

Effect of Salinity on Growth and Survival of Rohu, *Labeo rohita* (Ham.) under Laboratory and Field Conditions

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The limits of salinity affecting survival and growth performance of the Indian Major Carp, *Labeo rohita* was studied in laboratory and field conditions. A salinity range of 0 to 14 ppt was used at 2 ppt interval in the present study. Rohu could survive in waters upto 8 ppt salinity. Beyond 8 ppt, the fish showed signs of stress and mortality occurred. There was 100% mortality in 14 ppt salinity within 7-8 days. Although maximum growth was obtained at 0 and 2 ppt, growth was not markedly affected upto 6 ppt salinity. Rohu was cultured along with milkfish in brackish water pond, where salinity ranged from 1.9-8.9 ppt during the culture period of 120 days. As salinity increased above 8 ppt, Rohu showed stress signs and therefore, the culture was discontinued. The present study indicates that there is good potential for culturing these species in low saline areas, that otherwise remain unutilized.

Key words: Salinity tolerance, growth, survival, rohu, *Labeo rohita*

The brackish water habitat is characterized by a low saline and high saline phase. Extensive areas of brackish water remain unutilized during the low saline phase due to the lack of suitable candidate fish species in required numbers for culture. The freshwater regions in the coastal belt also come under the influence of saline water during summer months, posing a threat to the culture of freshwater species. It is, therefore, important to understand the tolerance of the freshwater culture species to salinity and also, to know the growth performance of the species under salinity stress. This information will enable aquaculture ventures to be taken up in the areas subjected to saline influence.

Several workers have reported the salinity tolerance of different freshwater fish species viz; Indian Major Carps [*Catla catla* (Ham.), *Labeo rohita* (Ham.), *Cirrhinus mrigala* (Ham.)] (Saha *et al.*, 1964; Ghosh *et al.* (1973), common carp, *Cyprinus carpio* Lin. (Ghosh & Pandit, 1976; Konstantinov & Martynova, 1992; Wang *et al.*, 1997), grass carp,

Ctenopharyngodon idella (Val.) (Chervinski, 1977; Maceina & Shireman, 1980; Konstantinov & Martynova, 1992; Routray & Routray, 1997), silver carp, *Hypophthalmichthys molitrix* (Val.) (Chervinski, 1977) and the Russian sturgeon; *Acipenser gueldenstaedti* (Konstantinov & Martynova, 1992). Although the limits of salinity that the Indian Major Carps can survive has been studied, the effect of salinity on the growth performance of these species, which is more important from the aquaculture point of view, has not been investigated. The Indian major carp, rohu (*Labeo rohita*) was, therefore, selected in the present study, to determine the salinity range for its optimum growth and the tolerance limits affecting growth and survival.

Materials and Methods

Labeo rohita (length 3.0-3.9 cm; weight-1.0-1.75 g) produced in the hatchery of the College of Fisheries, Panangad were acclimatized to laboratory conditions in freshwater and fed with pelleted feed. Salinity selected for the experiment ranged from 0-14 ppt, at

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2 ppt intervals with 8 treatments. Fishes were stocked in 70 litre fiberglass tanks at the rate of 12 numbers per tank in triplicate groups as per completely randomized design. After acclimatization for a week, salinity was gradually increased by 2 ppt daily to the required salinities. The tanks were covered with nylon netting to prevent the jumping out of fishes. *Ad libitum* feeding was done. The faecal matter and left over feed were siphoned out everyday and 25% of water was exchanged daily. Physicochemical parameters viz; temperature, pH and dissolved oxygen were monitored weekly following standard methods (APHA, 1998). The experiment was carried out for 30 days. Growth in terms of length and weight increment were calculated according to the following formulae % length gain = $(\text{Final length} - \text{Initial length} / \text{Initial length}) \times 100$ and Specific Growth Rate (SGR) = $(\ln W_1 - \ln W_0 / t_1 - t_0) \times 100$

The survival percentage was also recorded. The data were analyzed by ANOVA method (Snedecor and Cochran, 1967). Percentage data were transformed to arcsine.

In order to determine the growth performance of the fish under pond conditions, Rohu seeds (50 mm/3.0 g) were stocked along with milkfish, *Chanos chanos* (Forsk.) (40mm/2.0 g) in 1:1 ratio @4000/ha in two earthen ponds of 400 m² each (Table 2). Prior to stocking, the ponds were dewatered and tea seed cake @ 75 ppm was used for eradication of predatory and weed fishes. The pH of the pond was maintained at 7.5 by application of CaO @500 kg/ha. Cow dung @2000kg/ha was applied as a basic dose, followed by biweekly application of 2000 kg/ha cow dung and 100 kg/ha superphosphate during the remaining part of the culture period. Daily feed was given with ground nut oil cake and rice bran in 1: 1 ratio @ 2% of the total body weight of the stocked fishes. Salinity in these ponds was 1.5 ppt initially but increased upto 8.9 ppt towards the end of the experiment. The water temperature, pH, salinity and dissolved oxygen were analyzed regularly following standard procedures

(APHA, 1998). The experiment was discontinued after 120 days due to stress signs in *L.rohita* and development of reddish hue in the body. The final length and weight of rohu and milkfish were recorded (Table 3).

Results and Discussion

There was 100% survival upto 8 ppt salinity. The fishes were active and showed normal feeding and swimming behaviour. At 10 ppt and 12 ppt salinities, the fishes were apparently normal and there was no mortality during the first two weeks. However, after this period, mortality was recorded. The final percentage survival in 10 ppt and 12 ppt were 15.59% and 5.54%, respectively. Survival in salinities 0, 2, 4, 6 and 8 ppt were not significantly different, but showed statistically significant difference from those in 10 and 12 ppt. Unlike in the lower salinities, at 10 and 12 ppt salinities, the feed given was not taken completely even during the initial period of the experiment and the feeding intensity progressively decreased towards the termination of the experiment. At the highest salinity used in the experiment, viz., 14 ppt, mortality started from the first day onwards. The fishes showed signs of stress, with abnormal swimming behaviour and their balance apparently affected. There was complete cessation of feeding. Later, the fish became listless, lying motionless on the bottom of the tank and dying soon after. Within 7-8 days, 100% mortality occurred in 14 ppt salinity. Results of ANOVA are presented in Table 1.

The temperature, pH and dissolved oxygen in the tanks ranged between 29-30°C, 7.5-8.5 and 4-4.5 ppm, respectively, during the course of the experiment. In the lower salinities, especially in 0, 2 and 4 ppt, there was profuse algal growth due to *Chlorella* sp., while as the salinity increased, the algal growth reduced considerably and the water remained very clear at 10-14 ppt.

At the end of the experiment, the total length ranged from 3.5 cm to 4.9 cm and the weight varied from 1.25 g to 2.60 g. The results of ANOVA on growth of fish and

Table 1. Survival, percentage length gain and specific growth rate (SGR) of rohu in different salinities

	Salinity (ppt)							
	0	2	4	6	8	10	12	14
Av. initial wt. (g)	1.0-1.75	1.0-1.75	1.0-1.75	1.0-1.75	1.0-1.75	1.0-1.75	1.0-1.75	1.0-1.75
Survival (%)	100 ^a	100 ^a	100 ^a	100 ^a	100 ^a	15.59 ^b	5.54 ^b	0
% length gain	98.67 ^a	101.33 ^a	66.44 ^b	75.33 ^b	35.11 ^c			
SGR	2.28 ^a	2.27 ^a	1.66 ^{ab}	1.86 ^a	1.0 ^b			

*Same superscript indicates no significant difference at 5% level.

specific growth rate (SGR) are summarized in Table 1. Details of the various pond parameters and culture details of rohu and milkfish in field condition are presented in Table 2 & 3, respectively. Rohu seed stocked in the two ponds along with milkfish grew to 210 mm and 205 g in 120 days.

Table 2. Pond Parameters

Sl. No.	Parameter	Range
1	Pond depth	77-110 cm
2	Water temp.	29.5-30.5 ⁰ C
3	Water pH	7.5-8.0
4	Dissolved oxygen	5-6.5
5	Salinity	1.9-8.9
6	Zooplankton	0.5-1.5 ml/l
7	Benthos (Melania, Apsuodes, Polychaetes)	100-150/m ²

Although a riverine fish of freshwater habitat, the results of the present study suggests that this species can survive upto 8 ppt salinity and can be cultured in waters of salinity upto 6 ppt without its growth being affected. Saha *et al.* (1964) have reported a salinity tolerance limit of 14 ppt for the Indian Major Carps. Ghosh *et al.* (1973) have reported that early and advanced fry of major carps of 26 mm length died at salinities of 10 and 13 ppt, respectively, while fingerlings of Indian Major Carps tolerated salinity upto 12.5 ppt with 48 % mortality. The lethal limit of salinity tolerated by common carp was found to be 12.6 ppt (Ghosh & Pandit, 1976).

In the present study, active feeding was observed in the lower salinities upto 8 ppt. As the salinity increased further, feeding intensity reduced and there was no intake of feed

at 14 ppt, indicating that appetite was affected by salinity. A similar observation was made by Ghosh & Pandit (1976) in their experiment on salinity tolerance of common carp under Indian conditions. They too have reported active feeding of common carp at low salinity and very low feeding intensity at higher salinity from 7 ppt onwards. At 8-10 ppt salinity, avoidance of food and sluggish movements were observed. The differences in feed intake and growth with increasing salinity may be due to the different demands made on the metabolism of fish by regulatory mechanisms involved in adaptation to the environment, as suggested by Holliday (1971).

Table 3. Details of Biculture of *L. rohita* and *C. chanos*

Pond Area:	400 m ²
Date of stocking:	25-9-2000
Species:	<i>Labeo rohita</i> , <i>Chanos chanos</i>
Species ratio	1:1
Stocking density	4000/ha
Initial Size (mm/g)	<i>L. rohita</i> - 50 mm/3.0 g <i>C. chanos</i> - 40 mm/2.0 g
Date of harvest	23-1-2001
Rearing period (days)	120 days
Final Size (mm/g)	<i>L. rohita</i> - 210 mm/205 g <i>C. chanos</i> - 140 mm/55 g
Growth rate	<i>L. rohita</i> - 40 mm/month, 50 g/month <i>C. chanos</i> - 25 mm/month, 13 g/month

When salinity increases, the availability of dissolved oxygen decreases, and the buoyancy of fish is also affected. Salinity also has a direct effect on gaseous exchange. Thus, asphyxiation occurs in fishes placed in waters of high salinity. The extra energy required for ion and osmoregulation in saline water may raise the rate of standard metabolism and thereby reduce the scope for activity (Holliday, 1971).

In the present study, the highest percentage length gain was recorded in 0 and 2 ppt while the lowest was in 8 ppt. There was no significant difference in % length gain between 0 and 2 ppt and also between 4 and 6 ppt. However, the percentage length gain between 0-2 ppt, 4-6 ppt and 8 ppt was statistically different. SGR in 0, 2, 4, and 6 ppt was not significantly different among each other. Beyond 6 ppt salinity, there was no increment in growth. Mortality due to salinity stress occurred from 10 ppt salinity (Table 1). Routray & Routray (1997) also observed growth retardation only beyond 6 ppt salinity in their study on growth potential of grass carp in saline water. Maceina & Shireman (1980) reported that dietary conversion rates of grass carp were less efficient at 3 and 6 ppt salinities than in freshwater. Hence, growth was reduced slightly at 3 and 6 ppt salinities and greatly at 9 ppt salinity. In their study on the effect of salinity on food consumption, growth rate and energy conversion efficiency of common carp fingerlings, Wang *et al.* (1997) reported that SGR was high in fresh water, reduced with increase in salinity, and reached a negative percentage at 10.5 ppt.

In the pond conditions, Rohu showed normal behaviour until the salinity increased beyond 8 ppt, when the fish showed signs of stress, and the culture was discontinued. This observation was supported by the results of the laboratory investigation, where intensity of feeding, growth and survival were observed to decrease in salinities above 8 ppt. The growth rate of 40 mm/50.5 g per month obtained for Rohu in field conditions in the present biculture with milkfish, suggests that culture of the freshwater carp, Rohu is feasible in low saline areas particularly in the salinity affected agricultural areas. Considering the acute scarcity of seed of brackish water fishes and the impressive growth of the Indian major carps and exotic carps in low salinities, vast areas under saline influence can be profitably utilized for culture of freshwater carps or mixed culture of carps and brackish water fishes.

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