

Effect of Different Feeding Rates on Growth Performance and Survival Rate of Tilapia (*Oreochromis niloticus* L. 1758) Fingerlings Reared in Rectangular Hapas

Abstract

11 The study was designed with three experimental hapas namely T₁, T₂ and T₃ for a period of 8 weeks
12 commencing from 06th October to 06th December, 2017 to assess the effect of feeding ration on the
13 growth and survival rate of *Oreochromis niloticus*. The experiment. The hapas were equal in size
14 (0.0725 decimal) and rectangular in shape. A stocking density of 420 fish/decimal was used for the
15 experiment in all three treatments. The fish were dependent on natural food in T₁, fed at the rate of
16 8% of their body weight in T₂ and the feeding rate was 12% in T₃. Feeding frequency was two times
17 in a day in T₂ and T₃. The proximate composition of the experimental diet (% dry matter basis) was
18 moisture 11%, protein 30%, fat 6%, ash 10% and fiber 7%. The range of water quality parameters
19 (water temperature 28 to 32°C, Dissolved oxygen 5.6 to 7.8 mg/l and water pH 7.5 to 8.6) were
20 found suitable during the experimental period. The mean initial weight of Tilapia fry in three
21 treatments were 3g and the mean final weight of tilapia was (6.8±4.77) g for T₁, (9.88±5.76) g for
22 T₂ and (19.2±9.9) g for T₃, respectively. The mean initial length was 5 cm in three treatment and
23 final length was found (8.2±6.15) cm, (9.86±7.36) cm and (12±8.23) cm in T₁, T₂ and T₃,
24 respectively. The highest weight and length gain was found in T₃ having the feeding rate of 12% of
25 the body weight and lowest was found in T₁ in which no supplementary feed was used.

26 **Keywords:** Feeding Rate, Growth performance, *Oreochromis niloticus*, Survival rate

28

30 **Introduction**

31
32 Bangladesh is a land of river and fish are very much abundant in rivers and other natural water
33 body. Fish plays a crucial role in the Bangladeshi diet, providing more than 60% of animal source
34 food (DoF, 2015), representing a crucial source of micro-nutrients and possessing an extremely
35 strong cultural attachment. The economy of Bangladesh is primarily based on Agriculture and fish
36 (including shrimp and prawn) and fish is the second most valuable agricultural crop, and its
37 production contributes to the livelihoods and employment of millions. Fisheries contribution to
38 agricultural GDP 23.12% and fisheries contribution to national GDP 3.69% (DoF, 2015). The
39 employment of people (full time & part time) approximately 11% of the total population which in
40 number 17.80 million is involved in fisheries (DoF, 2015). Bangladesh earns 630.24 \$ million
41 foreign exchanges by exporting fish and fisheries product in 2013-14 (DoF, 2015). In Bangladesh
42 the aquaculture production from inland closed water-bodies is 55.15% of the total production.
43 (FRSS, 2015). Bangladesh ranked 5th as aquaculture producing country in the world (FAO, 2015).

44 The Nile tilapia, *Oreochromis niloticus* is a widely cultured species because it grows and
45 reproduces in a wide range of environmental conditions and tolerates stress induced by handling
46 (Tsadik and Bart, 2007). It is currently ranked second only to carps in global production. The
47 predominant advantage of monosex culture can be achieved in such aquaculture situations.
48 *Oreochromis niloticus* has been considered as one of the most important species of fish in tropical
49 & sub-tropical aquaculture (FAO, 2014). With increase in human population and diminished
50 natural fisheries resources, aquaculture is rapidly gaining importance. Pond aquaculture is growing
51 fast in many resource-constrained Asian countries. In order to maintain the present per capita
52 supply of aquatic products in the future, further growth of aquaculture production is needed as the
53 supply through capture fisheries cannot grow any more. But, fish culture on a small-scale basis has
54 often failed due to inadequate knowledge regarding ideal feeding rate, stocking density and feeding
55 frequency of fish.

56 However, feeding frequency is generally used to refer how many times the organisms should be fed
57 in a day. It is considered to be one of the important factors that affect fish growth, feed utilization
58 and gross fish yield. The full utilization of space for maximum fish production through intensive
59 culture can improve the profitability of the fish farm. Tilapia has established a secure position in a
60 number of water impoundments of Bangladesh, where one sex displays remarkable growth
61 superiority. Thus, culture of monosex tilapia might prove effective to induce a positive approach

62 towards tilapia culture in Bangladesh. Considering these aspects, the present study aims to evaluate
63 the growth performance of the all-male monosex tilapia population at various feeding rate and also
64 to evaluate growth performance on natural feed to determine an ideal feeding rate for tilapia culture
65 under this climatic and ecological conditions. Feed cost is one of the largest operational costs in
66 aquaculture. Therefore, the act of feeding may be pointed as one of the most important elements in
67 the culture practice. It is evident from the earlier studies that, rate of feeding plays a vital effect on
68 the digestibility of fish, as excess feeding may lead to leaching of nutrients and limited feeding may
69 reduce the growth rate of fish due to starvation. Therefore, it is important to standardize the feeding
70 frequency for the target species in aquaculture for desired growth. The main objective of the study
71 was to establish a suitable culture method and feeding frequency in which the growth of a major
72 fish species for aquaculture in Bangladesh *Oreochromis niloticus* response best.

73 **Methods & Materials**

74 *Study Area and duration*

75 The experiment was conducted in the Bismillah agro farm and hatchery (Fig.1). The study period
76 was conducted between 06th October to 06th December, 2017. An 8-week experiment was
77 conducted in pond where main source of water was pump and rain water. The water depth of the
78 water body was more than 3 feet on average, where net of the cage (hapa) was set in a manner that
79 it maintains minimum of water level always higher than 1.5 feet inside the cage.



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Fig. 1: The study area collected from google maps

82 *Experimental design*

83 This experiment was conducted by establishing 3 different cages in the water body using net and
84 local bamboo. The size of each cage was $8_L \times 4_W \times 4_H$ feet. Distance of each cage from its neighboring
85 one was maintained 100 cm. and same distance was maintained between the embankment and a
86 cage. Three cages were marked as treatment-1 (T_1), treatment-2 (T_2) and treatment-3 (T_3). In the
87 treatment of T_1 , no supplementary feed was given and fish was completely dependent on natural
88 food. In T_2 , feed was given by 8% of the body weight of the *Oreochromis niloticus* and in T_3 feed
89 was given 12% of the body weight (Table. 01). Stocking density was 420 fish/decimal in all three
90 treatments.

91 Table 01: Experimental layout of *Oreochromis niloticus*

Treatment	Size of the cage(dec.)	Stocking density/dec	Number of fish	Fish feed
T-1	0.0725	420	30	No
T-2	0.0725	420	30	8%
T-3	0.0725	420	30	12%

92

93 *Collection of fry and Conditioning*

94 The *Oreochromis niloticus* fry was collected from Bismillah Agro based farm, Noakhali. The fry
95 was 40 days old. The average length of the fry was 5 cm and weight were 3 g on average. Same
96 length and weight of fry were selected for this study. All fry were healthy and disease free. The fry
97 was conditioned in the Bismillah Agro farm for 3 hours before stoking in the experimental hapa.

98 *Stocking of fish*

99 After preparation of hapa fry (*Oreochromis niloticus*) was stocked into the hapa. All fishes were
100 similar in size and age. For every treatment 30 species were stocked. This species was healthy and
101 disease free. We use salt bath treatment for 3 minutes in 5ppm Epsom Salt Soaking Solution
102 (Magnesium sulfate) before stocking to ensure disease free fish.

103103

104 **Water quality parameters**

105 In the study period, water temperature, Dissolve oxygen, pH, abundance of natural food (plankton)
106 was recorded one times per week respectively. Water temperature of the experimental water body
107 was measured using a mercury Celsius thermometer one time in a week during the study period.
108 During the study period we measured temperature of the experimental water body at the same time
109 one day in a week. pH of the water body was measured one times in a week during the study period.
110 For this operation a digital portable pH meter (Model: HANNA- HI 96107) were used. To determine
111 the dissolve oxygen of the experimental water body a portable DO meter (Model: Lutron-DO-5509)
112 was used and DO was measured in the spot without collecting any water sample in the laboratory.

113 **Feeding management**

114 In this experiment floating starter feed (diameter: $2.6\pm 0.3\text{mm}$) is used throughout the experimental
115 period. Feed was given two times daily at 10:00 am in the morning and 5:00 pm in the afternoon.
116 The composition of the feed is given bellow.

1171 Table 02: Composition of feed used in the experiment

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Type of feed	Protein (minimum)	Moisture (maximum)	Fat (minimum)	Fiber (maximum)	Ash (maximum)
Floating starter	30%	11%	6%	7%	10%

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119 For T₁, no supplementary feed was supplied, T₂ feed were supplied according to 8% of the body
120 weight of the fish and for T₃ feed were supplied according to 12% of the body weight of the fish
121 (Fig. 2). Feeding rate was calculated from the average weight of tilapia after each sampling. Feed
122 was kept in air tight polythene bag. Feed was supplied directly without any feeding tray. Feed was
123 distributed evenly over the surface of the water inside the hapa. Half of the ration was supplied at
124 10:00 am and remaining half was supplied at 5:00 pm everyday respectively.



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Fig.2: The measurement of feeding ration

127 ***Sampling and measurement of length & weight***

128 Fishes were caught by using a scoop net from the hapa and measured the length and weight of each
129 species and data were recorded. For weighing an analogue balance machine was used and for length
130 a tap was used. Data on length and weight were taken every 7 days interval. During sampling day
131 all fishes were caught to confirm that if any fish have escaped or died. Health condition were
132 monitored during the sampling of fishes. The total sampling process were handled very carefully
133 as the small fry are very susceptible to handling stress. During sampling we tried to minimize the
134 sampling error carefully.

135 ***Study of growth parameters of fish***

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137 For evaluating the growth of fish, different growth parameters such as length gain (cm), weight gain
138 (g), specific growth rate (SGR % per day) and production (kg/ha/100 days) were taken into
139 consideration and were measured using the following formula:

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141 Weight gain (gm) = Mean final weight (gm) – Mean initial weight (gm)

142 Production = No. of fishes harvested × average final weight increase of fishes

143 Survival rate = $\frac{\text{No. of fish harvested}}{\text{No. of fish stocked}} \times 100$

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146 FCR= (Amount of feed given by dry weight)/ (Final live weight gain by the fish).

147 **Statistical analysis**

148 Data that are obtained from the experiment on growth performance, weight gain, increase in length,
149 survival rate and production were statistically analyzed to see whether the influence of different
150 treatments (feed) on these parameters were significant or not. This was done by using different
151 statistical method by the help of statistical software named Microsoft excel (version 2016).

152 **Results**

153 **Water quality parameters**

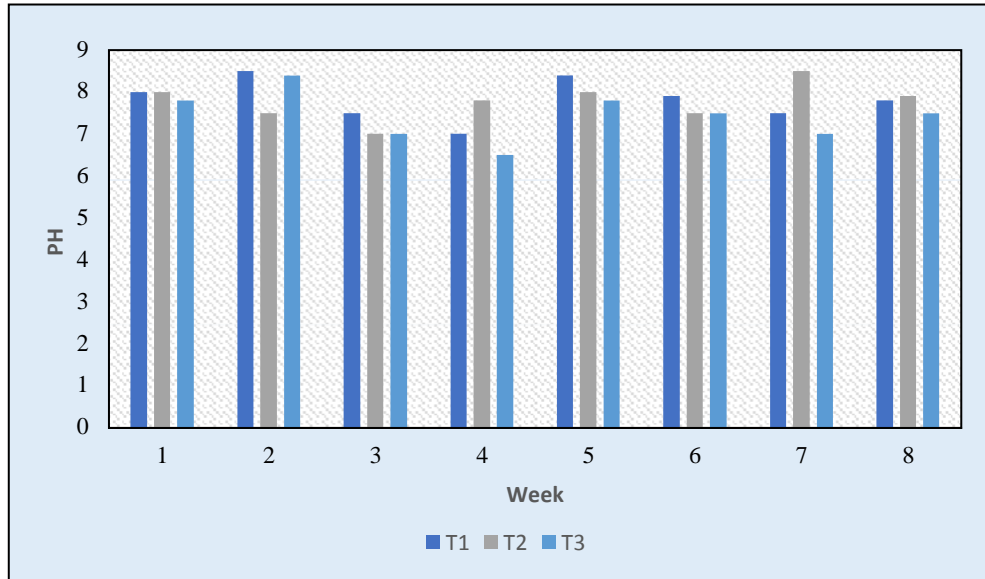
154 Water quality parameters of this experiment were monitored throughout the experimental period.
155 Temperature, pH, dissolve oxygen and transparency were observed during the whole study period.
156 Temperature, pH and dissolve oxygen were found variable and transparency was found almost
157 similar. All water quality parameter of the experimental water body is represented in the Table 03.

158 Table 03: water quality parameter

Treatment	Parameter	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week
T ₁	pH	8.0	8.5	7.5	7.0	8.4	7.9	7.5	7.8
	DO (mg/l)	7.0	6.3	6.8	7.1	6.4	6.9	6	6.6
	Temperature(°C)	30	32	29	28	30	29	30	31
T ₂	pH	8.0	7.5	7.0	7.8	8.0	7.5	8.5	7.9
	DO (mg/l)	7.0	7.5	7.0	7.4	6.0	6.5	7.4	6.0
	Temperature(°C)	30	29	31	28	30	32	30	29
T ₃	pH	7.8	8.4	7.0	6.5	7.8	7.5	7.0	7.5
	DO (mg/l)	5.8	6.5	6.4	7.6	6.5	7.6	7.3	6.0
	Temperature(°C)	28	30	32	29	30	32	31	32

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160 The pH of the experimental water body was measured in every 7 days interval during the study
161 period. The highest pH value was found 8.6 2nd week in T₁, and the lowest value of pH was found
162 7.5 in 2nd week. Average pH was highest in T₁ during the study period and it was 8.13 (Fig. 3).



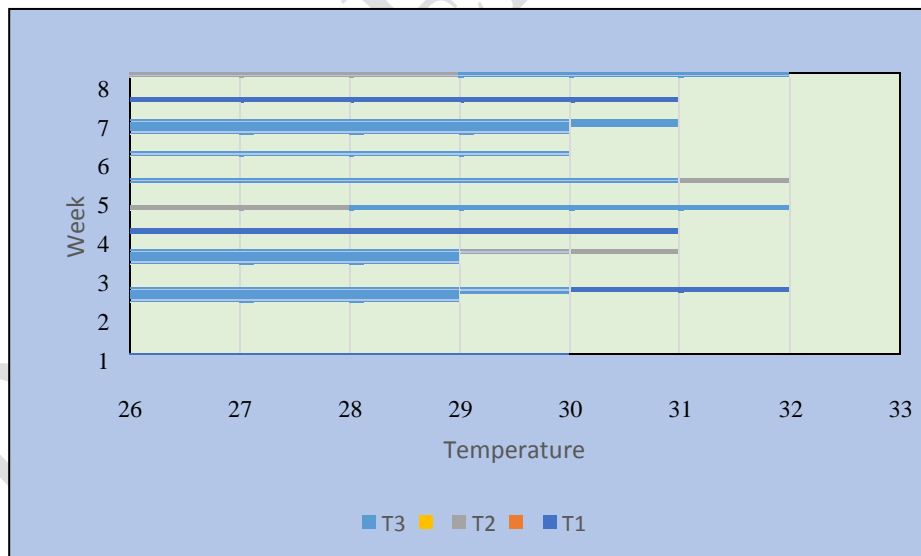
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Fig. 3: Variation of water pH during the study period

165 Temperature of the water was found highest 32°C in 2nd week in T1 and T3 and in 6th and 8th week
 166 in T2 and T3, respectively. The lowest temperature is recorded 28 °C in T1 2nd week and T2 in 4th
 167 week and T3 1st week. The average highest temperature was recorded 30.37 °C in T3 (Fig. 4).

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Fig. 4: Variation of water temperature during study period

171 Dissolve Oxygen was measured during the study period in every seven days interval. Highest DO
 172 was found 7.6 mg/l in T2. Lowest value of dissolve oxygen was recorded 5.6 mg/l in T1 in 8th week.
 173 From the figure we observe that the average DO level was higher at the beginning of the study
 174 period but the level of DO was decrease with the increase of the study period in all three treatments
 175 (Fig. 5).

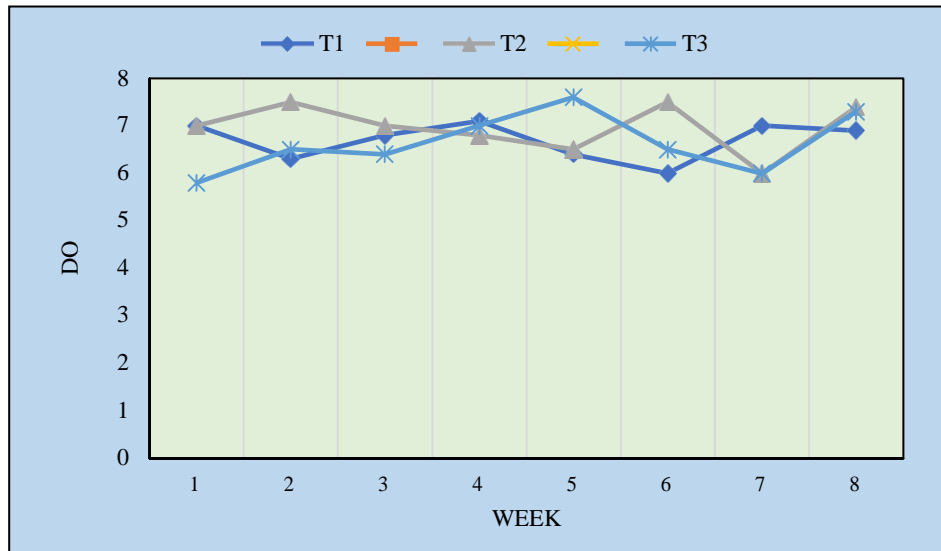


Fig. 5: Variation of water DO during study period

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179 ***Growth performance of Oreochromis niloticus***

180 Growth performance of Tilapia in different treatment was calculated by weight gain and increase
 181 in length. The evaluation of growth performance of *Oreochromis niloticus* in all treatment has been
 182 done in term of final weight gain (g), mean weight gain (g), average daily weight gain (g), percent
 183 weight gain (g), and survival rate of the species.

184 ***Weight performance***

185 Average total weight was calculated by using weight machine. The average initial weight of fish as
 186 in all treatments were 5g. Sampling was done randomly and found the weight of *Oreochromis*
 187 *niloticus* variable in different treatment. Weight of all fish increased with the time interval (from 1st
 188 week to 8th week). At the end of the experiment, average weight of *Oreochromis niloticus* in T₃ was
 189 found (19.2±9.9) gm, in T₂ weight was found (9.35±5.76) gm, in T₁ average weight was found
 190 (6.8±4.77) gm. The average weight gain of T₃ was found higher and lower in T₁ (Fig. 6).

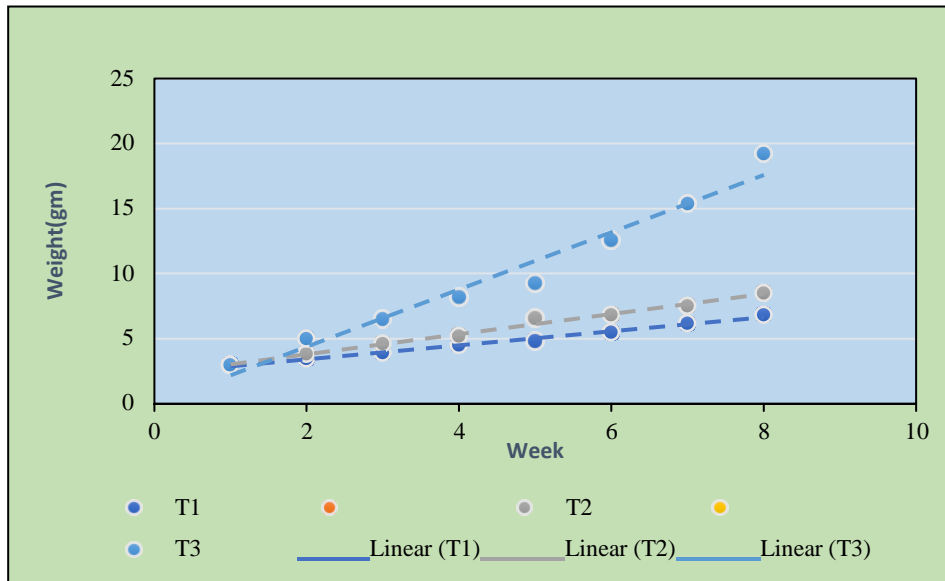


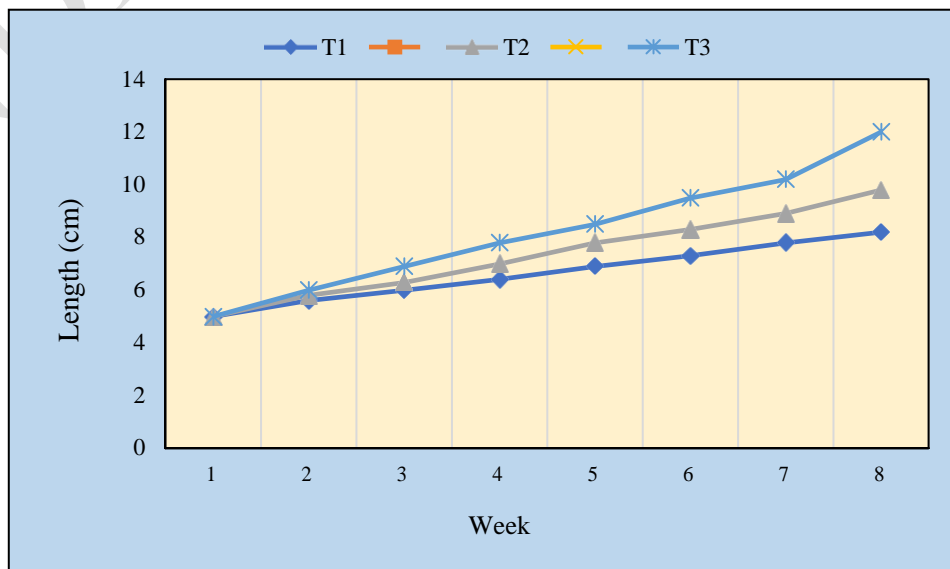
Fig. 6: Weight performance of Tilapia fry in different treatments

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193 *Observation of length performance*

194 Average total length was calculated by using a scale. Average Initial length of all fishes were 8 cm.
 195 For measurement of length of *Oreochromis niloticus*, random sampling was done and found the
 196 length variable in three treatments. Length of all fishes increased with the time interval. At the end
 197 of the experiment, average length of *Oreochromis niloticus* was found (8.2 ± 6.15) cm, (9.8 ± 7.36)
 198 cm and (12 ± 8.23) cm in T₁, T₂ and T₃, respectively. Increase in length was notable in T₃. Average
 199 increase in length was highest in T₃ than other three treatment. On the other hand, increase in length
 200 was found lowest in T₁ (Fig. 7).



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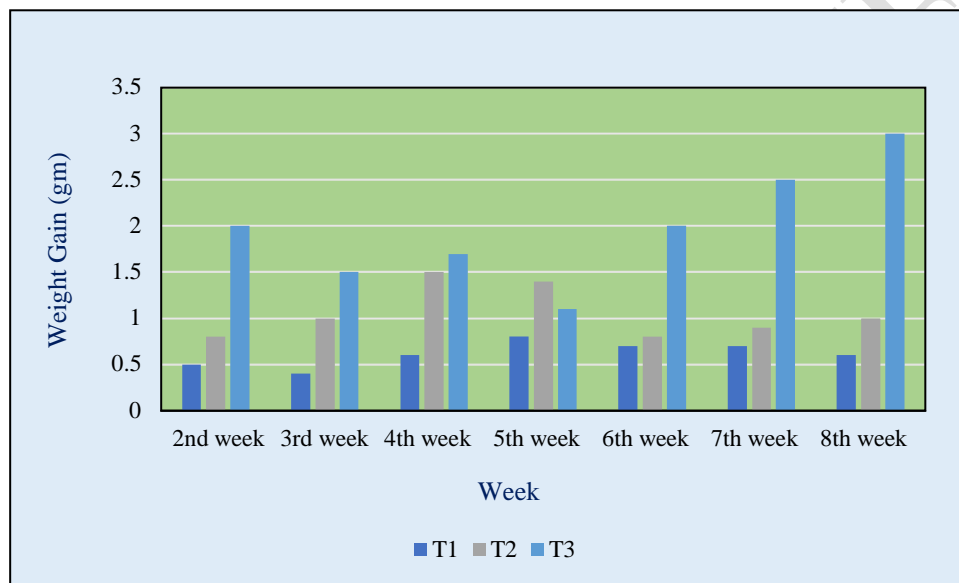
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Fig. 7: Length performance of *Oreochromis niloticus* fry in different treatment

UNDER PEER REVIEW

203 **Weight gain of *Oreochromis niloticus***

204 Weight gain of *Oreochromis niloticus* fish fry was observed during the study period in each
205 treatment. In each week weight gain was different. Final average weight was found 4.77g, 6.4g and
206 10.3g in T₁, T₂ and T₃, respectively. In T₁ weight gain was almost similar in every week. The
207 average weight gain in T₁ was (0.677±0.40) gm. In T₂ highest weight gain was recorded in 4th week
208 (1.5 gm) and lowest was found in 2st week (0.8 gm). In this treatment average weight gain was
209 (1.05±0.80) gm. In T₃ the highest weight gain was found in 8th week (3gm) and the lowest was
210 recorded in 5th week (1.1 gm). Average weight gain in T₃ was (1.97±1.12) gm (Fig. 8).



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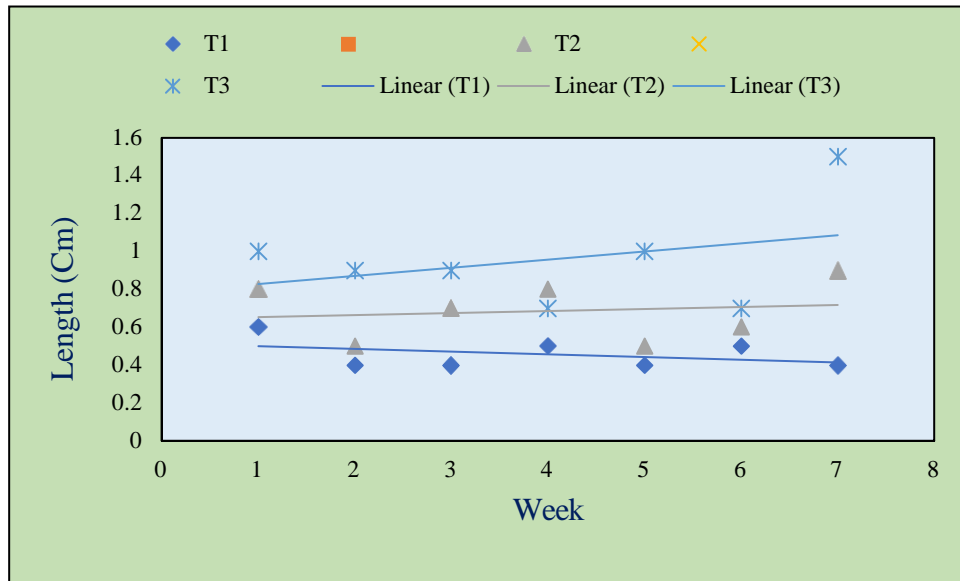
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213 Fig. 8: Variation in weight gain of *Oreochromis niloticus* in different treatment

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215 **Length gain of *Oreochromis niloticus***

216 Length gain of *Oreochromis niloticus* was observed during the whole study period in different
217 treatment. Final average length gain was 6.55 cm, 8.54 cm and 10.4cm in T₁, T₂ and T₃ respectively.
218 In T₁ highest length gain was found in 2nd week (0.6 cm) and the lowest was in 8th week and 3rd
219 week (0.4 cm). Average length gain in T₁ was (0.454±0.26) cm. In T₂ highest length gain was
220 found in 8th week (0.9 cm) and lowest was in 3th week (0.5 cm). The average length gain of T₂ was
221 found (0.685±0.69) cm. In T₃ highest growth was found in 8th week (1.5 cm) and lowest was in 5th
222 week (0.7 cm). The average length gain was (0.967±0.62) cm (Fig. 9).



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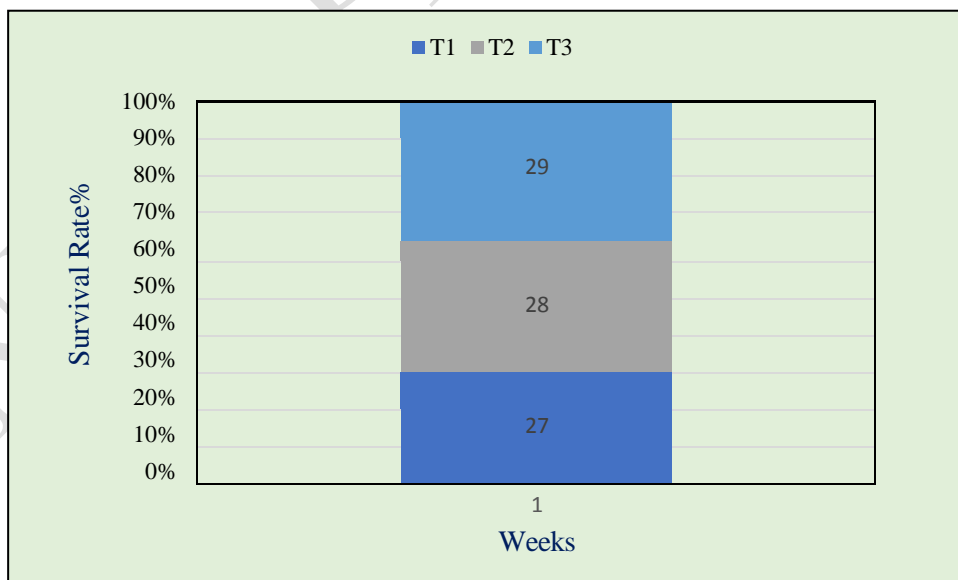
Fig. 9: Variation in length gain in different treatment

225 Survival rate

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227 The survival rate of fish was calculated and found variable in different treatment. Highest survival
 228 rate was found 96% in T₃. In T₁ survival rate was lowest and found 90%. In T₂ survival rate was
 229 93%. The variation in survival rate was due to environmental condition and different feeding
 230 percentage and feed utilization (Fig. 10).

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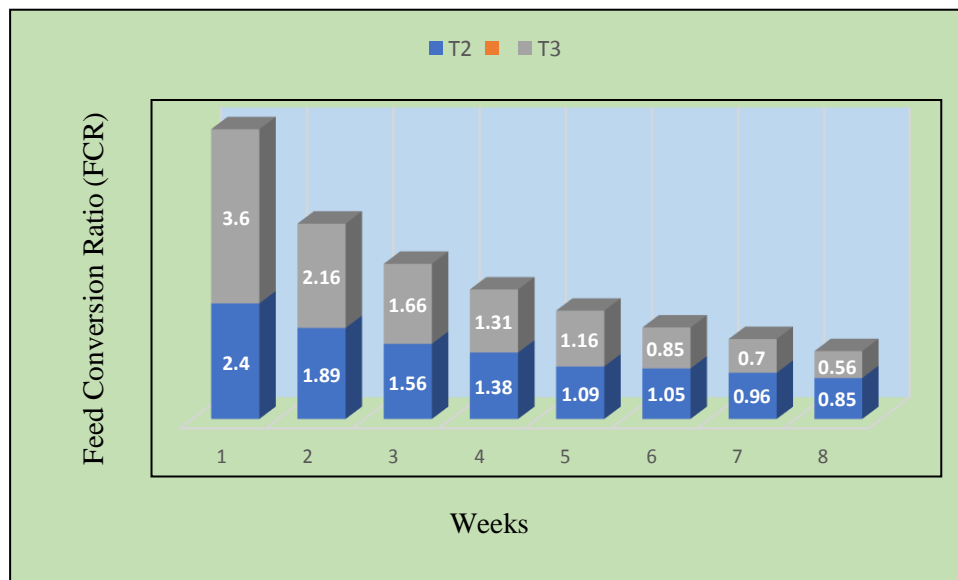
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Fig. 10: Survival rate of fry in different treatment

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235 **Observation of FCR**

236 FCR of the two experimental treatment (T₂ & T₃) was calculated after the study. In T₂ FCR is
237 found 2.4 and in T₃ FCR was found 3.6. In T₁ no feed were supplied this is why FCR was not
238 applicable for that treatment (Fig. 11).



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Fig11: Variation of FCR in different treatment

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242 **Discussion**

243 **Growth parameters**

244 **Weight performance**

245 The mean initial weight of fish fry in all three treatments were 3 g. At the end of the study, the mean
246 weight of *Oreochromis niloticus* were (6.8±4.77) g, (9.35±5.76) g and (19.2±9.9) g in T₁, T₂ and
247 T₃, respectively. The mean weight gains of fry at the end of the experiment were highest in T₃. The
248 mean weight of *Tilapia* fry at harvest was higher in T₃ (19.2±9.9g), followed by T₂ (8.5±5.76 g)
249 and T₁ (6.8±4.77g). The highest weight gain of *Oreochromis niloticus* was observed in T₃ in which
250 feed was given according to 12% body weight of the fish. Binh *et al.* (1997) carried out an
251 experiment in metal cage and found similar results in case of *Oreochromis niloticus* by feeding
252 formulated diet prepared by locally available material and used feed daily at a rate that decreased
253 with fish growth from 15% to 3% of body weight. Hussain *et al.* (2000) and Hasan *et al.* (1992)

254 reported a weight gain of about 128 g for Tilapia in on-farm ponds for a culture period of 6 months
255 fed rice bran at 5-6% of their body weight. Considering the 8 weeks culture period in this study,
256 compared to 6 months period by Hussain *et al.* (2000), Tilapia in the present study performed better
257 in respect of weight gain.

258 ***Length performance***

259 The mean initial length of fish fry in all three treatments were 5 cm. At the end of the study, the
260 mean length of Tilapia was (8.2± 6.65) cm, (9.8± 7.36) cm and (12± 8.23) cm in T₁, T₂ and T₃,
261 respectively. The mean length gains of fry at the end of the experiment were highest in T₃. The
262 mean length of Tilapia fry at the end of the study was higher in treatment T₃ (12 cm), followed by
263 T₂ (9.8cm) and T₁ (8.2cm). Olurin & Aderibigh (2006) collected One hundred juvenile of
264 *Oreochromis niloticus* after the end of the experiment and found the length of fish ranged from 5.5
265 to 11.4 cm. In the present study the highest average length was in T₃ (11.38) which was almost
266 similar to the findings of Olurin & Aderibigh (2006).

267 ***Survival rate (%)***

268 The mean survival rates of *Oreochromis niloticus* were recorded 93% in all three treatments. During
269 the study period. In the present study, higher survival was achieved as the fish can survive under
270 adverse conditions like low oxygen, high temperature and high pH value. The results of present
271 study were close to the research findings of Felt *et al.* (1998) who observed that the survival rates
272 of koi (*Anabas testudineus*) were varied from 60-80%. The result of this study also agrees with
273 Kohinoor (2000) for T₁ and T₃ who reported that the survival rates of *Oreochromis niloticus* varied
274 from 79%-92%.

275 ***Food Conversion Ratio (FCR)***

276 In the present study Food Conversion Ratio (FCR) values for Tilapia fry with the commercial feed
277 was 3.60 and 2.40 in T₁ and T₂, respectively. Lower FCR value (2.40) was obtained in T₂ with
278 supplemental feed at the rate of 8% body weight. Ahmed *et al.* (2013) found that Food Conversion
279 Ratio (FCR) was 1.51 and 1.40 respectively in homemade and commercial feed treatments in
280 Tilapia. Hossain *et al.* (2004) found FCR value formulated diet was 1.71-1.77 which was little
281 different from the present study. This difference could be due to the fact temperature and
282 geographical location difference as well management. In the present study moisture content was
283 11% which could also a cause of higher FCR value. Cruz and Laudencia (1998) indicated that the
284 fingerlings need 2030% crude protein in ration to give optimum results in ponds. The feed in T₂

285 and T₃ of the present study also contained crude protein within similar range. So, the change in FCR
286 is not due to protein in feed.

287 ***Water quality parameters***

288 Reproduction, growth, survivability and other activities of fish are largely depending on
289 temperature. Clarke (2004) reported that metabolic rates of organisms increase with the increase of
290 temperature. Again Clarke (1999) showed that perciform fish have not developed a mechanism that
291 allows them to adapt to the cold environment. Therefore, temperature has a remarkable effect on
292 overall production of fish. During the present study, the water temperatures were between 28°C and
293 32°C. Azaza *et al.* (2008) suggested that the growth and feed utilization of *Oreochromis niloticus*
294 juveniles may be higher at 26 and 30 °C. In the present study the temperature rang was higher than
295 Azaza. On the other hand, Platt & Hauser (2011) reported that the optimum temperature for feeding
296 is between 28.8 and 31.4°C and the fastest growth rate was at 31.4°C, at which the fish averaged
297 an increase of 3.42% of their body weight in 24 h. This temperature range is similar to the present
298 study. Ridha (2006) showed that (29.0±1.0) °C temperature of water can give a remarkable growth
299 (p<0.5) for (*Oreochromis niloticus*).

300 Dissolved oxygen of a water body is very important factor for fish culture. During the present study,
301 dissolved oxygen content was between 5.8 to 7.40 mg/l. DoF (1996) reported that suitable DO for
302 fish culture is from 5.0 – 8.0 ppm. The DO level of present study is not similar to DoF report. This
303 is due to environmental condition, type of water body and geographic location. Mollah & Haque
304 (1978) reported that DO level is 1.19 – 7.74 mg/l on average in two ponds in BAU Campus. The
305 findings of present study are similar to his study.

306 The range water of pH level in this study was 7.4 to 8.5. According to DoF (1996) the optimum
307 level for pH is 6.5 to 8.5. The level of pH in the present study is in optimum level according to
308 Boyd (1984) also described that pH level from 6.5 to 8.0 is acceptable for culture. But Mollah &
309 Haque (1978) said that pH level from 5.66-7.66 is suitable for fish culture. Compared to Mollah &
310 Haque (1978) pH level in the present study is little high. This is due to several environmental
311 condition, geographical location and other operational factors.

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313 Conclusion

314 *Oreochromis niloticus* has a high acceptance among the people of Bangladesh for its fastest growth,
315 low price and good test. This influences fish farmers to culture this species throughout the country.
316 In order to have a good profit farmers need to apply additional food as natural food is not always
317 enough for the higher growth in a limited time. In the view of economic aspect, using commercial
318 or supplemental feed in aquaculture should ensure minimum wastage of feed because feed
319 constitute the major part of the total budget and low feeding rate can reduce the target growth. For
320 that reason, fish farmer should have proper knowledge about the exact feed requirement of the fish.
321 Under the experimental condition, different treatments showed different growth rates. In the present
322 study, the mean final weight was higher in T₃. Although the individual weight gain in T₃ was highest
323 which might be due to difference in feeding rate. Based on the present experimental condition, it
324 can be recommended that the optimum feeding rate for Tilapia in hapa condition is 12% of their
325 body weight compared to 8% and only natural food is not sufficient for the profitable growth.

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