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Full Length Research Paper

Effect of different dietary protein levels on growth performance and feed utilization of hybrid catfish (*Heterobranchus bidorsalis* x *Clarias anguillaris*) fry in north-east Nigeria

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The effect of different dietary protein levels on growth performance and feed utilization of hybrid catfish *Heterobranchus bidorsalis* (male) x *Clarias anguillaris* (female) larvae in north-east Nigeria were carried out in circular plastic trough (40 cm diameter x 30 cm deep) indoors. Five dietary protein levels 35, 40, 45, 50 and 55% were tried in triplicates. The result showed an increase in the growth indices with increase in dietary protein levels. Most of the growth indices mean weight gain (MWG) specific growth rate, (SGR), mean daily weight gain (MDGW), protein index (PI), apparent protein efficiency ratio (APER), food conversion ration (FCR), nitrogen metabolism (NM), relative growth rate (RGR) and percentage survival (%SR) were higher in fry fed 50% crude protein. There was no significant difference (p > 0.05) among the growth indices of fry fed on both 50 and 55% crude protein levels. Higher dietary protein level was found to give higher growth rate in this region, though expensive. The higher protein levels obtained in this study could be due to the early weaning of the hybrid larvae from shell-free artemia to compounded diet.

Key words: Dietary protein, growth performance, hybrid catfish fry, North-east Nigeria.

INTRODUCTION

Fish is known to have high quality protein and its protein content can be as high as 60% on dry matter basis. Lack of good quality feed for economic production adversely affects growth rates, disease manifestation and total harvest of fish (Alatise et al., 2006). Protein is the most expensive component in supplementary fish feed (Fagbero et al., 1992). Intensively cultured fish usually require high protein feeds and since feeds are normally the largest variable cost item in commercial production; the profitability of intensive aquaculture is closely related to the world supply and cost of feed protein (Hoffman et al., 1997). Generally, increasing protein levels in fish diets can lead to improved fish production though it may be expensive (Babalola and Adebayo, 2006).

Feed constitutes 60-70% of total investment in aquaculture. Any reduction in dietary protein level without affecting fish growth can substantially reduce the cost of fish feed (Jamabo and Alfred-Ockiya, 2008). Dietary protein is used by fish for growth, energy and body maintenance (Kausshik and Medale, 1994). Protein requirement for maximum growth of any species of fish is a step forward in developing cost effective feed for fish farming and this has to do with determining the optimum amount required to produce maximum growth rate (Sang-Min and Tae-Jun, 2005). Dietary protein requirements of African catfish have been reported by several authors. Jamabo and Ockiya (2008) reported 40% crude protein for *H. bidorsalis*, Olufeagba (1999) recommended 45% for triploid *H. longifilis*, while Fagbenro et al. (1992) reported 42.5% dietary protein requirement for *H. longifilis*

Hybrid catfish (*Heterobranchus* sp. and *Clarias* sp.) species has been exploited by Nigerian farmers, especially in the east and southern part (Aluko, 1996). In

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Table 1. Composition of experimental diet (isocaloric).

Feed ingredients (%)	Diets (%)				
	D1 (35)	D2 (40)	D3 (45)	D4 (50)	D5 (55)
Fish meal	15.0	18.3	20.9	23.9	26.3
Groundnuts cake	8.8	12.1	15.5	18.7	22.1
Soy bean meal	13.3	18.1	23.2	28.1	33.2
Millet	49.4	37.6	25.6	13.8	1.8
Wheat offal	5.4	6.4	7.3	8.2	9.1
Vitamin premix	1.0	1.0	1.0	1.0	1.0
Salt	0.5	0.5	0.5	0.5	0.5
Bone meal	0.5	0.5	0.5	0.5	0.5
Lysine	1.0	1.0	1.0	1.0	1.0
Methionine	1.0	1.0	1.0	1.0	1.0
Vitamin C	1.0	1.0	1.0	1.0	1.0
Groundnut oil	0.5	0.5	0.5	0.5	0.5
Binder	2.0	2.0	2.0	2.0	2.0
Total	100.0	100.0	100.0	100.0	100.0
Crude protein composition of experimental diet (%)					
Calculated crude protein levels	35	40	45	50	55
Analysed crude protein levels	33.18	38.08	43.24	48.41	53.22
Crude fibre	7.00	40	11.5	11.5	12.5
Fats	2.50	2.00	3.50	3.00	3.50
Ash	1.50	1.60	1.80	1.80	1.90

northern Nigeria, especially north east, fish farming has just been embraced and hybrid catfish culture is being encouraged. Most of the commercial fish feeds in north east Nigeria were imported from Europe and Asia. They are expensive due to high cost of importation and transportation to the region. Use of live foods (zooplanktons) has been successful but it seemed to be labour intensive and it requires additional ponds for rearing which could be expensive. The development of fish starter feed using locally available feed material is therefore very necessary. The aim of this study therefore is to investigate the growth performance and feed utilization of hybrid African catfish *(H. bidorsalis* x *C. anguillaris*) fed with 5 diets of different crude protein levels. This is with the view to developing starter fish feed for farmers in Nigeria.

MATERIALS AND METHODS

Five experimental diets were formulated and labelled D1 (35%), D2 (40%), D3 (45%), D4 (50%) and D5 (55%) crude protein levels using locally available feed ingredients (Table 1). The various ingredients were ground with hammer mill, weighed, mixed, and pelleted using manual pelleter (meat mincer). The pelleted feed was re-ground into powdered after air drying and passed through 0.1 mm and 0.2 mm mesh sieves.

15 *Heteroclarias* fry produced at the fish hatchery in the Department of Fisheries, University of Maiduguri, Nigeria, with average weight 2.01 ± 0.33 g were stocked in each of the 25 circular plastic basins (40 cm diameter x 30 cm deep) containing 20 litres of water. Experimental diets were assigned into the plastic basins randomly in triplicates. Uneaten feed were siphoned every morning before feeding with topping immediately after siphoning. The fish were fed with the experimental diets at 5% of their body weight (BW) in split doses daily; morning (0800 h) and (1600 h) for 30 days. They were reared in the plastic basin without aeration. The fish were weighed weekly and the feed adjusted based on their body weight. Water quality parameters (dissolved oxygen, pH and temperature) were monitored daily through out the trial. Growth indices were calculated using the following formulae:

Percentage (%) survival = (Final number of fish/Initial number of fish) x 100.

Mean weight gain (MWG) = Final average weight (g) – Initial average weight (g).

Specific growth rate (SGR) = $[(\log_e W_2 - \log_e W_1) \times 100]/T$

Where W_2 = Final body weight (g), W_1= initial body weight of fish (g) and T = duration of studies in days.

Condition factor (K) = $W_2/L_2^3 \times 100$

Where W_2 = Final fish average weight (g), L_2 = Average total length (cm).

Average daily weight gain (ADWG) = Average weight gain (g) / T (days).

Feed conversion ratio (FCR) = Weight of dry feed dispensed (g) / Live weight gain of fish (g).

Apparent protein efficiency ratio (APER) = weight gain (g) / Apparent protein intake.

Protein index (PI) = Survival x [Final mean body weight (g) – initial

Table 2. Growth performance and protein utilization of F_1 hybrid (*Heterobranchus bidorsalis* x *Clarias anguillaris*) fry fed at different dietary protein levels for 30 days.

Growth index	Crude protein levels (%)					P-Values
	35	40	45	50	55	
MIW[1]	2.04 ± 0.27	1.99 ± 0.21	1.93 ± 0.12	2.20 ± 0.9	1.97 + 0.14	
MFW[2]	10.00 ± 0.56 [c]	12.33 ± 0.77 [c]	14.33 ± 1.0 [bc]	23.07 ± 4.76 [a]	20.90 + 1.22 [ab]	0.0097
MFSL[3]	8.85 ± 0.11 [b]	8.71 ± 0.17 [b]	9.00 ± 0.12 [ab]	9.04 ± 0.17 [ab]	9.78 + 0.57 [a]	0.1581
MWG[4]	7.96 ± 0.54 [d]	10.34 ± 0.63 [cd]	12.41 ± 0.87 [c]	24.35 ± 1.78 [a]	18.94 + 1.24 [a]	0.5402
SPG[5]	24 ± 2.65 [ab]	12.00 ± 2.65 [c]	18.00 ± 2.00 [bc]	25.67 ± 2.19 [a]	20.00 + 1.53 [ab]	0.0113
MDWG[6]	0.34 ± 0.02 [b]	0.34 ± 0.02 [ab]	0.48 ± 0.32 [ab]	0.59 ± 0.24 [ab]	0.70 + 0.41 [a]	0.2512
K[7]	1.46 ± 0.09 [b]	1.88 ± 0.19 [b]	1.96 ± 0.9 [b]	3.06 ± 0.5 [a]	2.28 + 0.26 [ab]	0.0193
PI[8]	2.53 ± 0.59 [b]	3.98 ± 0.82 [b]	4.71 ± 0.47 [ab]	9.40 ± 2.65 [a]	5.62 + 1.78 [ab]	0.0777
APER[9]	0.29 ± 0.02[a]	0.31 ± 0.02 [a]	0.32 ± 0.02 [a]	0.41 ± 0.9 [a]	0.42 + 0.23 [a]	0.1946
NM[10]	64.5 ± 4.44 [d]	82.09 ± 4.77 [cd]	100.55 ± 7.05 [c]	192.27 ± 4.44 [a]	153.42 + 10.04 [b]	0.0000
FCR[11]	1.05 ± 0.03 [ab]	1.01 ± 0.09 [ab]	1.28 ± 0,14 [a]	0.81 ± 0.30[ab]	0.79 + 0.21 [b]	0.0967
RGR[12]	390.91 ± 26.07[c]	525.59 ± 42.02[bc]	643.67 ± 5.04[b]	1117.17 ± 128.20[a]	969.76 ± 96.77[a]	0.0184
% SR[13]	62.22 ± 11.00 [a]	75.55 ± 11.76 [a]	75.55 ± 2.22 [a]	86.66 ± 6.67 [a]	62.22 + 21.89 [a]	0.6201

*Means with different superscript letters within a row are significantly different (P < 0.05).
[1]Mean initial weight (g), [2]mean final weight (g), [3]mean final standard length (cm) [4]mean weight gain, [5]specific growth rate %/day), [6]mean daily weight gain (mg/day), [7]condition factor, [8]protein index, [9]aparent protein efficiency ratio [10]nitrogen metabolism, [11]feed conversion ratio, [12]relative growth rate (%), and [13]percentage survival rate.

mean body weight (g)] / T. (Pangni et al., 2008)

Nitrogen metabolism (NM) = [0.54)(b-a)h]/2 (Jamabo and Alfred-Ockiya, 2008)

Where a = Initial weight (g), b = Final weight, (g) h = Experimental period (days) and 0.54 experimental constant.

Samples of the experimental diets were analysed for proximate composition using the standard (AOAC, 1990) methods. All growth data from the trials were subjected to 1-way analysis of variance (ANOVA). The significant difference between the means was determined by least significant difference (LSD) using statistix 8.0 for Windows.

RESULTS

The results of growth performance and feed utilization of hybrid Catfish *H. bidorsalis* (male) x *C. anguillaris* (female) fry fed different dietary protein levels to fingerlings stage are shown in Table 2. There was an increase in the growth indices with increase in dietary protein levels. At 55% crude protein, mean final weight gain (MFWG) decreased by 2.17 g, mean weight gain (MWG) 5.14 g, specific growth rate (SGR) 5.67%, condition factor (K), 0.78, protein index (PI) 3.78, feed conversion ration (FCR) 0.02, relative growth rate (RGR) 148% and percentage survival rate (%SR) by 24.44% but apparent protein efficiency ratio (APER) and nitrogen metabolism (NM) was higher at 55%.

The result shows that all the growth indices MFW (g) was higher in D4 (50%) followed by D5 (55%), D3 (45%), D2 (40%) and D1 (35%). There was no significant difference ($p < 0.05$) between the MFW values obtained in fish fed with D4 and D5. Similarly there was no significant difference ($p < 0.05$) between the MFW values obtained from fry fed D1 to D3, but significant difference ($p > 0.05$) existed between D1 to D3 compared to D4. Mean final standard length (MFSL) was also higher in fry fed D4 followed by D5, D3, D2 and D1 respectively. There was no significant difference ($p < 0.05$) between MFSL (cm) value obtained from D5, D4, D3, D2 and D1. However, D5 is different from D1 and D2 statistically.

The highest MWG (g) was obtained in fish fed D4 followed by D5 and the 2 diets are statistically the same ($p < 0.05$). SGR (%/day) was higher in D4 followed by D3, D5, D4 and lower in D2. There was no significant difference between the SGR value of fry fed D4, D1 and D5, similarly significant difference also does not exist between fry fed D2 and D3. MDGW (mg/day) was higher in fish fed D5 followed by D4, D3 and D2. Significant difference does not exist among D2 to D5 statistically ($P < 0.05$). The condition factor (K) and protein index (PI) was higher in both fry fed with D4 followed by D5. There was no significant difference ($p < 0.05$) between K and PI value form fry fed with D4 and D5. Similarly, there was no significant difference ($p < 0.05$) between K and PI value form fry fed with D1, D2 and D3. Apparent protein efficiency ration (APER) was higher in fry fed D5 followed by D4, D3, D2 and D1 respectively. Significant difference ($p < 0.05$) APER values in all the fish did not exist. Nitrogen metabolism was higher in D4 followed by those fed with D5, D3 and D2 and D1. There was significant difference ($p > 0.05$) the values of fry fed D4 compared to those fed D5. Feed conversion ration (FCR) in also higher in fry fed D3 followed closely by those fed with D1 and D2. And the least FCR was recorded in fry fed DD5.

Table 3. Physico-chemical parameters of the water in plastic basins during the experiment.

Parameter	Range	Mean
Temperature(°C)	25.00 - 32.00	28.50
Dissolved oxygen (mg/L)	4.50 - 5.60	5.05
pH	6.90 - 7.20	7.05

FCR of fry fed with D1 to D4 are statistically the same ($p < 0.05$), while those fed D5 are statistically different from the rest of the treatment. The highest relative growth rate (RGR) was higher in fish fed D4 and D5 with no significant differences ($p < 0.05$) between them. However, the RGR values obtained from fry fed D1 to D3 are also same statistically. Percentage survival rate was higher in fish fed D4 followed by D2 and D3, D5, D1. There are no significant differences ($p < 0.05$) between percentage survival values obtained from all the experimental diets.

DISCUSSION

The mean water quality values in the plastic basins (mean temperature; 28.5°C, DO 5.05 mg/L and pH 7.05) (Table 3) during this experiment are within the recommended ranges for fish culture (Viveen et al., 1985). The increases in growth rate and nutrient utilization with increase in dietary protein levels in some (MFSL, MFW, MWG, MDWG, RGR, PI, APER) are similar to the observations of Jamabo and Alfred-Ockiya (2008) on *Heterobranchus* fingerlings, Fagbenro et al. (1992) for *H. bidorsalis* fingerlings, Olufeagba (1992) for triploid *H. bidorsalis*, Faturoti et al. (1986) on C*larias lazera* and Obasa and Faturoti (2000) for *Cryptocoryne walker*. Though their own observation was obtained while using lower crude protein levels (40-45% crude protein).

The higher optimum protein levels obtained in this study is contrary to the report of Olufeagba (1999) for triploid which was 40% *Heterobranchus longifilis*, Jamabo and Alfred-Ockiya (2008) 40% for *H. bidorsalis.* The reason could be due to the fact that the parent stocks were obtained from natural water. Hybrids fry of *H. bidorsalis* (male) x *C. anguillaris* (female) produced from hatchery improved (selective breeding) broodstock may require lower dietary protein feed due to change in their genetic make up. Another reason could be due to early weaning of the hybrid larvae from shell-free artemia to compounded diet. This is in line with findings of Madu (1989), who reported that early weaning of catfish from artemia will required high dietary protein due to insufficiently developped digestive system to utilize low dietary protein levels.

Based on the result of this experiment, starter fish feed of 50% crude protein is needed for higher growth, highest mean weight gain and protein utilization in hybrid catfish in the North-east Nigerian under laboratory conditions. This result should therefore be the basic information to be extended to fish feed producers and fish hatchery operators.

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