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Growth performance of *Synodontis nigrita* raised on different dietary crude protein levels

Adebola Ajiboye*[1] and Emmanuel Faturoti[2]

1) Department of Animal Science and Fisheries Management, Bowen University, Iwo, Osun State, Nigeria.
2) Department of Wildlife and Fisheries Management, University of Ibadan, Ibadan, Oyo State, Nigeria.

Abstract

Synodontis nigrita is an important indigenous species with aquaculture potential. However, this is yet to be achieved due to scanty information on its nutrient requirements. This study investigated the effects of different dietary crude protein levels on growth performance and haematological parameters of *S. nigrita.* Six hundred *S. nigrita* (mean weight 10.14 ± 0.04 g) were stocked at four treatments and three replicate in concrete tanks. Fish were fed on varying levels of experimental diets: 30%, 35%, 40% and 45% crude protein levels. Growth parameters such as weight gain (WG), specific growth rate (SGR), food conversion ratio (FCR) and protein efficiency ratio (PER) and haematological parameters of the fish samples: haemoglobin concentration (HB), packed cell volume (PCV), red blood cell count (RBC) and white blood cell count (WBC) were determined after the feeding trial. The data were analyzed using Statistical Package for Social Sciences (SPSS), Version 11, 2001 and Statistical Analysis Software (SAS), Version 8, 2001. Duncan's multiple rage test was used to compare the differences among means. The WG of fish fed on 40% and 45% protein levels (5.73 ± 0.06g and 6.37 ± 0.13 g) were significantly higher ($p<0.05$) than those of fed on 30% and 35% protein levels. The SGR of 40% (0.54) and 45% (0.59) protein levels were significantly higher ($p<0.05$) than fish fed on 30% and 35% protein levels. The FCR of fish fed on 45% protein level was lower (10.84) compared to other fish fed on 30%, 35% and 40% protein levels. The PER of fish fed with 30%, 35%, 40% and 45% protein levels were not significantly different. Haematological data of fish fed by 40% and 45% protein levels, Hb(7.06 ± 0.18 and 7.84 ± 0.59 g/dl) and RBC (2.68 ± 0.28 and 2.93 ± $0.04\times10^6/mm^3$) were significantly higher ($p<0.05$) than in fish fed by 30% and 35% protein levels. *S. nigrita* requires high dietary protein levels for its successful aquaculture.

Key words: *Synodontis nigrita*, Protein requirements, Growth parameters, Haematological parameters

(✉) debron2005@yahoo.com

Introduction

Interest in fish and shellfish nutrition has increased greatly over the past two decades, due to the global increase in aquaculture (Lall, 2000). Natural foods in aquatic systems are however, not sufficient to supply all the nutrients required by the fish especially under culture condition. It is therefore essential that supplementary feeds to be included in their diets so as to ensure adequate growth, survival, resistance to diseases and reproduction. Nutrient requirements of each fish species differ and it is important for nutrition experts to take the requirements into consideration during feed formulation. Formulation of feed is usually performed by picking the right ingredient and feedstuff that is known to supply the right nutrient to the fish Though, there are many reports documented on some aspects of the biology of *S. nigrita* and other species, but there are, to date, little or no documented studies on domestication, growth and nutrient utilization of *S. nigrita* in captivity. This study investigated the growth performance of *S. nigrita* at different dietary crude protein levels and its effects on haematological parameters.

Material and Methods

Feeding trial experiment

Six hundred fish samples of *S. nigrita* with a mean weight of 10.14 ± 0.04 g were purchased from the fishermen at Asejire Lake for the experiment. The fish samples were transported with fifty liter containers. The fish were acclimatized for fifteen days in the laboratory before allotting them to treatments. Fish were stocked at 50 fish per treatment in three replicates in outdoor concrete tanks.

Four experimental diets, each representing a treatment (30%, 35%, 40% and 45% crude protein levels) were compounded (Table 1) and were fed at a ratio of 5% body weight. The fish were allocated to 2m×2m culture tanks with three replicates. Water was allowed to flow into the tanks throughout the period of the feeding trial.

Sample collection

Six hundred fish samples were collected fortnightly for evaluation of growth and feed utilization parameters.

Proximate analysis

Samples of diets and fish carcass were analyzed for proximate composition (Tables 2a and 2b) according to the procedures of A.O.A.C. (1990) for crude protein, lipid, fiber and ash composition.

Table 1: Experimental diets

Ingredients	30%	35%	40%	45%
Maize	52.44	42.34	32.23	22.13
Fish meal	28.81	35.54	42.28	49.01
Soya Bean Cake	14.40	17.77	21.14	24.51
Bone Meal	2.50	2.50	2.50	2.50
Oyster Shell	1.00	1.00	1.00	1.00
Vitamin/Premix	0.60	0.60	0.60	0.60
Common salt	0.25	0.25	0.25	0.25
Total	100	100	100	100

Table 2: Proximate composition of fish (A) and diet (B)

(A)

Components	Initial	30%	35%	40%	45%
Moisture	69.69	67.80	66.23	64.93	64.43
Ash	4.14	5.08	5.43	5.62	5.75
Crude protein	17.07	18.11	18.97	19.81	19.95
Crude fiber	4.32	3.63	3.74	3.91	3.98
Extracted ether	4.78	5.39	5.63	5.74	5.89
Total	100.01	100	100	100.01	100

(B)

Components	30%	35%	40%	45%
Dry matter	83.63	87.25	85.29	85.38
Crude protein	30.24	34.98	40.09	45.07
Crude fibre	8.87	8.55	9.13	9.25
Crude fat	4.23	4.32	4.39	4.46
Ash	8.83	8.87	9.40	9.51
Calcium	1.62	1.68	1.74	1.79
Phosphorus	0.09	1.13	1.19	1.22
Lysine	1.82	2.02	2.23	2.63
Methionine	0.55	0.63	0.72	0.84
Metabolizable energy (Kcal/kg)	2761.28	2730.35	2688.77	2643.23
Nitrogen	47.83	42.89	36.99	31.71

Water quality monitoring

The water quality parameters determined were temperature, pH and dissolved oxygen (DO). Water temperature was measured with mercury in glass thermometer. The reading was taken by dipping the thermometer in water to a depth of 0.5m. Dissolved Oxygen was determined by Winklers method while the pH was determined by using a pH meter model mtr-11E 15.

Determination of haematological parameters

Blood were collected from the fish at the vertebrae column before and after the feeding trial experiment into universal bottles containing disodium salts of ethylene diamine-tetra acetic acid (EDTA). Haemoglobin concentration was determined by cyame-thaemoglobin method described by Jain (1986). Packed cell volume was determined by a method described by Schalm et al., (1975). Red blood cell count (RBC) was determined by the haemocytometer method described by Jain (1986), White blood cell count was determined using Neubauer chamber. Mean corpuscular haemoglobin concentration (MCHC), Mean corpuscular volume (MCV) and Mean corpus-cular haemoglobin (MCH) were calculated using standard formulae (Dacie and Lewis, 1991).

Statistical analysis

The collected data were analyzed using Statistical Package for Social Sciences (SPSS), Version 11, 2001 and Statistical Analysis Software (SAS), Version 8, 2001. Duncan's multiple rage test was used to compare the differences among means.

Results

The growth performance and nutrient utilization of *S. nigrita* fed on different dietary proteins levels are shown in table 3. The highest mean weight gain (6.37 g) was recorded in fish fed by 45% crude protein level, while the least mean weight gain (3.71 g) was recorded in fish fed on the 30% crude protein level. As shown in table 3, the mean weight gain of 45% crude protein level was significantly higher ($P<0.05$) than those of fed on the 35% and 30% crude protein diets. There was no significant difference in the weight gain of fish fed by 40% and 45% crude protein levels. The 45% crude protein level had the highest daily growth rate (0.08 g), while fish fed by the 30% crude protein had the least value (0.04g). The results revealed that 45% crude protein had significantly higher ($P<0.05$) effects on growth rate than 30% crude protein level, while 35%, 40% and 45% crude proteins were not significantly different from each other (Table3). Fish fed on the 45% crude protein had the highest specific growth rate (0.59), while the least growth rate (0.37)

was recorded in 30% crude protein level. Table 3 revealed that SGR of fish fed by the 45% and 40% crude proteins were significantly higher (P<0.05) than those fed by the 30% and 35% dietary crude protein levels. Table 3 shows that 45% crude protein level had the highest (0.82 g) MDFI value and a value of 0.68g was the least value which recorded in 30% crude protein. The result of mean daily feed intake showed that 45% and 40% were significantly different (p<0.05) from 30% and 35% crude protein levels. The highest value of FCR (15.85) was recorded in 30% crude protein and the lowest was recorded value (10.84) was in 45% crude protein. The Gross efficiency of food conversion showed that 45% crude protein had the highest value of 9.23% and 30% crude protein had the lowest value of 6.38%. The Gross efficiency of food conversion for 45% crude protein was significantly higher (P<0.05) than 35% and 30% protein levels. Table 3 revealed that 45% crude protein had the highest (2.59) protein intake/week and 30% crude protein had the lowest value of 1.44. The values recorded showed that 40% and 45% crude proteins were significantly higher (p<0.05) than 30% and 35% crude proteins. The Protein efficiency ratio of both 40% and 35% crude protein had the highest value of 0.22, while both 30% and 45% crude proteins had the lowest value of 0.21. The PER of the four dietary crude protein treatments were not significantly different.

Table 3: Growth parameters and nutrient utilization of *S. nigrita* fed on different dietary crude protein levels

Parameters	30%	35%	40%	45%	Mean	±S.D
Mean initial weight (g)	10.12	10.15	10.13	10.16	10.14	0.02
Mean final weight (g)	13.83^{c}	14.93^{b}	15.86^{ba}	16.53^{a}	15.29	1.17
Mean weight gain (g)	3.71^{c}	4.78^{b}	5.73^{ba}	6.37^{a}	5.15	1.16
Mean weight per week (g/week)	0.31^{bc}	0.40^{ba}	0.48^{a}	0.53^{a}	0.43	0.10
Percentage weight per week (%/week)	3.06^{d}	3.92^{c}	4.71^{ba}	5.22^{a}	4.23	0.94
Specific growth rate (g)	0.37^{c}	0.46^{b}	0.54^{a}	0.59^{a}	0.49	0.10
Daily growth rate (g)	0.04^{c}	0.06^{ba}	0.07^{a}	0.08^{a}	0.06	0.02
Mean daily food intake (g)	0.68^{c}	0.74^{ba}	0.79^{a}	0.82^{a}	0.76	0.06
Mean weekly food intake (g)	4.78^{d}	5.18^{c}	5.54^{ba}	5.75^{a}	5.31	0.43
Feed conversion ratio	15.46^{d}	13.00^{c}	11.60^{b}	10.84^{a}	12.73	2.03
Gross feed conversion efficiency	6.47^{d}	7.69^{c}	8.62^{b}	9.23^{a}	8.00	1.20
Protein intake per week (g)	1.43^{c}	1.81^{b}	2.22^{b}	2.59^{a}	2.01	0.50
Protein efficiency ratio	0.22^{a}	0.22^{a}	0.22^{a}	0.21^{a}	0.22	0.01

Figures in rows having the same letter are not significantly different (p>0.05)

The highest haemoglobin value (7.84 g/dl) was recorded for fish fed on the 45% crude protein, while the lowest (4.70 g/dl) was recorded in 35% crude protein. Table 4 shows that in fish fed by the 40% and 45% crude protein levels, haemoglobin was significantly higher ($p<0.05$) than those fed on the 30% and 35% crude protein treatments. The highest packed cell volume (37.61%) was obtained in fish fed on the 45% crude protein level, and the lowest value (29.15%) was obtained in fish fed on the 30% crude protein diet. The PCV of fish fed on the 45% crude protein diet was significantly higher ($P<0.05$) than the other three treatments. The highest and the lowest RBC values was recorded for 45% and 30% crude protein diets with of $2.93\times10^6/mm^3$ and $2.11\times10^6/mm^3$ respectively. As shown in Table 4, RBC of the fish fed on the 40% and 45% crude protein levels were significantly higher ($p<0.05$) than those of fed on the 30% and 35% crude protein diets. Table 4 shows that fish fed on the 40% crude protein diet had the highest WBC ($19.43\times10^3/mm^3$) and those fed on the 35% crude protein diet had the lowest value ($16.09\times10^3/mm^3$). The results also indicated that WBC of fish fed on the 30% and 45% crude protein levels were significantly higher ($P<0.05$) than those of fed on the 35% and 40% protein levels. As shown in table 4, the highest MCHC (22.15 g/dl) was recorded in 40% crude protein diet while fish fed on the 35% crude protein had the lowest MCHC value (15.46 g/dl). The MCHC of 40% crude protein diet was significantly higher ($P<0.05$) than those of 35% and 30% crude protein diets. Fish fed by the 35% crude protein diet had the highest value of MCV (138.81ft) while the lowest value (119.07ft) was recorded for fish fed on the 40% crude protein diet (Table 4). The MCV of 35% crude protein diet was significantly higher ($p<0.05$) than those fed on 40% and 45% crude protein diets. In Table 4, fish fed on 45% crude protein diet had the highest MCH value (26.76 pg) while the lowest value (21.46pg) was recorded for fish fed on 35% crude protein diet. The MCH of fish fed on 45% crude protein diet was significantly higher ($p< 0.05$) than those fed on 30% and 35% crude protein diets.

Discussion

The 45% and 30% crude protein diets stimulated the highest and the lowest growth rates in *S. nigrita* respectively. The trend in weight gain in this feeding trial agreed with Dahlgren (1979) findings that suggested that an increase in dietary protein levels may lead to increase in growth rate in channel catfish (*Ictalurus punctatus*). Zeitoun et al. (1973) reported that increase in dietary protein level led to increase in growth rate and reduced survival rate in fingerlings of rainbow trout

(*Salmo gairdneri*). Faturoti et al. (1986) also reported that 40% crude protein diet was optimum for growth and nutrient utilization in *Clarias gariepinus*.

Table 4: Haematological characteristics of *S. nigrita* fed on different dietary protein levels

Blood parameters	Initials	30%	35%	40%	45%	Mean	±S.D
HB (g/dl)	7.06	5.04^{bc}	4.70^{b}	7.06^{a}	7.84^{a}	6.34	1.38
PCV (%)	37.53	29.15^{bc}	30.40^{b}	31.85^{b}	37.61^{a}	33.31	4.01
RBC (10^6/mm^3)	1.39	2.11^{b}	2.19^{b}	2.68^{a}	2.93^{a}	2.26	0.59
WBC (10^3/mm^3)	19.39	18.09^{a}	16.09^{c}	19.43^{b}	18.59^{a}	18.32	1.37
MCV (fl)		138.48^{c}	138.81^{c}	119.07^{b}	128.34^{a}	131.18	9.42
MCH (Pg)		23.94^{c}	21.46^{b}	26.37^{a}	26.76^{a}	24.63	2.46
MCHC (%)		17.29^{d}	15.46^{c}	22.15^{b}	20.85^{a}	18.94	3.10

Figures in rows having the same letter are not significantly different ($p>0.05$)

The food conversion ratio (FCR) recorded in this study showed that fish fed on 45% crude protein diet was the best that converted feed into flesh. The FCR decreased in value with increase dietary protein levels. This result agreed with the work of Jaucey (1982) on *Sarotherondon mossambicus*, Arowosoge (1987) on *Clarias lazera* and De-Gani and Viola(1987) on *Clarias gariepinus*. Lovell (1979) stated that fish are able to assimilate diets with higher percentage of protein due to lower energy requirements. The Gross efficiency of food conversion ranged between 6.38% and 9.23%. These values are lower than those reported by Brett (1971), who recorded 10-40% in Sockeye Salmon (*Oncorh-ynchus nerka*). The protein efficiency ratios obtained in the feeding trial were not significantly different. The values recorded (0.21 and 0.22) were lower than values obtained by some researchers. Cowey et al (1974) recorded 0.98 – 1.78 in Plarice (*Pleuronectes platessa*) fingerlings fed on different dietary protein levels. Also in common carp, Ogino and Saito (1970) reported higher values that ranged between 2.40 and 4.31. Jaucey (1982) reported 1.28 – 2.91 in juveniles of *Sarotherodon mossambicus* fed on 8-50% crude protein.

The values obtained for PCV ranged between 29.15% and 37.61%, and this agreed with Korzhuev (1964) who stated that on a general basis, fish haematocrit values ranged between 20% and 35% and rarely attained values greater than 50%. Also, lower values of PCV had been reported by Munkittrik and Leatherland (1983), Gabriel et al. (2001) and

Gabriel et al. (2004). Blaxhall (1971) reported that when PCV value of a fish was lowered, the fish had lost its appetite or the fish was affected by a disease. Red blood cell recorded in this study ranged between $2.11\times10^6/mm^3$ and $2.93\times10^6/mm^3$. These values were within the range ($2.3\text{-}2.9\times10^6/mm^3$) reported by Gabriel et al. (2004). The RBC values obtained in this study were greater than those obtained by Smith et al (1952) who reported red blood cell value to be from 1.24 million mm^{-3} in gold fish *Carassius auratus* to $1.88mm^{-3}$ in Warmouth, *Lepomis gulosus*. The haemoglobin values recorded in this study (4.70-7.84 g/dl) were within the range reported by Adeyemo et al. (2003) and Gabriel et al. (2004). Clark et al. (1978) observed that certain physiological stresses elevate haemoglobin levels in fish and that anaemia can be diagnosed by very low haemoglobin value. The WBC values recorded in this study ($16.09\times10^6mm^3$ and $19.43\times10^6mm^3$) were lower than the values reported by Andrew (1965) for bony fishes.

In this study, the growth performance of *S. nigrita* fed on different dietary crude proteins revealed that the optimum protein level was 40% crude protein. The food conversion ratio values obtained showed that the protein level that best converted feed into flesh was 45% crude protein.

S. nigrita demands diet that contains all essential nutrients needed for their growth and reproduction. It will be necessary to further investigate the effects of higher dietary protein levels on growth of *S. nigrita*.

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