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Effects of starvation on hybrid clariid catfish, ♀*Clarias gariepinus* x ♂*Heterobranchus bidorsalis* production

O.T. Adebayo
Department of Fisheries and Wildlife, Federal University of Technology, P.M.B. 704, Akure, Nigeria.
E-mail: adebot541@yahoo.com

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ABSTRACT. Effects of four feeding regimen [starved for 56days, starved for 28 days and subsequently fed for 28 days, fed for 28 days and subsequently starved for 28 days, and fed throughout the 56 day grow-out period (control)]: treatments 1, 2, 3 and 4, respectively on clariid catfish hybrid (♀*Clarias gariepinus* X ♂*Heterobranchus bidorsalis)* were studied over 56-days. Catfish in treatment 2 and 3 had lighter weight ($P < 0.05$) than the control. Carcass fat and protein increased when the catfish were fed but decreased when the catfish were subsequently starved, but not as low as in catfish in treatment 1. There was progressive reduction in carcass fat and protein in catfish starved over the 56 days. The hepato and viscero-somatic indices were significantly ($P < 0.05$) lower in catfish in treatment 1 than other treatments. Economic performance indices (gross profit, profit index and incidence of cost) were best in treatment 4 followed by treatment 3 and worst in treatment 1. These results indicate that clariid catfish hybrid on starvation at either first half or second half cannot catch-up with the control in terms of growth, carcass protein and fat, and yield.

KEY WORDS. Starvation, Clariid catfish hybrid, growth, carcass composition

INTRODUCTION

The production of hybrid Clariid Catfish (♀*Clarias gariepinus* X ♂*Heterobranchus bidorsalis*) surpassed the production of parental species (*H. bidorsalis* and *C. gariepinus*) and *Tilapia* due to its improved growth rate, high yield potential, efficient feed conversion, resistance to disease and good consumer acceptance (Hecht and Lublinkhoff, 1985; Legendre et al., 1992; Salami et al., 1993; Adebayo, 1998).

Several fish species are subjected to a natural starvation period during part of the year (Boujard et al., 2000). They have developed an impressive ability to endure protracted periods of starvation during which they mobilise their body reserves to stay alive (Collins and Anderson, 1995). Feed is the most expensive input in fish production, and represents more than 60% of the total cost of fish production (Olomola, 1990). Due to the high cost of fish feed, fish farmers embark on restricted feeding of fish stocks to reduce cost of production. The ability of fish to respond to cycles of under nutrition and re-feeding could be exploited in the commercial production of fish to either control the rate of weight gain or manipulate the final composition of the body tissues or improve growth efficiency (Quiton and Blake, 1990, Meloy and Joblking, 1992). This study was therefore conducted to assess the effects of imposition of feeding regimen (including starvation for various periods) on growth and survival, carcass composition, morphological measurements and economic performance of hybrid clariid catfish.

MATERIALS AND METHODS

Hybrid clariid catfish (45.25 ± 0.05g) were randomly stocked in 12 glass tanks (60 x 40 x 40 cm^3) at 10 catfish per tank. Four treatments were established with three tanks per treatment: (1) starved for 56 days, (2) starved for 28 days and subsequently fed for 28 days, (3) fed for 28 days and subsequently starved for 28 days, and (4) fed throughout the 56 day grow-out period. The fish were acclimatised to the rearing conditions and food for 7 days prior to the start of the experiment.

During the feeding period, the catfish were fed to satiation with practical diet containing 40% C.P (Table 1). All fish were removed from each tank every week and were batch-weighed, and the quantity of diet was adjusted based on new weight. Growth indices were estimated from weight measurement as follows:

% Weight gain (**WG**, %) = $[(W_f - W_1)/W_1] \times 100$

Specific growth rate (**SGR**, %/day) = $100 \times (L_n W_f - L_n W_1)$/rearing period (days)

Feed Conversion ratio (**FCR**) = dry weight of diet fed (g)/$W_f - W_1$.

Where: W_i and W_f are mean initial and final body weight respectively.

Table 1. Ingredient (g/100g dry matter) composition of experimental diet

Ingredient (g/100g dry matter)	%
Fish meal	14.3
Groundnut cake	43.0
Soybean meal	14.3
Yellow maize	18.3
Cassava starch	3.0
Cod-liver oil	1.0
Vegetable oil	1.5
Oyster shell	1.5
[1]Mineral and Vitamin Mix	2.5
Salt (NaCl)	0.5
Proximate composition	
Moisture (%)	9.5 ± 0.3
Ash (%)	9.4 ± 0.1
Protein (%)	39.9 ± 0.7
Lipid (%)	4.3 ± 0.7
Fibre (%)	3.4 ± 0.5
Nitrogen free extract (NFE)	33.6 ± 0.5

[1]Premix as supplied by Roche Nigeria Limited, Lagos.

At the end of experimental period, three fish from each tank were randomly captured and killed by decapitation. Fish were dissected and liver and viscera weighed to determine the hepatosomatic (HSI) and viscerosomatic (VSI) indices. The final body weight (bw), liver weight (lw), and viscera weight (vw) were determined. The hepatosomatic index (HSI) and viscerosomatic index were calculated as follows:

Hepatosomatic index (HSI) = 100 (Liver weight/body weight)

Viscerosomatic index (VSI) = 100 (viscera weight/body weight)

Carcass weight (cw) was estimated by subtracting viscera weight from body weight. Carcass to whole body weight ratio (cw/bw) was calculated as percentage of carcass to body weight. At the end of the experiment, proximate composition of fish was determined using the methods described by AOAC (1990): moisture was determined after oven-drying at 105°C to constant weight, ash by incinerating the dried residue for 24h at 550°C in a muffle furnace, total nitrogen (N) was determined by micro-Kjeldahl procedure and crude protein was estimated as N X 6.25, and crude lipid was determined after extraction of dried samples with petroleum ether.

Comparison of the economic performance indices of the various feeding regimen were based on the following assumptions: (1) that the cost of producing 1kg of feed was calculated based on the prevailing market price of ingredients, cost of transportation and handling charges; (ii) that the price of 1kg of clariid catfish hybrid was ₦150; (iii) all costs were based on prices in Akure (Nigeria) in 2002 US$ =₦110.

The following indices were calculated:

Net production (g/tank) = mean weight gain X total number of fish per tank at the end of the experiment.

Gross Profit (₦) = value of fish - cost of feed

Profit index = value of fish / cost of feed.

Incidence of cost = cost of feed/net production.

Statistical Analysis

All Percentage and ratio data were transformed to arcsine values prior to analysis. All data collected were subjected to one-way analysis of variance (ANOVA) test and where significant differences were indicated, means were tested using least significant Difference (LSD) test at 5% level of significance (Zar, 1984).

RESULTS

The WG and SGR of catfish on feeding regimen for various periods are presented in Table 2. The weight of the fish were 42.88 ± 0.20g, 116.38 ± 2.48g, 124.29 ± 2.20g and 211.42 ± 3.20g for treatment 1, 2, 3 and 4 (control) respectively. At the end of the 56 days grow-out period, the weight of the catfish in treatment 2 was slightly low but not significantly different ($P < 0.05$) from weight of catfish on treatment 3. All the growth indices showed significant difference ($P < 0.05$) at the end of the experiment as a result of feeding regimen. Fish survival for the 56-day were 60%, 75%, 80%, and 98% for treatment 1, 2, 3, and 4, respectively.

Table 2. Growth performance of clariid catfish hybrid on starvation for various periods during 56-day grow-out period.

Period	Day	Treatment	WG	SGR
1	1-14	1	-0.46 ± 0.00^a	-0.02 ± 0.00^a
		2	-0.44 ± 0.00^a	-0.02 ± 0.00^a
		3	40.58 ± 0.09^b	1.14 ± 0.05^b
		4	40.47 ± 0.08^b	1.14 ± 0.03^b
2	15-28	1	-0.45 ± 0.00^a	-0.02 ± 0.00^a
		2	-0.54 ± 0.00^a	-0.02 ± 0.00^a
		3	42.35 ± 0.08^b	0.72 ±0.01^b
		4	41.25 ± 0.08^b	0.70 ± 0.01^b
3	29-42	1	-0.54 ± 0.00^b	-0.02 ± 0.00^b
		2	35.31 ± 0.06^c	1.05 ± 0.01^c
		3	-0.98 ± 0.00^a	-0.03 ± 0.00^a
		4	41.91 ± 0.07^d	0.51±0.00^d
4	43-56	1	-0.98 ± 0.00^b	-0.04 ± 0.00^b
		2	36.83 ± 0.06^c	0.68 ± 0.01^c
		3	-1.92 ± 0.00^a	-0.02±0.00^a
		4	42.60 ± 0.06^d	0.40 ± 0.01^d

Values are means ± SD. Values in the same column with different superscripts within each period are ($P < 0.05$)

significantly different.

Table 3. Morphological measurements of clariid hybrid on starvation regimen.

Treatment	Body weight (g)	Total length (cm)	Liver weight (g)	Visceral weight (g)	CW/ BW	HSI	VSI
Initial	45.40 ±0.23	14.99 ±0.67	1.35 ±0.07	4.48 ±0.09	90.21 ±1.86	2.97 ±0.03	9.87 ±0.19
1	42.88 ±0.20^a	18.06 ±0.09^a	0.37 ±0.02^a	3.31 ±0.06^a	93.65 ±1.95^b	0.86 ±0.01^a	7.72 ±0.16^a
2	116.38 ±2.48^b	24.31 ±1.00^b	3.22 ±0.09^b	10.20 ±0.21^b	91.07 ±1.89^a	2.77 ±0.03^b	8.76 ±0.18^c
3	124.29 ±2.20^b	24.75 ±1.03^b	3.57 ±0.08^b	10.97 ±0.24^b	91.12 ±1.92^a	2.87 ±0.04^b	8.83 ±0.17^c
4	211.42 ±3.20^c	29.19 ±1.11^c	6.56 ±0.10^c	17.52 ±0.65^c	90.23 ±1.65^a	3.10 ±0.05^c	8.29 ±0.18^b

Values are means ± SD. Values in each column with different superscripts are significantly (P < 0.05) different.

Table 4. Carcass composition of clariid catfish on starvation for various periods during 56-day grow-out period.

Day	Treatment	%Moisture	%Protein	%Fat	%Ash
1	1	69.18 ± 3.06^a	17.30 ± 1.01^a	8.15 ± 0.08^a	4.09 ± 0.02^a
28	1	72.70 ± 3.37^b	16.01 ± 1.00^a	6.69 ± 0.05^a	4.19 ± 0.01^a
	2	72.73 ± 3.45^b	16.01 ± 1.00^a	6.77 ± 0.05^a	4.13 ± 0.01^a
	3	67.98 ± 3.23^a	18.45 ± 1.25^b	8.52 ± 0.06^b	3.73 ± 0.01^a
	4	68.21 ± 3.20^a	18.42 ± 1.27^b	8.55 ± 0.07^b	3.64 ± 0.01^c
56	1	75.59 ± 3.47^c	14.07 ± 0.96^a	4.34 ± 0.02^a	5.95 ± 0.09^d
	2	66.05 ± 3.06^a	18.26 ± 1.52^b	8.21 ± 0.06^b	4.02 ± 0.01^b
	3	66.01 ± 3.15^a	18.28 ± 1.45^b	8.67 ± 0.07^c	4.13 ± 0.01^c
	4	67.02 ± 3.24^b	19.35 ± 1.53^c	9.15 ± 0.08^d	3.18 ± 0.02^a

Values are means ± SD. Values in the same column with different superscripts within the same day are significantly (P < 0.05) different.

Table 5. Economics of production of clariid catfish hybrid on starvation for various periods during 56-day grow-out period.

	Treatments			
Parameters	1	2	3	4
Production period (days)	56	56	56	56
No. of fish/tank	10	10	10	10
Net production (g/tank)	-19.64±1.25^a	607.13±30.02^b	782.64±32.14^c	1736.26±123.63^d
Values of fish (₦0.15/g)	-2.95±0.03^a	91.07±15.62^b	118.65±20.53^c	249.93±24.72^d
Feed input (g)	-	473.43±22.14^a	577.19±26.68^a	1779.14±126.54^b
Cost of feed (₦0.02/g)	-	9.47±1.00^a	11.55±1.04^a	35.57±2.24^b
Gross Profit (₦)	-2.95±0.01^a	81.60±14.21^b	105.84±18.15^c	214.36±22.53^d
Profit Index	-	9.62±1.02^b	10.18±1.05^c	7.03±1.00^a
Incidence of Cost	-	0.016±0.00^a	0.015±0.00^a	0.020±0.00^b

Values are means ± SD. Values in each row with different superscripts are significantly (P<0.05) different.

Morphological measurements (HSI, VSI, and CW/BW) depicted in Table 3 showed no significant difference ($P < 0.05$) between treatment 2 and 3 but were highly significantly different from treatment 1 and 4. HSI, VSI, CW/BW in all the treatment were significantly higher than the initial value except treatment 1 which had lower value.

Carcass composition of clariid catfish hybrid on starvation for various periods is shown in Table 4. Carcass crude protein and lipid content of catfish hybrid on treatment 3 increased significantly up to day 28, it then decreased gradually till the end of the grow-out period and vice versa in treatment 2. Crude protein and fat content of catfish hybrid on treatment 1 significantly decreased as the period of starvation increased. At day 28, there was no significant difference ($P < 0.05$) between treatment 1 and 2, 3 and 4 while at day 56 there were significant differences ($P<0.05$) in all the treatments except treatment 2 and 3. There was significant difference in moisture content of fish at day 28 treatments, with treatment 3 having the least moisture content. At the end of the experiment, there was no significant difference between the moisture content of fish on treatment 2 and 3. As shown in Table 4, there was no significant difference in ash content of catfish hybrid on treatment 1, 2 and 3 at day 28 while there was significant difference in all the treatment groups at day 56.

The economic comparison of the varying feeding regime is shown in Table 5. Net production and value of hybrid catfish were highest in treatment 4 followed by treatment 3, 2 and 1 and were significant different form one another ($P < 0.05$). Gross profit realised from hybrid catfish subjected to treatment 1, 2, 3, and 4 were ₦-2.95, ₦81.60, ₦105.84 and ₦214.36 respectively and were significant different ($P < 0.05$) from one another. The incidence of cost and profit index recorded by fish subjected to treatment 2, 3, and 4 were 9.62, 10.18 and 7.03; and 0.016, 0.015 and 0.020 respectively.

DISCUSSION

The results of this study show that clariid catfish hybrid starved either at first or second half of the experimental periods were lighter in weight than the control. During the period, which the previously starved fish were fed with adequate amount of feed, the rate of weight gain was markedly greater than the control. However, the final weight was almost half of the control. This is in agreement with partial compensatory growth observed in rainbow trout, *Oncorhychus mykis* (Weatherly and Gill, 1981) and arctic charr, *Salvenius alpinus* (Miglavs and Jobling, 1989). In contrast to complete compensatory growth observed on salmonid (Dobson and Holmes, 1984; Quinton and Blake, 1990) and Atlantic cod (Meloy and Jobling, 1992). In the present study, the fish displayed partial compensation because starvation was severe and the duration was too long to allow for complete compensation to occur. According to Boujard et al., (2000), the duration of feed deprivation had a major effect on weight gain.

Fish survival was higher in treatment 3 than treatment 2. This may be attributed to the less body reserves of the catfish when they were subjected to starvation at first half of the experiment. As a result they cannot withstand the stress of starvation at second half of the experiment.

Carcass lipid and protein were higher in control than in other treatments. This disagrees with Miglavs and Jobling (1989) on arctic charr, *S. alpinus*, and Kim and Lovell (1995) on channel catfish, *Ictalurus punctatus*. In the present study the hybrid catfish were subjected to starvation for 56day unlike restricted feeding used in Miglavs and Jobling (1989) and Kim and Lovell (1995) experiments. The reduction in the carcass fat, protein and higher moisture content in the hybrid catfish starved throughout the experimental period agrees with Pector et al (1994) who found similar trend in *C. gariepinus*. The result suggests that during starvation, fat reserves (wherever situated) decreased to a level beyond which the muscle protein is used for energy in the hybrid catfish. Decrease in VSI and HSI in treatment 1 were attributed to utilisation of nutrient from these organs for metabolic purpose; similarly reported by Pector et al (1994) in *C. gariepinus*.

The result of this study shows that production of clariid catfish hybrid was better when adequately fed than subjecting them to starvation regimen. Fish yield of catfish fed throughout the study doubled the yield of fish subjected to starvation either at first or second half of the experimental period. Gross profit of adequately fed catfish doubled that of catfish starved at second half of the experimental period while it tripled the gross profit realised from catfish starved at first half of the experimental period. Based on growth and economic indices there is no benefit derived from subjecting clariid catfish hybrid to starvation regimen but suggest that feeding is beneficial in terms of growth, carcass protein and fat, yield and profit.

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