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Growth Performance and Nutrient Composition of Juvenile Nile Tilapia (*Oreochromis niloticus*) Fed *Spirulina* Flakes, Rice Bran and Mustard Oil Cake

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ABSTRACT

Introduction: Tilapia (*Oreochromis niloticus*) is an important cultured fish that is widely distributed in Bangladesh. This study was conducted to improve the growth performance and nutrient contents of the fish using five different types of feeds. **Methods:** Tilapia fingerlings were fed two types of commercial fish feeds (Feed-1 and Feed-2), *Spirulina* flakes (Feed-3), Feed-2 mixed with *Spirulina* flakes (Feed-4) and manually mixed feed made from a mixture of mustard oil cake and rice bran (Feed-5). After 4 weeks of being fed with the diets, growth parameters and meat nutrient composition of the tilapia fingerlings were recorded. **Results:** Significant growth in length and weight was observed in juvenile tilapia fish fed with commercial Feed-1 only, while growth performance varied significantly among fingerlings fed other types of feeds. Body tissue calcium (92.8 mg/100g), iron (1.29mg/100g) was higher in fishes fed with dry *Spirulina* flakes (Feed 3), while the highest amount of zinc (2.09 mg/100g) was recorded in fishes fed Feed-5. Protein (13.32%) content was highest in fish fed Feed-2 mixed with *Spirulina flakes* (Feed-4). **Conclusion:** Meat nutritional quality of tilapia can be improved by combining commercial feeds with *Spirulina* flakes, compared with feeding commercial feeds in isolation.

Keywords: Tilapia (*Oreochromis niloticus), Spirulina* flakes, nutrient value of fish

INTRODUCTION

Tilapia (*Oreochromis niloticus*) is an important cultured fish in Bangladesh as it is known for its high tolerance to adverse environmental conditions, relatively rapid growth and the ease with which they can be bred. Tilapia provides an important source of animal protein and income throughout the world (Sosa *et al.*, 2005). Tilapia can be cultured in vast areas of slight salt waters of Bangladesh as in the case of other countries like Pakistan, as this fish is very hardy and tolerant of high water temperature (Coward & Bromage, 2000). It is one of the most important commercial fishes. Bangladesh Fisheries Research Institute (BFRI) initiated the second introduction of tilapia fish into this country from Thailand in 1987 (Hussain, 2000). According to the recent aquaculture production statistics of tilapia, world production increased from 1970-2000 at an

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average rate of about 13.9% annually (FAO, 2003).

Several feed ingredients are used in the diet of tilapia. These include animal protein sources such as fishery by-products, shrimp meal, terrestrial animal by-products such as hydrolysed feather, bone meal and blood meal. Plant protein sources including soyabean meal, cottonseed meal, groundnut meal, sunflower, rapeseed, sesame seed, copra, macadamia and palm kernel along with aquatic plants such as *Azolla pinnata*, duckweed (Lemnaceae) and single-cell proteins have also been evaluated (Ogunji, 2004).

As protein is the main constituent of the fish body, a sufficient dietary supply is needed for optimum growth. Therefore, the amount of protein in the diet should be just enough for fish growth. Excess protein in fish diets may be wasteful and cause diets to be unnecessarily expensive (Ahmed, 2000).

In Bangladesh, fish farmers are generally using commercial feed that is available in the country. Presently, farmers cultivating tilapia fish are not getting a complete diet for tilapia culture. From some investigations at field level, farmers informed the researchers about the non-availability of a nutritive diet for this fish species. Farmers are not achieving the required nutritional levels and subsequent fish growth. An analysis of a few commercial feeds found that the nutrient levels were not up to the mark. Considering these conditions, an attempt has been made to enrich meat quality of tilapia by supplementing different feeds that are locally available for farmers. Thus the aim of this study was to assess growth and nutrient contents of fish meat by feeding commercial feeds with natural ingredients.

METHODS

Collection of samples

Live fry of Tilapia (*Oreochromis niloticus)* were collected and carried in oxygenated bags from Bangladesh Fisheries Research Institute (BFRI) at Mymensingh. The experiment was set up in mini tanks located in the laboratory of the Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka.

Five tanks were used for this experiment. Each of the tanks was five feet in length and two feet in width and one foot in water depth. All the tanks were filled with water and labeled according to experimental design. An aerator was used for 24 hours during the experimental period. In total, 120 fingerlings of tilapia were stocked in each of the tanks. The fingerlings were at first acclimatised for one day in clean water. The fish were then released slowly into the tank water and at the same time oxygen was supplied with the help of the aerator. No feed was given on the first day. From the second day of stocking, feed was given regularly at a rate of 10% body weight of fish.

Types of feed

Five different types of feed were supplied to the fish stocked in the tanks in two groups (Trial and control). The control groups were fed with two types of locally available commercial feed namely Quality Feed (Feed-1) and Saudi-Bangla Feed (Feed-2). The trial groups were fed only with (i) Feed-3 (dry *Spirulina* flakes); Feed-4 (a mixture of Feed-2 and 2% *Spirulina* flakes; and Feed-5 (70% rice bran manually mixed with 30% mustard oil cake).

Growth of tilapia

Initial measurements and weight were recorded and subsequent growth of the sample fry was measured after a 7-day interval. Length of the fingerlings was measured with measuring tape and weight taken with a weighing balance. Twenty samples were measured randomly at a time. After recording length and weight, the fingerlings were then slowly released into the labeled tank water. Feed was supplied as per experimental design. The tank was cleaned and filled with clean water in a weekly routine. Growth of the fingerlings

was measured consequently four times at intervals of 7 days with the experiment being continued up to 4 weeks.

Biochemical analysis

The samples were collected from the experimental tanks after four weeks for biochemical analysis to estimate whole body percentages of moisture, protein, fat, ash and minerals. The samples were then weighed and minced in a chemical tissue grinder. Required amounts of sample in duplicate were taken for the determination of moisture. The rest of the minced samples were collected as completely as possible for consequent analysis. Wet weight was recorded, dried in an oven at 100°C and weight of oven-dried sample was recorded. The dry sample was put through a mechanical grinder for proximate analysis with the values being later readjusted for wet weight.

The moisture content was obtained by difference between the fresh and the dry weight of the samples dried at 100± 1ºC until constant weight (AOAC, 1990). Protein was estimated using modified Kjeldahl method. Fat was determined according to the modified method described by Folch *et al*., (1957). The ash fraction was obtained by the incineration of the organic matter at about 600-700ºC (AOAC, 1990). Calcium, Phosphorus, Iron and Zinc were determined by analytical titration procedure.

RESULTS AND DISCUSSION

The composition of the supplemented diets used to feed the tilapia is shown in Table 1. The highest percentage of moisture (13.06%) was found in manually mixed Feed-5. *Spirulina* flakes (Feed-3) showed the highest protein content (60.70%) whereas Feed-5 had the lowest (20.29%) protein content.

Effects of different feeds on the growth (by length and weight) of tilapia fingerlings after four weeks of rearing are shown in Tables 2, 3 and 4. Length growth for the different treatments varied significantly as indicated by ANOVA. Maximum length and weight were found in Feed-1 (5.16 cm and 2.45 g), followed by Feed-2 (4.95 cm and 2.05 g) and Feed-4 (4.79 cm and 1.95 g). Feed-3 had the least effect over length and weight (4.39 cm and 1.52 g) of fishes. The LSD test showed significant differences among all the feeding trials except for Feed-4 and Feed-2.

Overall, the fingerlings under the different feeding regimes showed differences in growth as follows: Feed-1>Feed-2>Feed-4>Feed-5>Feed-3. Al-Shamsi, Hamza & El-Sayed (2006) experimented with the growth rates and survival of Nile tilapia (*Oreochromis niloticus*) fry using live food (*Chlorella vulgaris* and *Artemia fransciscana*), artificial feed and a combinations of both types. They obtained maximum body weight in fry fed on *A. fransciscana* nauplii and a

Table 1. Composition of supplemented diets used to feed tilapia fingerlings

	Composition of ingredients						
Types of feed	*Moisture (%)*	*Protein (%)*	*Fat (%)*	*Calcium (mg/100g)*	*Phosphorus (mg/100g)*	*Iron (mg/100g)*	*Zinc (mg/100g)*
Feed-1	11.0	34.0	8.0	25	175	na	na
Feed-2	12.0	30.0	5.0	na	na	na	na
Feed-3	7.0	60.70	0.27-0.47	40	104	10.6	1.2
Feed-4	9.5	45	5.2	21	48	6	0.65
Feed-5	13.06	20.29	11.94	na	na	na	na

na= not available; Feed-1: Quality feed, Feed-2: Saudi Bangla feed, Feed-3: *Spirulina* flake, Feed-4: Saudi Bangla feed and mixture of *Spirulina* flake and Feed-5: Hand made feed (mixture of rice bran and mustard oil cake)

Table 2. Effect of different feeds on average length and weight of Tilapia fingerlings, reared for 4 weeks under natural conditions

Kinds of feed parameters		*Time interval*				
		Initial	*7 days*	*14 days*	*21 days*	*28 days*
F-1	Mean length (cm) ± SD	4.03 ± 0.028	4.8 ± 0.238	5.34 ± 0.339	5.74 ± 0.285	5.87± 0.513
	Mean weight (g) ± SD	1.45 ± 0.232	1.87± 0.354	2.45± 0.336	2.75± 0.381	3.75± 0.855
F-2	Mean length (cm) ± SD	4.03 ± 0.028	4.7± 0.40	4.9± 0.514	5.47± 0.319	5.52± 0.509
	Mean weight (g) ± SD	1.45 ± 0.232	1.8± 0.429	1.91± 0.489	2.32± 0.387	2.92± 0.779
F-3	Mean length (cm) ± SD	4.03 ± 0.028	4.28± 0.193	4.53± 0.234	4.54± 0.281	4.64± 0.447
	Mean weight (g) ± SD	1.45 ± 0.232	1.46± 0.213	1.58± 0.184	1.6± 0.279	1.62± 0.357
F-4	Mean length (cm) ± SD	4.03 ± 0.028	4.52± 0.244	4.67± 0.222	5.3± 0.272	5.41± 0.357
	Mean weight (g) ± SD	1.45 ± 0.232	1.63± 0.231	1.7± 0.270	2.24± 0.301	2.78± 0.646
F-5	Mean length (cm) ± SD	4.03 ± 0.028	4.54± 0.241	4.77± 0.276	5.11± 0.319	5.26 ± 0.357
	Mean weight (g) ± SD	1.45 ± 0.232	1.55± 0.213	1.62± 0.241	2.0 ± 0.383	2.3 ± 0.482

F-1: Quality feed, F-2: Saudi Bangla feed, F-3: *Spirulina* flake, F-4: Saudi Bangla feed and mixture of *Spirulina* flakes and F-5: Hand made feed.

Table 3. DMRT for different supplemented feeds in relation to length of Tilapia fingerlings

	Type of feed	*N*	*Subset for alpha = .05*			
			1	2	3	4
Duncan (a)	Feed-3	100	4.3920			
	Feed-5	100		4.7260		
	Feed-4	100		4.7880		
	Feed-2	100			4.9510	
	Feed-1	100				5.1570
	Significant level		1.000	0.463	0.054	1.000

Means for groups in homogeneous subsets are displayed.
a Uses Harmonic Mean Sample Size = 100.00.

Table 4. DMRT for different supplemented feeds in relation to weight of Tilapia fingerlings

Type of feed		*N*	*Subset for alpha = .05*			
			1	*2*	*3*	*4*
Duncan (a)	Feed-3	100	1.5180			
	Feed-5	100		1.8050		
	Feed-4	100		1.9460		
	Feed-2	100			2.0790	
	Feed-1	100				2.4540
	Significant level		1.000	.119	.141	1.000

Means for groups in homogeneous subsets are displayed.
a Uses Harmonic Mean Sample Size = 100.000.

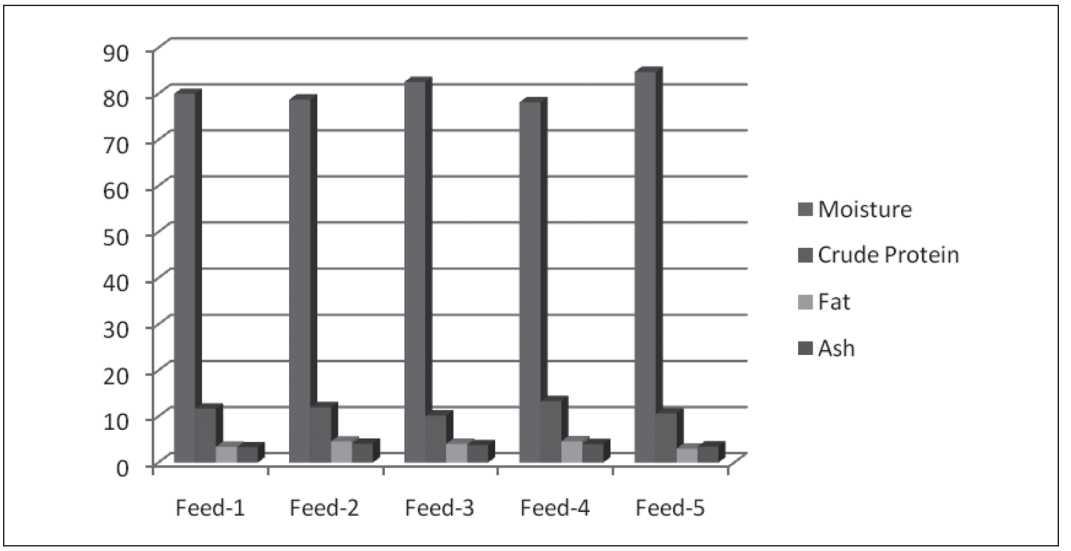

Figure 1. Moisture, protein, fat and ash content of tilapia fingerlings meat under different feed regimes

combination of the three food types, while the lowest growth rate was found in fry fed on *C. vulgaris* suspension alone. Takeuchi *et al*. (2009) examined the growth and body composition of juvenile tilapia fed raw *Spirulina* and obtained length and body weight as 3.40 ± 0.17 cm and 1.59 ± 0.26 g respectively. Comparatively, the present study showed better results with fingerlings fed *Spirulina* in terms of weight of 1.62 ± 0.366 g and height of 4.62 ± 0.41cm after 4 weeks. However, tilapia fed *Spirulina* flakes in this study showed the lowest growth compared to the other types of feeds used. The highest growth was observed in tilapia fingerlings fed on commercial feed-1 (Quality Feed).

Proximate analysis of tilapia

Results from the proximate analysis are shown in Figure 1. The highest moisture

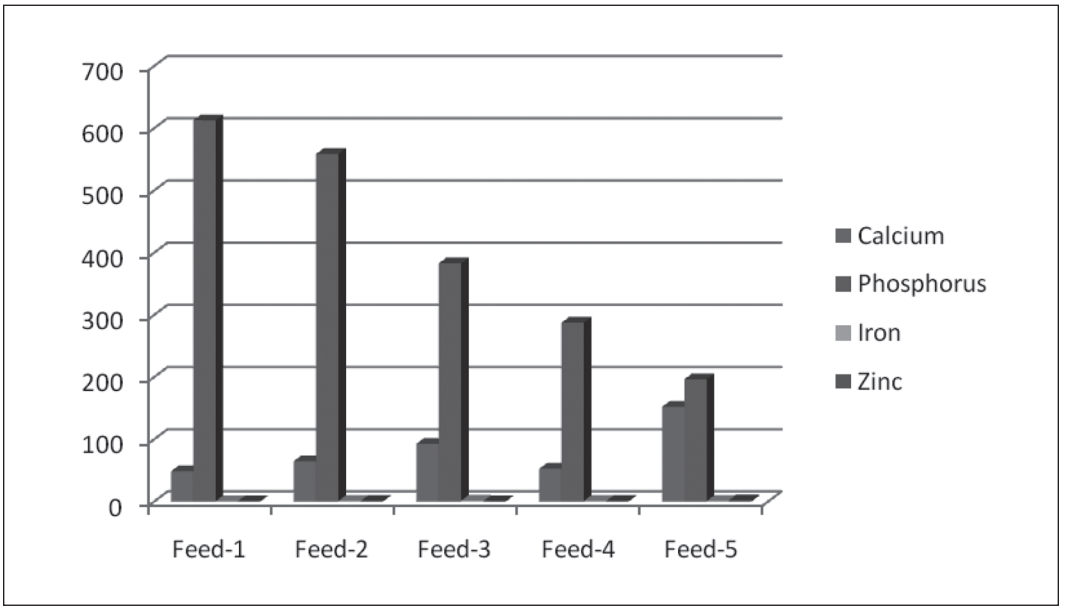

Figure 2. Calcium, Phosphorus, Iron and Zinc content of Tilapia fingerling meat under different supplemented feed

content of the tilapia fingerlings was observed in Feed-5-fed fingerlings (84.54%) followed by Feed-3 > Feed-1> Feed-2 > Feed-4. Protein content ranged between 13.32-10.19%, the highest in tilapia fed Feed-4 (13.32 %), while the lowest value was found in those fed Feed-3 (10.19 %) followed by Feed-2 (12 %), Feed-1 (11.68 %) and Feed-5 (10.63 %). Fat percentage of tilapia fingerlings varied between 3.01- 4.61 %.

The mineral contents in the fingerlings fed different types of feeds are shown in Figure 2. The highest calcium content was recorded in fingerlings fed manually mixed Feed-5 (152.10 mg/100g of fish), while the lowest was in commercial grade Feed-1 (48.40 mg/100g) fed fingerlings. The latter was still higher than the values reported in a study by Valverde *et al*. (2000). This may be due to the use of bone meal in commercial diet in Bangladesh.

The iron content ranged between 0.55-1.29mg/100g of fish. The highest Fe was found in fingerlings fed Feed-3(1.29 mg/100g), which comprised only *Spirulina* flakes. This result does not agree with the results reported by Valverde *et al*. (2000) but are comparable with that reported by Petenuci *et al*. (2008).

The percentage of zinc appears to be in the range of 0.58-2.09 mg/100g. Fingerlings fed with feed- 5 had the highest zinc (2.09mg/100g) content.

Nwanna (2005) who studied the effect of toasting and incubation of soyabean meal supplemented with phytase in practical diets on the growth and mineral deposition in Nile tilapia found that Ca, P, Fe and Zn ranged between 4.19-5.25 mg/100g, 5.22-6.49 mg/100 g, 0.351-0.774 mg/100g and 2.73-3.32 mg/100g respectively. In the present study, the Ca, P and Fe content were observed to be significantly higher in fingerlings fed the Quality feed, Saudi-Bangla feed, Blue green algae *Spirulina* and rice bran with mustard oil-cake mixture feed. It is evident that significant variations prevailed in the fish fed different prescribed feeds.

Nurullah *et al*. (2003) analysed the biochemical composition of some Bangladesh indigenous fishes, such as mola (*Amblypharyngodon mola*), dhela (*Rohtee*

cotio), chapila (*Gudusia chapra*), punti (*Puntius sophore*), tengra (*Mystus vittatus*) and kankila (*Xenentodon cancila*). Moisture was found to be in the range of 72.97 to 76.36% with the highest moisture content in chapila and the lowest in punti. Protein, the most important component was in the range of 14.08% to 21.70% with the highest value in kankila and the lowest in chapila. The authors reported that the protein level in tilapia fingerlings was significantly influenced by the plant feed (*Spirulina* flakes). Fish fed a mixture of *Spirulina* flakes and commercial feed-2 (Feed-4) had a higher content of protein than fish in the two control groups fed commercial Feed-1 and commercial Feed-2, the plant based Feed-5 (rice bran and mustard oil cake mixture) and Feed 3 which was 2% dry *Spirulina* flakes, also a supplemented plant based feed for fingerlings.

Islam & Joadder (2005) studied the seasonal variations of the proximate composition of freshwater Gobi, *Glossogobius giuris* (Hamilton) and reported 72% moisture, 19% protein, 8% fat, 0.5% calcium and 0.25% phosphorus. Petenuci *et al*. (2008) analysed the fishbone flour of tilapia and observed different levels of moisture (14.2%), protein (40.8%), total lipid (25.3%) and ash (18.3%). The percentage of phosphorus in the present study was observed to be in the range of 196.3- 612.7 mg%, which is nearly similar to the values determined by Valverde *et al*., (2000) It is apparent from the present study that the whole body lipid contents increased with increasing percentage of crude protein, as found in the fingerlings fed with Feed-4 (Saudi-Bangla and *Spirulina* flakes mixture).

Overall, the Saudi-Bangla feed supplemented with *Spirulina* flakes showed the highest amount of protein and fat accumulated in the fish meat. On the other hand, the highest percentage of calcium and zinc was observed in fish meat fed with the mixture of rice bran and mustard oil-cake. *Spirulina* flakes showed the highest amount of iron in tilapia fingerling meat.

CONCLUSION

The present study shows that the protein quality and fat content of tilapia is close to that of other fishes of Bangladesh. The best growth performance was observed in fish fed with commercial fish feed only. Significant differences was found between commercial (Quality feed) and *Spirulina* flakes feed. Though the growth performance of tilapia fingerlings did not improve with the supplementation of *Spirulina* flakes and a mixture of rice bran with mustard oil-cake, this mixture supplemented with commercial feed showed improved growth and better quality meat. Further studies on the meat quality of tilapia with the addition of other common natural ingredients are in progress.

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REFERENCES

Ahmed MH (2000). Improve productive performance in fish. PhD dissertation, Animal Production Department, Faculty of Agriculture, Zagazig University.

Al-Shamsi L, Hamza W & El-Sayed AF (2006). Effects of food sources on growth rates and survival of Nile tilapia (*Oreochromis niloticus*) fry. *Aquatic Ecosystem Hlth & Mgmt* 9(4): 447-455.

AOAC (1990). Official Methods of Analysis, 15th ed. Association of Official Analytical Chemists, Washington DC/Virginia, DC. USA.

Coward K & Bromage NR (2000). Reproductive physiology of female tilapia brood stocks. *Rev Fish Biol Fisheries* 40: 1-25.

FAO(2003). Summary of Food and Agricultural Statistics. Food and Agriculture Organization of the United Nations, Rome, Italy.

Folch MJ, Less M & Sloane-Stanley GH (1957). A simple method for isolation and purification of total lipids from animal tissue. *J Bio Chem* 26: 497.

Hussain MG, Kohinoor, AHM, Hossain A, Mazi MA & Dey MM (2000). Growth and production performances of GIFT strain of Nile tilapia, *Oreochromis niloticus* L., under different farming conditions in Bangladesh. *J Aqua Trop* 15(3): 273-280.

Islam MN & Joadder MAR (2005). Seasonal variation of the proximate composition of freshwater Gobi, *Glossogobius giuris* (Hamilton) from the river Padma. *Pakistan J Biol Sc* 8(4): 532-536.

Nurullah M, Kamal M, Wahab MA, Islam MN, Ahasan CT & Thilsted SH. (2003). Nutritional quality of some small indigenous fish species of Bangladesh. In: *Small Indigenous Species of Fish in Bangladesh.* Wahab MA. Thilsted SH and Hoq ME (eds), pp.151-158.

Nwanna LC (2005). Effect of toasting and incubation of soybean meal supple-mented with phytase in practical diets on the growth and mineral deposition in Nile tilapia. *J Anim & Vet Adv* 4(2): 234-239.

Ogunji JO (2004). Alternative protein sources in diets for farmed tilapia. *Nutr Abstracts and Reviews* 74(8): 23-32.

Patenuci ME, Stevanato FB, Visentainer JEL, Matsushita M, Garcia EE, de Souza NE and Visentainer JV (2008). Fatty acid concentration, proximate composition and mineral composition in fishbone flour of Nile Tilapia. *Archivos Latino-americanos De Nutricion* 58(1): 87-90.

Sosa IDLAB, Adillo MDLG, Ibanez AL & Figueroa JLIA (2005). Variability of tilapia (*Oreochromis* spp.) introduced in Mexico: Morphometric, meristic and genetic characters. *J App. Ichthol* 20: 7-10.

Takeuchi T, Lu J, Yoshizaki G & Satoh S (2009). Effect on the growth and body composition of juvenile tilapia *Oreochromis niloticus* fed raw *Spirulina*. *Fisheries Sci* 68(1): 34-40.

Valverde IM, Periago MJ, Santaella M & Ros G (2000). The content and nutritional significance of minerals on fish flesh in the presence and absence of bone. *Food Chem* 71: 503–509.