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EFFECT OF SALINITY ON GROWTH OF *CIRRHINUS CIRRHOSUS* IN CAPTIVITY

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ABSTRACT Juveniles of *Cirrhinus cirrhosus* was reared in captive conditions at different salinity levels including freshwater systems to observe the growth performances. Six uniform-sized (80 L capacity) rectangular glass aquaria (experimental tanks) were used for the purpose. Six uniform-sized (80 L capacity) rectangular glass aquaria (experimental tanks) were used for the exeriment. Salinity in experimental units was maintained from 0 ppt to 6.5 ppt by mixing desired saline water with freshwater from deep bore-well. In total, 300 fish juveniles were purchased from a private hatchery, stocked in a freshwater filled cemented tank (CT) after giving a dip bath in 0.5% $KMNO_4$ as a quarantine measure. After completion of 24 hours of stocking, saline water was added in the CT to raise the salinity up to 0.5 ppt and the juveniles were kept there for another 24 hours. Subsequently, juveniles were transferred to experimental tanks and each was stocked with 40 specimens. In every alternate day, salinity of the tanks was recorded and adjustment was made by adding fresh/ saline waters as per the requirement. After completion of 20 days and 40 days of rearing, body weights were recorded. All the results were compared. Results of the study revealed that normal growth was observed in salinity level 0 to 0.3 ppt. Furthermore, fish can survive up to ~ 4 ppt but showed comparatively slower growth rate. Therefore, it is resulted from the study that *Mrigala* juveniles can adopt gradual increase in water salinity at < 4 ppt and also perform well in their growth. Thus the present study suggests that *Mrigala* juveniles can be reared in coastal water with low salinity level with quite lower growth rate as in freshwater conditions.

KEYWORDS : *Cirrhinus cirrhosus,* juvenile rearing, low salinity, growth performance

1.Introduction

Fish is a major source of animal protein, essential minerals, vitamins and un-saturated fats[1]. In India, Carp culture is the mainstay in Indian freshwater aquaculture. Among carps, Catla (*Catla catla*), Rohu (*Labeo rohita*) and Mrigal (*Cirrhinus cirrhosus*) together called Indian major carp (IMC), possess culture importance due to their larger size, faster growth, market demand and are being cultured extensively all over the country including low salinity affected areas. *Cirrhinus cirrhosus* (Cypriniformes: Cyprinidae) is also known as white carp (locally called Mrigal), is one of the most important cultivable fresh water fish of India. It is highly delicious as well as full of many needy nutrients. This important food fish is well distributed in rivers and streams of India as well as throughout South Asia. This species is widely farmed as a candidate species in polyculture system among other IMCs. Semi-intensive or extensive carp polyculture is a traditional practice in India, in which more than one species of IMC are cultured in a single pond. Higher fish productions are generally achieved in all forms of polyculture rather than monoculture[2]. This is because with different feeding habits, the reared fish species can minimize the inter-specific and intra-specific competitions for the food available at various levels or zones in the pond and utilize the available natural food at different niches in the system more effectively. According to Halver (1984), polyculture may produce expected results if fish with different feeding habits are stocked in proper ratio and combination[3].

Aquaculture system always needs an ideal and healthy environment to maximize fish growth in a shorter period of time[4]. Under natural as well as aquaculture condition, a number of biotic and abiotic factors influence the growth of IMCs, where water salinity can potentially act as a stressor[5]. Salinity is one of the most important environmental factor, that regulates not only growth and survival of fish[5,6,7]. Salinity is considered as a limiting factor for the growth and survival of freshwater carp species (Catla, Rohu and Mrigal).

Chilika Lake, the largest brackish water lagoon of India is located along the east coast of India in which water salinity fluctuates between 0 ppt to 28 ppt. As influenced by the Chilika water, some of the near-shore aquaculture ponds along western side of Chilika having very low salinity. Similarly, the fringe areas of western and north-western side of Chilika Lake, are being used for carp farming in dugout ponds wherein the annual salinity level fluctuates from a minimum of 0.05 ppt to as high as 5 ppt with no sustainability in carp production. Under such culture conditions, information on the impact of salinity levels on carp growth is very relevant to the farming community for information on the growth potential of IMC, particularly for *Mrigal* in low saline waters. Therefore, present experiment was conducted with the carp species *Cirrhinus cirrhosus* to record its growth performances under different salinity level.

2. Materials and Methods

Current experiment was conducted in six rectangular glass aquarium of 80 liters capacity of sized 50 cm x 40 cm x 40 cm. All the experimental units (glass-aquaria) were cleaned properly before stocking of carp seeds (*Cirrhinus cirrhosus*). Before initiation of the experiment, brackish waters from the mouth area of Chilika Lake was collected using in 20 l glass jars by boat three days prior to stocking. First glass-aquaria or experimental unit (Control or A0) was filled with freshwater (60 l) collected from a deep-bore-well. Other five glass-aquaria were filled with calculated quantity (60 l) of collected brackish water manually and the salinity was adjusted to 0.2 ppt (Treatment-1 or A1), 1.6 ppt (Treatment-2 or A2), 3.5 ppt (Treatment-3 or A3), 4.5 ppt (Treatment-4 or A4) and 6.5 ppt (Treatment-5 or A5) by addition of desired quantity of aged bore-well water under vigorous aeration. Another cemented tank (CT) was used to serve as acclimatization unit (capacity of 250 l). The tank was filled with freshwater of aged bore-well water three days before procurement test species.

In total of 300 *Mrigal* seeds were purchased from a private hatchery, brought to the experimental site in oxygen packed polythene bags and stocked in the CT after giving a dip bath in 0.5% $KMNO_4$ as a quarantine measure. After completion of 24 hours of stocking in freshwater condition, brackish water (collected from Chilika) was added in the CT slowly to raise the salinity up to 0.5 ppt under strong aeration and the seeds were kept for another 24 hours before they were transferred to experimental tanks (A1 to A5). After acclimatization of all seeds in 0.5 ppt, each experimental tank was stocked with 40 seeds/juveniles by transferring from the CT. The salinity of each tank was monitored daily with a DKK-TOA made water quality checker (Model–WQC-ZZA) and salinity was maintained with addition of fresh water. Ambient temperature too was recorded daily at 10-11 am. Water volume was maintained during the experimental period using premixed saline water of equal salinity in each experimental tank. Commercial feed (first 20 days: 0.5 mm meshed, protein- 41%, fat- 6%; second 20 days: 0.6 mm meshed, protein- 36%, fat- 6%) available in the local market was used and provided to the test carp juveniles at 10% of average body weight twice daily during morning and evening hours. The experimental units were cleaned by siphoning out the unutilized feed and faecal matters daily on priority basis. Survival rate of the juveniles was also checked every day. To register the gross weight gain under different salinity levels, body weight were recorded by an electronic balance (Precisa, XB 320 M) respectively at 20^{th} day and 40^{th} day of rearing. Data generated was processed to record the growth performance.

3. Results

The detail results of growth performance of Mrigal (*Cirrhinus mrigala*) in terms of weight gain of the experiment conducted in captive conditions for 20^{th} day and 40^{th} days of rearing are summarized in Table 1. During the whole 40 days of experiment, the ambient temperature in the experimental tanks was ranged between 25.8°C to 27.2°C.

In A0 (Tank as control), water salinity was 0 ppt. Initial mean size of the juveniles at stocking was 0.20±0.05g. After 20 days of rearing, mean size of the juveniles was 0.53±0.13g. Similarly, the mean size of juveniles after 40 days of stocking was found to be 1.42±0.17g (Table1).

In A1, initial mean size of the juveniles at stocking was 0.22±0.09g which was grown to 0.55±0.15g after 20 days of rearing and the mean size increased to 1.43±0.16g after 40 days of rearing (Table 1). Similarly, in A2, initial mean weight of the juveniles was 0.22±0.08g. After 20 days of rearing, the juveniles were grown to the mean weight of 0.44±0.14g. The mean weight of juveniles after 40 days of rearing was found to be 1.36±0.18g (Table 1).

In A3, mean body weight of juveniles at stocking was 0.23±0.08g which grown to 0.43±0.15g and 1.28±0.21g after 20 days and 40 days of rearing. Similarly, the juveniles having mean weights of 0.22±0.05g (A4) and 0.24±0.05g (A5), grown up to 0.38±0.11g and 0.33±0.18g after 20 days of captive rearing management (Table 1).

As a freshwater species, *Mrigal* showed better growth performances at 0 ppt salinity. This performance also nearly found similar up to salinity 0.3 ppt after both 20 days and 40 days of rearing. But when salinity increased, comparative growth performances in both cases (20 and 40 days) gradually found decreased (Fig. 1). Growth performances clearly found lower at salinity 1.6 ppt and more. At higher salinity (4.5 to 6.4 ppt), the juveniles showed less growth as well as high mortality. So, after 20 days, the experimental tanks were found to be with very less to no fishes survived. Mortality was continued in both tanks and the last juvenile in A4 and A5 was survived till 26^{th} and 29^{th} days respectively. First mortality in the tank was noticed at very 1^{st} day of rearing on both tanks A4 and A5. Therefore, mean weight after 20 and 40 days was not included in the study.

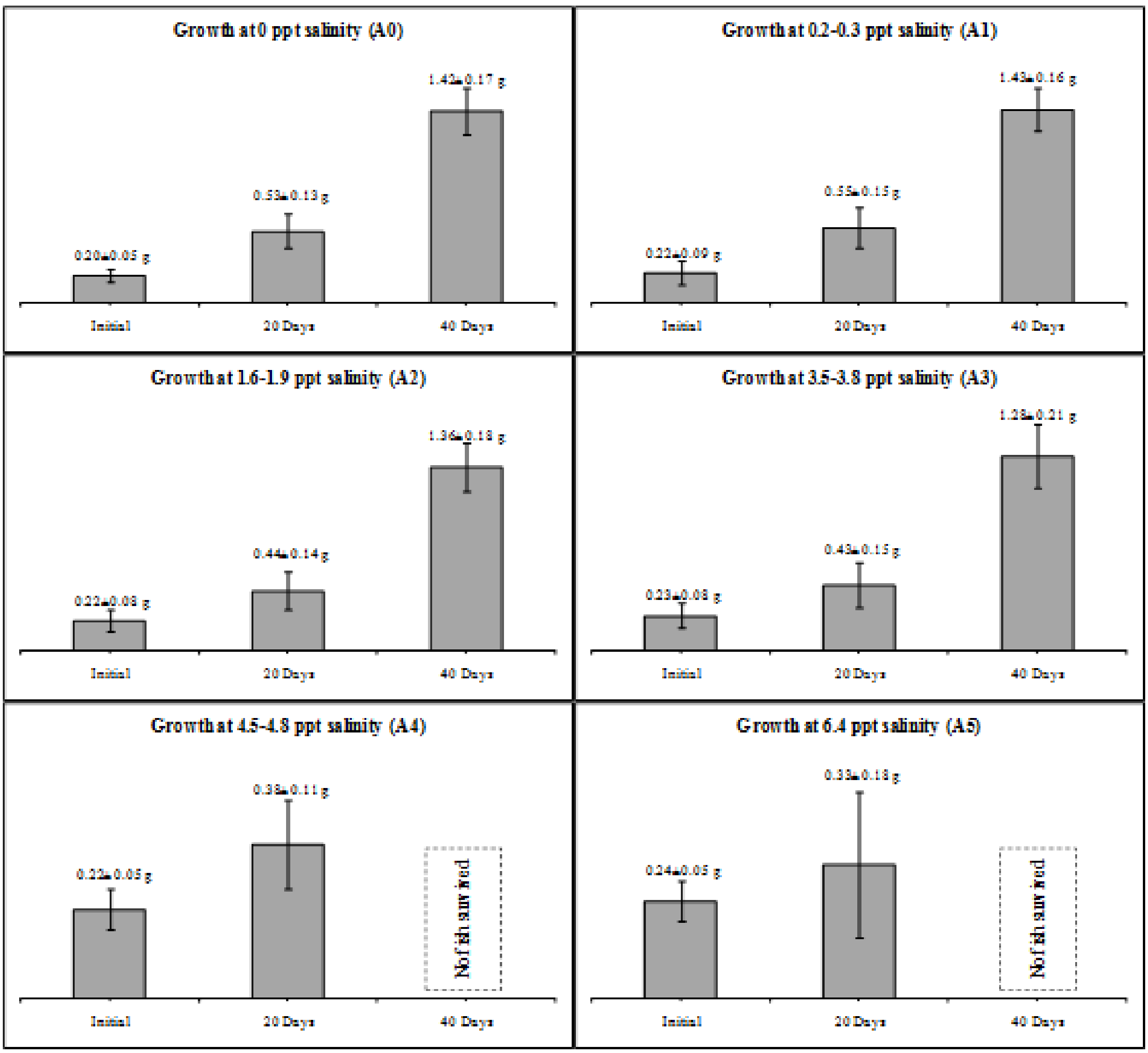

Fig. 1. Growth performance of *Mrigal* juveniles under different salinity conditions in 20 days and 40 days of rearing

Table 1. Details of growth performance of *Mrigal* juveniles under different salinity conditions

Experimental code	Salinity (ppt)	Mean weight ± SD		
		Initial	*20 days*	*40 days*
A0	0	0.20±0.05 (0.12-0.28)	0.53±0.13 (0.38-0.69)	1.42±0.17 (1.03-2.24)
A1	0.2-0.3	0.22±0.09 (0.13-0.26)	0.55±0.15 (0.34-0.71)	1.43±0.16 (1.04-2.21)
A2	1.6-1.9	0.22±0.08 (0.14-0.27)	0.44±0.14 (0.37-0.67)	1.36±0.18 (0.99-2.11)
A3	3.5-3.8	0.23±0.08 (0.12-0.29)	0.43±0.15 (0.40-0.69)	1.28±0.21 (0.99-2.06)
A4	4.5-4.8	0.22±0.05 (0.14-0.25)	0.38±0.11 (0.33-0.61)	No fish survived
A5	6.4	0.24±0.05 (0.12-0.29)	0.33±0.18 (0.28-0.57)	No fish survived

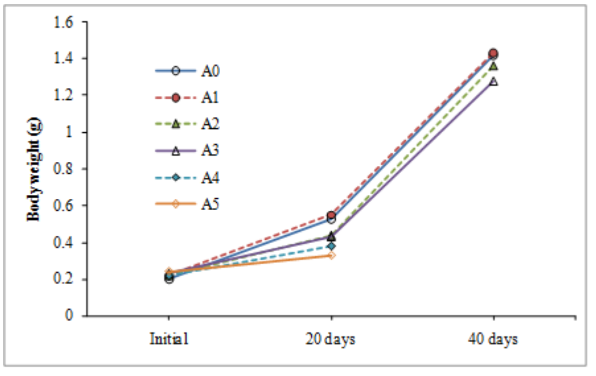

Fig. 2. Comparative growth performance of *Mrigal* juveniles at different salinity concentrations

In comparison of all the unit treatments, the *Mrigal* juveniles shown remarkable growth in extreme freshwater (0 ppt) conditions, whereas, the values gradually decreased with increase in salinity concentrations. In both cases (20 days and 40 days), growth performances was found to be decreasing as salinity increases (Fig. 2). But, interestingly, juvenile growth was near about similar in 0 ppt as well as 0.2-0.3 ppt salinity (Table 1). The rate of growth in first 20 days was slower than the next 20 days of rearing (Fig. 2).

1. Discussion

Salinity concentration in aquaculture system influenced mostly its growth and survival. Although role of water temperature and nutrition is also has similar role on it. In fish, habitat temperature greatly affects the feeding pattern which ultimately reflects in their growth[8]. Furthermore, as an important and basic parameter for any aquatic animal, water temperature was regularly monitored. In the current study, the range of water temperature was in ideal conditions for carps in aquaculture system. As the current study was lasted for near about a months, water temperature did not had any significant variations.

From the current study, we observed that *Mrigala* juveniles can tolerate a salinity regime up to 4 ppt. Although, fish mortality was also recorded in this salinity regime, but was a stable range. More than 4.5 ppt salinity, high mortality was found, as a result we can't even record growth data for the minimum comparison with other unit experiments. High growth performances in terms of body weight (BW) were recorded between 0 to 3.8 ppt salinity levels. Such results are an indication that the Mrigala juveniles were perfectly able to regulate their body physiology within this regime. 100% mortality was recorded after 20 days of rearing in 4.5 and above salinity level which indicates the developed osmo-regulatory failure in fish. Salinity stress in freshwater fish affects primarily gills, as the major organ involved both in osmo-regulation and waste nitrogen excretion[9].

In general, response to salinity has shown to be highly variable among fish species[4]. Such variation is associated with the interaction between osmoregulatory mechanisms with other physiological processes of fish[10] and also some extend to fish ecology[11]. Fish in hyper-osmotic environments would show more energy requirements than the normal for their osmoregulation[12,13]. Many researchers have been identified behavioral patterns in different carps at different salinity level. According to Kasim, common carp showed higher tolerant to salinity than that of *Rohu* and *Mirigala*[14]. Kilambi and Zdinak also reported that, grass carp fingerlings, showed up to 71-90 % mortality in 24 hours fewer than 15 % salinity concentrations[15].

Present experiment showed that growth performances in terms of weight gain were significantly affected in all tests. According to Canagaratnam, the efficiency of feed conversion depends on many factors, but the best response is probably strongly related to its environmental conditions in which the fish is habituated[16]. Therefore, current study, suggests the feed conversion in the juveniles reared at lower salinity (< 4 ppt) was good as compared to higher salinity levels. As a complete freshwater inhabit species, *Mrigala* may be difficult to survive in higher salinity above 4 ppt. Therefore, current study reveals that at least normal growth occurs in juveniles of *Mrigala* up to 0.3 ppt salinity and it can be affected at higher salinity level. But the species can survive and can adopt gradual increase in water salinity up to 4 ppt salinity. Therefore, this study may helpful in preparation of management plan for carp culture purpose in coastal waters where water salinity remains within the study level.

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