercial feed were not significantly (P>0.05) different from that fed with formulated diet. The final weights and condition factor (C.F) for commercially fed were 32.71g (0.93); 31.66g (0.68) and 32.0g (0.85) at 3, 5 and 10 fingerlings/m2 respectively, while those fed formulated feed were 34.43g (0.80), 35.33g (0.47), and 35.33g (0.90) respectively. Again, no significant (P>0.05) differences existed among them even at day-70. Though survival rate was highest in ponds stocked with 3 fingerlings /m2 and fed with commercial feed and lowest in ponds stocked with 10 fingerlings/m2 and fed with formulated feed 5 fingerlings /m2 with formulated diet is recommended due to optimal final weight, SGR and moderate survival.

Keywords: *Clarias gariepinus*; Earthen pond; Feed; Stocking density

Introduction

The African catfish, *Claries gariepinus* has been reported to be the most preffered cultured fish in Nigeria. [1] In a fish demand survey in Nigeria reported that the catfish outclassed Tilapia, carps and other freshwater species by a wide margin. It has also been reported that it is the most cultured in Africa and third in the world [2, 3].

[4] Posited that Nigeria is the highest producer of this clariid catfish in the world and that about 90% of farmed fish is *Claries gariepinus*. The importance attached to the culture of *C. gariepinus* in Nigeria is widely due to its high growth rate, ability to withstand stress, ability to spawn easily, ability to thrive under high density culture and good feed conversion tendencies. The fish also has excellent marketability profile. Feeding usually represents the single most expensive production cost in aquaculture. Dependence on imported or commercially compounded feed increases the cost of production. Besides the cost, logistic challenges sometimes result in the unavailability of commercial feeds. Consequently, the development of formulated feed from locally available feed stuff that will satisfy the nutritional requirement of the fish will be a major contribution to the need to produce good quality matured fish. This research was designed with the low-income fish farmer in mind. The overall objective is to compare the growth and feed utilization indices of fishes fed with commercial feed with those fed with formulated feed from locally available feed stuff.

Materials and Methods

Five experimental ponds of dimension 9m x 4m x 1m located at the fish farm complex, Institute of Oceanography, University of Calabar, Calabar (4° 56'N; 8° 22 'E) were partitioned by means of Indian bamboos and screened by means of mosquito nets into four small ponds each of dimension 4.5m x 2m x 1m. A total of eighteen ponds of 4.5 x 2m x 1m were used for the experiment. The ponds were drained, desilted, and limed using agricultural lime (CaO) at the rate of 200kg/ha [5]. The ponds were then impounded with water from the farm's reservoirs to a pond level of 0.75m.

Experimental design and stocking of ponds: Three stocking densities: 3 fingerlings/m^2; 5 fingerlings/m^2 and 10 fingerlings/m^2 were assigned to three ponds and fed with commercial feed. Each treatment was in triplicate. Another three stocking densities 3 fingerlings/m^2, 5 fingerlings/m^2 and 10 fingerlings/m^2 were assigned to 3 other ponds and feed locally formulated diet of similar protein level with the commercial feed. The trial with formulated feed was also in triplicates. The ponds fed with commercial feed were labeled CF_3I, CF_3II, CF_3III, CF_5I, CF_5II, CF_5III, $CF_{10}I$, $CF_{10}II$, and $CF_{10}III$, while those for formulated fed were labeled: FF_3I, FF_3II, FF_3III; FF_5I, FF_5II, FF_5III; $FF_{10}I$, $FF_{10}II$ and $FF_{10}III$.

Feed formulation: The following feed ingredients were used for the formulation of experimental feed - Blood meal, Groundnut meal, Soyabean meal, Yellow maize, Fish, Meat, Bone meal, Wheat offal, Palm oil, Vitamin premix, Common salt, Binder (Ogi).

The protein levels to be prepared were 55%, 45% and 42% which corresponded with the protein levels of the commercial feed used. The percentage inclusion for each feed ingredient to prepare the above protein levels was calculated using the Pearson Square method described by [6]. The processed ingredients were mixed manually by

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adding one ingredient at a time. The entire mixture was held together by a small quantity of a binder (pap) and molded into balls and sun dried.

The formulated feed was analysed for proximate composition at the Biochemistry Laboratory of the University of Calabar, Calabar.

Routine Management Techniques: The experimental ponds were maintained by ensuring that the weeds were removed from the water manually. The grass around the ponds was kept low to prevent snakes and other reptiles from being attracted to the pond.

The following water parameters were monitored thrice per week – Temperature (°C); pH, dissolved oxygen (Do) and transparency. While the nitrate, nitrite ammonia, phosphate, salinity, conductivity, and chlorophyll a were monitored monthly.

The commercial feed was fed to designated ponds by broadcast method at the rate 5% of fish body weight per day in two rations between 6.00 – 7.30am and 4.30 – 6.00pm daily. The formulated feed was also fed to designated ponds by breaking the balls and broadcasting the feed into the ponds at same time period as in commercial feed.

Growth Monitoring: Length and weight measurements of fish from each pond were carried out at 4 weeks, 8 weeks, and 10 weeks intervals. The ponds were dragged by a means of a small drag net and 10% of the total number of fingerlings stocked per pond caught and measured. The ponds were finally drained after 10 weeks to determine the mortality rates. The length and weight measurements of individual fish were also taken.

Determination of Growth and feed utilization indices:

- Growth Rate:

The Growth rate was determined using the formular described by [7].

$$\text{Weight gain (DW)} = \frac{\text{Final weight (wt)-Initial weight (wo)}}{\text{Time (t)}}$$

$$\text{Specific Growth Rate} = \frac{\text{Ln Wt} - \text{In Wo}}{\text{T}} \times 100$$

- Feed Utilization Parameters:

This was computed according to the formula by [8]: The parameters computed were feed conversion Ratio (FER), Protein Efficiency Ratio (PER); and feed efficiency (FE).

- Survival Rate:

This was determined using the formula. Survival Rate (SR) = $\frac{\text{Number of fish harvested}}{\text{Number of fish stocked}} \times 100$

Results

Water Parameters

The result of the water parameters monitored is presented in Table 1. Pond 4 ($FF_{10}I$, $FF_{10}II$, $FF_{10}III$) recorded the lowest dissolved oxygen (DO) of 4.344±0.155 mg/l. While pond 1 (CF_3I, CF_3II, CF_3III) recorded the highest DO value of 6.69 mg/l.

The pH was lowest in pond 5 (FF_3II, FF_3III, FF_5II, FF_5III) with 6.715±0.176 and highest in pond I, 7.305 mg/l. Pond I also recorded the lowest temperature and transparency values of 25.4 ℃ and 0.385 respectively.

Physical Parameters				
Pond	DO(mg/l)	pH	Temp. (oC)	Visibility (m)
1	6.901	7.305	25.444	0.385
CF3I, CF3II, CF3III	± 0.312	± 0.140	± 0.199	± 0.017
2	6.596	6.955	26.967	0.544
CF10I, CF10II, CF10III, FF3I	± 0.120	± 0.093	± 0.199	± 0.018
3	6.148	6.981	26.389	0.574
CF5I, CF5II, CF5III, FF5I	± 0.276	±0.141	± 0.339	± 0.014
4	4.344	7.226	27.50	0.596
FF10I, FF10II, FF10III	± 0.155	± 0.386	± 1.02	± 0.0229
5	5.97	6.715	28.16	0.586
FF3II, FF3III, FF5II, FF5III	± 1.70	± 0.176	± 1.04	± 0.018

Table 1: Mean and standard error of water parameters monitored

Nutrients Parameters/ Ponds	CF3I, CF3II, CF3III	CF10I, CF10II, CF10III, FF3I	CF5I, CF5II, CF5III, FF5I	FF10I, FF10II, FF10III	FF3I, FF3II, FF5II, FF5III
	1	2	3	4	5
Conductivity (µs/cm)	106	89	94	115	103
Sulphate (mg/l)	5.332	4.497	4.729	5.785	5.182
Ammonia (mg/l)	0.364	0.761	0.324	0.349	0.657
Nitrite (mg/l)	0.000	0.001	0.001	0.000	0.001
Nitrate (mg/l)	0.857	0.507	0.427	0.554	0.774
Phosphate (mg/l)	0.012	0.016	0.009	0.013	0.008
Chlorophyll (µg/l)	50	50	70	70	60

Table 2: Result of water parameters of earthen ponds monitored on the 6th week

The result of water parameters monitored on the 6th week of culture is presented in Table 2. Nitrite was generally low in all the ponds (0.000 – 0.001). The conductivity, sulphate, ammonia, nitrate, phosphate, and chlorophyll value were also within acceptable ranges [9, 10].

- The protein content of the commercial feed which was labelled by the manufacturers to be 45% turned out to be 42.6±0.7 upon analysis.
- The crude protein values of formulated feed calculated using Pearson's square method to be 55%, 45% and 42% for samples B, and D after proximate analysis became 44.50±0.61%; 42.6±0.79 and 41.96±0.03, respectively.
- Analysed values of moisture content, ash, crude fat, crude fibre, carbohydrate, and caloric value were all within recommended ranges for the culture of *C. gariepinus*.

Samples	Moisture	Protein	Ash	Crude fat	Crude fiber	Carbo-hydrate	Caloric value
A Commercial Feed (*45%)	31.91±0.62	42.6±0.7	3.1±0.1	9.94±0.06	0.54±0.03	12.54±0.01	309.66±2.42
B Formulated Feed (*55%)	33.94±0.15	44.50±0.61	3.6±0.1	9.33±0.14	0.81±0.01	8.06±0.50	294.25±1.67
C Formulated Feed (*45%)	33.86±1.15	42.6±0.79	2.83±0.05	9.87±0.05	0.66±0.05	10.82±1.94	302.57±0.32
D Formulated Feed (*42%)	30.96±0.01	41.96±0.03	2.31±0.01	9.73±0.06	0.57±0.003	15.02±0.05	315.51±0.32

Table 3: Proximate composition of formulated and commercial feed (in mg/100g) by calculation

*CP – crude protein

Growth and Survival Studies

The mean length (XL) and mean weight (Xwt) of fish stocked at 3 fingerlings/m2 and fed with commercial feed (ponds CF_3I, CF_3II and CF_3III) and formulated feed (Ponds FF3I, FF3II and FF3III) are presented in Table 4.

The mean length (XL) and mean weight (Xwt) of fish stocked at 5 fingerlings/m2 and fed commercial feed (ponds CF_5I, CF_5II, CF_5III) and formulated feed (pond FF_5I, FF_5II, FF_5III) are presented in Table 5 while the mean length (XL) and mean weight (Xwt) of fish stocked at 10 fingerlings/m2 and fed commercial feed (ponds $CF_{10}I$, $CF_{10}II$ AND $CF_{10}III$) and formulated feed (ponds $FF_{10}I$, $FF_{10}II$, $FF_{10}III$) is presented in table 6.

- Daily weight gain (DW) and Specific Growth rates (SGR).

Table 7 shows the DW and SGR determined on the 56th day of culture.

- Survival Rate

The survival rate is presented in table 8.

- The quantity of feed used in all the experimental ponds are presented in Table 9 - 11.

Period (days) Ponds/ Xl&x-wt		1	28	56	70	Condition factor I – Initial F – Final
CF3l	L(cm) wt(g)	4.4±0.107 1.1±0.001	16.00±1.15 28.33±1.67	18.67±1.33 35.00±5.00	15.80±1.13 39.20±8.09	I=1.29 F=0.99
CF3ll	L(cm) wt(g)	4.1±0.125 1.1±0.003	15.00±1.73 28.33±7.26	18.33±2.33 30.00±7.64	39.5±7.90 16.9±1.10	I=1.59 F=1.00
CF3lll	L(cm) wt(g)	3.9±0.112 1.0±0.001	16.33±1.76 30.00±7.64	15.66±0.997 33.33±6.67	16.9±1.10 46.70±8.44	I=1.68 F=0.96
FF3l	L(cm) wt(g)	8.29±0.19 4.1±0.801	17.00±0.58 36.67±3.33	16.83±1.36 33.33±6.67	16.17±1.13 37.50±6.26	I=0.719 F=0.886
FF3ll	L(cm) wt(g)	3.8±0.120 1.2±0.003	15.00±5.52 21.67±9.28	16.00±2.08 36.67±8.82	-	I=2.18 F=0.89 8 Wks
FF3lll	L(cm) wt(g)	3.8±0.118 1.1±0.004	16.67±1.76 26.67±6.67	17.33±2.73 33.3±12.0	-	I=2.00 F=0.63

Table 4: Mean length and weight of fish stocked at 3 fingerlings/m2 and feed commercial feeds (ponds CF3l, CF3ll, CF3lll) and formulated feed (FF3l, FF3ll, FF3lll)

Period (days)		1	28	56	70	Condition factor I – Initial F – Final
Ponds/L& wt						
CF5l	L(cm) wt(g)	4.0±0.091 1.5±0.015	15.2±0.86 25.00±3.16	16.80±1.16 33.00±8.00	-	I=2.3 F=0.63
CF5ll	L(cm) wt(g)	3.7±0.101 1.3±0.132	31.00±4.0 17.60±1.12	36.0±6.78 15.00±1.95	-	I=2.5 F=0.59
CF5lll	L(cm) wt(g)	3.8±0.170 1.5±0.021	17.60±1.12 30.00±4.47	15.00±1.95 26.00±6.78	-	I=2.7 F=0.77
FF5l	L(cm) wt(g)	4.5±0.008 1.16±0.11	15.00±1.00 28.00±5.15	16.60±1.63 34.00±8.72	26.0±1.21 96.0±26.6	I=1.27 F=0.05
FF5ll	L(cm) wt(g)	4.1±0.018 1.0±0.003	16.80±0.97 33.00±5.39	16.80±1.32 35.00±8.37	-	I=1.45 F=0.73
FF5lll	L(cm) wt(g)	4.1±0.021 1.5±0.004	16.2±0.66 30.00±4.47	17.80±1.20 37.00±7.00	-	I=2.17 F=0.65

Table 5: Mean length and weight of fish stocked at 3 fingerlings/m2 and fed commercial feeds (ponds CF5l, CF5ll, CF5lll) and formulated feed (FF5l, FF5ll, FF5lll)

Period (days)		1	28	56	70	Condition factor I – Initial F – Final

Ponds/ L& wt						
CF10l	L(cm) wt(g)	8.68±0.167 4.5±0.801	16.1±0.90 31.50±5.78	16.1±0.86 35.00±4.59	-	I=0.64 F=0.83
CF10ll	L(cm) wt(g)	8.7±0.182 4.5±0.761	16.30±1.00 30.50±5.08	14.50±0.70 27.50±3.52	-	I=0.68 F=0.90
CF10lll	L(cm) wt(g)	9.8±0.201 4.7±0.810	14.50±1.23 30.00±6.62	15.90±0.92 33.50±5.06	-	I=0.49 F=0.83
FF10l	L(cm) wt(g)	4.0±0.121 1.2±0.01	17.00±1.82 36.50±4.54	16.90±0.90 42.00±5.17	-	I=1.875 F=0.87
FF10ll	L(cm) wt(g)	4.6±0.09 1.3±0.057	17.30±0.70 35.50±3.83	15.00±1.37 33.00±7.73	-	I=1.33 F=0.97
FF10lll	L(cm) wt(g)	4.4±0.081 1.4±0.063	16.30±1.02 32.00±4.73	15.20±0.80 31.00±5.10	-	I=1.64 F=0.88

Table 6: Mean length and weight of fish stocked at 3 fingerlings/m2 and fed commercial feeds (ponds CF10l, CF10ll, CF10lll) and formulated feed (FF10l, FF10ll, FF10lll)

Ponds	Daily Weight gain (g/day)	Specific growth rate (%)	Mean ε_cSE of DW	Mean ε_cSE of SGR.
CF3I	0.682	6.17	0.591	6.31
CF3II	0.516	5.90		
CF3III	0.577	6.86	±0.004	±0.173
FF3I	0.521	3.74	0.576	5.30
FF3II	0.633	6.10		
FF3III	0.575	6.08	±0.001	±0.002
FC5I	0.562	5.51	0.539	5.51
CF5II	0.619	5.93		
CF5III	0.437	5.09	±0.011	±0.010
FF5I	0.586	6.03	0.608	6.03
FF5II	0.607	6.34		
FF5III	0.633	5.72	±0.005	±0.003
CF10I	0.550	3.78	0.491	3.50
CF10II	0.410	3.23		
CF10III	0.514	3.50	±0.004	±0.001
FF10I	0.728	6.34	0.607	5.88
FF10II	0.566	5.77		
FF10III	0.528	5.53	±0.012	±0.021

Table 7: Daily weight gain and specific growth rate of fish cultured in earthen ponds and fed with commercial feed (CF3l, CF3ll, CF3lll; CF5l, CF5ll, CF5lll; CF10l, CF10ll, CF10lll) and formulated feed (FF3l, FF3ll, FF3lll; FF5l, FF5ll, FF5lll; FF10l, FF10ll, FF10lll)

	Commercial feed			Formulated feed		
	3 Fingerlings / m2	5 Fingerlings / m2	10 Fingerlings / m2	3 Fingerlings / m2	5 Fingerlings /m2	10 Fingerlings /m2
Total number stocked	81	135	270	81	135	270
Total mortalities	53	91	218	68	127	269
Total number harvested	28	44	52	13	8	1

Table 8: Total number of fish stocked, total mortalities and survival rate in the earthen ponds on the 70th day of culture

Period (days) % body weight	Mean wt of fish (g)/SD	Qty of feed/ day (kg)	Mean wt of fish (g)/SD	Qty of feed/ day (kg)	Mean wt of fish (g)/SD	Qty of feed/day (kg)
	C3I		C3II		C3III	
1 (5%)	1.1		1.1		1.1	
	27	0.0014	27	0.0014	27	0.0014
28 (5%)	28.3		28.3		30.0	
	27	0.0382	27	0.0382	27	0.0400
56 (3%)	35.0		30.0		31.6	
	27	0.0283	27	0.0243	27	0.255
70 (3%)	39.2		39.5		46.7	
	10	0.0117	8	0.0094	10	0.0140
Total qty of feed used per pond (kg)		1.48		1.43		1.50
	F3I		F3II		F3III	
1 (5%)	4.10		1.2		1.10	
	27	0.0055	27	0.0016	27	0.0014
28 (5%)	36.67		21.67		26.67	
	27	0.0495	27	0.0292	27	0.0360
56 (3%)	33.33		36.67		33.30	
	27	0.0269	27	0.0297	27	0.0269
70 (3%)	37.50					
	1	0.0011	-	-	-	-
Total qty of feed used per pond (kg)		1.89		1.24		1.4

Table 9: Quantity of feed given per day for fish cultured in earthen ponds at 3 fish/m2 and fed with commercial and formulated feeds

i.Total quantity of feed used to culture fish at 3 fish/m2 and fed with commercial feed = 4.41kg

ii.Total quantity of feed used to culture fish at 3 fish/m2 and fed with formulated feed = 4.80 k

Period (days) % body weight	Mean wt of fish (g)/SD	Qty of feed/ day (kg)	Mean wt of fish (g)/SD	Qty of feed/ day (kg)	Mean wt of fish (g)/SD	Qty of feed/ day (kg)
	CF5I		CF5II		CF5III	
1 (5%)	1.5		1.3		1.5	
	45	0.0033	45	0.0029	45	0.0033
28 (5%)	25.0		31.0		30.0	
	45	0.0562	45	0.0697	45	0.0675
56 (3%)	33.0		36.0		26.0	

	45	0.0445	45	0.486	45	0.0351
70 (3%)	-	-	-	-	-	-
Total qty of feed used per pond (kg)		2.20		2.66		2.43
	FF5I		FF5II		FF5III	
1 (5%)	1.16		1.0		1.5	
	45	0.0026	45	0.0022	45	0.0033
28 (5%)	28.0		33.0		30.0	
	45	0.063	45	0.0742	45	0.0675
56 (3%)	33.0		35.0		37.0	
	45	0.0459	45	0.047	45	0.0499
70 (3%)	96.0					
	8	0.0230	-	-	-	-
		2.45		2.75		2.03

Table 10: Quantity of feed given per day for fish cultured in earthen ponds at 5 fish/m2 and fed with commercial and formulated feeds

i.Total quantity of feed used per pond (kg)

ii.Total quantity of feed used to culture fish at 5 fish/m2 and fed with commercial feed = 7.29kg

iii.Total quantity of feed used to culture fish at 5 fish/m2 and fed with formulated feed = 7.23kg

Period (days) % body weight	Mean wt of fish (g)/SD	Qty of feed/day (kg)	Mean wt of fish (g)/SD	Qty of feed/ day (kg)	Mean wt of fish (g)/SD	Qty of feed/day (kg)
	CF10I		CF10II		CF10III	
1 (5%)	4.2		4.5		4.7	
	90	0.0189	90	0.0202	90	0.0211
28 (5%)	31.50		30.50		30.0	
	90	0.1417	90	0.1372	90	0.135
56 (3%)	35.0		27.50		33.50	
	90	0.1575	90	0.0742	90	0.0900
70 (3%)	-	-	-	-	-	
Total qty of feed used per pond (kg)		6.682		5.425		5.615
	FF10I		FF10II		FF10III	
1 (5%)	1.2		1.3		1.4	
	90	0.0054	90	0.0058	90	0.0063
28 (5%)	36.5		35.50		32.0	
	90	0.1642	90	0.1597	90	0.1575
56 (3%)	42.0		33.0		31.0	
	90	0.1134	90	0.0891	90	0.0837
70 (3%)	-	-	-	-	-	-
Total qty of feed used per pond (kg)		5.751		5.875		6.331

Table 11: Quantity of feed given per day for fish cultured in earthen ponds at 10 fish/m2 and fed with commercial and formulated feeds

i.Total quantity of feed used to culture fish at 10 fish/m2 and fed with commercial feed = 17.72kg

ii.Total quantity of feed used to culture fish at 10 fish/m2 and fed with formulated feed = 17.95 kg

Weight (g)	Commercial			Formulated		
	3 Fish/m2	5 Fish/m2	10 Fish/m2	3 Fish/m2	5 Fish/m2	10 Fish/ m2
Initial weight	1.06	1.43	4.46	2.13	1.22	1.30
Final weight	32.77	31.66	32.00	34.43	35.33	35.33
Weight gain	31.41	30.23	27.54	32.30	34.11	34.03
Total weight						
Gain x SD at	879.48	1,330.12	1,432.08	419.90	272.88	34.03
70 days						

Table 12: Total weight gain for fish cultured in earthen ponds and fed with commercial and formulated feed

	Commercial			Formulated		
	3 Fish/ m2	5 Fish/m2	10 Fish/m2	3 Fish/ m2	5 Fish/ m2	10 Fish/m2
Total weight of food consumed (g)	4410	7290	17,720	4800	7230	17,950
Total weight of food produced (g)	879.48	1,330.12	1,432.08	419.90	272.88	34.03
FCR at day 70	5.0	5.4	12.3	11.4	26.4	527.4

Table 13: FCR for fish cultured in earthen ponds as at the 70th day of cultured

Weight (g)	Commercial				Formulated			
	3 Fish/ m2	5 Fish/ m2	10 Fish/ m2	Statistic	3 Fish/m2	5 Fish/ m2	10 Fish/ m2	Statistic
Initial weight(g) Initial C.F	1.06 1.52	1.43 2.5	4.46 0.68		2.131.63	1.22 1.63	1.30 1.61	
Final weight(g) Initial C.F	32.77 0.98	31.66 0.68	32.00 0.85	NS P>0.05 P>0.01	34.43 0.80	35.33 0.47	35.33 0.90	NSP>0.05 P>0.01
Daily Weight Gain DW (g/day)	0.591	0.539	0.691		0.576	0.609	0.607	

Specific growth Rate (SGR) (%) Survival rate	6.31 34.5	5.51 32.5	3.50 19.2	Sig at 1%p<0.01 Sig at 1%P<0.01	5.30 16.0	6.03 5.9	5.88 0.3	NS P>0.05 Sig at P<0.05
Benefit cost rate (BCR)	0.274	0.250	0.111		0.193	0.083	0.004	

Table 14: Summary of result of maximizing production of *C. gariepinus* in earthen ponds

Table 12 shows the total weight gain for fish commercial and formulated feeds.

The result of the FCR is presented in Table 13 while the summary of results for study is presented in Table 14.

Discussion

The water quality parameters were within the levels recommended by [9] and [10] for the culture of *C. gariepinus* as defined for warm water fish species. The calculated values of crude protein of the formulated feed (55%, 45% and 42%) were slightly higher than values determined by proximate analysis (44.50 ± 0.61, 42.6 ± 0.76 & 41.98 ± 0.03) respectively. The values were however within recommended ranges for the culture of *C. gariepinus* [11]. Similar results of crude protein content for *C. gariepinus* were observed by [12].

The effect of the three stocking densities 3, 5 and 10 fingerlings/m^2 on the mean final weight, SGR and DW were compared. The mean, final weight, SGR and DW were highest in ponds stocked at 3 fingerlings/m^2. There was however no significant difference in the final weight of fish in the three stocking densities at 5% and 1% level of significance. It means there was optimum production at the three stocking densities. Survival rate was highest in ponds stocked at 3 fingerlings/m^2 and fed with commercial feed. The lowest survival rate was recorded in ponds stocked at 10 fingerlings/m^2 and fed with formulated feed. The cause of the high mortality was however suspected to be a fish-eating reptile, Iguana, which were reported to have entered ponds FF_3II, FF_3III, and FF_5I, FF_5III, FF_{10}I, FF_{10}II and FF_{10}II. The significant difference in the survival rate of fish stocked at 5 fingerlings/m^2 and 10 fingerlings/m^2 attributed to the activities of the fish-eating reptile. [13] Summarized mortality causes during the culture of *C. gariepinus* to include: Predation by various organisms, shortage of adequate feeds and poor water quality. According to [14] predators can either enter the pond through the inlet pipes (eggs and larva as well as some adult frogs and toads) or through the air (insects and birds). [15] Working on predator defense and feeding adapted stocking of *C. gariepinus* showed that adult amphibians, aquatic insects and flying predators were responsible for 28%, 6% and 23% respectively of mortalities. The present experiment implicated the presence of Iguana, a reptile that feeds on fish in the ponds. On the other hand, the highest mortalities (80.2% & 99.7%) recorded in ponds stocked at 10 fingerlings/m^2 and fed with commercial and formulated feed, respectively, could be as a result of increased stocking densities. It may also be an indication of shortage of adequate food (Hogendorn *et al*, 1983, possibly exacerbated by increased competition and cannibalism [16], a common problem that led to mortality rate in the region of 98% particularly at stocking densities of about 100 fingerlings/m^2 [17, 18]. The need therefore to maximally protect earthen ponds from aquatic reptiles and other organisms that could constitute a threat to the survival of pond raised fish cannot be over emphasized as maximization of production may not be achieved in earthen ponds without adequate screening of the ponds against mortality – causing organisms.

Conclusion

Three stocking densities 3 fingerlings/m^2, 5 fingerlings/m^2 and 10 fingerlings/m^2 were fed with both commercial and formulated feeds in 18 experimental ponds of 9m^2 each experimental ponds and each stocking density was replicated 3 times. Results after 70 days (10 weeks) showed that there was no significant difference in the final weight of fish for all the categories (P>0.05; P>0.01).

The highest daily weight gain (DW) and specific growth rate (SGR) of 0.591 and 6.31 respectively however was recorded in ponds stocked at 3 fish/m^2. The highest survival rate of 34.5% was also recorded in ponds stocked at 3 fingerlings/m^2 and closely followed by ponds stocked at 5 fingerlings/m^2 with 32.5%. Ponds stocked at 5 fingerlings/m^2 and fed with formulated feed also recorded the highest weight gain of 0.608 and specific growth rate of 6.03 amongst ponds fed with formulated feed. Therefore 5 fingerlings/m^2 is recommended with locally formulated feed as there was no significant difference between the final weight and SGR of fish stocked at 5 fingerlings/m^2 and the existing practice of 3 fingerlings/m_2 with commercial feed.

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