

# Effects of Salinity on the Feeding Efficiencies, Growth Performances and Survival Rate of 11<sup>th</sup> Strain of Tilapia (GIFU) in Laboratory Condition

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## Authors' contributions

*This work was carried out in collaboration among all authors. Author AFMAR designed the study, performed the statistical analysis. Author SC wrote the first draft of the manuscript. Author SC and BSS managed the analysis of the study. Also, author MHM and AFMAR managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

Feeding experiment was conducted for 45 days to evaluate the effects of salinity on the feeding efficiencies, growth performances and survival rate of 11<sup>th</sup> strain of tilapia, *Oreochromis niloticus* (GIFU) in laboratory condition. Three rectangular glass tanks were used for the experiment with different level of salinity (0 as control; 8ppt and 10ppt (ppt means parts per thousand, g/l) as treatment 1 and treatment 2 respectively) using two replicates for each level of salinity. Seventy-five fingerlings were stocked in the tanks. The investigation was conducted at one feeding rate (3% of body weight) which has given twice a day in a 1 X 2 factorial experiment. Average food conversion ratios (FCR) were  $2.66 \pm 0.04$ ,  $1.76 \pm 0.04$  and  $1.69 \pm 0.07$  in controls, T<sub>1</sub>, and T<sub>2</sub> respectively. Average protein efficiency ratios (PER) were  $0.63 \pm 0.04$ ,  $1.31 \pm 0.01$  and  $1.68 \pm 0.02$  in control, T<sub>1</sub>, and T<sub>2</sub> respectively. The feed efficiency (FE) were  $35.22 \pm 1.54$ ,  $32.45 \pm 1.22$ , and

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31.54 ± 1.85 in control, T<sub>1</sub> and T<sub>2</sub> and specific growth rate (SGR) were 0.42 ± 0.03 %/d in control, 0.99 ± 0.03 %/d in T<sub>1</sub> and 1.34 ± 0.09 %/d in T<sub>2</sub> respectively. The net weight gain of fish in T<sub>2</sub> (39.12 ± 0.17 g) and T<sub>1</sub> (31.1 ± 0.02 g) were significantly higher than that of control (30.00 ± 0.21 g). The net length gain of fish in T<sub>2</sub> (12.12 ± 0.03 cm) and T<sub>1</sub> (10.5 ± 0.02 cm) were significantly higher than that of control (9.5 ± 0.04 cm). The survival rates were 85%, 100% and 100% in C, T<sub>1</sub> and T<sub>2</sub> respectively. The proximate composition of fishes, water quality parameter, feeding efficiencies and growth performances were better in T<sub>2</sub> than that of T<sub>1</sub> and C. The best growth was found from T<sub>2</sub> (salinity 10 ppt) and lower growth was found from control (salinity 0 ppt) in case of GIFU. The present study revealed that GIFU can tolerate a wide range of salinity and shown better growth and survival rate.

**Keywords:** *Tilapia*; GIFU; growth performance; proximate composition; water salinity.

## 1. INTRODUCTION

Bangladesh is an agro-based riverine country. It is endowed with 6, 78,724 hectare of closed waterbody and 40, 24,934 hectare of open waterbody [1]. Some climatic conditions such as vast water resources, warm temperature, high rainfall and favorable humidity make the country very rich in aquatic biodiversity and at present it has the assemblage of 275 freshwater, 475 marine water, 24 prawns and 36 species of shrimps [2,3]. During the period of 2010-2011, the country's total yield was 30, 61, 687 metric tons and it is increasing day by day. Per capital annual fish intake is 18.94 kg/person in 2010-2011 against demand of 20.44 kg/person. So, there is a vast gap between supply and demand of fish [4,5,6,7]. For that reason, the culture period of fishes and even the species of fishes vary from one to another [8,9].

Ecologically important fish species may result from climate-driven changes causes changes in growth, reproductive success and mortality. Adaptations could include both changes in the life history events (migration, spawning etc.) and/or physiological changes e. g. thermal reaction norms of key traits such as growth, increased tolerance to lowered pH/ocean acidification etc [9]. About 80% people of our country directly or indirectly depends on agricultural sector for their livelihood. More than 10% population of Bangladesh is directly or indirectly depending on fisheries sector for their livelihood. Moreover, 10% coastal areas will be flooded with saline water in the near future [9]. So, it is high time to choose a freshwater species that can tolerate an appropriate salinity range to cope with the problem faced by coastal water farmer to meet up their food demand.

Tilapias (*Oreochromis* spp.) are cichlid fishes, which have become one of the most important species in global and important fresh water

finfish in aquaculture (Fujimura, et al., 2011). GIFU is the 11<sup>th</sup> generation strain of Nile tilapia (*Oreochromis niloticus*). Tilapia aquaculture is rapidly expanding with a global production of about 2.8 million metric tons in 2008 and estimated to increase to 8.89 million metric tons by the year 2020 [10]. In our country several different strains have been developed by BFRI (Bangladesh Fisheries Research Institute) such as mono sex, GIFT etc. These are very fast-growing species, having high survival rate and FCR, SGR etc. By producing salinity tolerant GIFU, it would be possible to improve the socio-economic condition of coastal people. Salinity is one of the limiting factors in the life history of GIFU. Effects of salinity was reported on oxygen, pH, temperature and specific gravity by Nikolsky [11], on gametes and fertilization period of the fish by Holliday and Jones [12] and Rockwell [13]; on metamorphosis, early development and hatching of teleosts by Heut (1947), Kinne [14]; on behavioral response by Baggerman (1960) was done before. Growth rate of the native species and Indian major carps (IMCs) is relatively slow and increased the aquaculture cost due to salinity in Bangladesh. Any improvement of the above-mentioned growth parameter in saline water will benefit lots to the producers, fish farmers and finally the consumers. Combined effects of salinity (0, 8, 12, and 16 ppt) and temperature (24, 28, and 32°C) on growth and feed utilization of juvenile Nile tilapia, *O. niloticus* (Linnaeus, 1758) were studied [15]. Final mean weights of fish were significantly higher at 32 °C and 28°C than 24°C at 12 ppt salinity. Feed conversion efficiencies and protein efficiency ratios were highest at 32°C and 8 ppt salinity, and lowest at 28°C and 16 ppt salinity. However, the effects of salinity on feeding efficiencies, growth performances and also on survival rate of 11<sup>th</sup> generation strain of tilapia (GIFU) in laboratory condition has not yet been reported.

The overall objectives of this study will be to know the effects of salinity on feeding efficiency and growth performance of GIFU. Because the aforesaid species show potential production so it might be a potential candidate for aquaculture in an area where salinity intrusion is a major problem especially in coastal area of Bangladesh.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Fish and Acclimation in the Laboratory

The 11th strain of tilapia, (GIFU) i.e. Nile Tilapia (tilapia in Bengali) *Oreochromis niloticus* (Linnaeus, 1758) advanced fingerlings (75 samples) were used as experimental animals obtained from earthen ponds of hatchery complex of Zubin Agrobased Industries Limited (ZAIL), Noakhali, Bangladesh. The fishes were conditioned in the laboratory over a period of seven days. During conditioning, the fishes were not given any food. Before experimental stocking, the fishes were fasted for 7 days to evacuate their previous gut contents. After fasting, length (cm) and weight (g) of 10 fish and total batch weight was measured. The total batch weight was taken 15 days interval to determine the feeding ration. The fishes were selected with same size during fasting and week fish was culled out by removing the dead ones. After fasting the fishes were given sample diet to determine the feeding ration.

### 2.2 Experimental Systems

The fingerlings were cultured in captive environment in flow-through glass tanks (150 L). The flow rate maintained into the tanks was 1 L/min. Air blower was used for aeration. Six glass tanks were filled with tap water and placed inside the Laboratory, Department of Fisheries and Marine Science, Noakhali Science and Technology University, Bangladesh.

### 2.3 Experimental and Indicator Variable

The experimental variables were the levels of salinity (0 ppt as control; treatment 1 with 8 ppt and treatment 2 with 10 ppt). The reason for selecting salinity range as 8 and 10 ppt because GIFU shows higher growth in this salinity range as suggested by our literature review. There were three aspects of this study, for example, feeding efficiencies, growth performances and survival rate. Water salinity, dissolved oxygen

(DO), temperature, pH and transparency in the glass tanks were also monitored at 15 days interval.

### 2.4 Sampling

The culture potentiality was assessed by recording the rate of growth in terms of gain in length (cm) and in weight (g) of fish. The samples were taken from each experimental unit by using a small seine net after 15 days interval to determine feed conversion ratio (FCR), protein efficiency ratio (PER), average daily gain (ADG), specific growth rate (SGR), and feeding efficiency. The total number of samples was 10 for the above-mentioned variables. Weight was taken with a digital balance (Scout Pro Balance – Model: SP402) and length with a measuring scale. All the data recorded in a note book and spread sheet and then finally calculated the average length and weight of fishes according to treatment on each sampling day. Dissolved oxygen, water temperature, pH, salinity and transparency were monitored in the culture tanks at the time of fish sampling.

### 2.5 Feeding Schedule and Frequency

The fishes were fed twice a day and the time of feeding was every day morning (between 8 and 9 am) and afternoon (4 to 5 pm). The fishes were fed 3% of their body weight (BW).

### 2.6 Experimental Design

The effect of salinity on feeding efficiencies, growth performances and survival rate of 11<sup>th</sup> strain of tilapia (GIFU) assessed with one-way ANOVA. The tanks were placed by following completely randomized design (CRD) method. The experiment was conducted with 2 replicates (Table 1).

### 2.7 Feeding Efficiencies

#### 2.7.1 Feed conversion ratio (FCR)

Food conversion ratio (FCR) is calculated from the number of kilos of feed that are used to produce one kilo of whole fish. Food conversion ratio (FCR) was determined by the following formula (as suggested by AOAC):

$$FCR = \frac{\text{Feed consumed by the fish (g) (dry weight basis)}}{\text{Live weight of the fish (g)}}$$

**Table 1. Experimental design**

Treatment	Replication	Stocking density/treatment	Feeding frequency (Twice a day)
Control	R <sub>1</sub>	25	Morning (8.00-9.00 am) and
0 ppt	R <sub>2</sub>	25	Afternoon (4.00-5.00 pm)
Treatment 1 (T <sub>1</sub> )	R <sub>1</sub>	25	Morning (8.00-9.00 am) and
8 ppt	R <sub>2</sub>	25	Afternoon (4.00-5.00 pm)
Treatment 2 (T <sub>2</sub> )	R <sub>1</sub>	25	Morning (8.00-9.00 am) and
10ppt	R <sub>2</sub>	25	Afternoon (4.00-5.00 pm)

### 2.7.2 Protein efficiency ratio (PER)

Protein efficiency ratio was determined by using the following formula:

$$PER = \frac{\text{Total weight gained}}{\text{Protein fed}}$$

### 2.7.3 Feed efficiency (FE)

Feed efficiency was determined by the following formula (as suggested by AOAC):

$$\text{Feed efficiency} = \frac{\text{Weight gained in wet weight}}{\text{Feed intake in dry weight}} \times 100$$

### 2.7.4 Specific growth rate (SGR, %/d)

Specific growth rate (SGR) was calculated as the percentage increase in weight per animal per day suggested by Hopkins (1992).

$$SGR\% = (\ln FW - \ln IW) / \text{days} \times 100$$

Where, SGR% = Percentage increase in body weight per fish per day;

ln FW = natural log of final weight or weight at harvest,

ln IW = natural log of initial weight;

### 2.7.5 Average daily gain (ADG)

Average daily (weight, g) gain was determined by using the following formula: -

$$ADG = \frac{\text{Total final fish weight} - \text{Total initial fish weight}}{\text{Days}}$$

### 2.7.6 Condition factor or ponderal index

The condition factor or ponderal index 'k' was calculated by using the following formula as suggested by Hile (1936):

$$k = \frac{W}{L^3} \times 100$$

Here,

k= condition factor;

W= body weight in grams; and

L= body Length in centimeters.

### 2.8 Survival rate (%)

Survival rates were measured on the basis of total fish harvested at the end of each fortnight until the end of the study. The survival rate was calculated by using the following formula (as suggested by AOAC),

$$\text{Survival rate (\%)} = \frac{\text{No. of actual fish survived}}{\text{No. of actual fish stocked}} \times 100$$

### 2.9 Feed and Carcass Analysis

The experimental diet was ground to a fine power by using a mortar and pestle, analyzed for moisture, crude protein, crude lipids, ash and nitrogen free extract.

### 2.10 Statistical Analysis

The effect of salinity on feeding efficiencies, growth performances and survival rate of 11<sup>th</sup> strain of tilapia (GIFU) assessed with one-way ANOVA. The tanks were placed following completely randomized design (CRD) method. The experiment was conducted with 2 replicates. SGR, PER, FCR, ADG, and feeding efficiency were transformed into square root transformations before analysis. Statistical analysis was performed by DMRT and one-way analysis of variance (ANOVA) to test the significance (p<0.05) of variation between the treatment value through SPSS 11.5 Statistical Software 11.5.

## 3. RESULTS AND DISCUSSION

GIFU, at present is an important commercial fish species in Bangladesh though its culture is limited to the freshwater pond only. But Tilapia is a highly tolerant species as far we know [16].

According to Mahfuz et al., growth rate of fish increase with the increase of dietary protein till the optimum level is reached. Jana and Chakraborty [17] suggest the growth, reproductive potentials, and survival of each species are affected by the nutrient conditions of the culture media. In the present study the experiment was conducted in closed condition in aquaria that were different than any natural environment.

The study had three aspects: Feeding efficiencies, Growth performances and survival rate of GIFU.

### 3.1 Feeding Efficiency

#### 3.1.1 Feed conversion ratio (FCR %)

The highest FCR ( $2.66 \pm 0.04$ ) was found in the control while the lowest FCR ( $1.69 \pm 0.07$ ) was measured in treatment 2. FCR ( $1.76 \pm 0.04$ ) observed in the treatment 1 was significantly lower than that of control & higher than that of treatment 2 (Fig. 1).

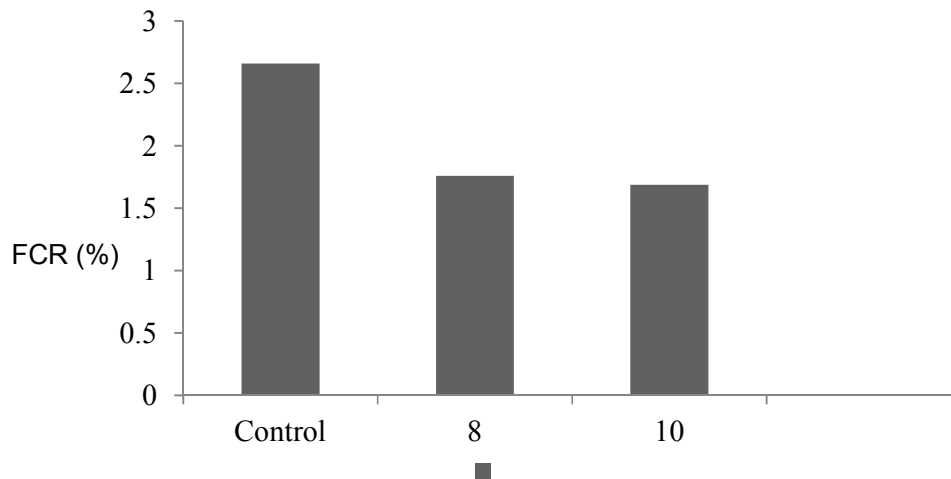
FCR was high in the control and decrease with increasing levels of salinity. The highest FCR in the control could be due to less utilization of feed while low FCR in the treatment 2 and 1 might be explained by better utilization.

Doolgindachabapom [18] observed similar FCR (1.8 to 3.0) in koi brood fish. Gaumet et al. [19] found that food conversion ratio (FCR) were lower in a diluted environment in case of juvenile turbot suggest that growth conditions could be improved by adaptation to brackish waters.

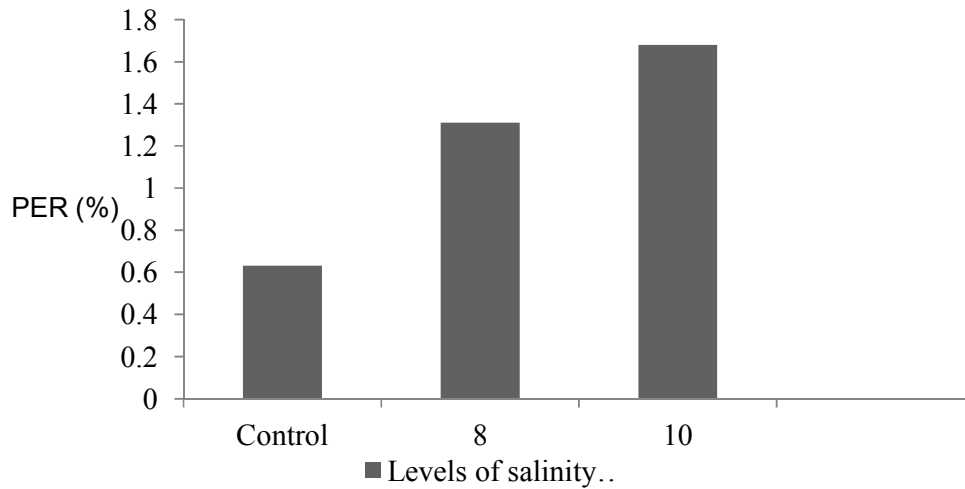
#### 3.1.2. Protein efficiency ratio (PER %)

PER was highest in the treatment 2 ( $1.68 \pm 0.02a$ ) and lowest in the control ( $0.63 \pm 0.04$ ). However, PER in the treatment 1 ( $1.31 \pm 0.01$ ) was significantly higher than that of control and lower than treatment 2 (Fig. 2).

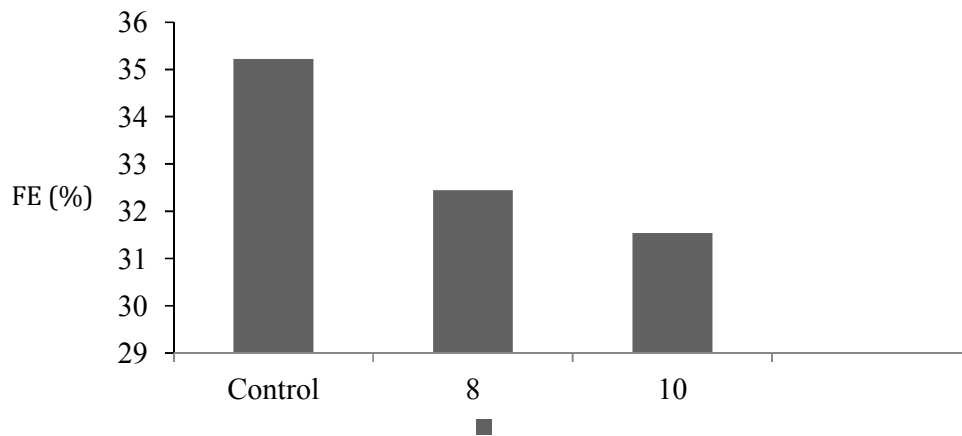
Similar to FCR, the highest PER was found in the treatment 2 followed by treatment 1 and lowest in the control. This differences in the PER could also be linked to the low utilization efficiencies of feed due to no salinity and levels of salinity ( $T_1$ ,  $T_2$ ) in the tank where the experimental animals are stocked. Fish could utilize protein more efficiently from feed when they are reared in saline water compared to the fish which are reared in normal water. Woo and Kelly (1995) found that protein efficiency ratios (PER) of sea bream cultured at 15 ppt were consistently higher than those at other salinities. Likongwe et al. [15] observed highest PER at 8 ppt salinity in *Oreochromis niloticus*.



**Fig. 1. Feed conversion ratio (FCR) of feed in GIFU (*O. niloticus*) which are cultured with and without salinity measured in a laboratory experiment. Bars (mean  $\pm$  SEM) with different letters are significantly different ( $p < 0.05$ )**



**Fig. 2. Protein efficiency ratio (PER %) of feed with and without salinity in GIFU (*O. niloticus*) observed in a laboratory trial. Bars (mean  $\pm$  SEM) with different letters denote significant differences ( $p < 0.05$ )**



**Fig. 3. Feed efficiency (%) of feed with and without salinity in GIFU (*O. niloticus*) observed in a laboratory test. Bars (mean  $\pm$  SEM) with no letters denote insignificant differences ( $p < 0.05$ )**

### 3.1.3 Feed efficiency (%)

Although there were no significant differences in the feed efficiency (FE) across all treatments ( $T_1$ :  $32.45 \pm 1.22$ ,  $T_2$ :  $31.54 \pm 1.85$  and control:  $35.22 \pm 1.54$ ), the feed efficiency was high in the control and declined gradually between two treatments (Fig. 3).

Feed efficiency was similar across all treatments and controls. However, there was a decreasing trend in the feed efficiency with increasing levels of salinity. This decreasing trend in feeding

efficiency in treatment indicates the effectiveness of salinity and their benefit to use.

### 3.1.4 Specific growth rate (SGR, %/d)

The highest SGR ( $1.34 \pm 0.09$  %/d) was measured in the treatment 2 while the lowest SGR ( $0.42 \pm 0.03$  %/d) was found in the control. However, the SGR ( $0.99 \pm 0.03$  %/d) observed in the treatment 1 was significantly lower than that of treatment 2 and higher than that of the control (Fig. 4).

### 3.1.5 Average daily gain (ADG, g/d)

The highest ADG ( $0.26 \pm 0.03$  g/d) found in the fish was in treatment 2 while the lowest ADG ( $0.14 \pm 0.01$  g/d) found in the fish was in control. However, the ADG ( $0.2 \pm 0.01$ g/d) measured in the treatment 1 was significantly lower than treatment 2 and higher than that of control (Fig. 5).

SGR and ADG were highest in the treatment 2 followed by treatment 1 and lowest in the control. Fish fed in salinity water could help for better growth by better assimilation of feed. Different fish species may require different level of salinity. Imsland et al. (2007) observed that the specific growth rates (SGR) of *Hippoglossus hippoglossus* reared at 15 ppt (SGR:  $1.29 \pm 0.03$ ) and 25 ppt (SGR:  $1.25 \pm 0.04$ ) was significantly higher than that of other salinities.

### 3.1.6 Condition factor (k)

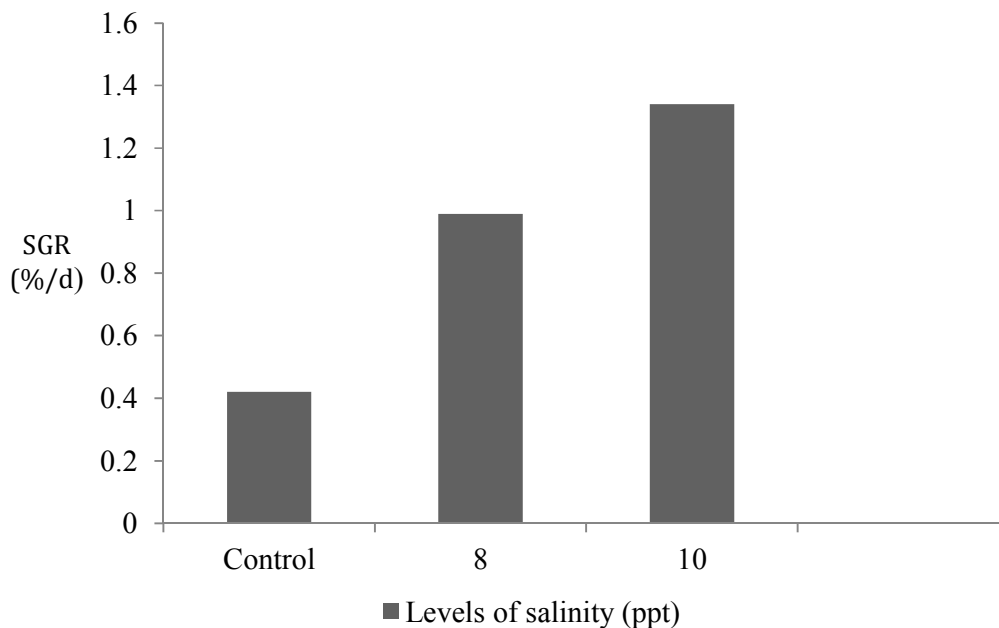
The condition factor k was highest ( $0.57 \pm 0.02^b$  %) in the treatment 2 and lowest in the control ( $0.31 \pm 0.08^a$  %). However, condition factor ( $0.42 \pm 0.08^a$  %) in the treatment 1 was similar to those of control and treatment 2 (Fig. 6).

### 3.2 Growth Performance

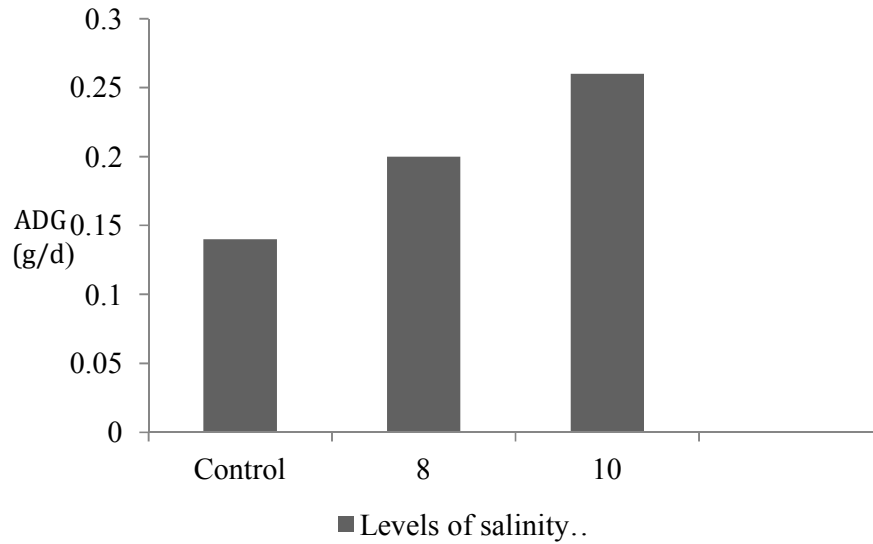
In the present study, the final weight gain (g) was obtained  $30.00 \pm 0.21$ ,  $31.1 \pm 0.02$  and  $39.12 \pm 0.17$  g in C, T<sub>1</sub> and T<sub>2</sub> respectively. The final length gain (cm) was obtained  $9.5 \pm 0.04$ ,  $10.5 \pm 0.02$  and  $12.12 \pm 0.03$  cm in C, T<sub>1</sub> and T<sub>2</sub> respectively for 45 days experimental period (Table 3). Table 3 shows the growth performance of GIFU in present study.

Salinity has influence on the growing capacities in larger fish, juveniles or adults and it appear that marine fish present higher developmental or growth rates at lower salinity and fresh water fish at higher salinity [20].

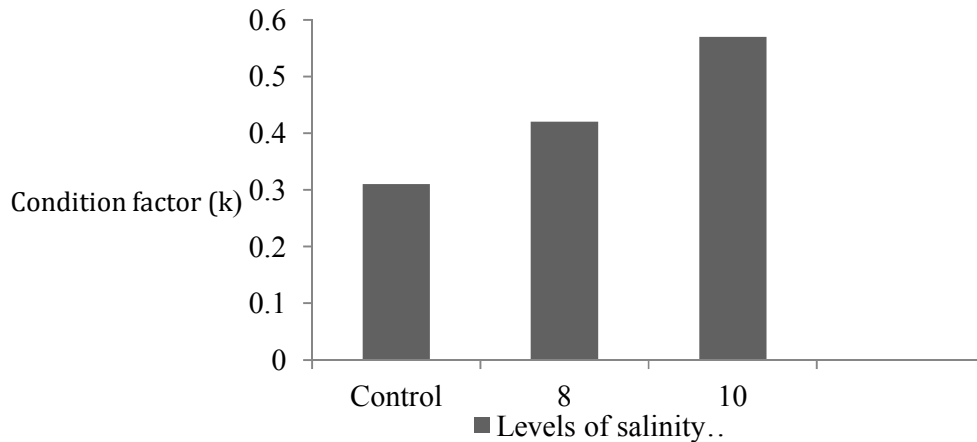
In the present study, the highest final weight gain (g) was obtained in T<sub>2</sub> than that of control and T<sub>1</sub> respectively. The highest final length gain (cm) was obtained in T<sub>2</sub> than that of control and T<sub>1</sub> respectively for 45 days experimental period. It seems that when saline water used for culture in case of GIFU, higher production can be achieved and growth is high in 10 ppt than in 8 ppt and higher than control.



**Fig. 4. Specific growth rate (SGR, %/d) measured in GIFU (*O. niloticus*) fed feed with and without salinity upon culturing 45 days in flow-through glass tanks (150 L) with continuous air diffusion. Bars (mean  $\pm$  SEM) with different letters are significantly different ( $p < 0.05$ )**



**Fig. 5. Average daily gain (%) in GIFU (*O. niloticus*) sampled upon culturing 45 days in flow-through plastic tank (150 L) with continuous air diffusion. Bars (mean  $\pm$  SEM) with different letters are significantly different ( $p < 0.05$ )**



**Fig. 6. Condition factor (k) in GIFU (*O. niloticus*) determined after 45 days upon culturing in flow-through plastic tank (150 L) fed feed with and without salinity. Bars (mean  $\pm$  SEM) different letters indicate significant differences ( $p < 0.05$ )**

**Table 2. Feeding efficiencies of GIFU**

Parameter	Control	T <sub>1</sub>	T <sub>2</sub>
FCR	2.66 $\pm$ 0.04 <sup>c</sup>	1.76 $\pm$ 0.04 <sup>b</sup>	1.69 $\pm$ 0.07 <sup>a</sup>
PER	0.63 $\pm$ 0.04 <sup>c</sup>	1.31 $\pm$ 0.01 <sup>b</sup>	1.68 $\pm$ 0.02 <sup>a</sup>
FE	35.22 $\pm$ 1.54 <sup>c</sup>	32.45 $\pm$ 1.22 <sup>b</sup>	31.54 $\pm$ 1.85 <sup>a</sup>
SGR	0.42 $\pm$ 0.03 <sup>b</sup>	0.99 $\pm$ 0.03 <sup>b</sup>	1.34 $\pm$ 0.09 <sup>a</sup>
ADG	0.14 $\pm$ 0.01 <sup>a</sup>	0.2 $\pm$ 0.01 <sup>a</sup>	0.26 $\pm$ 0.03 <sup>b</sup>
CF	0.31 $\pm$ 0.08 <sup>a</sup>	0.42 $\pm$ 0.08 <sup>a</sup>	0.57 $\pm$ 0.02 <sup>b</sup>

Values in a same row having same superscripts are not significantly different ( $p > 0.05$ )



**Table 3. Growth performance of GIFU**

Treatment	Parameters			
	Weight gain(g) (M±SE)	Length gain(cm) (M±SE)	Final weight gain (M±SE)	Final length gain (M±SE)
C	30.00 ± 0.21 <sup>b</sup>	9.5 ± 0.04 <sup>c</sup>	3412.12 ± 30.10 <sup>b</sup>	125.52 ± 1.32 <sup>c</sup>
T <sub>1</sub>	31.1 ± 0.02 <sup>a</sup>	10.5 ± 0.02 <sup>b</sup>	3555.55 ± 27.01 <sup>a</sup>	145.01 ± 0.36 <sup>b</sup>
T <sub>2</sub>	39.12 ± 0.17 <sup>a</sup>	12.12 ± 0.03 <sup>a</sup>	4363.63 ± 25.23 <sup>a</sup>	162.14 ± 1.02 <sup>a</sup>

Values of the parameters in each column with different subscripts (a, b, and c) differs significantly ( $p < 0.05$ )

Bray and Lawrance [21] found highest mean final weights in case of *Penaeus vannamei* when they are cultured in 5 and 15 ppt salinities. Farnandes et al. [22] found that salinity improved the growth of females in *Oreochromis niloticus* that was accompanied by the highest plasma T<sub>3</sub> levels. Imsland et al. (2007) observed that the final mean weight of *Hippoglossus hippoglossus* reared at 15 ppt and 25 ppt was significantly larger than other salinities. Lam and Sharma [23] found that the growth and development of carp larvae increased with increasing salinity from fresh water to 10‰ sea water. Likongwe et al. [15] observed higher final mean weight at 12 ppt salinity in *Oreochromis niloticus*. Konstantinov and Martynova [24] reported that in experimenting with fresh water species (Carp, *Cyprinus carpio*, White Amur, *Cyprinus idella*, and Russian sturgeon, *Acipenser guldenstaedti*) a salinity of 2 ppt considerably increased growth rate and food efficiency, by improving the food conversion rate. Secor et al. (2000) found that growth of *Morone saxatilis* was approximately 40% higher at 7 ppt than at 0.5 ppt because salinity had a strong effect on striped bass growth rates. Suresh and Lin [25] showed that a range of 10 – 20 ppt is optimal for growth in tilapia. Woo and Kelly [26] found that growth rates of sea bream cultured at 15 ppt were consistently higher than those at other salinities. Growth enhancement was accompanied by a reduction in oxygen consumption, ammonia excretion rates, liver lipid levels and hepatic glucose-6-phosphatase activity. Growth enhancement at 15 ppt may be explained by reduction of metabolic cost of osmoregulation, and reorganization of metabolism which would allow protein sparing in favor of a shift towards preferential utilization of carbohydrate and lipid.

### 3.3 Survival Rate

The survival rate of GIFU (*O. niloticus*) during the period of experiment was 85%, 100% and 100% in C, T<sub>1</sub> and T<sub>2</sub> respectively (Table 4) although similar stocking density was maintained in all treatments.

Salinity is an important factor affecting the survival, metabolism and distribution of fish species [25]. The survival rate of GIFU (*O. niloticus*) during the period of experiment was 85%, 100% and 100% in C, T<sub>1</sub> and T<sub>2</sub> respectively although similar stocking density was maintained in all treatments. So, saline water does not effect on survival rate of fish. Even survival rate was 100% in 8 and 10 ppt saline water than in normal water. Stickney (1979) stated that the effect of salinity on survival rate depends on the ability of body fluid for tolerate changes of osmolality and ion concentrations. The results of this study showed that different levels of salinity had affected to the growth performance where the best growth was achieved at 8 ppt and 10 ppt.

### 3.4 Proximate Composition

#### 3.4.1 Proximate composition of feed

Proximate composition of feed that were used for the fingerlings of GIFU has indicated on the following table (Table 5). From the table it has been observed that the moisture content (%) was ranged from 9.11 to 10.75, Protein (%) was from 29.65 to 30.05, Lipid (%) was from 4.22 to 6.51, Ash (%) was from 17.01 to 18.91, and Nitrogen free extract (%) was from 26.35 to 28.69.

It has been observed that the moisture (%) was ranged from 9.11 to 10.75, Protein (%) was from 29.65 to 30.05, Lipid (%) was from 4.22 to 6.51, Ash (%) was from 17.01 to 18.91, and Nitrogen free extract (%) was from 26.35 to 28.69 in the feed.

The protein requirement of fish is influenced by various factors such as fish size, water temperature, feeding rate, availability and quality of natural foods and overall digestible energy content of diet. The crude protein content of experimented feeds analyzed is within the acceptable range recommended for fish [27].

**Table 4. Survival rate of GIFU**

Survival rate (%) (M±SE)	C	T <sub>1</sub>	T <sub>2</sub>
1.	85 ± 0.21 <sup>a</sup>	100 ± 0.00 <sup>a</sup>	100 ± 0.00 <sup>a</sup>

Values of the parameter in each row with different superscripts differs significantly ( $P < 0.05$ )

**Table 5. Proximate composition of the experimental feed**

Sample no.	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Nitrogen free extract (%)
1	10.75	29.76	5.91	17.01	26.35
2	9.11	30.05	4.22	18.91	27.90
3	9.56	29.65	6.51	17.89	28.69
Average ± Mean	9.81 ± 0.21	29.82 ± 0.85	5.55 ± 1.18	17.94 ± 0.95	27.65 ± 1.19

Means within each comparison in the same column with the different superscripts differ significantly ( $P < 0.05$ ) and Means within each comparison in the same column with the same superscripts are not significantly different ( $P > 0.05$ )

Watanabe et al. (2002) observed that catfish production was increased through the use of high amounts of protein (35% or more) in their diet and phase feeding may be more profitable.

Lipids are primarily included in formulated diet to maximize their protein sparing effect by being a source of energy. In this study, the lipid content was Lipid (%) was from 4.22 to 6.51 which are similar to the findings of Luquet [28] who stated that dietary lipid levels of 5 to 6% are often used in tilapia diet.

The moisture (%) was ranged from 9.11 to 10.75 indicated to have the smaller number of microbial loads [29].

### 3.4.2 Proximate compositions of fish

Proximate composition of experimental fish has shown in the Table 6. The moisture content (%) of fish was ranged from 63.28-69.71, Protein (%) was from 19.62 to 24.62, fat (%) was from 5.13 to 7.91 and the Ash was from 0.99 to 1.41.

Moisture, protein, fat and ash as major components and carbohydrates, vitamins and minerals as minor components form the main constituents of fish body. Fish protein is very rich in amino acid such as methionine, lysine and

tryptophan. Besides fishes is a rich source of essential nutrients required for supplementing both infant and adult diets [30].

#### 3.4.2.1 Moisture variation

The moisture content (%) of raw fish was 69.71 which is more or less similar to the findings of Begum and Minar [6,7] where they found the estimated moisture content (%) for *G. chapra*, *C. soborna*, *A. punctata*, *C. psendeutropius atherinoides*, *P. sarana* was 76.01, 77.91, 75.46, 76.60, 71.3. Mahfuz et al. [16] found the moisture was 72.41 for *L. bata*, and 71.75 for *L. gonina* [31]. On the other hand, the moisture content for T<sub>1</sub> was 65.25 and T<sub>2</sub> was 63.28 which showed significant variation ( $P < 0.05$ ) from the normal one.

#### 3.4.2.2 Protein variation

The protein content of raw fish was 19.62 which were much more similar with the findings of Mazumder et al. (2008) in *G. chapra* and *P. chola*. The results of protein percentage in *Labeo rohita* and *L. calabasu* of the research findings of Saha and Guha which were 16.6% and 14.7% respectively. Gheyasuddin et al. [32] also found the result of protein percentage in silver pomfret

**Table 6. Proximate compositions of experimental fish muscle**

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)
Control	69.71 ± 2.23 <sup>c</sup>	19.62 ± 1.19 <sup>b</sup>	7.91 ± 0.54 <sup>c</sup>	1.41 ± 0.18 <sup>b</sup>
T <sub>1</sub>	65.25 ± 1.81 <sup>b</sup>	22.01 ± 1.11 <sup>b</sup>	6.80 ± 0.98 <sup>a</sup>	1.02 ± 0.24 <sup>a</sup>
T <sub>2</sub>	63.28 ± 1.02 <sup>a</sup>	24.62 ± 0.90 <sup>a</sup>	5.13 ± 1.01 <sup>b</sup>	0.99 ± 0.15 <sup>a</sup>

Means within each comparison in the same column with the different superscripts differ significantly ( $P < 0.05$ ) and Means within each comparison in the same column with the same superscripts are not significantly different ( $P > 0.05$ )

**Table 7. Water quality parameters taken at 15 days interval**

Water quality parameters	Control (0 ppt) (M±SE)	Treatment 1 (8 ppt) (M±SE)	Treatment 2 (10 ppt) (M±SE)
Dissolved oxygen (mg/l)	5.1 ± 0.01	6.4 ± 0.22	7.0 ± 0.01
Temperature (°C)	28.01 ± 0.20	30.50 ± 0.12	31.47 ± 0.16
pH	7.09 ± 0.02	9.41 ± 0.23	8.04 ± 0.01
Transparency (cm)	20.56 ± 0.43	16.01 ± 0.25	14.23 ± 0.12

Values of the parameter in each row with different superscripts differs significantly ( $p < 0.05$ )

(*Stromateus cinereus*) was 16.70% and Ribbon fish (*Trichiurus haumela*) was 16.6% while the percentage was much higher in *C. gariepinus* 19.64% and in *Cirrhinus reba* 19.74% found by Osibona et al. [33] and Mridha et al. [34] respectively.

#### 3.4.2.3 Lipid variation

The lipid content of the experimented fish sample was observed 5.13 % in T<sub>2</sub> and 7.91 % in control. This species usually contains more amount of oil than any other marine estuarine fishes. The average values of lipid were much higher when compared to some native fish such as *G. chapra*, *C. soborna*, *A. punctata*, *C. psendeutropius atherinoides* where the values of lipid were ranged from 4.55, 3.99, 4.5, 1.87 respectively [6,7]. The presents study depicts that the variation in the level of lipid may be due to season which in turn affect the fish diet. Stansby [35] in his experiment on proximate composition of Pacific Cod (*Gadus macrocephalus*) and Mackerel (*Scomber scombrus*) found that Pacific cod contained higher percentage of lipid content in comparison to Mackerel. In his report Pacific Cod and Mackerel contained 0.6% and 13.0% fat.

#### 3.4.2.4 Ash variation

The ash content of experimented fish was 1.41 in control. Chakwa and Shaba [36] found higher amount of ash content in *Claris gariepinus* (3.06%) than the studied fish, while Devadsan et al. (1978) in his experiment found lower amount of ash content in six freshwater fishes *L. rohita* (1.31%), *Catla catla* (0.93%), *Cirrhinus cirrhosus* (1.40%), *L. calabasu* (1.02%), *Mystus seeghala* (0.91%) and *Wallagu attu* (0.72%). According to Devadsan et al. (1978) variation in proximate composition of fish flesh may vary with species variation, season, age and feeding habit of the fish. Generally, moisture content shows inverse relationship with lipid content. [6,7,4,5,30,37,31].

### 3.5 Water Quality Variables

The water quality parameters were recorded from the three different treatments during the experimental period which are shown in Table 7.

Dissolved oxygen concentration was maintained between 5 and 7 mg/l. Banerjee [38] and Siddik et al. [39] considered 5.00 to 7.00 mg/l of dissolved oxygen content of water to be fair or good in respect of productivity and water having dissolved oxygen below 5.00 mg/l to be unproductive. The water temperature ranged between 28 and 31 °C. Similar temperature was also achieved by Siddik et al. [39] where temperature range was between 17.86°C - 29.91 °C. Most of the tilapia strain do not grow well when the temperature is 16 °C and do not survive at temperature below 10°C or more than a few days (2007). In addition, pH was maintained between 7 and 9 and transparency was between 14 to 20 cm throughout the entire study periods. In the present study transparency varied from one sampling date to others and might be due to the abundance of plankton and unused feed mix with the water. Swingle (1969) stated that pH ranges from 6.5 to 9 was suitable for fish culture.

### 4. CONCLUSION

The current study showed that the importance of evaluating the role of salinity on the feeding efficiencies, growth performances, survival rate, and proximate composition of the feed and the fish, GIFU (*Oreochromis niloticus*) and also on water quality variables. A significantly positive effect of the highest salinity level on the feeding efficiency and growth performances of (GIFU) is demonstrated in this study i. e. GIFU grows fastly in 10 ppt salinity than 0 and 8 ppt. However, salinity did not affect the survival rate of GIFU and the interesting thing was that the survival rate of GIFU in control situation was lower than that of the saline water. A significantly positive effect of proximate composition of the GIFU is demonstrated in this study. The water quality

variables were also better in all three treatments. Aforesaid GIFU was taken under consideration for the salinity tolerances and culture potentials. Currents research simulation has proved that GIFU species would enable more efficient successful aquaculture operations and substitution for freshwater fish species in the climatic affected zone of the greater Noakhali coastal region.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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