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A study on the tolerance and behavioral responses of *Catla catla* (Hamilton, 1822) advance fry to varying salinities under inland saline water

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Abstract

The tolerance and behavioral study of *Catla catla* was studied under inland saline water at varying salinities. Healthy and properly acclimatized advance fry of catla approx. 3 ± 0.5 gm were stocked @ 1gm/liter at different salinities (ppt) with 4 treatments and a control viz. 0(control), 5(T₁), 10(T₂), 15(T₃) and 20(T₄) in pre-treated inland saline water. The experiment was carried in triplicates using CRD design and calculated LC₅₀ values by probit analysis. Behavioral studies was conducted based on reflex action, feeding pattern, swimming behaviors. The calculated LC₅₀ values (ppt) at different intervals (hr.) 1, 6, 12, 24, 48, 72 and 96 were 17.191, 12.412, 12.412, 9.931, 7.254, 7.254 and 7.254 respectively. From the present study it can be concluded that advance fry of *Catla catla* can with stand up to 5 ppt salinity without any adverse effect in behavior and survival. Further, >7.254ppt shows adverse effect in terms of survival and behavior.

Keywords: *Catla catla*, LC₅₀ value, behavioral study, probit analysis, inland saline water

Introduction

Global population coupled with climate change due, to global warming and limited available resources viz. land and water, raised a challenging task before the world of food security. Indiscriminate use of the limited valuable resources made the situation worsen. In that direction increasing inland saline area is a matter of concern which is considered unfit of less productive for agricultural purposes.

Aquaculture is one of the suitable ways to utilize such inland saline area where agricultural productivity is nominal. Impact of salinity have been studied for several species under culture system [2]. Fish culture under saline environment leads to stress among freshwater fishes [3]. India is a carp country with three indigenous major carp which is showing encouraging results under slight saline water bodies. Gujarat is having approx. 0.035 million km² inland saline affected area, which can be utilized for the culture of suitable aquaculture species. Therefore, it is the need of the hour to explore the new techniques and ways for increasing productivity by utilizing such barren land.

Catla inhabits freshwater and one of the faster-growing species compare to other major carp. Salinity is one of the important environmental factors effects survival, growth and distribution of many aquatic organisms. It's important to understand the growth performance and behavior of catla under different salinities. A change in salinity affects the survival and growth of fish [13] and due to the salination of freshwater, many freshwater species might be under severe stress and threat due to their inability to cope up with extreme physiological and osmotic stress. Therefore for the present study was concentrate to assess the salinity tolerance, survival, and behavior study of *Catla catla* under Inland saline water using LC50 assay.

Material and Methods

The experiment was carried out in the wet laboratory of the Postgraduate Institute of Fisheries Education and Research (PGIFER), Kamdhenu University, Rajpur (Nava) Himmatnagar.

The advance fry of Catla (*Catla catla*) an average weight (gm) 3.0 ± 0.1 , and length (cm) 5.3 ± 0.4 respectively were stocked @ 1 gm/liter under inland saline water, were collected from the government hatchery, Ukai, Gujarat. The fish were acclimatized for a period of two weeks prior to the start of the experiment.

Preparation of desired salinity from inland saline water

Inland saline water of salinity 36 ppt was filtered and collected from inland saline ponds of the Surendranagar region of Gujarat. The desired salinity (ppt) viz. (0, 5, 10, 15, and 20) was prepared by diluting with freshwater. Salinity was measured by twice per day using digital refractometer (HANNA HI-96822 Seawater Refractometer) to maintain the salinity and provision of aeration were made two weeks prior before starting the experiment.

Experimental Design

The experiment was conducted in triplicates with different salinity (ppt) i.e. one control (0 ppt) and four treatments viz. 5(T₁), 10(T₂), 15(T₃) and 20(T₄) respectively, using CRD design. The experiment was conducted for a period of 96 hrs. or four days. The observed behavior viz. swimming pattern, reflux action and response to external stimuli was classified under different code responses viz. N:M:H:D:- Normal, Moderate, Hyperactive and Death respectively and monitored on visual basis at the following hours viz. 1hr, 6hr, 12hr, 24hr, 48hr, 72h, and 96hrs. Dead specimens were removed immediately after death and their numbers registered and calculated percentage death. There was no provision of feeding made during the experiment. Salinity was measured twice a day in morning and evening hrs. On a regular basis to maintain the desired salinity level.

Statistical analysis

The observed data were analyzed with SPSS statistical analysis software (Version: 25) using probit Analysis Statistical Method.

Results & Discussion

The observed physico-chemical water quality parameter viz. pH and temperature (°C) were recorded twice per day using a digital thermometer and pH meter (PCTestr 35) is depicted in table 1. The observed fish behavior (swimming pattern, reflux action, and response to external stimuli) of catla during the experiment are described in table 2. The percentage of death of fish exposed to different salinities at different times is described in table 3. The observed LC₅₀ values by using probit analysis of *Catla catla* under various salinities at different duration are portrayed in table 4. and illustrated in Fig.1.

Table 1: Physico-chemical water quality parameters, namely pH and temperature (°C), recorded twice daily during the experimental period using a digital thermometer and a pH meter (PCTestr 35).

Treatment (ppt)	pH	Temperature °C
Control	7.8 ± 0.01^a	26.3 ± 1.34^a
T ₁	8.0 ± 0.02^b	26.5 ± 1.44^a
T ₂	8.1 ± 0.01^b	26.9 ± 1.52^a
T ₃	8.1 ± 0.03^b	26.8 ± 1.52^a
T ₄	8.0 ± 0.02^b	26.6 ± 1.64^a

Water quality parameter pH and temperature (°C) during the experiment (Mean $\pm$ SEM)

Table 2: Behavioral responses of *Catla catla* observed during the experiment, including changes in swimming pattern, reflux action, and response to external stimuli under different salinity treatments.

Treatment (ppt)	Duration (hrs.)						
	1	6	12	24	48	72	96
Control	N	N	N	N	N	N	N
T ₁ (5 ppt)	N	N	N	N	N	N	N
T ₂ (10 ppt)	N	N	M	H	D	D	D
T ₃ (15 ppt)	N	H	D	D	D	D	D
T ₄ (20 ppt)	D	D	D	D	D	D	D

Observed behavioral response of *Catla catla* under various salinities at different duration (hrs.) (N = Normal, M = Moderate, H = Hyperactive, D = Death)

Table 3: Percentage mortality of *Catla catla* exposed to varying salinity levels at different exposure durations.

Treatment (ppt)	Mortality (%)						
	1	6	12	24	48	72	96
C	0	0	0	0	0	0	0
T ₁	0	0	0	0	0	0	0
T ₂	0	0	0	0	50	50	100
T ₃	0	100	ND	ND	ND	ND	ND
T ₄	100	ND	ND	ND	ND	ND	ND

Percentage death of fish exposed to different salinities at different times. (*ND = Data not found due to 100% mortality)

Table 4. Median lethal concentration (LC₅₀) values of *Catla catla* under different salinity levels at various exposure durations, estimated using probit analysis.

Duration (hrs.)	Observed LC ₅₀ values using probit analysis of Catla	95% confidence limit (CL*)
1	17.191	-
6	12.412	11.29-13.628
12	12.412	11.219-13.628
24	9.931	7.783-11.027
48	7.254	5.829-8.629
72	7.254	5.829-8.629
96	7.254	5.829-8.629

Observed LC₅₀ values of advance fry of Catla under various salinities (ppt) at different duration (hrs.) under inland saline water and 95% confidence limit.



Fig 1: Observed LC₅₀ values using probit analysis of *Catla catla* at different duration and various salinitie

Discussion

Seeds quality is the key of success for high production during a culture cycle in aquaculture. Fish behavior are the prime indication deciding the health status of any fish. In the past several study was design to investigate the tolerance level of Indian major carp and chines carp at different salinity concentration using NaCl but the information with respect to salinity tolerance of IMC in inland saline water is lacking [7]. In the present experiment the behavioral (swimming pattern, reflux, and response to external stimuli

like feed, sound etc.) anomalies were observed among the fish when exposed to different salinities.

The visual observation stating that the catla showed normal (N) behavior in control and T₁ respectively. Whereas, moderate (M) at 12 hrs in T₂ and hyperactive (H) at 24 and 6 hrs in T₂ and T₃ respectively. Further the results revealed that the fishes start dying after 48, 12 and 1 hrs in T₂, T₃ and T₄ respectively. Few behavior like erratic swimming pattern and fast movement in operculum were noticed within 10 minutes after stocking of fishes in T₄, however difficulty in breathing and lethargy were seen after 45 minutes before death of fish within 1hr of exposure. Similar observation was seen under treatment T₃ after 12 hrs of exposure which was supported by [9] they observed that at a specific salinity, an erratic behavioral trend was noticed in different carps, in which common carp displayed higher tolerance to salinity than that of rohu and mrigal. In the present study it was observed the feeding rate of fishes was gradually decreasing with increasing the salinity concentration. Similar observation was noticed by [16] where no significant changes were observed in feed intake of freshwater carp, *C. Carpio* up to 6 ppt salinity, during first 10 days of long term rearing in different salinities viz; 1.5, 3, 6 and 10 ppt (prepared through commercial-grade NaCl & CaCl₂).

Mortality was observed within all the treatments except control and T₁. Whereas, fifty to hundred percent mortality were observed in T₂ within 48 to 72hr respectively. However in T₃ and T₄, 100% mortality was observed at 6 and 1hr respectively. The calculated LC₅₀ values at different point of interval (hr.) viz, 1, 6, 12, 24, 48, 72, and 96 are 17.191, 12.412, 12.412, 9.931, 7.254 and 7.254, 7.254ppt respectively. Our results are in agreement with the findings of [1] conducted experiment on salinity tolerance to *Barbodes goniotus* at different point of interval at different salinity using common salt and seawater respectively they revealed that after 18 ppt all the fishes died within 96 hrs. In the present study the obtained LC₅₀ values of catla at 96 hrs is approx. 7.254 which was shows in the agreement with the finding of [9] they revealed that, *L. fimbriatus* can tolerate salinity (commercial mother salt solution) levels up to 7.07 ppt. However [20] noticed a slight lower values in case of, *Labeo rohita* and *Cirrhinus mrigala* and suggested that they can tolerate salinity up to 6 ppt, which was supported by [7] who conducted similar experiment on *L. rohita* using NaCl for salinity concentration and revealed that there was 100 % survival percentage obtained up to 6 ppt. Similar study was conducted by [11] revealed that 71-90% of grass carp fingerlings died within 24hrs at similarly [16] conducted experiment to test the tolerance level in *Cyprio carpio* under different salinity prepared using (NaCl and CaCl₂) the result shows that at 6 ppt the survival rate was 100%.

Some other freshwater fishes like catfish and murels have exhibited better salinity tolerance than carps, [4] revealed that spotted snakehead, *Channa punctatus* adapted well to 10 ppt salinity without any signs of distress. However, *Pangasianodon hypophthalmus* survived up to 15 ppt, but optimum salinity for culture under inland saline area was recommended up to 10 ppt [18]. Further, the salinity tolerance study is equally important in ornamental fishes likewise, [14] conducted similar studies on, *Carassius auratus* and the results showed that 100% survival of the fish up to 5 ppt salinity, was recorded between 90 and 94% under 8 and 10 ppt, respectively.

Conclusions

In the present experiment it can be concluded that advance fry of *Catla catla* can be culture under inland saline water having 7 ppt salinity without compromising the survival rate, however to see the growth performance of catla at this salinity i.e. 7 ppt a long term study is required, which can help to make a suitable protocol to culture *Catla catla* under inland saline water.

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