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Research Article

Survival and Growth Performance of *Cyprinus carpio* Under Different Levels of Salinity during Summer Season

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ABSTRACT

Effects of different salinity level (0, 2, 4, 6 and 8 ppt) on the growth and survival of Cyprinus carpio fry for 28 days. The result showed no significant effect (P>0.01), in Weight Gain (WT), Percent body weight gain (%WBG), Specific Growth rate (SGR) for those fishes reared in 0, 2, 4 and 6 ppt salinity but negative significant impact was observed in 8 ppt respectively. The best specific growth rate (SGR) and Net Weight Gain (NWG) was obtained in control. The statistical analysis of variance of growth mean value indicates highly significant results (p<0.05) between each other. Mortality was observed in 8 ppt was no significance different (P>0.01). 100 % mortality was recorded in 8 ppt (14-28 days) salinity which indicates the developed osmo-regulatory failure in fish.

Key words: *Cyprinus carpio, Salinity, Survival, Growth.*

INTRODUCTION

Common carp is one of the most significant fish species for aquaculture for all over the world and represent the species of choice due to high growth rate, ease in reproduction, tolerance to environmental stress and its market demand.

The common carp (*Cyprinus carpio*) is a familiar example of a stenohaline fish[1] and although it shows some tolerance to salinity and diluted sea water (0.03–0.30 % salinity) has been reported to improve growth, survival and development of carp larvae contact to higher levels of salinity appears to have unfavourable effects on carp[1,2,3]. Exposure to diluted artificial sea water (1.5 % salinity) results in increased levels of cortisol and glucose in the blood and increased ion levels and plasma osmolality in juvenile common carp[4]. In carp larvae, introduction to diluted sea water showed clear adverse effects at 1 % salinity or higher, with increased mortality and lower growth rates [2].

MATERIAL AND METHODS

Experimental fish:-

For conducting this study, the fish "*Cyprinus carpio*" was chosen as experimental fish and fish seed procured from Fish Seed Unit, Dhakrani, Dehradun, Uttarakhand (India).

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Experimental setup:-

The experiment was conducted in fifteen glass aquaria (1x1x1 ft) filled with 20 liters of water for a culture period of 28 days at the lab of Fisheries at Doon (PG) College of Agriculture and Allied science, Dehradun, Uttrakhand (India). A total number of 150 healthy infection free fry (*C. carpio*) were obtained from fisheries department Dehradun. The aquarium tanks were cleaned properly and filled with fresh water.

The healthy fry of uniform size (0.39±0.003g) were randomly distributed in fifteen experimental groups (0, 2, 4, 6, and 8 ppt salinity) and designated as control, T1, T2, T3 and T4 respectively in triplicates. The levels of salinity were maintained using sea salt (0, 2, 4, 6, and 8 g/NaCl). Each aquarium was stocked with 10 fry of common carp and fed on commercial pelleted feed having 24% protein. All the groups were fed twice daily for a period of 28 days. At the end of every seven days, the weight of experimental fish was noted using weighing machine. The growth parameters such as net weight gain, per cent gain in weight and specific growth rate were analyzed at weekly intervals. Survival (%) was calculated at the end of the experiment.

Water quality parameters such as temperature, pH and dissolved oxygen were determined on initial day and subsequently on initial, 7, 14, 21 and 28 day of the experimental period following standard methods[5].

RESULT

The present experiment is conducted to evaluate the effect of salinity on growth performance of *Cyprinus carpio* fry.

Water quality parameter

The water temperature ranged between a minimum of 22.85ºC (T1) and maximum of 26.35ºC (T1). The average was lowest 24.57ºC in T3 and highest 24.80ºC in T2 (Table 1). During the experimental period a narrow fluctuation in the values of dissolved oxygen was recorded (Table.4.1). The trend in pH fluctuation remained similar in the all the treatments throughout the experimental duration. It fluctuated between 7.18 to 8.23 with minimum being in control and maximum in T4 respectively.

Effect of salinity on the survival of *C. carpio*

The 100 % survival of common carp was recorded in 0 to 6 ppt salinities, in 8 ppt salinity survival rate was 90 % at 7 days rearing period and decreased up to 0 % at 28 days rearing period (Table 2). The positively significant result found that common carp can tolerate environmental salinities up to at least 8 ppt salinity, but survival at salinities of at least 6 ppt salinity (6 g/l) and higher requires profound changes. Based on these results and foregoing, salinity rate of 0.0 ppt (control) is favorable for survival of *C. carpio*. The highest Survival rates were found in control followed by 2, 4 and 6 ppt salinity.

Growth performance

A total one hundred fifty healthy infection free fry of *C. carpio* were randomly divided into five groups kept in salinities of range 2, 4, 6, and 8 g/l NaCl and a control (tap water) for 28 days during summer seasons (May, 2018). A control in fresh water (0.0 ppt) was also maintained. From this study, the weight gained decreases with increase in salinity. The result showed that the best daily growth rate was found with lower concentrations of salinity.

Net weight gain

The highest weight gain was observed in control tank with 0 % salinity (0.32±0.021), 0.25 g in T1, 0.22g in T2 and 0.19 g in T3 respectively (Table 3). ANOVA (Net weight gain) shows fortnightly net weight gain at (5%) level. Mean values gain significant differences in control and treatments. The percent weight gain of common carps are shown (Table 3). Control showed the highest percent weight gain (58.34±3.46) followed by T1 (42.22±2.03), T2 (36.11±1.47), and T3 (31.11±0.55). The per cent weight gain in control was statistically ANOVA significant as compared to all treatments.

Effect of salinity on specific growth rate

Specific growth rate decreased with increased in salinity level. The highest SGR (1.52±0.08) was recorded at 0.0 ppt salinity (control) and lowest SGR (0.97±0.01) was recorded at 6 ppt

salinity at 28 day respectively (Table 3). Specific growth rates at 4 ppt and 6 ppt were significantly lower than 0 ppt salinity.

Total length

The average total length gain had marked differences among different treatments (Table 3). All the treatments showed higher gain in total length than T4. Still the highest (1.17±0.03) length gain was obtained in control followed by treatments T1, T2, and T3 with respective length gains 1.16 cm, 1.16 cm and 1.15 cm.

DISCUSSION

The findings of the study showed that carp, could tolerate salinity regime between 0 to 6 ppt. In this regime no mortality were recorded. High growth performance in terms of total length, body weight and specific growth rate were recorded between 0 to 6 ppt salinity levels. This is an indication that the fish were perfectly able to regulate their body physiology within this regime. 100 % mortality was recorded in 8 ppt (14-28 days) salinity which indicates the developed osmo-regulatory failure in fish. Salinity in freshwater fish affects primarily gills, as the major organ involved both in osmoregulation and waste nitrogen excretion. High salinity displayed a highly disrupted epithelium with a diffuse oedema of both the primary and the secondary lamellae and this could be the reason why 100 % carp fish were died in salinity 8 ppt and above.

In terms of specific growth rate (SGR) the highest SGR (1.52±0.08) was detected at 0 ppt at 28 day duration, but SGR decreased with increasing salinity. Increased net weight gain of the fish suggested that the fish were able to regulate osmotic pressure of the body fluids, the more the osmo-regulate Growth in terms of NWG and SGR was influenced by temperature, salinity as well as their interactions in *Colistium nudipinnis*[6]. Common carp can tolerate, survive and grow in a low brackish water environment ranging between 1.5-6 ppt salinities without any signs of stress. At low temperature, in 12 ppt salinity, survival was 50 % while high and mild temperatures reduced survival of the fingerlings in waters having concentration above 6 ppt. The best growth rate was recorded in 0 ppt. while among graded level the most adaptable salinity was 1.5 ppt. at all the temperatures. The growth rate decreases as salinity increases. Fish behavioral characteristics are highly influenced by the metabolism rate and fish become restless due to high salinity as this increase fish metabolism rate. The restlessness or hyper activeness or erratic behavior in high salinities indicates fast rate at which the fish were approaching their tolerance limits and loss of water to external medium from the body. In case of *C.carpio* from this research normal response was found up to 6 % salinity and then hyper-activeness or erratic behavior or death shown at 8 % salinity. In present study, growth rate in terms of NWG and SGR decreased with increase in salinity. Maximum growth was found in T1 (2 ppt) followed by T2 (4 ppt), T3 (6 ppt) and T4 (8 ppt). Conducted a research where a total of four hundred and fifty fingerlings were subjected to salinity regimes of 0, 1.5, 3, 6 and 12 ppt for 60 days during different seasons[7]. They concluded that 100 % survival was detected at 0 to 6 ppt salinity during all seasons. Mortality recorded was 100 % at 12 ppt salinity during summer and autumn, while 50 % survival was observed during winter. Fish showed high appetitive behavior to food between 0 to 6 ppt salinities. The present study suggests that common carp fry can be reared in coastal water with salinity of up to 6 ppt with 100 % survival rate indicating that the high salinity areas may be explored for fisheries as well as for stocking enhancement programs. The highest mortality was observed after every 12 hours interval in the treatments having high salt concentrations with variable temperatures[8]. Analysis of variance showed that salinity was highly significant among temperature, time and salt. The reported that *B. gonionotus* fry can be stocked at 3 fry L^{-1} without adverse effect on its growth and survival and survive well at 10 ppt. Treatment with 15 and 20 ppt were terminated due to mass mortality between 3-7 days of exposure.

As for the rest of the treatments, it was found that *B. gonionotus* fry cultured at 0 ppt showed significantly higher ($p<0.05$) final body weight and total length as compared to 5 and 10 ppt. However, by the end of the experimental period, the percentage of survival was significantly the highest at 10 ppt. effect of different salinity levels on the growth and survival of *Clarias gariepinus* fry was studied in indoor hatchery system for a period of three weeks. They reported that significant difference $p>0.05$ highest weight gain was presented by fry in 0.2 ppt medium. All fry raised in 4.2 ppt died within 24 hours. Based on results and foregoing, they concluded that salinity rate of 0.4 ppt is favorable for growth and survival of *C. gariepinus* fry[9].

Growth in terms of AIBW, NWG and SGR was influenced by temperature, salinity as well as their interactions in *Colistium nudipinnis*[6]. Results reveal that growth of common carp fingerlings was influenced by temperature, salinity as also by their interactions. It is concluded that *C. carpio*, though a freshwater fish species, has tendency to tolerate and adapt to grow in a low brackish water environment ranging between 1.5 ppt-6 ppt salinities. Better growth rates at lower salinities compared to high salinities might be due to the lower energetic requirement of fish for the maintenance of the osmotic and ionic equilibrium as osmoregulation is lower in freshwater and the energy thus saved is directed to increase growth.

In present study, Maximum growth rate was found in control (0 ppt) followed by T1 (2 ppt) T2 (4 ppt) and T3 (6 ppt). The shyrbot fingerlings (*Barbus grypus*), maximum growth was found in T1 (0 ppt) followed by T2 (1.5ppt), T3 (3 ppt) and T4 (6ppt) and who also recorded highest growth in freshwater (0 ppt) closely followed by 3 ppt and 6 ppt salinity. With the increase of salinity the growth rate decrease and showed a significant difference at higher salinity ($p>0.05$)[10]. This result confirms that increase in salinity causes an overall decrease in growth rate in freshwater fishes and hence higher salt concentration could be said to hamper growth in freshwater fish. Loss of energy due to osmoregulation and stress could be the most important factor[11]. Freshwater fish showed the best results in terms of survival, NWG and SGR when reared in freshwater but growth decreased with increase in salinity has been increasingly ratified and similar results were largemouth bass (*Micropterus salmoides*) where specific growth rate (SGR) decreased as the salinity increased[12,13,14]. High growth rate was observed in goldfish adapted to 0 ppt to 2 ppt at about 1.2 % day-1as compared to 8 ppt and 10 ppt which was 0.4 % day-1and 0.2 % day^{-1} respectively[15]. Eurasian perch, *Perca fluviatilis* had higher growth rate at 0 ppt declined with increase in salinity with minimum growth at 10 ppt[16]. The specific growth rate of common carp in terms of weight gain was high in fresh water, reduced with increase in salinity, and reached a negative percentage at 10.5 ppt. The daily food consumption rate of the common carp fingerlings was high in fresh water (0-0.5 ppt) and diminished with an increase in salinity up to 6.5 ppt[17].

Table 1: Range and average values (± Standard deviation) of selected water quality parameters during the experimental period

Parameter	Treatment				
	Control	**T1**	**T2**	**T3**	**T4**
Temperature (◦C)	23.85-25.5 (24.57±0.63)	22.85-26.35 (24.61±1.27)	23.75-25.45 (24.79±0.59)	23.87-25.9 (24.75±0.53)	24.05-25.65 (24.80±0.64)
DO (mg/l)	6.03-7.26 (6.84±0.49)	6.95-8.20 (7.54±0.50)	7.12-8.40 (7.66±0.52)	7.10-7.85 (7.55±0.29)	6.6-7.95 (7.22±0.56)
pH	7.18 -8.12 (7.59±0.43)	7.29-8.04 (7.62±0.29)	7.21-8.16 (7.66±0.32)	7.33-8.15 (7.75±0.28)	7.24-8.23 (7.71±0.45)

Table 2: Survival (%) of common carp in different treatments

Treatments	Salinity (ppt)	0-7th days	7th-14th days	14th-21st days	21st-28th days	0 -28th days
Control	0	100±0.0^{a}	100±0.0^{b}	100±0.0^{a}	100±0.0^{a}	100±0.0^{a}
T1	2	100±0.0^{a}	100±0.0^{b}	100±0.0^{a}	100±0.0^{a}	100±0.0^{a}
T2	4	100±0.0^{a}	100±0.0^{b}	100±0.0^{a}	100±0.0^{a}	100±0.0^{a}
T3	6	100±0.0^{a}	100±0.0^{b}	100±0.0^{a}	100±0.0^{a}	100±0.0^{a}
T4	8	100±0.0^{a}	90±0.2^{a}	-	-	-

Table: 3. Growth parameters of common carp fed with feed experimental diet

S. No.	Treatments	Control (0 ppt)	T1 (2 ppt)	T2 (4 ppt)	T3 (6 ppt)	T4 (8 ppt)
1	**Net weight gain (g)**	0.32±0.021^{a}	0.25±0.012^{b}	0.22±0.009^{c}	0.19±0.003^{c}	-
2	**Per cent gain (%)**	58.34±3.46^{a}	42.22±2.03b	36.11±1.47^{c}	31.11±0.55^{d}	-
3	**Specific growth rate (%)**	1.52±0.08^{a}	1.26±0.05^{b}	1.10±0.03^{c}	0.97±0.01^{d}	-
4	**Total Length (cm)**	1.17±0.03^{a}	1.16±0.00^{b}	1.16±0.02^{b}	1.15±0.01^{c}	-

CONCLUSION

This study concluded that the survival decreases with increase in salinity level and growth rate decreases with considerable increase in salinity level. Therefore this study stated that high level of salinity adversely affect the growth rate and survival of common carp (*Cyprinus carpio*)

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