Growth performances of Nile tilapia (*Oreochromis niloticus*) fed with seaweed (*Hypnea* sp.)

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Abstract. Nile Tilapia (*Oreochromis niloticus*) is one of the fastest growing aquaculture species of Bangladesh. In this study, juvenile tilapia was reared with commercial feed supplemented with seaweed *Hypnea* sp. for three months to assess the effect of seaweed on growth. In total 30 similar sized tilapia fingerlings of one month age were kept in each of 10 aquaria. They were fed under five treatments, *viz.* T1 (5% sea weed), T2 (10% sea weed), T3 (15% sea weed), T4 (20% sea weed) and C (Commercial feed) with a replica for each. The average daily growth (0.093 ± 0), specific growth rate(2.04 ± 0.01), and value of condition factor (K) for T2 $(K=2.32\pm0.05)$ was found to be highest while the feed conversion ratio (FCR)of this treatment (1.94 ± 0.01) was found to be the lowest, after3 months of rearing period. In addition, it was evident that excess seaweed supplementation caused ceasing of growth performances. All these results indicated that using 10% seaweed (*Hypnea* sp.) as supplementary food additives with commercial feed can be considered as best for Nile tilapia to improve their growth within the culture period.

Keywords: Seaweed, Feeding, Nile tilapia

Introduction

At present, aquaculture becomes one of the widely accepted popular industry of Bangladesh by means of nutritional security, source of livelihoods and earning of foreign currencies. Some exotic fishes are now considered as advantageous contributors as culture species. Among them, Nile tilapia (*Oreochromis niloticus*) is the most popular exotic fish species due to its easy culture system, high demand and affordable market price. Tilapia contributed 10.58% of the inland fish production of Bangladesh in 2016-2017 (DoF 2017). This fish belonging to the "Cichilid" group which is native to African countries and one of the similar fish Mozambique tilapia (*O. mossambicus*) was first introduced in Bangladesh from Thailand through UNICEF in 1974. Later, it has been proved that Genetically Improved Farmed Tilapia (GIFT) and only-male monosex tilapia culture are commercially highly profitable. Research on different factors of tilapia culture for improvement got importance in Bangladesh. Feed is one of the issues having a great impact on fish health, production and culture economy. Growth of Nile tilapia *(O. niloticus)* was found to be good with different supplementary feed (El- Sayed 2006). In Bangladesh, commercial feed industry mostly depends upon foreign sources for ingredients. That in turn influences the cost and quality of feed. Seaweed is one of the aquatic plants that can be used as the supplementary feed of fish. *Sargassum, Ascophyllum, Caulerpa, Eucheuma, Porphyra, Laminaria* etc. are some seaweed which

are widely used as fish feed supplements (Chapman 1973, Okazaki 1971, McHugh 2003). In Bangladesh, seaweeds are found in the littoral and sub-littoral zones of Saint Martin's island naturally but seaweed culture is not very common yet. Earlier 133 spp. of seaweed were recorded in Saint Martin's Island by Islam (1976). Four new records were added later by Zafar (1992). Among these seaweed species, ten species are considered as commercially important within which three species are green seaweed, two species are brown seaweed and five species are red seaweed. But seaweed culture is still in initial stage in Bangladesh. According to Zafar (1992), *Caulerpa recemosa* and *Hypnea* sp. can be cultured at Saint Martin's island. *Hypnea* sp. is of special concern, as it is one of the most abundant seaweed found along the water of the Saint Martin's island. In this study, an initiative has been taken to observe the effects of *Hypnea* sp. as a supplementary feed on the growth performances of Nile tilapia (*O. niloticus*).

Materials and Methods

The study was conducted at the wet laboratories of Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka. Live Tilapia fingerlings of 30 days old were collected from the Bangladesh Fisheries Research Institute (BFRI), Mymensingh. They were transported to the laboratory of BCSIR in oxygenated polythene bags. Two types of commercial feeds (Mega Feed Industry) were supplemented with *Hypnea* sp. powder from BFRI Marine Technology Station, Cox's Bazar. Nursery feed was used for1st seven days and floating feed was used after seven days. Nursery feed contained 35% crude protein, 6% crude fat, 5% crude fiber and 12% moisture and floating feed contained 30% crude protein, 3% crude fat, 10% crude fiber and 12% moisture.

The feeding trials were conducted in ten aquaria with a duplicate for three months with experimental feeds. In total 30 tilapia fingerlings having more or less similar body length and weight were stocked in each glass aquarium of volume ($30 \times 14 \times 6$ inches) at Zoology Section of BCSIR, Dhaka, Bangladesh. The fingerlings in each aquarium were fed twice in a day at 5% of the average body weight. To run the experiment properly, all the aquaria were cleaned up, prepared with necessary facilities and oxygen supply was ensured before the fingerlings were stocked. Sixty liter of clean tap water was kept in each aquarium. The feces and other dirt were removed and water was changed once in a week. Dead fingerlings were counted. Thermometer, pH meter (Jenway, Model 3020, UK), dissolved oxygen meter (Model Oxi 3150i, Germany) and Jenway 4510 conductivity meter were used to measure water temperature, pH, dissolved oxygen, Total Dissolved Solids (TDS) and conductivity respectively.

Tilapia fingerlings were treated with five different experimental feeds in which one was control that means contained only commercial feed as basal diet and four feeds contained various percentages of seaweed supplementation. The commercial feed was supplemented with 5%, 10%, 15% and 20% seaweed in T1, T2, T3 and T4 respectively. After preparing the mixture, hand pellet machine was used to prepare

pellet format of feed. The feeds were then dried and stored in airtight bottle in fridge until used.

Growth in length and weight of tilapia fingerlings were measured at 30 days interval. Lengths of the fingerlings were measured with measuring scale and weight with weighing balance. Five fingerlings/fish from each aquarium were measured randomly at a time. After recording length and weight the fingerlings were then slowly released into the aquarium.

Average daily gain was calculated by the formula:

$$ADG = \frac{\text{Mean final fish weight} - \text{Mean initial fish weight}}{T-t}$$

Where, T = Final day, t = Initial day

Specific growth rate was calculated by the formula:

$$SGR\,(\%) = \frac{(\ln WT - \ln Wt)}{T-t} \times 100$$

Where, ln wT = Natural log of weight at time T
ln wt = Natural log of initial weight, T = Final day, t = Initial day

Condition factor was calculated by the formula:

$$K = (W/L^3) \times 100$$

Where, K = Condition factor, W = Body weight in gram (g), L = Body length in centimeter (cm)

Feed conversion ratio was calculated by the formula:

$$FCR = \frac{\text{Feed (g) consumed by the fish}}{\text{Weight (g) gain of the fish (W2} - \text{W1)}}$$

Where, W2 = Final weight (g); W1 = Initial weight (g)

The data were subjected to one-way analysis of variance (ANOVA) test using SPSS version 20.0. Where ANOVA revealed significant difference ($p < 0.05$), Tukeys test was applied.

Results and Discussion

In this study, growth performances of tilapia fingerlings have been analyzed based on Average Daily Gain (ADG), Specific Growth Rate (SGR%), Condition Factor (K) and Feed Conversion Ratio (FCR). During 3 months of rearing period, two types of analysis were performed for ADG, SGR(%), K and FCR. Firstly, the data were compared among five treatments and secondly, periodic data for each of three months were compared within each treatment.

The highest value of ADG of tilapia was observed in T2 (0.093 ± 0.0 g) followed by T1, T3 and lowest ADG was observed in C (0.082 ± 0.003 g) and T4 (0.082 ± 0.005 g), when ADG were compared among treatments. There was no significant differences among the treatments ($p > 0.05$) (Table I).

Table I. Average Daily Gain (ADG) at 3 months rearing period

Treatments	1st month (g)	2nd month (g)	3rd month (g)	Average for 3 months (g)
T1 (5% Seaweed)	0.045±0.006	0.075±0.001	0.144±0.006	0.088±0.004
T2 (10% Seaweed)	0.041±0.004	0.107±0.075	0.132±0.004	0.093±0.000
T3 (15% seaweed)	0.049±0.013	0.060±0.014	0.140±0.042	0.083±0.005
T4 (20% seaweed)	0.039±0.013	0.066±0.022	0.141±0.024	0.082±0.005
C (Control)	0.047±0.012	0.099±0.013	0.101±0.008	0.082±0.003

Values are mean ± SEM gram of duplicate groups of 30 fishes.

When ADG were compared for every month within each treatments, in all treatments, the highest ADG were found for 3rd month. For T1, there were significant differences among 3rd (0.144±0.006 g), 2nd (0.075±0.001 g) and 1st (0.045±0.006 g) month. Statistically model assumptions were not violated and the value of ADG for three months were co-related in T1. For T2, ADG for 2nd (0.107±0.075 g) and 3rd (0.132±0.004 g) month were significantly higher than 1st month (0.041±0.004 g) but the model assumptions were not fulfilled. The value of ADG for three months were co-related in T2. There was no significant differences for ADG value among 3 months within C, T3 and T4 ($p > 0.05$) (Table I). Overall, the highest ADG was found in T1 at 3rd month (0.144±0.006 g) and the lowest one was in T4 at 1st month (0.039±0.013 g).

Increased ADG of the fish suggested that the fish were able to regulate osmotic pressure of the body fluid, this was in agreement with suggestions of Nikolsky (1963), who reported that the more the osmoregulatory adaptation, lesser the difference between the composition and pressures of internal fluid of the organism and its external environment. ADG value relies on size of fish, sex, age, physiological condition and so on.

The highest average SGR (%) among five treatments was achieved by T2 (2.04±0.01), followed by T1 and T3 and the lowest SGR (%) was found in C (1.92±0.04) and T4 (1.92±0.06). There were no significant differences among the treatments ($p > 0.05$) (Table II). When SGR was compared within each treatments for different months, the highest SGR was found for C in the 2nd month (2.31±0.42) and for T1 in the 1st month (2.04±0.21). The highest SGR for T2 was in 2nd month (2.53±0.19) which was significantly higher than 3rd month (1.69±0.06), the method assumptions were not totally fulfilled and the values for 3 months were not co- related. For T3, the highest SGR was in 1st month (2.14±0.43) and for T4 was in 3rd month (2.14±0.36). Overall, the highest SGR was in T2 at 2nd month (2.53±0.19) and the lowest was in C at the 3rd month (1.36±0.08) (Table II).

Table II. Specific Growth Rate (SGR) at 3 months rearing period

Treatments	1st month (%)	2nd month (%)	3rd month (%)	Average for 3 months (%)
T1 (5% Seaweed)	2.04 ± 0.21	1.89 ± 0.07	2.01 ± 0	1.99 ± 0.05
T2 (10% Seaweed)	1.88 ± 0.14	2.53 ± 0.19	1.69 ± 0.06	2.04 ± 0.01
T3 (15% seaweed)	2.14 ± 0.43	1.52 ± 0.14	2.12 ± 0.73	1.93 ± 0.06
T4 (20% seaweed)	1.78 ± 0.47	2.08 ± 0.41	2.14 ± 0.36	1.92 ± 0.06
C (Control)	2.06 ± 0.37	2.31 ± 0.42	1.36 ± 0.08	1.92 ± 0.04

Values are mean $\pm$ SEM of duplicate groups of 30 fishes.

According to Medawar's (1945) fifth law, "the specific growth rate declines more and more slowly as the organism increases in age" at various conditions. Minot (1990) reported that for most animals the specific growth rate is highest early in life and that it typically decreases with increasing age, becoming zero in some animals. Again SGR may vary depending on temperature, salinity, DO, light intensity, water current and so on.

The highest value of average condition factor (K) of tilapia was observed in T2 (K$=2.32 \pm 0.05$) followed by C, T4, T3 and lowest condition factor was found in T1 (1.76 ± 0.09), when K were compared among treatments. There was no significant differences among the treatments ($p > 0.05$).When K values were compared at months interval individually within each treatment, highest condition factors in C was found for 3rd month (2.21 ± 0.385). In T1, the highest K was in initial condition. In T2, K value of the 3rd month (2.32 ± 0.05) was significantly higher than that of the 1st month (1.63 ± 0.130); method assumptions were not violated and K value for 1st, 2nd and 3rd month were co-related. In T3, the highest K value was found initially. In T4, K value was high initially and K for 3rd month (1.97 ± 0.055) was significantly higher than 2nd (1.61 ± 0.065) and 1st (1.51 ± 0.010) month and they were co-related. Overall, the highest K value was found in T2 at 3rd month (2.32 ± 0.05) and the lowest one was in T4 at 1st month (1.51 ± 0.01) (Table III).

Table III. Condition factor at 3 months rearing period

Treatments	Initial	1st month	2nd month	3rd month
T1 (5% Seaweed)	2.18 ± 0	1.63 ± 0.055	1.89 ± 0.005	1.76 ± 0.090
T2 (10% Seaweed)	2.18 ± 0	1.63 ± 0.130	2.20 ± 0.130	2.32 ± 0.050
T3 (15% seaweed)	2.18 ± 0	1.72 ± 0.035	1.83 ± 0.045	1.96 ± 0.095
T4 (20% seaweed)	2.18 ± 0	1.51 ± 0.010	1.61 ± 0.065	1.97 ± 0.055
C (Control)	2.18 ± 0	1.60 ± 0.005	1.72 ± 0.505	2.21 ± 0.385

Values are mean $\pm$ SEM of duplicate groups of 30 fishes.

Comparison of average FCR among different treatments resulted the lowest FCR in T2 (1.94 ± 0.01) followed by T1, T3, C and the highest one was found in T4. There was no significant differences among the treatments ($p>0.05$) (Table IV). When compared FCR for each of 3 months within each treatment, in C the lowest FCR was observed for the 2nd month (1.5 ± 0.20). In T1, the lowest FCR was for the 3rd month (1.86 ± 0.08). In T2 lowest FCR was for the 2nd month (1.38 ± 0.10). Here, FCR for 2nd and 3rd month was significantly lower than 1st month. Statistically method assumptions were not fulfilled and the values were not co- related. In T3 lowest FCR for 3rd month (2.09 ± 0.62) and in T4 for 3rd month (1.95 ± 0.33). Overall, the lowest FCR was found in T2 at 2nd month (1.38 ± 0.10) and the highest one was in T4 at 1st month (3.74 ± 1.25) (Table IV).

Table IV. Food Conversion Ratio (FCR) at 3 months rearing period

Treatments	1st month	2nd month	3rd month	Average for 3 months
T1 (5% Seaweed)	2.90 ± 0.39	1.95 ± 0.03	1.86 ± 0.08	2.05 ± 0.1
T2 (10% Seaweed)	3.19 ± 0.31	1.38 ± 0.10	2.02 ± 0.06	1.94 ± 0.01
T3 (15% seaweed)	2.83 ± 0.77	2.58 ± 0.62	2.09 ± 0.62	2.18 ± 0.13
T4 (20% seaweed)	3.74 ± 1.25	2.49 ± 0.82	1.95 ± 0.33	2.21 ± 0.13
C (Control)	2.90 ± 0.73	1.5 ± 0.20	2.67 ± 0.22	2.20 ± 0.09

Values are mean $\pm$ SEM of duplicate groups of 30 fishes.

The efficiency feed conversion ratio depends on many factors but the best response is probably strongly related to optimize the environment to approximate that to which the fish is accustomed. Analysis of all results indicated that T2 (10%) seaweed showed best growth performances during 3 months rearing period.

Conclusions

In this experiment, effects of different levels of seaweed (*Hypnea* sp.) on growth performance of Nile tilapia (*O. niloticus*) were evident. The use of seaweed as a supplement with commercial feed would be effective in its optimum level of application. On the other hand, excessive amount of seaweed may decrease the growth performances. In this study, after analyzing all results it can be concluded that among all treatments, T2 (10% seaweed) could be considered as optimum for Nile tilapia fingerling growth. Thus, commercial culture of Nile tilapia using seaweed (*Hypnea* sp.) powder as supplementary food additives has a chance to improve growth performance in comparison with other commercially sold feed.

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