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Effect of Dietary Protein Level on Growth and Body Composition of Juveniles Nile Perch (*Lates niloticus*, Linnaeus 1758)

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Abstract

Nile perch (*Lates niloticus,* Linnaeus, 1758), is a carnivorous fresh water fish that have good market demand and suitable for aquaculture. The present study was designed to determine the effect of dietary protein level on growth and body composition of juveniles Nile perch. Five experimental diets with increasing levels of protein (30, 35, 40, 45 and 50 g crude protein 100 g^{-1} feed) were prepared and fed in duplicate groups of Nile perch (initial weight : 8.67 ±0.17 g) reared in ten 50 L tank for 8 weeks. Results showed that dietary protein level significantly influenced weight gain, specific growth rate and feed conversion ratio. The WG and SGR increased with increasing the protein level up to 45% content. Feed conversion ratio was lowest in Nile perch fed 45% protein and highest in those fed 30% protein. Fish fed with the 30% protein diet had the lowest survival and those fed 50% protein diet had the highest survival. There was no significant difference (P>0.05) in Moisture among the dietary treatments. Protein and lipid showed linear increase as dietary protein levels increased. Fish fed diet ≥ 45% protein had the highest protein content, followed by fish fed 30 to 40% protein and lowest in the initial fish. Fish fed diet containing 50% protein had the highest lipid carcass content, whereas the lowest lipid content among treatment was observed in the initial fish. Under the experimental conditions applied, juvenile *L. niloticus*, require 45% dietary protein for optimized growth.

Keywords: Nile perch, *Lates niloticus*, Protein levels, Growth

1. Introduction

The Nile perch, *Lates niloticus* (Linnaeus, 1758), Family centropomidae, is a freshwater carnivorous fish of wide geographical distribution throughout the Ethiopian Region of Africa, occurring commonly in all major river basins including the Nile, Chad, Senegal, Volta and Congo. Most *Lates niloticus* in their natural environment feed on fish and insects (Goldschmidt et al., 1993; Ogutu-Ohwayo, 1993). Moreover, Nile perch is of great social economic importance in the East African region (Gumisiriza et al., 2009; Beuving, 2010). The Nile perch fishery is however under threat due to the intensive fishing pressure on the fishery that has resulted in a tremendous decline of its populations (Munyaho, 2004; Njiru et al., 2009). Current strategies for increasing Nile perch production point towards the culture of this species (Gregory, 2006). The culture development of this species will depend mainly on the availability of its seed and the development of well balanced and suitable feed.

Protein is the dietary macronutrient whose requirement is prioritized in nutritional studies, either because it represents the highest fish feed cost (Lovell, 1989; Fagbenro *et al*., 1992; Meyer and Fracalossi, 2005), or by greatly affecting fish weight gain (Martinez-Palacios et al., 2007; Zuanon et al., 2009), or needed for reproduction and survival of fish (Wilson and Halver, 1986).

In fish food, protein provides the essential and non essential amino acids to synthesize body protein and in part provides energy for maintenance (NRC, 1993; Kaushik and Médale, 1994). Feed constitutes 60-70% of total investment in intensive aquaculture. Any reduction in dietary protein level without affecting fish growth can substantially reduce the cost of fish feed (Fiogbé, 1996; Kim *et al*., 2003)

The determination of *Lates niloticus* nutritional requirements is essential for optimizing its aquaculture production. To our knowledge, data concerning the optimal dietary protein level for *Lates niloticus* juveniles have not been published. Given this lack of information on the basic nutrient requirements of this species, the present study has been undertaken to conduct experimentation with different protein level diets from 30% to 50% to determine growth performance and body composition of *Lates niloticus* juveniles.

2. Materials and Methods

2.1 Experimental Conditions

Wild Juvenile capitaine, *Lates niloticus*, weighing around 8.7 g at the beginning of the feeding trial were used in this study. These fish were obtained from a local fish dealer at the Diama dam, Saint- Louis, Senegal. Fish were acclimated to the experimental conditions for a period of two weeks. During this period, they were fed with a commercial catfish diet obtained from the National Aquaculture Agency hatchery located in Richard Toll district.

At the beginning of the experiment, fish were bulk-weighed and counted. Each experimental diet was randomly assigned to duplicate with 10 fish (mean weight: 8.67±0.17 g) per glass tank. Water levels in each glass tank were maintained at 50 L and aerated constantly.

Experimental diets were hand-fed two times a day at 08:00 and 17:00 to apparent satiation,

over a 30-min period for 8 weeks.

Fish were subjected to a photoperiod of 12-h dark and 12-h light and all tanks had similar light conditions. Dissolved oxygen levels and water temperature were monitored daily and averaged 7 mg/l and 30 ℃, respectively. Fish were bulk weighed every 2 weeks with fish being starved for 12 h prior to weight measurements and 12h after. All aquaria were cleaned up every day in the morning by scrubbing and siphoning off accumulated waste materials. Each meal after feeding the uneaten food was removed manually to estimate food consumption.

2.2 Experimental Diets

Five experimental diets were formulated to contain graded level of protein from 30% to 50% in 5% increments. Fishmeal and shrimp meal were used as protein sources, fish oil as lipid source. Fishmeal and shrimp meal were finely grounded and poured through a sieve of 425µm mesh. Vitamin and mineral premix were mixed separately with the cellulose and the binder before being added to the main ingredient mixture. Diets were supplemented with fish oil after the addition of water (Table 1). The semi-moist mixture was then pressure pelleted in the food grinder using a 2 mm die, dried at 35 ℃ for two days, cut to desired sizes, packaged into plastic bag and stored frozen until its usage. The diets were screened prior to feeding in order to remove the fines.

2.3 Sampling and Analytical Methods

At the beginning of the feeding trial, 10 fish were randomly sampled from the initial fish and at the end of the 8-week experiment 3 fish from each tank were sampled and all the sample are freeze-dried for subsequent proximate analyses.

The experimental diets and samples of the fish carcasses were analyzed for proximate composition according to the Association of Official Analytical Chemists: AOAC (1984) procedures. Crude lipid was determined by the ether extraction method by Soxtec System HT (Soxtec System HT6; Tecator); crude protein was determined with a Kjeltec system 1002 (Tecator), as describe by Mattisek et al., 1988 ; crude fiber was determined by the Fibertec system M 1020 hot extractor (FOSS Tecator) as describe by Folch et al., 1957 ; crude ash by incineration in a muffle furnace at 550 ℃ for 24 h, and dry matter by drying in an oven at 105 ℃ for 24 h;

Table 1. Formulation and proximate composition of the experimental diets of Nile perch (*Lates niloticus*).

Ingredients	30%	35%	40%	45%	50%
Fish meal	32.9	37.7	42.5	47.3	52
Shrimp meal	24	27.5	31	34,5	38
Fish oil	6	6	6	6	6
Cellulose	33.1	24.8	16.5	8.24	0
Binder	1	1	1	1	1
Vit premix[a]	1	1	1	1	1
Min premix[a]	2	2	2	2	2

Poximate composition[b]					
Ash	5.34	5.72	6.13	6.5	6.9
Crude protein	32.3	36.6	42.4	47.1	51.5
Crude lipid	9.98	10.51	11.05	11.58	12.12
Crude Fiber	3.3	3	2.7	2.8	2.5

[a] Vitamin premix and mineral premix as given in Lin and Shiau. (2003).
[b] Values are presented in % dry matter.

Several parameters were routinely monitored to ensure good water quality maintained. Water temperature and dissolved oxygen was measured everyday using YSI Model 58 oxygen meter (Yellow Springs Instrument, Yellow Springs, OH, USA). Water pH was measured everyday by pH tester DMT-30 Series.

2.4 Calculations and Statistical Analysis

Growth response parameters were calculated as follows: Weight gain (%) = 100* ((final mean body weight - initial mean body weight)/ initial mean body weight); Specific Growth Rate (SGR, % /day) = 100* ((In Wt- In Wi) /T), where Wt is the weight of fish at time t, Wi is the weight of fish at time 0 and T is the rearing period in days; Feed Conversion Rate (FCR) = total dry feed fed g/ fish / total wet weight gain g/ fish. Survival rate (%) = 100* (number of fish which survived/initial number of fish).

Results are presented as mean ± SEM. Data were subjected to one-way analysis of variance (ANOVA) to test the effect of 5 dietary protein levels as main effect. Treatment effects were considered significant at $P < 0.05$; Duncan's new multiple range tests was used to compare significant difference among treatments. The survival data were transformed into a normal distribution using the arcsine square root prior to analysis of variance. All statistical analysis was carried out using the SAS/PC statistical software.

3. Results

During the experiment water temperature monitored ranged from 29 to 30 ℃, dissolved oxygen content in the present experiment ranged from 5.5 to 7 mg/l and pH ranged from 7.5 to 8.

Weight gain (WG), specific growth rate (SGR), feed conversion rate (FCR) and survival of Nile perch fed different diets are presented in Table 2. Weight gain and SGR were highest ($P < 0.05$) in Nile perch fed diets containing ≥ 45% protein, followed by 40% protein, then 35% group and lowest in fish fed with the 30% diet. The WG and SGR increased with increasing the protein level up to 45% content, but no further improvement was seen when dietary protein was increased to 50%. Feed conversion ratio was lowest in Nile perch fed 45% protein and highest in those fed 30% protein. Fish fed with the 30% protein diet had the lowest survival and those fed 50% protein diet had the highest survival (Table 2).

Table 2. Initial, final weight, weight gain, SGR, FCR and survival of Nile perch (*Lates niloticus*)[1]

Treatments					
Parameters	30%	35%	40%	45%	50%
WG (%)	81.56 ±3.53^{d}	129.63 ±3.97^{c}	147.43 ±2.41^{b}	158.14 ±0.94^{a}	156.95 ±1.39^{a}
SGR	1.06 ±0.03^{d}	1.48 ±0.03^{c}	1.62 ±0.02^{b}	1.69 ±0.01^{a}	1.69 ±0.01^{a}
FCR	2.07 ±0.06^{a}	1.52 ±0.09^{b}	1.36 ±0.04^{cd}	1.24 ±0.03^{d}	1.45 ±0.05^{bc}
Survival (%)	70.00 ±14.14^{b}	75.00 ±7.07^{ab}	85.00 ±7.07^{ab}	85.00 ±7.07^{ab}	95.00 ±7.07^{a}

[1]Values are means ± standard deviation (n = 2). Within a row, means with different superscript letters differ significantly ($P < 0.05$).

There was no significant difference (P>0.05) in Moisture among the dietary treatments. Protein and lipid showed linear increase as dietary protein levels increased. Fish fed diet ≥ 45% protein had the highest protein content, followed by fish fed 30 to 40% protein and lowest in the initial fish. Fish fed diet 50% protein had the highest lipid content, whereas the lowest lipid content among treatment was observed in the initial fish (Table 3).

Table 3. Effect of dietary protein level on composition of whole body of Nile perch juveniles[1]

Parameters						
	Initial fish	30%	35%	40%	45%	50%
Moisture	77.91 ±0.15	77.74 ±0.19	77.11 ±0.14	77.51 ±0.11	77.61 ±0.69	77.35 ±0.07
Protein	51.49 ±0.36^{c}	52.55 ±0.21^{b}	52.52 ±0.30^{b}	52.91 ±0.15^{b}	54.61 ±0.08^{a}	54.76 ±0.06^{a}
Lipid	11.24 ±0.09^{d}	12.22 ±0.14^{c}	13.32 ±0.38^{b}	13.51 ±0.04^{b}	13.76 ±0.08^{ab}	14.10 ±0.05^{a}
Ash	20.09 ±0.16^{a}	20.33 ±0.24^{c}	20.85 ±0.07^{ab}	20.45 ±0.21^{bc}	20.28 ±0.73^{c}	20.26 ±0.17^{c}

[1]Values are means ± standard deviation (n = 2). Within a row, means with different superscript letters differ significantly ($P < 0.05$).

4. Discussion

The present study is the first report to our knowledge regarding nutritional needs of Nile perch during the juvenile stage. It is well known that protein is the most important and expensive item of the feed that should be supplied in adequate amounts to support good growth with minimal cost (Wee and Tacon, 1982; Zehra and Khan, 2011). The development of the dietary protein level requirement for growth performance and body composition of juvenile Nile perch is a first step for better understanding of its nutritional states.

The current study showed significant effects of dietary protein level on growth performance of juvenile Nile perch. Weight gain and specific growth rate of fish were improved significantly with increasing dietary protein levels from 30% to 45%. There were no difference between fish fed 45% and 50% protein and the best FCR was obtained with fish fed on diet containing 45% protein. This may be due to the increase in protein utilization and digestibility with the increase in dietary protein level up to 45%. Based on these growth performance data, a 45% crude protein diet can be considered as the probable lower limit of the dietary protein range for good

growth in Nile perch juveniles. As there are no previous published works on the protein requirement for Lates juveniles, it is difficult to compare the results obtained in this experiment. Our results are consistent with previous studies conducted on different species that weight gain and specific growth rate increased with dietary protein level increases up to an optimal level (Luo et al. 2004; Mohanty & Samantaray 1996; Gunasekera et al. 2000; Yang et al. 2002). Arzel et al (1995) reported that the protein requirement for *Salmo trutta* to be between 48 to 53%; Fiogbe and Kestemont (1995) reported 45-53% for *Carassius auratus*. In general, carnivorous fish need 400–550 g kg^{-1} dietary protein (Millikin 1983; Wilson and Halvar, 1986; Wilson 1989; NRC 1993; Kaushik, 1995; Chou et al. 2001).

Luo et al (2004) reported that optimal dietary protein requirement for E. coioides juveniles to be closed to 480 g kg^{-1} when fishmeal and casein were used as protein sources. Chen & Tsai (1994) reported that E. malabaricus required 478 g kg-1 dietary protein for maximum growth with casein as the protein source. Shiau & Lan (1996) suggested that the dietary protein level that yielded maximum growth of E. malabaricus was 502 g kg^{-1} with fishmeal as a sole protein source. Lazo et al. 1998 reported that the optimal dietary protein requirement for Florida pompano to be 450 g kg^{-1}.

The difference reported may be the results of different protein sources used, formulation methods, different fish sizes, differences between species, different environmental conditions, level of dietary intake and experimental duration.

In the present study, the best FCR was obtained with fish fed on diet containing 45% protein, the poorest FCR was observed in fish fed on diet having 30% protein, but there was no significant difference between FCR obtained by 35, 40, 50% protein diet. These results are in line with those of Wee & Tuan, (1988) who reported that better FCR values were obtained with increasing dietary protein levels up to 42.5% and deteriorated slightly by diet containing 50% tilapia species. Florida pompano (2004) also showed that the best FCR were obtained at 45% protein level with Florida pompano.

The increase of dietary protein levels increased the whole-body protein deposition in Nile perch juveniles. This observation was in agreement with that reported for other fish species.

Ahmad et al (2012); Tidwell et al. (2005) and Pedro et al., (2001) reported the increase in carcass protein content with the increase in dietary protein level. This observation is in agreement with our findings. However, crude lipid contents of fish carcass significantly increased with increasing dietary protein level ($P < 0.05$). The associated decrease in dietary carbohydrate levels in higher protein diets may be explained by metabolic changes towards an inhibition of the lipogenic pathway (Rema et al. 2008; Dias et al. 2004).

The survival rate of *L. niloticus* juveniles under different treatments ranged from 70 to 95% being 70% in fish feed containing 30% proteins. Some of the mortalities recorded were mainly due to the fish jumping out of the experimental tank despite the fact that the tanks were covered by a net.

In conclusion, our results indicate that diets for juvenile *Lates niloticus* containing 45% crude protein is recommended for better growth performance.

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