International Journal of Agricultural Sciences ISSN: 2167-0447 Vol. 4 (1), pp. 083-089, January 2014. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Salinity tolerance level of GIFU tilapia strain (*Oreochromis niloticus*) at juvenile stage

Monjurul Hasan, Bhakta Supratim Sarker, K. M. Shahriar Nazrul[1*] and Umma Salma Tonny[1]

Department of Fisheries and Marine Science, Noakhali Science and Technology University, Noakhali-3814, Bangladesh.
[1]Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

Accepted 06 December, 2013

An experiment was conducted to determine the salinity tolerance level at juvenile stage of Nile tilapia strain, GIFU. Juveniles of GIFU tilapia were subjected to five salinity levels for a period of 24 days. A total of 150 hatched fry of GIFU tilapia with initial individual weight of 0.013 g were stocked in 5 jars of 10 liter capacity for the experiment. Feed were given at a rate of 13% of total body weight per day containing 40% crude protein. Room and water temperature was maintained at 30 ± 2°C and 28±2°C respectively. Water was exchanged at the rate of 30% per day. At the end of experiment result showed that both growth and survival rate of fry were recorded highest at 0ppt salinity and lowest at 15ppt salinity respectively. Both growth and survival rate at 5ppt salinity was found better than 10ppt and 15ppt salinity. This finding suggests that juveniles of GIFU tilapia strain could survive well up to 5ppt salinity. Temperature was not found to be a significant factor either on survival rate or growth performance. The obtained results clearly indicate that, GIFU tilapia has lower ability to higher salinity tolerance at juvenile stage.

Key words: Salinity tolerance, GIFU tilapia, juvenile stage, survival rate, growth rate.

INTRODUCTION

Bangladesh is highly vulnerable to the effects of climate change in fisheries because of its economics, diets and social dependencies on fisheries sector (Chowdhury et al., 2010). Climate change is likely to adversely affect both the fresh water and marine fisheries in Bangladesh. Climate change may directly affect fishery production along many pathways. Cyclone, Sidr (15 Nov, 2007) and Aila (27 May, 2009) hit South and South West part of Bangladesh and destroy the coastal embankment infrastructure and increase the salinity. Water salinity and its distribution in the coastal area are increasing with the increasing of sea level rise (Faisal et al., 2004; Alam M 2003; World Bank 2000). Water salinity exceeds the expected salinity level that especially required for fresh water fish production.

Studies have shown that any loss caused by disease outbreaks in shrimp, due to extreme climate events and water stress, may be compensated either by poly-culturing saline tolerant fish species (tilapia, pangasius) with shrimp in dry season or mono-culturing in sequential mode after shrimp (Alam MJ, 2009).

Tilapia is gaining popularity in the west as well because of its white muscle with mild flavor with no intra-muscular bones. Tilapias are a good source of protein and a popular target for artisanal and commercial fisheries in Bangladesh.

Different tilapia species and strains vary considerably with respect to salinity tolerance (Suresh and Lin, 1992; Avella et al., 1993). Moreover, there are species and strain-specific variations with respect to the possible effect of salinity on growth performance (Suresh and Lin, 1992). Baroiller et al., (2000), stated that *Oreochromis niloticus* does not tolerate salinities above 20ppt and might not be suitable for culture in full-strength seawater (37 to 40ppt). The Blue and Nile tilapias can reproduce in salinities up to 10ppt to 15ppt, but perform better at salinities below 5ppt. Fry numbers decline substantially at 10ppt salinity (Pompa and Masser, 1999).

GIFU tilapia has higher growth and survivability along with good market value. GIFU tilapia is the 11th strain of *O. niloticus*, introduced in Bangladesh from China which was invented by a Chinese professor Dr. Li Sifa. By producing salinity tolerant GIFU tilapia through the intro-

*Corresponding author. Email: shahriar_rimon@yahoo.com Tel. +8801717162260

duction of technology it would be possible to improve the socio-economic condition of coastal dwelling people.

The present study was specifically geared towards determining the survival rate and growth performance of GIFU tilapia strain at juvenile stage in different salinities and to determine its salinity tolerance level at juvenile stage.

MATERIALS AND METHODS

Experimental Site and Duration

The experiment was carried out in a commercial tilapia hatchery known as Zubin Agro-based Industries Limited (ZAIL) located in Mannan Nagar, Noakhali, Bangladesh**.** This hatchery is well developed for producing monosex tilapia fry. There is a well organized inlet and outlet system to maintain water level in the ponds. Periodically water is added in the ponds to maintain good quality and water level is monitored at regular intervals from a deep tube-well. The entire research was conducted from November 2011 to November 2012 including the experiment for 24 days from July 14, 2012 to August 6, 2012.

Specimen

The specimen used for the experiment was GIFU tilapia, a strain of Nile tilapia. A total of 150 fry (0.039g/ individual) of GIFU tilapia were stocked for the experiment after the absorption of their yolk sac.

Experimental Design

Single factor (salinity) experiment with 5ppt, 10ppt, and 15ppt treatments was designed incorporating two controls 0ppt and 0ppt black. Each treatment and control had three replications.

Equipments

Cylindrical transparent plastic jars of 10 litre capacity were used for the experiment. Three plastic jars were painted black outside the jars. Air pump (RESUN® Model: AC-9908) was used for aerating the water in the jars. Aeration was done at every two hours interval during the experiment for a period of 5 minutes. Air stone was used for creating air bubble in water. Salinity Refractometer (Extech RF20 Portable Salinity Refractometer) was used to measure the diluted brine solution into 5ppt, 10ppt, and 15ppt treatments. It was also used to check the salinity of the jar water in a regular interval after water exchange. Fish were weighed using a Kingship digital weighing scale (model GEW-6). At first the machine was balanced, then fish were weighed in an air tight room. Mercury laboratory thermometer was used to keep the daily reading of room and water temperatures. Plastic pipes were used connecting the air stone to flow the air into the water

Brine Solution

Brine solution (200ppt) was collected from Upakul Fresh Water Prawn Hatchery, Sonapur, Noakhali. Brine was diluted into 5ppt, 10ppt, and 15ppt salinity through serial dilution method. The reading of the dilution was rechecked by Salinity Refractometer.

Feed

Fine mesh starter grade nursery feed was fed to fish fry. Feed was prepared at a ratio of 60mg 17 alpha-methyltestosterone per kg containing 40 % protein Feed were delivered to fry by hand. Fish were fed with the nursery feed six times a day. The feeding rate was 100 mg/1000 fry for Day (D) 1-5, it is then increased ¼ for every 5 days up to D20, which was continued to D24.

Water Exchange Schedule

Water was exchanged daily at the rate of 30% throughout the experiment to remove the excreta as well as unused feed in other to avert water quality problems.

Statistical Analysis

Data generated from the study were analyzed by MS Excel (Version 2007) and SPSS (Version11.5).
Survival rate was determined as 100 (final total fish number ÷ initial total fish number). Means of survival rate for controls and treatments were subjected to one-way analysis of variance at 0.05 level of significance and compared by Tukey HSD multiple comparison test.

RESULTS

Survivability

Day-wise survivability was observed. Survival rate per day was recorded for every control and treatment individually with their replications.

Control 0ppt Survivability

In case of 0ppt control, Replication R1 indicates that survival rate was 100% from D1 to D24, no mortality occurred. R2 indicates that survival rate was 100% from D1 to D17, then decreased to 90% in D18 and 80% in D22

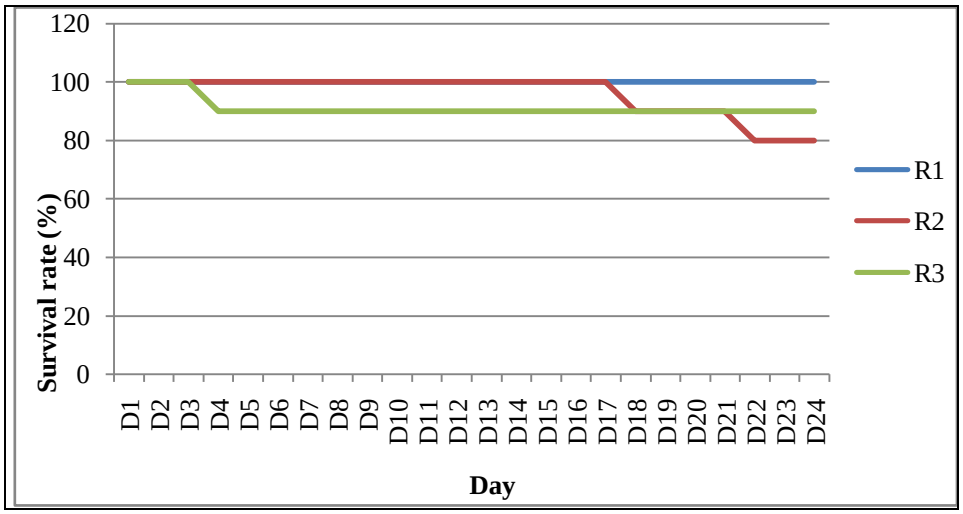

Figure 1. Diagram of survival rate (%) in 0ppt control for three replicates.

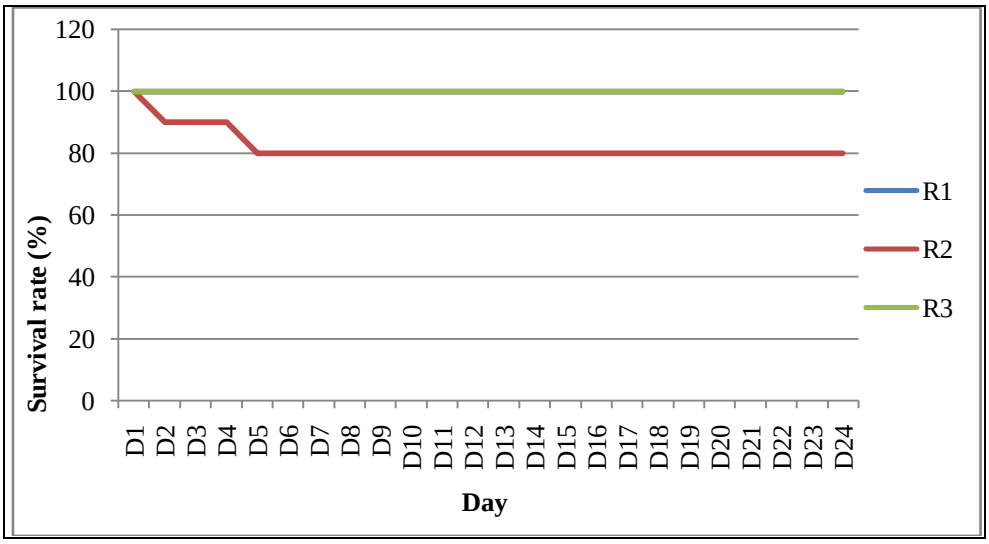

Figure 2. Diagram of survival rate (%) in 0ppt black control for three replicates.

to the last day. R3 indicates survival rate was decreased to 90% in D4 which existed to D24 (Figure. 1).

Control 0ppt Black Survivability

In case of control 0ppt black, R1 and R3 overlapped in 100 scale which indicate that survival rate was 100% from D1 to D24. R2 indicates that survival rate was decreased to 90% in D2 and 80% in D5 which existed to D24 (Figure 2).

Treatment 5ppt Survivability

In case of 5ppt treatment, R1 and R3 overlapped as survival rate in both replicate as 100% from D1 to D22, and then decreased to 90% in D23. R2 indicates that survival rate was decreased to 90% in D3, 80% in D21, 70% in D23 (Figure 3).

Treatment 10ppt Survivability

In case of 10ppt treatment, survival rate was lesser than 0ppt control, 0ppt black control and 5ppt treatment. R1 indicates survival rate was 100% in D1 then decreased to 30% in D2. R2 indicates survival rate became 0% from D2 and there was no fry left in R2 replicate. The other line for R3 indicates survival rate was 100% from D1 to D6, decreased to 90% in D7 and became 60% in D21 (Figure 4).

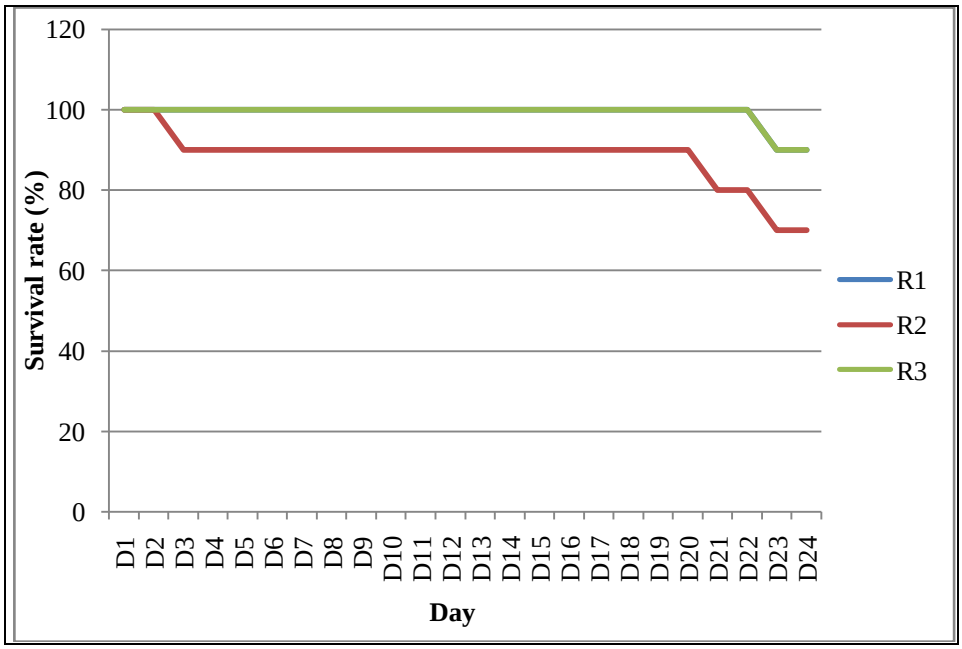

Figure 3. Diagram of survival rate (%) in 5ppt treatment for three replicates.

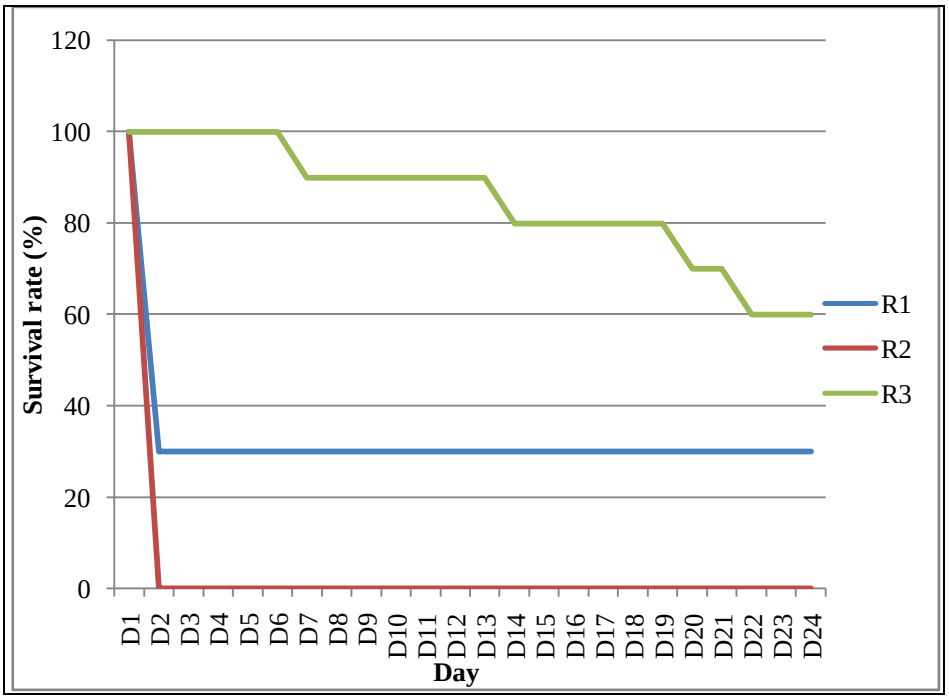

Figure 4. Diagram of survival rate (%) in 10ppt treatment for three replicates.

Treatment 15ppt Survivability

In case of 15ppt treatment, the lowest survival rate was observed. R2 and R3 overlapped as survival rate in both replicate as 0% from D2 to D24 and there were no fry left in R2 and R3 replicate. R1 indicates that survival rate continuously decreased from D2 to 24 and became 10% in D20 (Figure 5).

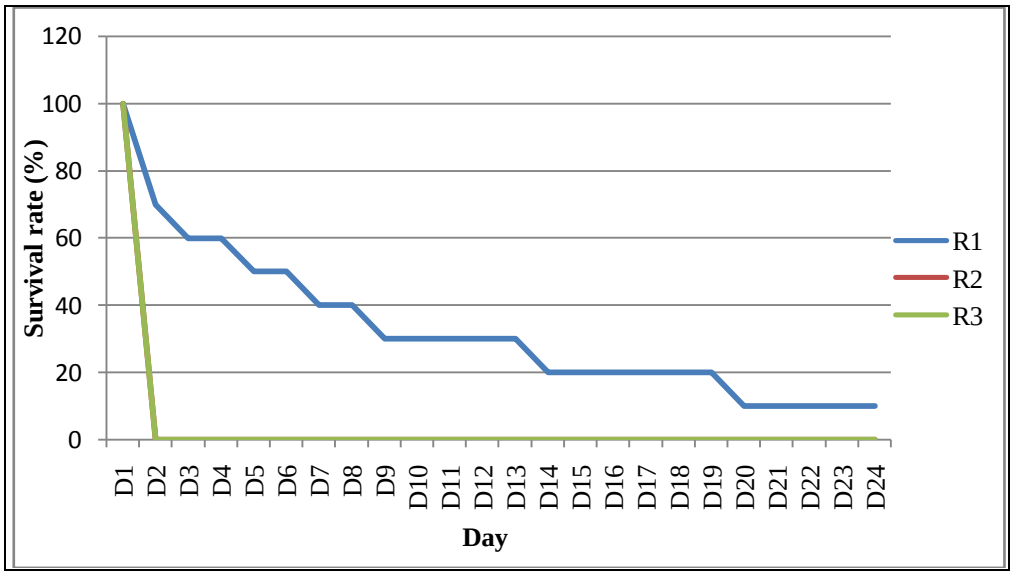

Figure 5. Diagram of survival rate (%) in 15ppt treatment for three replicates.

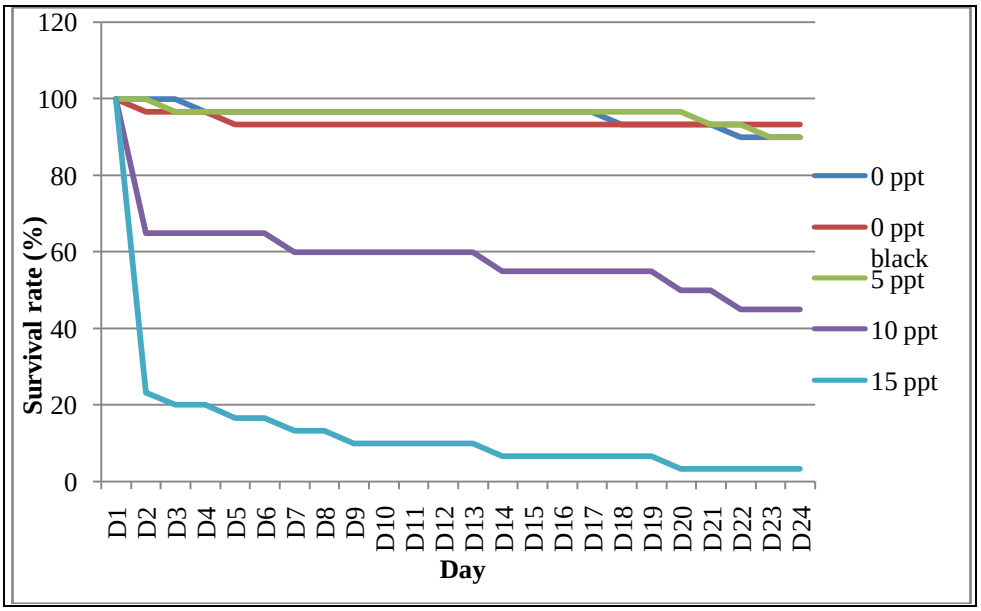

Figure 6. Diagram of survival rate (%) among controls and treatments.

Comparison of Survivability among Controls and Treatments

When comparing the survival rate among controls and treatments, survival rate was more or less similar in 0ppt control, 0ppt black control and 5ppt treatment which is indicated by the first three lines. The other two lines decreased a lot from D1 to D24 indicate that survival rate was low in 10ppt treatment and very low in 15ppt treatment (Figure 6).

There was no significant difference in survival rate among 0ppt control, 0ppt black control, 5ppt treatment but those have significant difference with 10ppt treatment and 15ppt treatment in R1 replicate. There was no significant difference in survival rate between treatment10ppt and 15ppt (Table 1).

Table 1. Survival rate among controls and treatments.

No. of replicate	Control		Treatment		
	0ppt	**0ppt black**	**5ppt**	**10ppt**	**15ppt**
R1	*10.00 ±0.00[a]	10.00 ±0.00[a]	9.91±0.06[a]	1.428±0.29[b]	3.29±0.46[b]
R2	9.58 ±0.14[a]	8.20 ±0.10[b]	8.83 ±0.14[ab]	0.41 ±0.41[c]	0.41 ±0.41[c]
R3	9.12±0.06[b]	10.00±0.00[a]	9.91±0.06[a]	8.45±0.26[b]	0.41±0.41

*(Mean±SE).

Table 2. Initial and final weights in controls and treatments.

Number of fry and weight		Control		Treatment		
Period		**0ppt**	**0ppt black**	**5ppt**	**10ppt**	**15ppt**
Initial	Number (total)	30	30	30	30	30
	Weight (gram) Total	0.39	0.39	0.39	0.39	0.39
	Weight (gram)/ individual	0.013	0.013	0.013	0.013	0.013
Final	Number (total)	26	27	23	9	1
	Weight (gram) Total	2.75	2.33	1.85	0.63	0.05
	Weight (gram)/ individual	0.106	0.086	0.080	0.07	0.05

In each controls and treatments means having different superscripts are significantly different (ANOVA, $P<0.05$).
In R2 replicate, there was no significant difference in survival rate between 0ppt and 5ppt, 0ppt black and 5ppt treatment, but significant difference between two controls 0ppt and 0ppt black. There was significant difference between 0ppt control and10ppt treatment, 0ppt black and 10ppt treatment, 5ppt treatment and 10ppt treatment, 0ppt control and 15ppt treatment, 0ppt black control and 15ppt treatment, 5ppt treatment and 15ppt treatment (Table 1).

In R3 replicate there was significant difference in survival rate between 0ppt control and 0ppt black control, 0ppt control and 5ppt treatment, 0ppt black control and 10ppt treatment, 5ppt treatment and 10ppt treatment. Survival rate was significantly different in 15ppt treatment with all other controls and treatments (Table 1).

Growth Performance

A total of 150 fry were stocked in the 15 experimental jars, where the number in each jar was 10. The total number of fry in each control and treatment is 30. The average total initial weight for controls and treatments was found as 0.39 gram and the individual weight was 0.013 gram. Growth performance was analyzed after the end of experiment (Table 2).

The final individual weight for controls and treatments with corresponding replicate was found 0.106 g in 0ppt control, 0.086 g in 0ppt black control, 0.080 g in 5ppt treatment, 0.07 g in 10ppt treatment, 0.05 g in 15ppt treatment. Growth was found lower gradually from 0ppt black control to 15ppt treatment in comparison with 0ppt control (Table 2).

Tolerance Level

Tolerance level was found to be higher in both controls 0ppt and 0ppt black salinity. It was found lower gradually from 5ppt to 15ppt (Figure 7).

DISCUSSION

The present experiment was conducted with the aim of generating knowledge about salinity tolerance level at juvenile stage of GIFU tilapia strain.
The actual feeding was lower than normal feeding due to

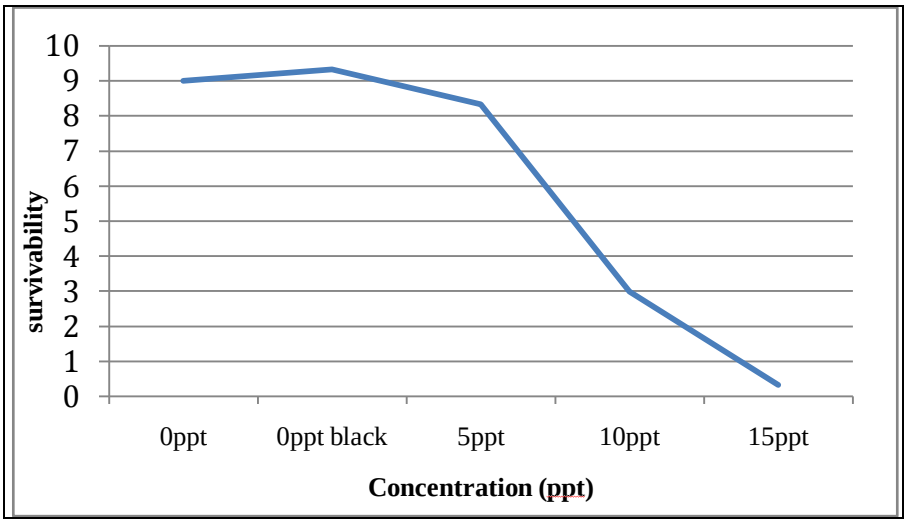

Figure 7. Diagram of tolerance level among controls and treatments.

some mortality. The feed percentage used for the GIFU Tilapia fry in the experiment was 13% of total body weight (1 g for 1000 fry) per day containing 40 % crude protein for the 1st two weeks which is very similar to the experiment done by Ridha (2006). The worker used feed at a rate of 10% of total body weight per day for the first two weeks containing 50% crude protein in one experiment. This is similar with other experiment of Ridha (2008) where the fry were fed at 20% of the total body weight per day containing 50% crude protein for the first two weeks.

There was little fluctuation in feeding schedule from accurate time observed by the hatchery technician which seems to be very normal and may not be a candidate to be a significant factor for either lower growth or survival rate of fry.

Aeration was done at every 2 hours interval daily. The dissolved oxygen (DO) concentration was optimum throughout the whole experiment.

Water was exchanged at the rate of approximately 30% per day and this is similar to the experiment done by Ridha (2008). In his experiment approximately 20% water was exchanged. Water exchange replenished the waste and excreta which kept the water quality better throughout the whole experiment.

Room temperature in both morning and evening was maintained 30.0±2°C. On the other hand water temperature in both morning and evening was maintained 28.0±2°C throughout the whole experiment which is similar to the same experiment of Ridha (2008). The worker maintained water temperature at 29.0 ±2°C. The morning and evening temperature for room and water were fluctuated in D17, D19, D20, and D23 which may not have influences either in growth performance or survival rate. The findings by El-Sherif et al., (2009) revealed that water temperature at 25-30^{o}C were more suitable for culture of Nile tilapia fingerlings to obtain optimum growth performance and survival rate. In their experiment, Pompa et al., (1999), found that growth performance and survival was better at 30°C but declined with decline in temperature.

Survival rate was found better at controls 0ppt and 0ppt black and treatment 5ppt salinity. The poor survival rate observed at treatment 10ppt and 15ppt salinity. The salinity tolerance level found in the experiment was lower up to 15ppt salinity in comparison with statement of Pompa et al., (1999) who reported that Nile tilapia grows well up to 15ppt salinity. Villegas (1990a), found juvenile Nile tilapia could survive well at 15ppt (87%), direct transfers of Nile tilapia to >15ppt resulted in 50% mortality at 20ppt and complete mortality at 32ppt. Relationship on stocking size and survival was observed by Bolivar et al (2004), results on survival rate of Nile tilapia was significantly affected by stocking size of fingerlings. The smaller the size of the fingerlings stocked, the lower the survival as compared to fingerlings stocked at larger sizes. In relation to size at stocking and survival, larger fingerlings can withstand the conditions of the environment as compared to small fingerlings which is much vulnerable and prone to mortality (ADB 2005). Results showed that survival rate did not fluctuate with the fluctuating temperature in D17, D19, D20, and D23.

There were no significant differences in initial weight of fry. The final individual weight of fry at salinity 0ppt control was found 0.106 g which was lower compare to the study by Ridha and Lone (1990) who obtained a final body weight of 0.23g at salinity 0ppt control. Growth performance was found lower up to salinity 15ppt treatment from 0ppt control. This result assumes that growth decreases with increasing salinity which is quite similar to the observation of Pompa et al., (1999) who found that Nile tilapia performs better at salinities below 5ppt. This result reveals significant differences with the other report. Villegas (1990b) found that highest growth is

achieved at 0-10ppt in Nile tilapia. Lei and Li (2000), reported optimal salinities for growth and feed consumption for Nile tilapia is 14-15ppt. There was no significant relation between growth performance and temperature fluctuation in this study though Pompa et al., (1999) found in the same experiment that growth performance was better at 30°C but declined with decline in temperature. It is assumed that, there might have some effect of light which could have caused less growth in 0ppt black control.

CONCLUSION

The experiment was conducted with a view to knowing the survival rate, growth performance and salinity tolerance of GIFU tilapia strain. The highest fry survival rate was found in 0ppt black salinity, and the lowest in 15ppt salinity. The highest growth was observed in 0ppt and the lowest in 15ppt. This suggest that GIFU Tilapia strain cannot tolerate higher salinities (>5ppt) at juvenile stages and optimum level of salinity is <5ppt for the growth and survival rate. It is suggested that further studies should be carried out in order to produce a tilapia hybrid that has a combination of high salinity tolerance and fast growth performance.

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