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Effect of Organic Fertilizer and Formulated Feed on the Growth Performance and Condition Factor of *Clarias gariepinus*♂ and *Heterobranchus longifilis*♀ Hybrid

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ABSTRACT

Clarias gariepinus ♂ X *Heterobranchus longifilis* ♀ hybrids (Commonly referred to as *Heteroclarias*) grow faster and attain bigger sizes than their genetic parents, hence, its high aquaculture importance in Nigeria. A 12-week feeding trial was conducted in the University of Calabar fish farm to investigate the effect of organic fertilizer and formulated feed on the growth performance of a hybrid clariid catfish (*C. gariepinus*♂ *x H. longifilis*♀) cultured in earthen ponds. One hundred and twenty fingerlings (1.56±0.09 g) were fed twice daily on MULTIFEED and allowed to acclimatize for two weeks. Ten fingerlings were thereafter randomly selected from the general pool and distributed into each of three pairs of hapas (1×1×1 m), fitted into each of four earthen ponds using the various treatments. DT01 was not given any treatment (control); DT02 was treated with organic fertilizer to enhance natural food production; DT03 was treated with artificial feed only while DT04 was treated with both organic fertilizer and artificial feed all fortified with the basal diet (B). Throughout the experiment, water and soil variables were found to be within the acceptable range for catfish culture. Results showed a significant difference ($p<0.05$) in weight gain, total length increase and growth parameters for other treatments in comparison with the control experiment. Fish fed a combination of natural and artificial feed performed best followed by those fed artificial feed only while those that were allowed to graze naturally on available food in the pond performed least. It was therefore concluded that Heteroclarias hybrid fingerlings should be cultured in a combined feeding condition for effective growth; better condition factor and maximum productivity.

Key words: Artificial feed, daily weight gain, specific growth rate, hapas, hybrid

INTRODUCTION

Heteroclarias are hybrids that result from either the crossing of the Clarias egg gamete with the sperm gamete of the Heterobranchus or vice versa (Odedeyi, 2007). *Clarias gariepinus* and *Heterobranchus* sp. are species of high aquaculture importance in Nigeria. They are widely cultured owing to their high market price, fast growth rate and ability to withstand adverse pond conditions especially low oxygen content (Olele, 2011). *Heterobranchus* grows faster and attain bigger size

than *Clarias* which matures earlier, become more adaptable and has higher fecundity (Sogbesan and Madu, 2008). The hybrid of these two fishes transfers desirable traits between species, combine desirable trait of two species into a single group of fishes. The hybrids of *Heterobranchus* and *Clarias* exhibit the fast growing quality of *Heterobranchus* reaching up to 1.0 kg under eight months in ponds and become highly resistant to disease than their parental species hence they are preferred for pond culture (Legendre *et al*., 2006; Ndome *et al*., 2011).

This hybrid catfish is carnivorous and Fishmeal (FM) makes up a major part of the formulated feeds for any carnivorous fish or shrimp species as a protein source (Miles and Chapman, 2006). This is so because; the fishy flavor and the high content of good quality protein in FM are usually an important factor in fish nutrition (Udo and Umoren, 2011). However, FM is the most expensive protein source in animal and aqua feeds (Ekelemu, 2010). This culminates in high cost of feed and low or no profitability of the overall production system. According to Madu *et al*. (2003), it constitute 40-60% of the recurrent cost of most intensive fish farm ventures which negates the economic viability of the farm when cheaper alternatives are not available and this has been a major problem to fish farmers in Nigeria (Udo *et al*., 2011a). Efforts to proffer solution to this problem have resulted in researchers embarking on studies to search for possible replacements to FM (Khan *et al*., 2003; El-Marakby *et al*., 2006) and determination of the optimum level of inclusion in a formal least-cost diet (Udo *et al*., 2011c).

The soaring cost of artificial feed is due to the fact that the conventional feed ingredients used in compounding are competed for by human and livestock alike for consumption (Adesulu and Mustapha, 2000). Moreover, compounded feeds for intensive fish culture have been developed in few industrialized countries where a preference for farmed fish has increased. Therefore, to meet animal protein needs in developing countries, intensification of aquaculture system is needed (Falayi, 2003) where the cheapest but most nutritive feed ingredient that will not only enhance their well being but which will enhance human growth will be used.

The effect of natural feeds on the growth performance of Heteroclarias hybrid fingerlings has not been exhaustively investigated. The present study therefore, seeks to investigate the effects of natural and artificial feed on the growth performance of Heteroclarias Hybrid fingerlings cultured in earthen ponds.

MATERIALS AND METHODS

Location and climate: The study was carried out in facilities of the Institute of Oceanography (IOC), University of Calabar, Cross River State, located at the South-Eastern part of Nigeria. The area is 42 meters above sea level at Latitude 4°25′-7°00′N; Longitude 7°15′-9°30′. It occupies a total area of 54,000 km^2 (NRCRI, 2000). The mean ambient temperatures recorded were 28-32°C in the middle of the day during the study which started in March and ended in to May 2011. The water source was a perennial water reservoir recycled through a network of pipes, filter tanks, into earthen ponds.

Data collection for basal diet formulation: Nutrient composition of feed ingredient was obtained from proximate analyses of the ingredients as shown in Table 1. The organic fertilizer was also analyzed. Nutrients analyzed include: Moisture (MO), Crude Protein (CP), Crude Fibre (CF), Calcium (Ca), Phosphorus (P), Lysine (LS) and Methionine+cystine (MT). This was done according to the methods of AOAC (1999). Estimation of the Metabolizable Energy (ME) of ingredient for the feed was calculated by converting the gross energy using the following equation as described by Miller and Payne (1959).

Mineral element analysis: Calcium and the phosphorus content of the ingredients were determined using a Perkin-Elmer Model 5000 Atomic Absorption Spectrophotometer (AOAC, 1999).

Amino acid profile determination: The amino acid profile of the ingredients was determined using methods described by Shahidi *et al.* (1999). The samples were dried to a constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon Sequential Multi-sample amino acid analyzer (TSM) using ion-exchange chromatography (Technicon Instruments Corporation, Dublin, Ireland). Details have been outlined by Adeyeye and Afolabi (2004).

Experimental design: This consisted of three net-hapas (1×1×1 m) artificially fitted into four earthen ponds (36×14 ×1.5 m) using bamboo sticks. These were designated as DT01, DT02, DT03 and DT04. No treatment was given to DT01 which served as control, hence fish here only grazed on natural feed without enhancement. DT02 was fertilized with organic fertilizer (50 kg of chicken manure). DT03 was unfertilized but was treated with commercial feed (MULTIFEED) while DT04 was fertilized in addition to the application of the commercial feed. The chicken manure used was obtained from the University of Calabar Poultry farm.

Formation of the basal diet (B): The biochemical composition of various feed ingredients used in the formulation of B is shown in Table 1. B was formulated using simplex algorithm of linear programming technique. The percentage ingredients were converted to weight based on the bag size of 50 kg. These were measured accordingly with a Camry Emperors kitchen balance into the feed mill for milling. The diets mixtures were then extruded through a 2 mm die ring to form noodle-like strands which was mechanically broken into pellets of suitable size for Heteroclarias hybrid fingerlings. The diets were sun-dried at 31-32°C and stored at -20°C in air-tight polythene bags prior to use. This was made to compost 50% of each dietary treatment. The Composition of organic fertilizer, MULTIFEED and B used in the 90 days culture of Heteroclarias hybrid is presented on Table 2.

Fish maintenance: One hundred fingerlings of *C. gariepinus* ♂ x *H. longifilis* ♀ hybrids were procured from Bayou farms and industries in Akai Ubium, Nsit Ubiom Local Government Area of Akwa Ibom State, Nigeria. These fingerlings were collected in an opened plastic rubber with oxygenated water and were transported to the study location by car. After 14 days of acclimatization, a group of 30 fish were stocked in triplicate ponds for each dietary treatment following a Completely Randomized Design (CRD). All groups of fish were fed *ad libitum* to a level close to apparent satiation. The experiment ran for a period of 90 days. Fish were fed 6 days week^{-1} (twice daily at 9.00 am and 3.00 pm) by hand casting. Prior to stocking, all the ponds were cleared and limed to eliminate parasites and invertebrate predators and properly fertilized and allowed to stand for two weeks, for the growth of natural food. The ponds were filled with fresh water from the reservoir to a height of 0.8 m. The net-hapas were then fitted into each pond to hold the experimental subjects during the course of the experiment. Each of the four treatments was stocked with 30 fingerlings (4.1±0.53 cm mean total length; 1.56±0.09 g mean weight), respectively, initial mean weight was 1.56±0.09, *ab initio*. Fish in DT01 (unfertilized) were not given commercial diet. They relied on the natural feed in the pond. Those in DT02 (fertilized) were not given artificial diet commercial diet but natural food production was enhanced by fertilizer application. Those in DT03 were fed with commercial diet (Multi-feed) at the rate of 20% body weight twice daily while those in DT04 fed with commercial diet at the same rate as those in DT03 and also had additional feeding

from the natural food due to the fertilized nature of the pond. DT02 and DT04 were fertilized every 10-14 days. This feeding lasted for 12 weeks.

Data collection: The weights of all the fingerlings in each hapas were measured every two weeks using an electron balance (scout pro-400×0.01 g, model SPE 402, code number 80104013) while total length measurements were recorded to the nearest 0.1 mm with the aid of a measuring board each fortnight.

Evaluation of fish performance: Fish in each experimental unit were batch-weight at every fortnight interval to know the growth and health status of the fish and to adjust the feeding rate. Data obtained were used for estimation of average weight gain (final weight - initial weight), mean length increment (final length-initial length) specific growth rate [(100 x Ln final average weight-Ln initial average weight)/days], Length-weight relationships was calculated using $W = a \times L^b$, where; W= weight of fish in grams, L = Length of fish in centimeter, a = Intercept on y-axis while b = Slope. The condition index was also obtained from the length/weight values, using the equation:

$$K = W/L^3 \times 100$$

Water analyses: Water quality parameters of the experimental tanks was analyzed at every 15 days (APHA, 1995) and recorded for the following: maximum and minimum temperature, dissolved oxygen, total alkalinity, pH and total ammonia nitrogen. Water parameters measured were found to be within acceptable limit for fish growth and health (Boyd, 1990).

Statistical analysis: Data were analyzed by one-way ANOVA and regression analysis. Post hoc multiple comparison was carried out using Tukey's test at $p<0.05$. The statistical package used for the analysis of data was SPSS statistics, version 17.0.

RESULTS

Biochemical composition of feed ingredients used in basal diet formulation: Ingredients used in the formulation of the Basal diet (B) include: fishmeal, groundnut cake, blood meal, dried brewer's grain and white maize meal (Table 1). The result of the analysis shows that groundnut cake had the highest (19.10%) moisture content while fishmeal had the lowest (12.57%). In terms of crude protein, blood meal had the highest (76.20%) value while white maize meal recorded the lowest (9.38%). Top on the least of crude fiber is dried brewer's grain with the value of 20.00% while the lowest (1.08%) was recorded in fish meal. Also, fishmeal had the highest (5.14%)

Table 1: Biochemical composition of various feed ingredients used in basal feed formulation for Heteroclarias hybrid during the 90 days study

	Content (%)							
Ingredients	MO	CP	CF	Ca	P	LS	MT	ME (kcalk g^{-1})
Fish Meal	12.57	66.23	1.08	5.14	2.89	4.85	2.62	2861
Groundnut cake	19.10	41.40	7.74	0.19	0.63	1.59	0.57	2892
Blood Meal	15.12	76.20	1.46	0.29	0.09	6.90	1.00	3080
Dried Brewer's grain	12.89	18.60	20.00	0.20	0.16	0.81	0.98	1980
Whit maize meal	13.06	9.38	2.31	0.03	0.12	0.27	0.24	3434

MO: Moisture, CP: Crude protein, CF: Crude fibre, P: Phosphorus, LS: Lysine, MT: Cysteine+methionine, ME: Metabolizable energy

Table 2: Composition of organic fertilizer and formulated feed used in the 90 days culture of Heteroclarias hybrid

Ingredients	DT01	DT02	DT03	DT04
Organic fertilizer	-	50.00	-	25.00
MULTIFEED	-	-	50.00	25.00
Salt	0.30	0.30	0.30	0.30
Fish meal	4.00	4.00	4.00	4.00
Groundnut cake	12.95	12.95	12.95	12.95
Blood meal	5.00	5.00	5.00	5.00
Dried brewer's grain	12.98	12.98	12.98	12.98
White maize meal	14.93	14.93	14.93	14.93

Table 3: Nutrients composition Organic fertilizer, formulated feed and Multifeed used in the culture of Heteroclarias hybrid during the 90 days study

Nutrients	0rganic fertilizer	Basal diet	MULTIFEED®
Dry matter (%)	92.40	90.88	90.092
ME	3126.00	3102.16	3045.30
Methionine	1.66	0.71	0.893
Lysine	2.83	1.94	1.866
Phosphorus	0.80	0.48	0.827
Calcium	0.75	0.54	1.110
Lipid	16.10	7.01	12.50
Crude fibre	2.45	6.32	2.18
Crude protein	35.00	35.00	44.00
Cost implication			
Formula cost (#)	-	175.20	300.00
Bag size (kg)	-	50.00	50.00
Cost bag^{-1}	-	8760.00	15000.00

calcium content while white maize meal had the lowest (0.03%). Phosphorus was very high (2.89%) and very low 0.09%) in blood meal. The highest (4.85 and 2.62%) lysine and methionine values were observed in fishmeal while the lowest (0.27 and 0.24%) were seen in white maize meal, respectively. Metabolizable energy was very high (3434 kcal kg^{-1}) in white maize meal and the lowest (1980 kcal kg^{-1}) value was recorded in dried brewer's grain.

The basal diet: The ingredient combinations of the diets for Heteroclarias hybrid fingerlings are shown in Table 2. The B contained the highest value of White Maize Meal (WMM) (14.93%) and the lowest value of Fishmeal (FM) (4.00%).

The formula cost for B was 175.20 naira while that of MULTIFEED was 300.00.The nutrient content of B shows that, DM, P, Ca, MT, LS and ME contents were, 90.88, 0.48, 0.54, 0.71, 1.94% and 3102.16 kcal g^{-1}, respectively (Table 3). The B was so formulated to have similar nutrient composition with the organic fertilizer and the commercial feed. However, all the nutrients were within the ranges of nutrient requirements for African catfish (NRC, 1993).

Growth performance of the studied fish under different feeding conditions: The increase in length with time of the studied fish under different treatments is shown in Fig. 1. Mean length increased from initial value of 4.1±023 cm to a final value of 7.2±057 cm in DT01; 4.0±0.46 cm to 9.6±0.48 cm in DT02; 3.9±0.52 cm to 10.4±0.77 cm in DT03 and 4.1±0.53 cm to 11.2±0.9 cm in DT04. Mean lengths in test conditions were significantly better ($p<0.05$) than the control. Tukey's multiple comparison test at $p<0.05$ revealed that DT04 was significantly different from others.

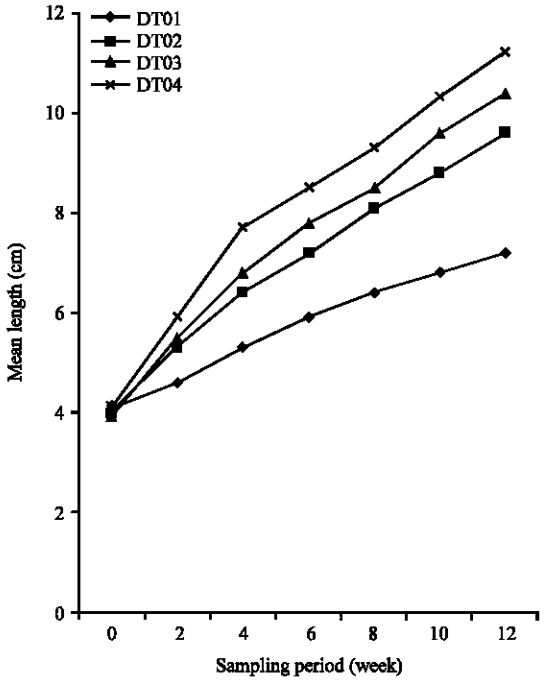

Fig. 1: Forthnightly variation in the mean length of Heteroclarias hybrids fingerlings fed different type of feeds

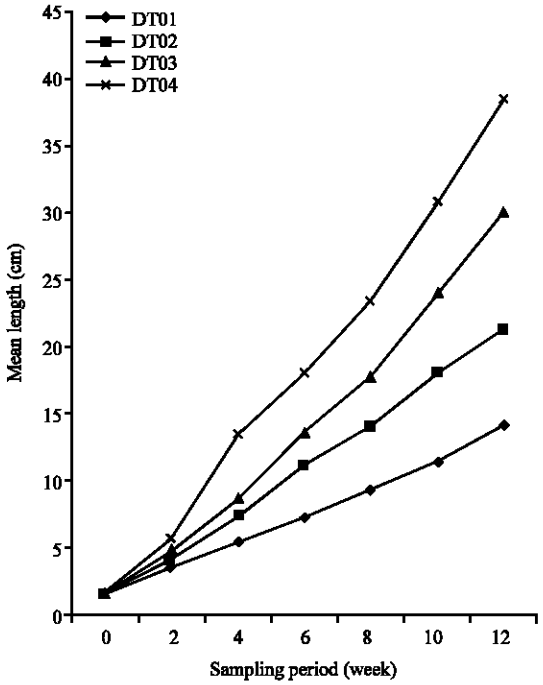

Fig. 2: Forthnightly variation in mean weight of Heteroclarias hybrid fingerlings fed different feed for 90 days

Figure 2 shows the increase in weight with time of the studied fish under different treatments. Mean weight increased from an initial value of 1.55±003 g to a final value of 14.37±1.22 g in DT01;

Table 4: Length-weight relationship, condition factor and growth performance of Heteroclarias hybrid fingerlings reared in different culture systems for 90 days

	Culture condition			
Growth indices	DT01	DT02	DT03	DT04
a	-0.79	-0.81	-0.87	-0.94
b	2.24	2.47	3.04	3.11
r	0.96	0.95	0.94	0.94
r^2	0.92	0.90	0.89	0.89
k	3.83	2.40	2.68	2.74

a: Intercept, b: Regression coefficient, r: Correlation coefficient, r^2: Coefficient of determination, k: Condition factor

1.56±0.09 g to 21.27±1.29 g in DT02; 1.54±0.03 g to 30.20±1.08 g and 1.67±0.2 g to 38.56±0.73 g in DT04. Similarly, Tukey's multiple comparison test at $p<0.05$ revealed that DT04 was significantly different from others.

The results of the analysis of the length/weight relationship of Heteroclarias under the three different study conditions are shown in Table 4, in DT01, the value of intercept (a) was -0.79, the slope (b) was 2.24; correlation coefficient (r) was 0.96 while the coefficient of determination (r^2) was 0.92. In DT02, "a" was -0.81, "b" was 2.47 while r^2 was 0.95. Also, in DT03 "a" was -0.87; "b" was 3.04; r was 0.94 while r^2 was 0.89. But for DT04, "a" was -0.94; "b" was 3.11; r was 0.94 while r^2 was 0.89. The values for k were 3.83, 2.40, 2.68 and 2.74 for DT01, DT02, DT03 and DT04, respectively.

DISCUSSION

The ingredients used in the formulation of the basal diet which was used to fortify each of the dietary treatment were well utilized by African catfish since they are omnivores (Udo *et al.*, 2011b). According to Bhattacharya and Taylor, 1975), hen excreta contain 10-35 crude protein, 14-24% crude fiber and about 21,000 kcal kg^{-1} metabolizable energy on a dry matter basis. This findings agree with the present study in terms of crude protein (35%) supplied by the organic fertilizer. Also, because of the short digestive tract of the poultry, 80% of chicken manure represents undigested feedstuffs with as much as 20-30% of total protein (Chen, 1981) therefore, apart from their use as fertilizers, chicken manure are also valuable as feed and feedstuff (Nash and Brown, 1980). The values of growth performance in the control and DT01 where only organic fertilizer was applied attest to this fact in this study. According to Sogbesan (1998) fingerlings are always able to convert the protein components in natural meals more efficiently than those found in artificial feed. This observation agree with that of the present study where organic fertilizer which enhanced the growth of zooplankton provided adequate protein, lipids, fatty-acids, minerals and enzymes for the fingerlings. Fasakin *et al.* (2003) and Ajani *et al.* (2004) found that fishes reared on qualitative natural meals as that of diets DT02 achieve adequate growth. This was because they utilized the nutrient from such feeds better and faster than those from artificial feed. This finding debunk such claims as fishes fed artificial diet (MULTIFEED) performed better than those fed natural feed only. This point is further buttressed by the result of the length-weight relationship analysis which shows that the value of regression coefficient (b) is below 3 in DT02 which is similar to the value in the control portraying negative allometric growth indicating that the fish changed different

dimension with growth while that of DT03 and DT04 were above 3 indicating a positive allometric (i.e., fish became heavier with increase in length). The value of condition factor (k) was also used to compare the condition of fatness of fish based on the hypothesis that the heavier fish of a particular length are in better condition. A comparison of k shows that fish in DT02 was in the worst condition. The high values of condition factors may be due to the richness in oxygen of the pond and the low rate of pollution. Little wonder then the low level in DT02. The disadvantage of organic fertilizer lies in the fact that they deplete dissolved oxygen during decomposition and offend the aesthetic value of a pond (Adigun, 2005). Although, some researcher (Lan and Pan, 1993; Madu *et al.*, 2003) reported that the nutritive value of natural food promotes better growth and higher yield in fish than that achieved from artificial feeds this fact should not be overemphasized. It may be true that natural food promote better growth than artificial but when organic fertilizer is used to enhance their growth, the reverse is the case due to the aforementioned reason. In present study, fish fed artificial feed only performed better than those fed natural food enhanced by organic fertilizer but both combination performed best. A combination of natural and artificial feeding enhanced better growth of fingerlings as revealed by (Holm and Moller, 1984; Ovie, 1986; Kibria *et al.*, 1997) as well as minimized problems associated with artificial diets (Ovie, 1986; Eyo *et al.*, 2006) and organic fertilizer treated ponds. The mean values of DWG and SGR obtained in this study attest to this fact. These values are better than those obtained for their parental stock (Nwanna, 2003; Ojutiku, 2008) which further the fact Heteroclarias hybrid fingerlings perform better than their parental stock counterparts.

Present study revealed that DT04 proved to be the most conducive for rearing Heteroclarias hybrid juvenile. It was the best alternative in comparison with DT02 and DT03 because it gave rise to the best growth rate and size increase. It was richer in crude protein, crude fiber and lipids necessary for adequate growth and survival of fingerlings. This was as a result of the synergetic interaction between natural food and supplemental feed which reduced the artificial feed input and their production cost. In contrast, the use of Multifeed only resulted in laborious water quality monitoring; it was less economically viable and not easily affordable to all fish farmers.

CONCLUSION

In general, results of this study have shown that DT04 was the best alternative for the rearing of Heteroclarias hybrid fingerlings. The diet resulted in the best growth/total length increase, as well as the best condition factor. Again on the basis of easy availability, compatibility, affordability and less competition, DT04 proved to be superior to DT03 while DT02 is lagging behind in terms of water quality. It can be concluded from this study that the cost of fish production was greatly reduced and the growth rate and the general growth indices of fish greatly improved. Therefore for better growth and productivity of Heteroclarias hybrid fingerlings a combination of organic fertilizer and artificial diet should applied.

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