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Effects of Dietary Protein Level on Growth Performance, Carcass Composition and Survival Rate of Fry Monosex Nile Tilapia, *Oreochromis niloticus* Reared under Re-circulating System

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Abstract

Fry monosex Nile tilapia (*Oreochromis niloticus*) were fed in five dietary protein levels (21%, 25%, 32% 37% and 45%) to investigate casual effects on growth performance, carcass composition and survival rate. Tests were carried out in 10 glass tank (50 x 25 x 40 cm) containers (50 L) of reticulating system maintained at 30 ± 1°C. At the beginning of tests, one hundred tilapia fry were randomly divided into five different groups with two replicates. Diets were fed to duplicate groups of ten fry with an initial weight of 1.25 ± 0.25 g/fish during 42 days. The results showed significant effects of dietary protein on growth performance of reared fish. Weight gain (WG) and Specific Growth Rate (SGR) increased significantly with increasing dietary protein levels between 32.38% and 37.63%. However, 45.5% of crude protein showed less important increase in growth parameters. The best Feed Conversion Rate FCR (1.26) was noticed in diet containing 37.63% of crude protein. Accordingly, higher survival rate (%) was recorded in fish fed on diets containing 32.38 and 37.63%. There was no significant difference in protein body content of tilapia fed on five diets as compared to the initial fish. Lipid body content increased significantly with high dietary protein levels from 21.88% to 45.50%. The carcass crude lipid was recorded as higher (9.4%) in the fry fed on diet containing 45.50% protein, followed by fish fed on diet having protein 21.88%. From results, diet containing 37.63% crude protein appears to be more suitable for monosex Nile tilapia growth, in related experience conditions. In this line, it is recommended to feed monosex tilapia fry.

Keywords: Protein, tilapia, *Oreochromis niloticus*, Growth

1. Introduction

Aquaculture is nowadays developing in Senegal and has become an increasingly important

source of animal protein. Tilapia, the most farmed species worldwide, is considered as the most semi-intensive cultivated freshwater fish in Senegal (NAA, 2012).

Feeding represent 40-60% of production costs in aquaculture, with protein sources accounting for significant proportion of such cost (Fotedar, 2004). It provides the essential and non-essential amino acids which are required for muscle formation and enzymatic function, on one hand, and also provides energy for maintenance, on the other hand (Yang et al., 2002). Excess protein in fish diet might be wasteful and make diet uselessly expensive (Ahmad, 2000).

One of major factors which limit economic success in any commercial farming of species is food requirement. As important dietary stuff, protein consisted of animals directly influences on the formulation of diets and therefore affects production's cost. A wide range of feeding habits from carnivorous to herbivorous animals has been suggested as one possible reason for the wide range in protein requirements among fish species. As the main and most expensive component of the diet, protein draws greater attention in nutrition requirement studies.

Protein (most expensive macronutrient) requirement for fish fry is high and ranges from 35% to 56% (Jauncy & Ross, 1982). Furthermore, dietary protein requirements decreased with the development size and age of fish (El-Sayed & Teshima, 1991). Based on various studies general conclusion is made that tilapia fry of size <1 g requires diet with 35-50% protein, while 1-5 g fish requires diet with 30-40% protein and 5-25 g fish requires diet with 25-35% protein (Balarin & Haller, 1982).

Fry feed generally contains higher level of protein because the latter and energy requirements are higher in the early stages of life. Protein content of fry feed for tilapia farming has not been standardized yet although some farms use food stuff having 40% protein. So, it is essential to recommend the appropriate protein level of fry feed for economic production of healthy fry and maximize its lifespan as well.

However, the present study has been undertaken to conduct experimentation with different protein level diets viz. 21%, 25%, 32% 37% and 45% protein of fry feed to determine growth performance and survival rate of tilapia fry at different protein levels.

The main objective of this trial was to determine the optimum protein level which is necessary for optimum growth of monosex Nile tilapia (*Oreochromis niloticus*) under re-circulating system.

2. Materials and Methods

2.1 Culture Conditions

Male sex-reversed tilapia fry (*Oreochromis niloticus*) of initial weight 1.25 ± 0.25g were collected from tilapia hatchery in Richard Toll, Saint Louis, Senegal. Fish were acclimated to experimental conditions for a two week period. During this period, they were fed on commercial diet as previously done at the above mentioned hatchery. To determine the initial body composition, 20 randomly selected fish were killed, filleted and stored at -18°C for proximate analysis on a later stage (AOAC, 1990). At the beginning of the experiment, one

hundred were randomly divided into five different groups with two replicates containing 10 fish in each of them. Fish were kept in 10 glass tank (50cm x 25cm x 40cm) containers (50 L). Each aquarium was put in a re-circulating system maintained at 30 ± 1°C. An air stone continuously aerated each aquarium. All aquaria were cleaned up every day in the morning and the afternoon by siphoning off accumulated waste materials. Fish were fed with 10% of body weight per day and gradually decreased to 4% each day. Each diet was fed twice a day at 08: 00 (a.m.) and 17:00 (p.m.) for 42 days to duplicate groups of fish. Each group was weighed in the beginning and in each couple of weeks; the amount of diet fed was adjusted, accordingly. A photoperiod of 12 h light, 12 h dark (08:00-20:00h) was used. Fluorescent ceiling lights supplied the illumination. After 6 weeks of feeding or farming, concerned fish were taken out from each treatment, while the dorsal muscle tissue of each of them was dissected and used for body composition analysis.

2.2 Diet Preparation

Five diets were formulated to contain different levels of digestible protein and approximately equal amount of digestible energy. Out of the total dietary protein, 10% were from fish meal (FM, crude protein 58.71%) and 90% from different ratios of maize meal and shrimp waste meal (crude protein 48.12%) (Table1).

Table 1. Composition of experimental diets for tilapia (*Oreochromis niloticus*)

Ingredients	21%	25%	32%	37%	45%
Fish meal	170	170	170	170	170
Maize meal	578	432	285	138	7
Shrimp waste meal	72	218	365	511	643
Cellulose	100	100	100	100	100
Fish Oil	20	20	20	20	20
Vegetable oil (PO + SO)*	40	40	40	40	40
Vit mix[a]	10	10	10	10	10
Min mix[b]	10	10	10	10	10

*PO : peanut oil

*SO: soybean oil

PO/ SO: ratio 1:1

Main protein sources (fishmeal, shrimp waste meal and maize meal) already grounded into mill were passed as particles through no. 40 (425µm) mesh sieve. Mineral mix and vitamin mix were purchased from Aquavet Company, Thiès, Senegal. After having thoroughly mixed ingredients, appropriate quantity of water (30% for 100 g of mixed ingredients). At first feeds were formulated containing 21%, 25%, 32%, 37% and 45% protein from three ingredients such as fish meal, maize and shrimp waste meal. Formulation of feeds was done by Pearson's method. After formulation, feeds were prepared by mixing ingredients and a proximate analysis was realized. The protein levels of the prepared feeds were found 21.88%, 25.57%, 32.38%, 37.63% and 45.50% (Table 2). Diets were supplemented with 6% of fish oil mixture (FO) and vegetable oil (VO). Dough was passed through an extruder to produce spaghetti and dried at 37°C for two days. The dried diet was packaged into plastic bag and stored frozen

ready to be used. The proximate composition of the experimental diets and samples of the dorsal muscle was analyzed according to AOAC standard methods (1984).

Table 2. Proximate analysis of experimental diets fed tilapia (*Oreochromis niloticus*)

Treatments					
Composition	21%	25%	32%	37%	45%
Dry matter *	89.55	89.12	88.87	88.39	87.31
Crude Protein *	21.88	25.57	32.38	38.63	45.5
Crude lipid *	8.96	7.4	6.71	7.21	5.02
Crude fiber *	4.9	6.4	3.57	7.04	9.42
Ash	02	02.42	02.98	03.76	04.46
Energy (cal/kg)	176.4	196.48	211.11	217.73	266.1

*presented in percentage of dry weight

2.3 Growth Parameters

Growth response parameters were calculated as follows: weight gain (WG, g/ fish) = final mean body weight - initial mean body weight; specific growth rate (SGR, % /day) = ((In Wt- In Wi) /T) x 100, 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).

2.4 Water Quality Measurement

Water temperature and dissolved oxygen were measured every other day using YSI Model 58 oxygen meter (Yellow Springs Instrument, Yellow Springs, OH, USA).

2.5 Statistical Analysis

The data were analyzed using the statistic system (SAS-PC) (Joyner, 1985) and subjected to one-way analysis of variance (ANOVA). Treatment effects were considered significant at $P<0.05$; Duncan's test was used to compare significant difference among the treatments.

3. Results

The water temperature monitored during the study period in the experimental aquarium was 29 to 31°C, dissolved oxygen content in the present experiment ranged from 5 to 7 mg/l. The Weight Gain (WG), Specific Growth Rate (SGR) and Feed Conversion Rate (FCR) for fry tilapia after the feeding trial are presented in Table 3. Dietary protein level significantly influenced the tilapia fry's growth and the best results were obtained with a dietary protein level of 32% and 37% in respect of weight gain, SGR and FCR as well as survival. So diet containing approximately 32% to 37% protein might be acceptable protein percentage for production of *O. niloticus* fry. The FCR in different treatments ranged from 1.26 to 1.91. The best FCR (1.26) was observed in diet containing 37% of crude protein (Table 3). The survival rate of *O. niloticus* fry under different treatments ranged from 75 to 100% being 75% in fish fed on diet containing 21%, 90% in fish fed on diet containing 25% and 45%. Significantly ($P<0.05$) higher survival rate (100%) was recorded in the case of 32 % and 37% (Table 3). Carcass composition data are presented in Table 4. There was no significant difference in protein body content of tilapia fed the five diets as compared to the initial fish. Lipid body

content increased significantly (P<0.05) with increasing dietary protein levels from 21% to 45%, but there was no-significant increase with the diet of 37% protein as compared to the initial fish. The carcass crude lipid was recorded as the highest (9.4%) in the fry fed on diet containing 45% crude protein followed by fish fed on diet 21%. There was no significant difference (P> 0.05) in the carcass crude lipid of the fry fed on diet with 25% and 32% protein level.

Table 3. Initial, final weight, weight gain, SGR, FCR and survival of tilapia (*Oreochromis niloticus*)

	Treatments				
Parameters	21%	25%	32%	37%	45%
Initial weight g/fish	1.24	1.25	1.21	1.24	1.26
Final weight g/fish	9.55	10.45	13.87	14.92	9.97
Weight gain g/fish	8.31^{b}	9.21^{b}	12.66^{a}	13.68^{a}	8.71^{b}
Weight gain (%)	672.12^{b}	740.79^{b}	1050.79^{a}	1102.35^{a}	694.05^{b}
SGR	1.66^{ab}	1.68^{ab}	1.39^{ab}	1.26^{a}	1.91^{b}
FCR	4.84^{b}	5.07^{b}	5.82^{a}	5.92^{a}	4.93^{b}
Survival (%)	75	90	100	100	90

^{ab} Means in the same column with the different letter are significantly different (P <0.05)

Table 4. Proximate analysis of dorsal muscle of tilapia (*Oreochromis niloticus*)

Composition	Initial fish	21%	25%	32%	37%	45%
Protein (N x 6.25%)	18.38^{a}	19.69^{a}	18.81^{a}	19.88^{a}	18.75^{a}	20.12^{a}
Lipid (%)	3.4^{c}	7.4^{bc}	5.0^{ab}	4.2^{bc}	3.7^{c}	9.4^{a}

^{abc} Means in the same column with the different letter are significantly different (P <0.05)

4. Discussion

The present study showed significant effects of dietary protein level on growth performance of fry monosex Nile tilapia. Weight gain and specific growth rate of fish were improved significantly with increasing dietary protein levels from 21% to 37%. However, there was no significant increase in fish fed on diet containing 21%, 25% and 45% protein. The best results were obtained with a dietary protein level of 32% and 37% in respect of weight gain, SGR. This may be due to the increase in protein utilization and digestibility with the increase in dietary protein level up to 37%. The decrease in WG and SGR at 45% dietary protein level may be due to the decrease in protein utilization and digestibility above 37% dietary protein level. Many authors obtained conflicting results from their studies on tilapia nutrition. The dietary protein requirements of several species of tilapia have been estimated to range from 20% to 56% (El-Sayed & Teshima, 1992). Siddiqui et al., (1988) reported an optimum dietary requirement of 40% for *O. niloticus* fry (initial weight. 0.838g), and 30% for young fish (initial weight, 40g). Jauncey (1982a) and El-Sayed & Teshima, (1992) also reported 40% for fingerlings and fry respectively. Kaushik et al. (1995) observed the maximum growth rates and feed efficiency at 35% dietary protein for the same species. Diyaware et al. (2009) revealed the best growth rate in hybrid catfish, *Heterobranchus bidorsalis* × *Clarias anguillaris* fry at 40% dietary crude protein level which also provided support to our finding. Sotolu (2010) who

reported 40% dietary protein level resulted in efficient mean weight gain, specific growth rate and feed conversion ratio in *C. gariepinus*. Adewolu & Adoti (2010) reported that fish fed continuously on high protein diets (35%) resulted in significantly higher growth rate and feed utilization in *C. gariepinus*. Ahmad et al. (2012) reported that the highest growth rate in tilapia achieved in feed having 40% dietary protein level during the research period. The difference reported may be due to different protein sources used, various components, formulation methods, 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 37% protein, the poorest FCR was observed in fish fed on diet having 45% protein, but there was no significant difference between FCR obtained by 21, 25, 32% 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.

The survival rate of *O. niloticus* fry under different treatments ranged from 75 to 100% being 75% in fry feed containing 21.88% proteins. Significantly ($P<0.05$) higher survival rate (%) was recorded in case of diet containing 32% and 37%. Survival rate more than 80% is excellent in nursery operation (Sumi et al., 2011). Therefore from findings, it can be suggested that fry feed containing 32 to 37% proteins is suitable for tilapia fry rearing.

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. In contrast, in the present study there was not any significant difference in protein body content of tilapia fed on five diets as compared to the initial fish. No relation between the dietary protein content and the carcass fat composition was observed. There was no defined trend identified in this study. This is in contrast with results reported by (Ahmad et al., 2012) who reported that carcass lipid content exhibited positive relationship with dietary lipid level in tilapia and in rainbow trout reported by (Yamamoto et al., 2000; Gumus & Ikiz, 2009). Moreover, Attack et al. (1979); Chen & Tsai, (1994) observed either linear or inverse relationships respectively.

Data for lipid content of the fish body in response to dietary levels could be divided into three groups. The first group refers to fish which carcass lipid content increased significantly ($P<0.05$) with increasing dietary protein levels from 21% to 45%. The second group was composed of fish fed on diet of 37% protein that body lipid content did not show any significant increase as compared to initial fish. Conversely, the last group has lipid contents that decreased significantly with increasing dietary protein levels up to 30% crude protein (Bahnasawy, 2009). The carcass crude lipid was recorded as the highest (9.4%) in the fry fed on feed 45% followed by fish fed on diet 21%. The same observations have been reported by (Ahmad et al., 2012).

In conclusion, this study indicates that diet containing 37% crude proteins appears to be more suitable, economical and successful culture of the tilapia fry.

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