Journal of Fisheries International 1(1-2) : 40-43, 2006

Optimum Crude Protein Requirement of the Catfish, *Chrysichthys nigrodigitatus*

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Abstract: Fingerlings of *Chrysichthys nigrodigitatus* were fed four isocaloric diets at different crude protein levels to determine the optimum protein requirement of the species. Significant differences ($p<0.05$) were recorded for the growth indices, weight gain and average daily growth rate, the highest values obtained for the fingerlings fed the 35% crude protein diet. Similarly, the estimated cost of production was best (and least) in the 35% protein diet. The nutrient utilization parameters had variable results among the treatments. While there was no significant difference in values obtained for apparent feed conversion ratio, the nitrogen metabolism showed significant variation, the 35% crude protein diet giving the best result. The quadratic regression analysis of weight gain on the protein intake indicated that the optimum protein requirement of the fish is 35.06%. It is therefore, concluded that 35% crude protein is optimal in the diet of of fingerlings of *Chrysichthys nigrodigitatus*.

Key words: Crude protein, catfish, *Chrysichthys nigrodigitatus*

INTRODUCTION

The protein requirement of fish has been defined as the protein content, which gives maximum growth, maximum economic profit and maximum protein deposition. The determination of protein requirement of fish is a very critical factor in aquaculture production. This stems from the fact that fish feed constitutes over 60% of the production cost and the protein component represents the most expensive in terms of overall feed cost. According to Sang-Min and Tae-Jun[1] protein requirements have been studied in aquaculture species with the aim of determining the minimum amount required to produce maximum growth and not be used for energy. Fagbenro *et al.*[2] had posited that the production of any aquaculture species can be economical only when its qualitative and quantitative feed requirements are known, making possible the formulation of nutritionally balanced least cost diets. It is felt that with the increasing intensification of aquaculture production process, nutritional studies of this nature would play significant roles in optimizing this system.

Chrysichthys nigrodigitatus is a clarotid catfish Teugels[3] with great aquaculture potentials Erondu[4]. Infact, Oteme *et al.*[5] outlined its advantages over the traditional aquaculture species and concluded that it is a novelle species for aquaculture. Few nutritional studies have been conducted on the species and so the nutritional requirements of the species have not been elucidated. This study is therefore aimed at determining the crude protein requirement of fingerlings of the species raised in cages. It is hoped that the results of the present study will contribute significantly to the knowledge of the culture requirements of the species.

MATERIALS AND METHODS

Four isocalorific diets were formulated at different crude protein levels viz 25, 30, 35 and 40% for the experiments. Table 1 gives the formulation and composition of the experimental diets. The various ingredients were mixed and pelleted with a manual meat mincer and then air-dried.

The fingerlings used for the experiment were procured from the African Regional Aquaculture Centre fish farm, Aluu. Individuals of fairly uniform size (7.2-9.9 cm) and initial average body weight of 8.94g were used.

The feeding trials were conducted in $1m^3$ fixed cages held in a reservoir receiving tidal fresh water. The reservoir was also the water source for the ponds in which the fingerlings were raised from the fry stage. The fingerlings were randomly assigned to the cages at a stocking rate of 8 fish/cage. There were two replicates per treatment diet.

The experimental fish were fed their respective diets at 5% body weight per day. The daily ration was split into two and dispensed at 0900 h and 1500 h. The fish in each cage was batch-weighed fortnightly and from the data, the quantity of feed to be dispensed was adjusted to reflect the new weight. During this period the cages were cleaned

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Table 1: Composition of the experimental diets

	(% Crude protein)			
	25	30	35	40
Fish meal	20	20	20	20
Wheat bran	49.22	33.09	13.74	-
Soyabean meal	13.03	29.16	48.51	62.25
Palm oil	4	4	4	4
Vitamin premix	0.25	0.25	0.25	0.25
Bone meal	3	3	3	3
Oyster shell	2	2	2	2
Salt	0.5	0.5	0.5	0.5
Garri (Binder)	8	8	8	8
Proximate Composition (% Dry Matter)*				
Crude protein	25.85	30.69	35.36	40.62
Ether extract	7.68	7.78	7.70	7.90
NFE	53.33	49.56	43.87	38.13
Ash	7.75	6.90	8.33	9.18
Gross energy (Mcal g^{-1})	4.47	4.60	4.64	4.69

*estimated values

to allow for water circulation in them. The experiment lasted for ten weeks after which the fish were individually measured for standard length and weight taken. From the data, the following growth indices and nutrient utilization parameters were calculated for each treatment. Weight gain, specific growth rate, apparent feed conversion ratio, apparent protein efficiency ratio (APER), Nitrogen metabolism

The indices were calculated using the following formulae:

- Weight gain = Final average weight – initial average weight

- Specific growth rate = $\frac{\text{Loge } W_2 \text{ - Loge } W_1 \text{ X } 100}{T}$

W_2 = Final body weight W_1 = Initial body weight of fish
T = duration of study in days

- Average daily growth rate = $\frac{\text{Average Wt gain (g)}}{\text{T (days)}}$

- Apparent feed conversion ratio =

$$\frac{\text{Wt of dry feed dispensed}}{\text{Live weight gain}}$$

- Apparent protein efficiency ratio =

$$\frac{\text{Wt gain (g)}}{\text{Apparent Protein intake}}$$

- Nitrogen metabolism = $\frac{(0.54)\ (b\text{-}a)h}{2}$

a = initial weight, b = final wt
h = experimental period (days); 0.54 = experimental constant

Statistical analyses: One-way Analysis of Variance (ANOVA) was used in determining any statistical variation of the above indices among the treatment groups. The Duncan's multiple range test was used in separating the means. Regression line of best fit for the analysis of the relationship between the weight gain and the protein intake was used to estimate the protein requirement of the fish.

RESULTS

The values of the physico-chemical parameters determined are as follows: Temperature had a range of 24.0-26.2°C with a mean of 25.1±0.8°C; transparency-11.1-14.0 cm, mean of 12.1±1.1cm; pH-6.5-7.5, mean of 7.2±0.4 and dissolved oxygen values ranged from 5.7 to 6.2 mg DO/l, mean 6.1±0.1 mg L^{-1}. The water quality during the period is thus considered suitable for fish production. The performance of the fish under the different treatments is presented in Table 2. The results show significant differences among treatments in the growth indices- weight gain and average daily growth rate. The values recorded for fish fed the 35% crude protein diet was significantly better and different from the other treatments. No significant difference was found in the values recorded for the other experimental diets (i.e., 25, 30 and 40).

The values recorded for the apparent feed conversion ratio showed no significant statistical variation among the treatments. The values were 2.63, 2.72, 2.04 and 2.45 for the fish fed diets containing 25, 30, 35 and 40% crude protein, respectively.

Table 2: Growth and nutrient utilization data of *C. nigrodigitatus* fingerlings fed at different crude protein levels (*Treatments with the same superscripts are not significantly different)

	% Crude protein			
Parameters	25	30	35	40
Mean initial body weight (g)	8.94	8.94	8.94	8.94
Mean final body weight (g)	34.48[a]	33.42[a]	40.30[b]	36.83[a]
Average daily growth rate (g/day)	0.35[a]	0.34[a]	0.50[b]	0.38[a]
Specific growth rate	1.85[a]	1.81[a]	2.22[a]	1.94[a]
Apparent feed conversion ratio	2.63[a]	2.72[a]	2.04[a]	2.45[a]
Apparent protein efficiency ratio	1.54[a]	1.26[b]	1.35[ab]	1.07[a]
Nitrogen metabolism	503.89[a]	482.90a	716.56[b]	550.20[a]

The data obtained from the apparent protein efficiency ratio gave a different trend from the other indices. The order of magnitude of the values was 25> 35> 30> 40%. These variations were statistically significant ($F = 5.45$; $p<0.05$). When Duncan's Multiple Range Test was used to separate the means, three sub sets were obtained, each representing treatments with no statistical variation (Table 2). From the result, the APER values for fish fed 25 and 35% crude protein diets were not significantly different; while the 25% crude protein diets gave significantly different values from the rest (30 and 40%). The values for 30, 35 and 40% were not significantly different ($p>0.05$)

The nitrogen metabolism values for the different treatments showed significant variation ($F = 6.57$; $p<0.05$). The fish fed the 35% crude protein diet was significantly better than the rest. The other treatments had the same effect on the nitrogen metabolism of the fish.

The estimated production costs using the various diets were N234.25, N271.85, N227.56 and N297.43 kg^{-1} of fish for 25, 30, 35 and 40% crude protein diets, respectively. From the data 35% CP diet gave the best result.

The regression line of the best fit for predicting or defining the protein requirement of the fish was computed using the general quadratic model (SPSS soft ware). The regression equation obtained from the computation is:

Weight gain = $-59.25 + 5.12PRT - 0.07(PRT)^2$. $R^2 = 0.36$, PRT = Protein requirement. From the above equation the optimum value of PRT (X) was derived and expressed as:

$X = \beta_1/2\beta_2$ The computed value is 35.06% and is the optimum protein requirement of the fish.

DISCUSSION

The remarkable increase of the growth indices with increase in protein until an optimum level was reached is in agreement with the work of Dahlgren, which reported higher growth rate with increase in dietary protein levels in the channel catfish, *Ictalurus punctatus*. The optimum protein level, from the present study based on the growth and nutrient utilization indices, estimated production costs and the computed value (35.06%) from the quadratic regression is 35%. This deduction is in conformity with the EIFAC standards on fish nutrition studies, which specifies that optimal nutrient requirement of fish should be determined at the maximal possible rates of growth and also through polynomial regression analysis. Similar results have been reported by some authors[6,7] for the same species in different environments. The decline in the growth indices after the optimum level (i.e., 35%) can be attributed to the fact that beyond a certain limit the animal body cannot use all of the protein for protein purposes because the maximum has been reached Phillps[8]. According to Jauncey[9] after the optimum level, the excess protein is deaminated and excreted and energy for growth is utilized for this process. Thus, after the optimum protein level (i.e., 35% in the present study) there is a possible reduction in the dietary energy available for growth. Fagbenro and Akegbejo-Samsons,[10] have also suggested that excess protein in relation to energy could reduce growth due to metabolic demands of nitrogen excretion, rather than for protein deposition. These postulations are applicable to the present study since all the diets were isocaloric. This response pattern has also been reported for other tropical species[11-12]. The relatively low FCR values in all the treatments is suggestive of the capability of the species to accept and utilize compound diets as suggested by Fagbenro *et al.*[2] in a related study.

The nitrogen metabolism followed the same trend as the growth indices, the best or optimal value obtained from the 35% crude protein diet. The implication is that the efficiency of nitrogen metabolism is best at the optimal dietary protein level Erondu[4]. The determined optimum crude protein requirement of fingerlings of the species is considered useful information for the optimization of cost in the culture of the species, which is promising and has a huge potential in expanding the Nigerian aquaculture industry.

It is believed that a compound diet of 35% protein would provide nutrients that will ensure optimal growth of *C. nigrodigitatus* in production systems without natural food. Hem[13] and Erondu[4] have reported good growth of the species in cages and pens and other aquaculture facilities with adequate water exchange. The result of the present study is therefore, envisaged to have practical application in these systems.

ACKNOWLEDGEMENT

We are grateful to Prof E.C. Nduka of the department of Mathematics/Statistics of the University of Port Harcourt for the statistical analyses.

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