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Effect of Different Salinity on Survival and Growth of Amur Carp, *Cyprinus Carpio Haematopterus* (Linnaeus, 1758)

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ABSTRACT

In inland saline water in an arid/semi-arid region of Haryana, India, a 60-day experiment was carried out to evaluate the growth and survival response of Amur carp, *Cyprinus carpio haematopterus* (Linnaeus, 1758). Following acclimatization, 300 fingerlings with an average weight of 8.38 0.04 g were evenly distributed into 5 treatment groups (salinities: control C 0 ppt; T1 3 ppt; T2 6 ppt; T3 9 ppt and T5 12 ppt) with 3 replicates in 500 L FRP tanks. Throughout the investigation, 9 ppt and 12 ppt were found to have changed behaviors such as swimming activity and appetite. While physio-chemical characteristics of the water, such as pH, temperature, and dissolved oxygen (DO), did not differ significantly over the course of the experiment, others, such as ammonia, nitrite, total dissolved solids (TDS), and conductivity, did. The highest survival rate was obtained in T1, whereas T2, T3, and T4 all showed a declining tendency as salinity increased. Fish growth (ADG, SGR, and TWG) considerably decreases (P0.05) from control to T4, although FCR significantly increases with salinity. According to the findings, Amur carp (*Cyprinus carpio* haematopterus) may be cultivated at a density of 6 ppt, and most likely as low as 5 ppt.

Key words: *Amur carp, Salinity, Survival, Growth, Saline Water*

Introduction

One of the most rapidly expanding food producing industries in the world is aquaculture. It produces 44.14% of the fish consumed by humans worldwide. According to FAO (1998), Asia, whose influence in aquaculture has persisted over the millennia, continues to dominate global output. According to FAO (2016), Asia is responsible for 88.91% of the world's aquaculture production. The primary cultured species, Indian Major carps and exotic carps, account for more than 70% of global aquaculture production. According to DAHDF (2016), India is the second-largest producer of fish in the world. Fish are impacted by water salinity either directly or indirectly because changes in salinity have an impact on fish development and survival. For fish to survive, both in freshwater and in saltwater, their capacity to control bodily fluids independently of their surroundings is crucial. The farmed fish experience stress and are unable to function effectively as a result of the shift in salinity. So, according to Nahar *et al.* (2016), they have displayed poor output and stunted development. Different species have varying levels of tolerance to salt (Larsen *et al.,* 2012).

According to Sahoo *et al.* (2015), the amur carp is one of the Indian major carps (IMCs) that have been successfully raised in commercial aquaculture in the Indian subcontinent for at least the last 60 years. Cyprinid fish, or amur carp (*Cyprinus carpio haematopterus*), are a kind of fish. According to Basavaraju and Reddy (2013), the amur carp grows around 29.7% and 40.33% quicker in monoculture and polyculture systems, respectively.

However, there has only been a small amount of study on how inland saline water affects the development and survival of freshwater fish. The purpose of the current study is to ascertain how different salt levels affect the development and survival of Amur carp.

Materials and Methods

Experimental site: A 60 days experiment was conducted at College of Fisheries Sciences, Chaudhary Charan Singh Haryana Agricultural University (CCS HAU), Hisar, Haryana, India.

Preparation of inland saline water with different salinities: Inland saline water of 24 ppt was obtained from tube well of Soil Department of CCS HAU, Hisar and used for the preparation of treatment water. The treatment water of 0, 3, 6, 9 and 12 ppt were prepared by diluted saline water with bore-well water (salinity <0.5).

Experimental setup and design

The experiment included five treatments (4 treatments + 1 control; Table 1), each of which had three replications and each of which had 20 Amur carp fingerlings. Amur carp fingerlings were gradually exposed to increasing salinities at a rate of 1 ppt hr-1 to acclimate them to various experimental salinities (0, 3, 6, 9 and 12 ppt). To assess the impact of salinity on fish development and survival, acclimatized fingerlings were randomly dispersed at 20 in aquariums (three copies for each salinity level). 300 Amur carp fingerlings were purchased from a licensed fish farmer in the hamlet of Dabra near Hisar. $KMnO_4$ was used to disinfect the fingerlings. The experimental fishes were fed with commercial floating feed diet thrice daily at the rate of 5% of body weight for two months.

Ingredients of Diet: Maize, soya bean meal, wheat flour, broken rice, rice bran fresh, rice bran solvent, soyabean oil, mustard meal, fish meal, amino acid, vitamin, mineral and premix. Feed pellet size was 0.8 - 0.9 mm.

Physio-chemical analysis of water: Water quality parameters were analyzed throughout the experiment at regular interval. The temperature, pH and salinity were recorded by using mercury thermometer, digital pH meter (Aquasol, AM-P-PH) and digital salinity meter (Refractometer) respectively. Electrical conductivity and DO was recorded by using digital labtronics conductivity meter (Microprocessor COND-TDS-SAL Meter) and Aquasol dissolved oxygen testkit (AEDO8) respectively. Ammonical-Nitroogen ($NH_{3-}N$) and Nitrate-Nitrogen (NO_3-N) was recorded by using calorimetric assay kit (Sunpu Biochem.).

Growth parameters: Growth parameters like Average daily weight gain (ADG), Feed conversion ratio (FCR), Specific growth rate (SGR), percentage increase in length and weight and survival rate and total weight gains were recorded fortnightly.

Total weight Gain(g) = Final Weight Gain (g) – Initial Weight Gain (g)

$$\text{Average Daily Weight Gain (AGD)} = \frac{\text{Mean final weight – Mean initial weight(g)}}{\text{No. of culture days}}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Amount of dry feed consumed}}{\text{Live weight gain}}$$

$$\text{Specific Growth Rate (SGR)} = \frac{\text{Log}_e \text{ final body weight – Log}_e \text{ initial body weight}}{\text{Number of days}}$$

$$\text{Average Daily Weight Gain (ADG)} = \frac{\text{Mean final weight – Mean initial weight (g)}}{\text{No. of culture days}}$$

$$\text{\% Increment in Weight} = \frac{\text{Mean final fish weight – Mean initial fish weight (g)}}{\text{Mean initial fish weight}}$$

$$\text{\% Increment in Lengt} = \frac{\text{Mean final fish length –Mean initial fish length}}{\text{Mean initial fish length}}$$

$$\text{Survivability} = \frac{\text{Total number of fishes harvested}}{\text{Total number of stocked}}$$

Results and Discussion

Survivability: With an increase in saline level, there was a discernible steady drop in the survival rate (Table 1). All fingerlings survived in salt levels of 0 ppt over their 60-day growing period. At 15 days at 3 ppt salinity, the survival rate was 81.7%; at 60 days, it had dropped to 71.7%. The highest survivorship was seen at 3 ppt, followed by a steady decline with rising salinity and complete mortality at 12 ppt. According to study results, amur carp can survive in a salinity range of 0 to 6 ppt. The fact that the fish can survive an intermediate salinity range suggests that their bodily fluids may be able to function, at least temporarily, in an abnormal range of internal osmotic and ionic concentrations. Amur carp has a 100% survival rate between 0 and 5 ppt salinity, according to Singh *et al.* (2020), while death was seen above 5 ppt salinity. According to Singh, G. *et al.* (2018), there was no mortality at the salinities of 0, 2, and 4 ppt for *Cyprinus carpio* Linn. (Common carp), however there was a progressive rise in mortality when the salinity rose above 4 ppt. However, Mubarik *et al.* (2018) observed the effect of different salt concentrations (Control, 6, 8 and 10 mg/L) on *Cyprinus carpio* and the results showed that mortality of *Cyprinus carpio* increases with the increase of salt concentration. Singh *et al.* (2019) found that *Cyprinus carpio* could tolerate salinity from 0 to 6 ppt and between thesesaline levels no mortality was recorded. They concluded that from 0 to 6 ppt salinity, 100% survival was detected during all seasons and 100% mortality was recorded at 12 ppt salinity during summer and autumn, while 50% survival during winter.

Various salinities of saline water (0, 3, 6, 9 and 12) were used to assess the growth performance of Amur carp (Table 2). The results were statistically analyzed, and all of the treatments showed a substantial change. According to Küçük (2013), freshwater fish normally thrive in freshwater environments with low salt levels and their growth declines as salinity levels rise, supporting the findings of the current study. Other researchers on various freshwater fishes (Wang *et al.*, 1997; Rani and Gulia, (2015), Upadhyay, (2015), Abullah, (2016) also provided assistance for the study linked to growth. At 6 ppt salt, the percentage increment in body weight was significantly reduced, and at 9 ppt salinity, the smallest percentage increase in body weight was seen after 60 days of rising. The length of the body was similarly impacted by salt levels. As salinity rose, the specific growth rate (SGR) dropped. At 6 ppt salinity, the SGR value started to significantly decline, and the lowest SGR was found at 60 days of rearing. Similar to SGR, the average daily weight gain (ADG) of Amur carp fingerlings dropped as the salinity rose. The 45-day growing period at 0 ppt salinity (control) had the highest ADG compared to other salinities and durations. Iwama (1996) hypothesized that the energy that may be used for growth is instead used to maintain the intracellular ionic and osmotic control. According to Luz *et al.*, (2008), the gold fish, *C. auratus*, did not significantly alter over the course of the 21-day trial up to salinity of 6 ppt, but their growth considerably decreased at salinities of 8 and 10 ppt. When Akhtar *et al.*, (2013) exposed the juveniles of *L. rohita* to salinity 3.8 ppt for 30 days, they saw a 25% decrease in SGR of fish. According to Küçük *et al.* (2013), blue tilapia, O. aureus, reached its maximum growth rate at 12 ppt and then began to fall as salt levels rose to 16–24 ppt. Information about effect of salinity stress on growth

Table 1. Survivability of Amur carp at different salinities after 60 days

	Treatments				
	C	T_1	T_2	T_3	T_4
Survivability	100±0.0	71.67±3.33	41.67±7.27	*	*

* 100% mortality at the end of experiment

Table 2. Growth parameters of Amur carp reared at different salinities after 60 days

Parameters	Treatments				
	C	T_1	T_2	T_3	T_4
% weight gain	12.43±0.83	12.03±0.89	8.89±1.15	*	*
% body length	3.23±1.1	4.00±0.74	3.22±1.77	*	*
ADG	0.16±0.01	0.15±0.01	0.12±0.02	*	*
SGR	0.78±0.05	0.76±0.05	0.57±0.07	*	*
FCR	6.09±0.43	6.31±0.50	8.73±1.12	*	*
Total weight gain	191.96	174.69	100.04	*	*

*100% mortality at the end of experiment (Percentage = %)

of some species is in consistent, may be due to genetic differences. Islam *et al.* (2014) also recorded the significant decrease in growth of *L. rohita* (rohu) reared in 0, 2, 4, 8 and 12 ppt saline water for 90 days. SGR of rohu was reduced by 50% at 8 ppt salinity. De Azevedo *et al.* (2015) observed that in Nile tilapia (*Oreochromis niloticus*), there was significant reduction in the daily weight gain in at 14 and 21 ppt of saline water. Further, Sharma, (2017) observed that after 120 days of experiment there was no significant changes in NWG and SGR of another ornamental fish, koi carp (*C. carpio*) in inland saline water of different salinities viz; 2, 4, 6, 8, 10 and 12 ppt. According to Kumar, (2018), the concentrations of 8 and 10 ppt had a substantial impact on *L. rohita* growth and survival. With rising salinity, rising trends in feed conversion ratio (FCR) were observed. Amur carp fingerlings reared with 0 ppt salinity (Control) at 15 days had a significantly lower FCR than those raised at various salinities and for other lengths of time. The FCR for rohu cultivated at various salinities shown an increasing tendency with rising salinities, similar to the current study (Islam *et al.*, 2014; Nahar *et al.*, 2016; Singh *et al.*, 2019). For common carp cultivated at various salinities, Wang *et al.*, (1997) reported minimal FCR at 2.5 and 0.5 ppt salinity, respectively, and that FCR increased with increasing salinity.

Physio-chemical analysis of water: The results of the present study have revealed the significant impact of salinity on various water quality parameters. The results showed that the value of pH (7.07 to 8.43), temperature (20.10°C to 28.27°C) and dissolved oxygen (3.5 to 7.5 mg/l) were found within the optimum range and no significant difference was observed which is supported by different workers in different studies (Santosh and Singh, 2007; Bhatnagar and Devi, 2013). However, increase in salinity significantly affects the other water quality parameters like, ammonia, nitrite, total dissolved solute (TDS) and conductivity as presented in table 14 to 17. Singh *et al.* (2020) reported that the most of the water quality parameters remained at optimum levels and no significant difference was observed in DO, temperature, pH, NH_4^+-N and NO_2-N among different treatments throughout the experimental period. But significant difference was observed in parameters like salinity, total alkalinity, total hardness, calcium and magnesium hardness, Na^+, K^+, Ca^{2+} and Mg^{2+} ions concentration at different salinities and the values were increased with increasing salinity. They concluded that for any suitable aquaculture practice, water quality parameters are very essential because it may affect the physiology of fish. Al-Khashali *et al.* (2013) observed that water temperature ranged between 24 °C to 26 °C, dissolved oxygen 6.2 mg/l to 6.8 mg/l and pH between 7.0 to 7.4 where the values were in normal levels of gold fish living which is similar to the finding of present study.

Conclusion

This experiment with various salinities revealed that the Amur carp survived the least under salinities of 9 and 12 ppt and the most under 3 ppt, followed by 6 ppt. It is abundantly obvious from the experiment's arithmetic that Amur carp do better in terms of survival and growthupto 6 pptin saline water.

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Table 3. Physio-chemical parameters of water

Parameters	Treatments				
	C	T_1	T_2	T_3	T_4
pH	7.80±0.15	7.27±0.03	7.50±0.06	8.3±2.77	8.2±2.73
Temperature (^{0}C)	26.70±0.25	26.43±0.20	26.87±0.03	28.8±9.60	27.3±9.10
Salinity (ppt)	0.67±0.01	3.10±0.05	6.07±0.07	9.16±3.05	12.19±4.06
DO (ppm)	5.17±0.44	5.33±0.67	4.67±0.60	3.5±1.20	7.5±2.50
NH_4^+-N (ppm)	1.47±0.03	2.03±0.03	2.17±0.07	3.00±1.00	3.00±1.00
NO_2-N (ppm)	0.22±0.007	0.26±0.007	0.27±0.003	0.05±0.17	0.03±0.01
TDS	0.37±0.05	2.17±0.01	3.12±0.07	4.44±1.50	6.45±2.15
Conductivity	0.91±0.01	8.76±0.02	12.46±0.28	19.64±6.55	25.8±8.60

Conflict of Interest

The author (s) certifies that they have No Conflict of Interest in the subject matter or materials discussed in this manuscript.

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