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Optimum Dietary Protein Requirement of Malaysian Mahseer (*Tor tambroides*) Fingerling

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Abstract: The optimum dietary protein requirement of the Malaysian mahseer (*Tor tambroides*) fingerlings was determined in this study. In this completely randomized designed experiment, formulated diets of five levels of dietary protein (30, 35, 40, 45 and 50%) were tested on the *T. tambroides* fingerlings (initial body weight of 5.85±0.40 g), reared in aquarium fitted with a biofiltering system. The fingerlings were fed twice daily at 5% of biomass. The fingerling body weight and total length was taken at every two weeks. Mortality was recorded daily. The dietary protein had significant effects on the body weight gain and Specific Growth Rate (SGR) of the fingerlings. The body weight gain and SGR of fingerlings fed with the diet with the dietary protein level of 40% was significantly higher ($p<0.05$) than that of 30, 35 and 50%. The feed conversion ratio of the 40% dietary protein was the significantly lowest at 2.19±0.163. The dietary protein level of 40% was the most optimum for *T. tambroides* fingerlings.

Key words: Dietary protein, Malaysian mahseer, *Tor tambroides*, fingerlings

INTRODUCTION

Mahseers are big-scaled cyprinid carps (Nandeesha *et al*., 1993). The streamlined cylindrical body, powerful muscular tail and hypertrophied lips are some of the important characters that enable them to swim, withstand and live in fast flowing streams (Menon *et al*., 2000). Mahseer's fin area is also greater than the total superficial area of the rest of its body (MacDonald, 1948). This fish inhabits both rivers and freshwater lakes but swims upstream to rapids to with rocky bottoms to breed. Similar to other types of carp, they are omnivorous and feed on small fish, plants, insects and mollusks (Pisolkar and Karamchadani, 1984; Talwar and Jhingran, 1992).

According to Ng (2004), there are two species of *Tor* in Malaysia, *Tor tambroides* (Kelah) and *T. douronensis* (Semah). *Tor* are highly valuable and priced in Malaysia and have a great potential for freshwater aquaculture industry cite. The *Tor* are also recognized as excellent game fish as well as highly sought after as ornamental fish in the aquarium fish industry due to their attractive colorations (Ng, 2004).

Not much is known on the nutritional requirement of *T. tambroides*. This study was conducted to determine the optimal protein requirement of *T. tambroides* fingerlings reared in aquaria for 14 weeks.

MATERIALS AND METHODS

Malaysian mahseer (*Tor tambroides*) fingerlings with total length of 6.0±0.05 cm and body weight of 5.85±0.40 g were initially acclimatized in a 1 tonne fiber glass tank. Fifteen glass aquaria (76×38×38 cm) were randomly stocked with 15 fingerlings each and provided with aeration as well as fitted with top bio-filters. The water in the aquarium was changed (100%) fortnightly to maintain good water quality.

Five experimental isocaloric (4.2 kcal g^{-1}) diets containing 30, 35, 40, 45 and 50% dietary protein were tested in triplicates. The ingredients and the proximate composition of the experimental diets were described in Table 1. The diets were processed by kitchen meat mincer. The spaghetti-like feed were dried in the oven at 40°C and broken into pellets by hand and sieved to desired size. The fingerlings were fed twice (0800 and 1700 h) daily at 5% body weight for 14 weeks.

Water quality parameters in the aquarium such as the dissolved oxygen, temperature, pH and ammonia were monitored weekly. Temperature, pH and dissolved oxygen were measured using a YSI 556MPS (USA). Ammonia-nitrogen was measured by LaMotte Ammonia Nitrogen Test Kit. The fish samplings were done every two weeks, prior to the water exchange. The individual body weight and total length were recorded. The mortality was

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Table 1: Proportion of different ingredients and proximate composition of the experimental diets (% as fed basis)

Items	Dietary protein (%) 30	35	40	45	50
Ingredients					
Fish meal	10.00	10.00	20.55	48.30	64.45
Soya meal	53.49	71.90	71.90	41.90	21.16
Rice bran	30.58	13.55	3.00	3.00	3.00
Fish oil	3.93	2.55	2.55	4.80	5.85
Mineral premix	1.00	1.00	1.00	1.00	1.00
Vitamin premix	1.00	1.00	1.00	1.00	1.00
Casein	-	-	-	-	3.54
Proximate composition					
Moisture	11.40	11.80	11.20	10.00	8.60
Ash	14.68	12.23	12.02	16.02	17.63
Crude fiber	3.95	4.03	3.62	3.05	2.31
Crude fat	5.21	5.62	5.71	9.58	10.05
Crude protein	33.75	37.08	42.64	47.08	53.34
Gross energy (kcal g^{-1})	4.25	4.14	4.16	4.31	4.72

recorded daily. At the end of the feeding trial, the fingerlings from each treatment and their replicates were sacrificed for proximate analyses.

The experimental diets were also subjected to proximate analyses. Crude protein was estimated by 2400 Kjeltec Analyzer Unit while crude lipid was analyzed by Foss Tecator Lipid Analyzer. Crude fiber was analyzed by Fibertec System (Fibertec 2010 Hot Extractor Foss Tecator). Moisture content was determined by an Infrared Moisture Determination Balance, (Model: A and D, AD-4715, Japan). Ash was estimated according to AOAC (1985). Gross energy was determined by a bomb calorimeter (Model: LECO, AC-350, USA).

The data on body weight, total length, survival, Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), proximate composition and water quality parameters were analyzed using one-way Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT). These data were analyzed using Statistical Analysis System (SAS Inc., USA). All the percentage values were arc-sine transformed prior to analysis (Gomez and Gomez, 1984).

RESULTS

The survival rate of the fingerlings were generally very high at 91-100% and no significant differences were observed ($p>0.05$) among the treatments.

The dietary protein level had significant effects ($p>0.05$) on the body weight gain and total length gain of *T. tambroides* fingerlings. Although significantly different from other treatments, the body weight gain of fingerlings fed with 40 and 45% dietary protein were not significantly different ($p>0.05$) with each other. However, the 40% dietary protein gave a slightly higher body weight gain (66.23±14.70%) compared to 45% dietary protein (63.79±9.73%).

Table 2: Body weight, total length, specific growth rate and feed conversion ratio of *T. tambroides* fed with different levels of dietary protein for 14 weeks

Dietary protein (%)	BW Final (g)	BW Gain(%)	TL Final (g)	TL Gain (%)
30	7.37 ± 0.13^{d}	36.01 ± 4.81^{b}	6.44 ± 0.17^{b}	10.73 ± 7.28^{b}
35	8.37 ± 0.57^{c}	48.47 ± 18.93^{ab}	6.89 ± 0.22^{b}	12.26 ± 3.44^{b}
40	10.67 ± 0.80^{a}	66.23 ± 14.70^{a}	7.91 ± 0.28^{a}	25.38 ± 5.62^{a}
45	9.67 ± 0.51^{b}	63.79 ± 9.73^{a}	7.72 ± 0.13^{a}	25.71 ± 1.58^{a}
50	8.44 ± 0.33^{c}	42.29 ± 10.69^{ab}	6.92 ± 0.48^{b}	16.48 ± 6.22^{ab}

Values in each row which have different superscripts are significantly different ($p<0.05$)

Table 3: Specific growth rate, feed conversion ratio, protein efficiency ratio and survival rate of *T. tambroides* fed with different levels of dietary protein for 14 weeks

Dietary protein (%)	SGR (% day^{-1})	FCR	PER	Survival (%)
30	0.31 ± 0.05^{b}	2.82 ± 0.12^{a}	0.06 ± 0.01^{b}	100.0 ± 0^{a}
35	0.39 ± 0.07^{ab}	3.02 ± 0.21^{a}	0.08 ± 0.02^{ab}	93.33 ± 11.55^{a}
40	0.51 ± 0.08^{a}	2.19 ± 0.16^{b}	0.11 ± 0.02^{a}	95.56 ± 7.70^{a}
45	0.50 ± 0.05^{a}	2.66 ± 0.13^{a}	0.08 ± 0.01^{ab}	91.11 ± 10.18^{a}
50	0.37 ± 0.11^{ab}	2.80 ± 0.32^{a}	0.05 ± 0.02^{b}	100.0 ± 0^{a}

Values in each row which have different superscripts are significantly different ($p<0.05$)

There were no significant differences in the total length among fingerlings fed with 30, 35 and 50% protein diets. But they were significantly lower ($p<0.05$) than those fed 40 and 45% protein diets. Although not significantly different with 45% protein diet, the 40% protein diet gave the highest total length gain (25.38±5.62%). Therefore, 40% dietary protein gave the best growth in terms of body weight and total length gain of *T. tambroides* fingerlings (Table 2).

The diet with 40% dietary protein gave the significantly highest Specific Growth Rate (SGR) (0.51±0.08% day^{-1}) than 30, 50 and 35% diets (0.31±0.05, 0.37±0.11 and 0.39±0.07% day^{-1}, respectively) as shown in Table 3.

The Feed Conversion Ratio (FCR) of each diet ranged from 2.19±0.16 to 3.02±0.21. The lowest FCR was observed at 40% dietary protein and it was significantly different than the rest of the diets (Table 3). It was also observed that the 40% diet gave the significantly highest Protein Efficiency Ratio (PER) than other diets (Table 3).

There were no significant differences in the crude protein, crude lipid and Nitrogen-Free Extract (NFE) content of the fish carcass. However, fingerlings fed with 40% dietary protein had the highest crude protein content at 50.24±1.53% but the lowest crude lipid content at 4.38±0.14%. The crude fiber content of fingerlings fed with 30 (0.25±0.08%) and 35% (0.56±0.21%) of dietary protein were significantly different with each other compared to the rest of the diets. The ash content of fingerlings fed with the 50% dietary protein (11.35±0.73%) was significantly the highest compared to 30, 35 and 40% diets, as shown in Table 4.

Table 4: Carcass composition (% dry matter) of *T. tambroides* fed with different levels of dietary protein for 14 weeks

Dietary protein (%)	Crude protein	Crude fiber	Crude lipid	Ash (%)	NFE
30	48.89 ± 3.76^a	0.25 ± 0.08^b	4.57 ± 0.13^a	9.91 ± 0.23^b	36.38 ± 3.66^a
35	48.28 ± 1.18^a	0.56 ± 0.21^a	4.46 ± 0.56^a	9.97 ± 0.27^b	36.74 ± 1.53^a
40	50.24 ± 1.53^a	0.34 ± 0.09^{ab}	4.38 ± 0.14^a	9.41 ± 0.20^b	35.63 ± 1.76^a
45	49.98 ± 1.43^a	0.36 ± 0.16^{ab}	4.88 ± 0.04^a	10.34 ± 0.16^{ab}	34.44 ± 2.49^a
50	48.90 ± 0.59^a	0.30 ± 0.10^{ab}	4.46 ± 0.02^a	11.35 ± 0.73^a	34.99 ± 1.34^a

Values in each row which have different superscripts are significantly different ($p<0.05$)

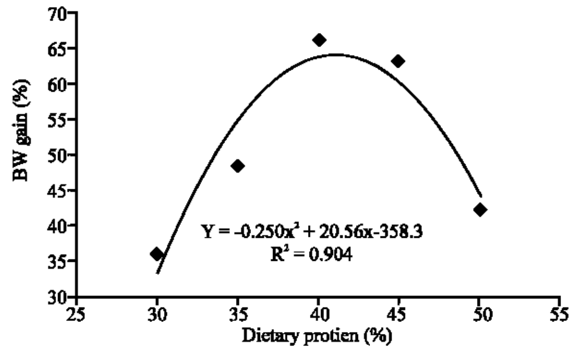

Fig. 1: The dietary protein and body weight gain of *Tor tambroides* juveniles

DISCUSSION

This present study indicated that the optimum dietary protein level for the growth of *Tor tambroides* fingerlings was 40% (Fig. 1). This finding was similar to that reported by Muzaffar-Bazaz and Keshavanath (1993) for *T. khudree*. Sunder *et al.* (1998) reported that *T. putitora* grows and survive better at a slightly higher (45.4%) dietary protein diet. However, Joshi *et al.* (1989) in an earlier work recommended 35% dietary protein as the best for the growth of *T. putitora*.

Ng *et al.* (2008) estimated that the optimum dietary protein requirement of *T. tambroides* is 48% which is higher than found in this study. However, Ng and his co-workers used semi-purified diets and F1 generation of fish fingerlings produced from pond-raised broodfish in their study while practical diets and acclimatized wild fish were used in this study. Freshwater fish such as tilapia is known to be more efficient in utilizing feed with natural ingredients rather than purified ingredients (Nguyen, 2008). Semi-purified diet ingredient such as casein has adequate levels most essential amino acids as reported by Nguyen (2008) but it is lack in arginine. Therefore, the smaller size *T. tambroides* fingerlings in Ng *et al.* (2008) study required a higher level of protein to compensate the arginine deficiency and to meet their metabolic energy needs.

The SGR obtained by *T. tambroides* fingerlings in this study (apparently for all experimental diets) were much lower than other commonly cultured freshwater fish such as common carp (1.28%) and tilapia (1.40%) as stated by Kaushik (1998). However, the SGR of this study is similar to those of other mahseers such as *T. tor* (Shehgal, 1999) and *T. khudree* (Ogale, 2002). Islam (2002) stated that the SGR of *T. putitora* ranged between 0.55% day^{-1} and 0.75% day^{-1} in the outdoor earthen ponds and 0.28% day^{-1} and 0.33% day^{-1} in the indoor cement cisterns.

However, Ng *et al.* (2008) found higher SGR ranging from 1.2 to 1.68% day^{-1} using 20.9±0.1 g pond-raised F1 *T. tambroides* fish and 2.88 to 3.21% day^{-1} using similar smaller 0.67±0.15 g.

The FCR values of this study were reasonably low. This could be achieved by the appropriate twice daily feeding rate at 5% biomass, good utilization of feed and proper digestibility of feed ingredients. Rahman *et al.* (2006) also observed low FCR values among *T. putitora* fingerlings which they attributed to smaller ration size, higher digestibility and proper utilization of feed.

According to Hossain *et al.* (2002), the FCR values of *T. putitora*, reared in static water condition in aquarium and fed with semi-purified diets containing casein and gelatin as the dietary protein sources, ranged between 1.12 and 2.21. However, Islam (2002) reported very high FCR (5.28-9.55) for pond-reared *T. putitora* when fed with supplementary feed containing 20-30% protein content under a semi-intensive farming. Ng *et al.* (2008) also reported low FCR (2.13-3.2) for *T. tambroides* fingerlings and suggested that FCR improves with increasing dietary protein up to 50%.

According to Hossain *et al.* (2002), the PER values decreased progressively as the percentage of protein increased. Even though this decreasing trend was also observed with the increasing dietary protein of 40, 45 and 50%, there was an increasing trend with the increasing dietary protein from 30, 35 to 40%. The declining PER of *T. tambroides* fingerlings when higher dietary protein levels were fed was also depicted in Ng *et al.* (2008) study. Davis and Stickney (1978) stated that fish convert protein more efficiently when fed dietary protein level less than optimal level that yields the maximum growth and feed efficiency. In another study on *T. aurea*, Winfree and Stickney (1981) noted that the protein requirement of *T. aurea* fingerlings decreases with growth. Steffens (1981) also reported that raising the dietary protein level improves the growth rate and food conversion but reduces PER and Protein Productive Value (PPV) in *Salmo gairdneri* and *Cyprinus carpio*.

The different levels of dietary protein in their diets did not significantly affect the crude protein, crude lipid and NFE contents of *T. tambroides* carcass. Ng *et al.* (2008) also observed that the dietary protein and lipid levels were did not significantly affect final whole-body, muscle and liver lipid content of *T. tambroides*. In contrast, Hossain *et al.* (2002) reported that a progressive increment of dietary protein increases the lipid content in *T. putitora* carcass.

Apparently, it can be concluded that the optimum dietary protein level for *T. tambroides* fingerling is 40% based on the growth performance, FCR and carcass crude protein content when reared using a practical diet in bio-filtered tank system.

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