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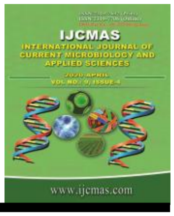

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Influence of Water Alkalinity in Production of Stunted Fingerlings of *Catla catla* (Hamilton)

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ABSTRACT

Keywords

Catla catla, Stunting, Alkalinity, Water quality, Seed rearing

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Study was conducted for 90 days to know the effect of varying water alkalinity in production of stunted fingerlings of *Catla catla* in outdoor FRP tanks (1000 litre). Tanks filled up to 800 litre marks were grouped into three triplicated treatments and were stocked with catla seed (3.9g, 67±0.27mm) at 16nos per tank (20m^{-3}). Three alkalinity levels, i.e. 80, 150 and 200 mg $CaCO_3L^{-1}$ were used and designated as Control, T-1 and T-2, respectively. Pond water (80 mgL^{-1}) and bore well water (360 mgL^{-1}) were used as the two sources to get the desired alkalinity level. Fishes were fed with powdered feed @ 8% of their respective biomass in all the treatments. The survival of catla decreased significantly ($p<0.05$) with the increase in alkalinity from control (97.92±3.61%) to T2 (89.58±3.61%). The average harvested body weight and length in T-1 (8.83±0.40g, 8.73±0.17cm) and T-2(8.28±0.19g, 8.65±0.10cm) were similar ($p>0.05$), but both were significantly lower than the control (9.64±0.12g, 9.02±0.02cm). Similarly, specific growth rate of T1 (0.91±0.05) and T2 (0.84±0.03) were similar and significantly lower than control (1.01±0.01). The biomass yield also reduced significantly with increase in alkalinity from control (151.00±4.63g) followed by T1 (132.43±6.06g) and T2 (118.77±7.56g). Such results indicated pronounced effect of increased alkalinity on suppressing fish growth and suggested possibility of manipulating this parameter as a tool for stunting of catla seed.

Introduction

Three species of Indian major carps (IMCs) *viz*., catla, *Catla catla*, rohu *Labeo rohita* and mrigal *Cirrhinus mrigala* account for more than 67% of the total inland fish production in India (Anon, 2018). Catla is the fastest growing species in the Indian major carp group that is widely cultured in India. Despite its consumer preference, its propagation in the culture system is often constrained by availability of quality seed (fingerlings and juveniles). The reasons attributed are its poor breeding response and poor survival in nursery. Therefore, availability of quality seed and their continuous supply as stocking material is highly necessary for round the year culture practice.

Stunting is a process of suppressing the normal growth of an individual by manipulating various factors that affect the growth process. Stunting in fishes has been explained by manipulating various factors like high stocking rate (Wedemeyer and McLeay, 1981; Pickering, 1981; Wedemeyer, 1997, Jena *et al.*, 1998, Das *et al.*, 2016), low food availability (Abdel-Hakim *et al.*, 2009; Ali *et al.*, 2003), photoperiod manipulation (Boeuf and Bail, 1999; Bani *et al.*, 2009) etc. The effect of environmental variables on the growth, survival and physiological responses of fish have been thoroughly studied (Jobling, 2002).

Water quality plays a major role in growth, survival and health of different fish species (Boyd, 1979). The role of water quality and its optimum range for carp culture (Indian major carps) have been extensively studied (Banerjea, 1967; Jena *et al.*, 1998, 2002 a,b; Tripathi *et al.*, 2000; Das *et al.*, 2004, 2005). Water quality in fish ponds is affected by the interactions of several chemical components. Although most aquatic organisms can live in a broad range of alkalinity concentrations, the desired total alkalinity level for most aquaculture species lies between 50-150 mgL^{-1} $CaCO_3$, but no less than 20 mgL^{-1} (Wurts, 2002).

Parameters like Carbon dioxide, pH, alkalinity and hardness are interrelated and can have profound effects on pond productivity, the level of stress in fish health, oxygen availability and the toxicity of ammonia (Boyd, 1979, Wurts, 2002). Although Indian major carps can withstand a wide range of water variability in grow-out culture (Jena *et al.*, 2002a,b; Das *et al.*, 2004a, 2005; Sahu *et al.*, 2007), they are more vulnerable (stressed) during the seed rearing phase (Jena *et al.*, 1998;Das *et al.*, 2004b; Das *et al.*, 2006; Pawar *et al.*, 2009). Among the three species of IMC, catla juvenile is the most vulnerable to changes in pH and alkalinity (Das *et al.*, 2006). Considering the role of water quality as a stress factor for growth and survival of carps, the present study aimed at finding the influence of varying alkalinity on the growth and survival of catla juveniles, so that stunting of the same can be adopted during seed rearing phase.

Materials and Methods

The experiment was carried out in 9 circular FRP tanks of 1000 litre capacity in outdoor condition at ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, India (Latitude $20^{0}11^{/}06^{//}$- $20^{0}11^{/}45^{//}$N, Longitude $85^{0}50^{/}52^{//}$E) for a period of 90 days from May, 2018 to August, 2018.Pond water was filtered through bolting silk net (No.25, mesh size 64 μ) and filled up to 800 litre marks in the tanks. A total of three treatments including control were triplicated and used for the study.

Fry of catla (3.9g, 67±0.27mm) collected from the Institute farm and acclimated for 15 days were stocked in tanks of control, T-1 and T-2 groups at 20m^{-3} densities (16nos/ tank), to study the influence of varied water alkalinity on fish growth. Three alkalinity levels, i.e. 80, 150 and 200mg as $CaCO_3L^{-1}$ were used and designated as Control, T-1 and T-2, respectively. Pond water (80mgL^{-1}) and bore well water (360mgL^{-1}) were used as the two sources to get the desired alkalinity level. Further renewal of water levels was done at 7 days intervals. Extruded floating feed pellets

(3 mm diameter, 26% crude protein, 5% crude fat, 6% fibre, 11% moisture; ABIS, Indian Solvent Industry, Rajnandgaon, Chhattisgarh, India) were crushed to smaller crumbles and fed @ 8% of their respective biomass in all the treatments by broadcasting on the water surface.

Water samples from tanks were collected between 0700 and 0800hrs at 15 days intervals for measuring and monitoring the important physico-chemical parameters. Water temperature and pH (Elico, Hyderabad, India) were measured *in situ*. Water samples were collected and brought to laboratory for estimating dissolved oxygen (Wrinkler's method), total alkalinity, total hardness and inorganic nutrients, *viz*., total ammoniacal nitrogen (TAN), nitrite, nitrate and phosphate following standard methods (APHA, 2005). Sampling of catla fry were also carried out at 15 days intervals for assessment of their growth in terms of length and weight. Specific growth rate (SGR) of fish was calculated using the formula:

% SGR= (*ln* final weight−*ln* initial weight) × 100x (number of days of culture) $^{-1}$

The data on fish length and weight, survival and specific growth rate were subjected to statistical analysis using PC-SAS programme for Windows, release v6.12 (SAS Institute, Cary, NC, USA).The value of parameters among the treatments was compared at 5% level of significance by using Duncan's Multiple Range Test.

Results and Discussion

Figures 1 and 2 represent the variation in the different water quality parameters. Water temperature of treatment tanks varied in the range of 26.7-34.5°C in the experiment period but no significant difference in temperature was found within the treatments at any time of sampling. Dissolved oxygen value ranged from 3.2 to 5.67mgL^{-1} and gradually increased during the rearing period in all treatments. There was marked difference in the pH of water, being higher in the control followed by T-1 and T-2.Value of free carbon dioxide was higher in T-1 and T-2 in comparison to control but no marked difference was found within the treatments (T-1 and T-2). The value of total alkalinity and hardness of water did not show any significant variation due to regular monitoring of the water alkalinity.

The value of NO_3 did not differ significantly among the control and treatments. Although the value of TAN and NO_2 were higher in the treatments than the control but no marked difference was found among T-1 and T-2 (Fig. 2). In contrast, the phosphorous contents of control remain in higher side than the treatments throughout the rearing period but did not vary significantly among the treatments at any point sampling. The growth curves as depicted in Fig. 3 revealed that higher water alkalinity adversely affected the length and weight gain process in the stunting effect of catla fingerlings. Further, the stunting effect increased with increased alkalinity from control to T-2.

The survival of catla decreased significantly with the increase in alkalinity from control (97.92±3.61%) to T2 (89.58±3.61%) as depicted in Table 1. The average harvested body weight and length in T-1 (8.83±0.40g, 8.73±0.17cm) and T-2(8.28±0.19g, 8.65±0.10cm) were similar ($P>0.05$), but both were significantly lower ($p<0.05$) than the control (9.64±0.12g, 9.02±0.02cm).Similarly, specific growth rate of T1 (0.91±0.05) and T2 (0.84±0.03) were similar and significantly lower ($p<0.05$) than control (1.01±0.01). The biomass yield also reduced significantly from control (151.00±4.63g) to T1 (132.43±6.06g) and T2 (118.77±7.56g).

Total alkalinity and total hardness are common water quality variables important to productivity of aquatic ecosystems and aquaculture production (Boyd *et al.*, 2016).The total alkalinity (TA) of water is defined as the concentration of titratable bases, mainly bicarbonates (HCO_3^-) and carbonates (CO_3^{-2}), expressed as $CaCO_3$ equivalents. Total alkalinity of water in the present study was maintained at 80, 150 and 200mg as $CaCO_3L^{-1}$ in control, T-1 and T-2 respectively.

Typically, underground water has higher carbon dioxide concentrations, and lower pH and oxygen concentrations. The reason is due to bacterial processes in the soils and various underground particulate mineral formations through which these water moves (Wurts and Durborow, 1992).Lower pH and higher CO_2 concentration in T-1 and T-2 may be due to higher alkalinity of tank water prepared by mixing of bore well water (360 mgL^{-1}) with the pond water (80 mgL^{-1}). Further, fish respiration has added CO_2 in these tanks with obvious consequence of lowering of the water pH (Fig. 1). Lower dissolved oxygen (DO) and pH concentration might have affected the organic (faeces and waste feed) decomposition process leading to a proportionately higher nitrogen species in T-1 and T-2 than the control (Ghosh and Mohanty, 1981; Boyd, 1990; Avnimelech *et al.*, 1992; Avnimelech, 1999; Durborow *et al.*, 1997; Das *et al.*, 2005; Hargreaves and Tucker, 2004;Jena *et al.*, 2007; Pawar *et al.*, 2009).

The growth indices of the catla fingerlings are presented in Table 1. In the present work, significant reduction of harvested body weight (HBW), survival and specific growth rate (SGR) of catla from the Control to T-1 and T-2 clearly show the detrimental effects of the stressful water quality on the growth performance (Barton and Iwama, 1991; Wedemeyer, 1997; Parker, 1988; Vijayanand Leatherland, 1988). Comparatively higher TAN concentration in higher alkaline waters of T-1 and T-2 might have reduced the feed consumption resulting in decreased fish growth as depicted in figure 3 (Skov *et al.*, 2011). Decrease in fish biomass yield per tank from control to T-2 corresponds to their decrease in survival and growth in each treatment (Jena *et al.*, 2007; Pawar *et al.*, 2009).

Table.1 Yield attributes of catla fingerling subjected to stunting process using varied alkalinity (n=3)

Treatment	**Control- 80mgL^{-1}**	**T-1-150 mgL^{-1}**	**T-2-200 mgL^{-1}**
HBL (cm)	9.02±0.02 ^{a}	8.73±0.17 ^{b}	8.65±0.10 ^{b}
HBW (g)	9.64±0.12 ^{a}	8.83±0.40 ^{b}	8.28±0.19 ^{b}
Survival (%)	97.92±3.61^a	93.75±0.00^{ab}	89.58±3.61 ^{b}
BM/tank (g)	151.00±4.63 ^{a}	132.43±6.06 ^{b}	118.77±7.56 ^{c}
SGR	1.01±0.01 ^{a}	0.91±0.05 ^{b}	0.84±0.03 ^{b}

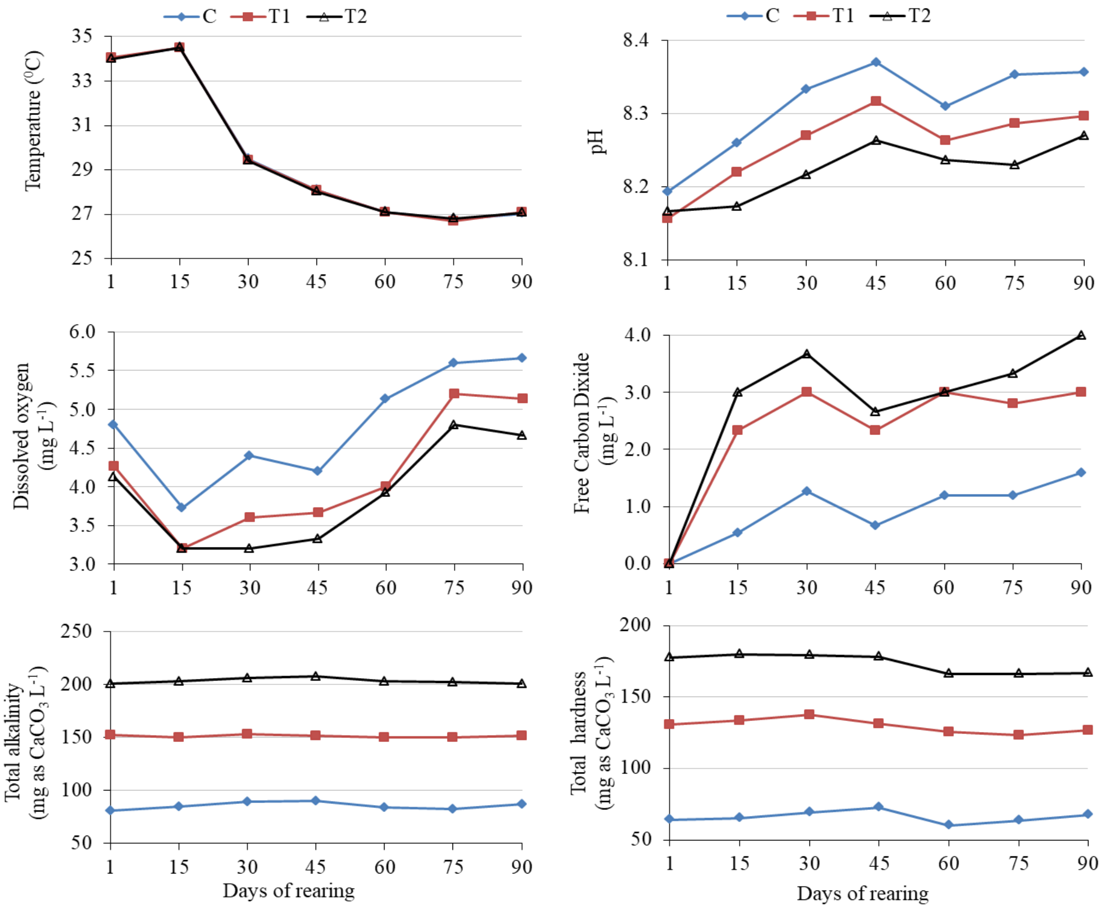

Fig.1 Water quality parameters in the tanks during the seed rearing (n=3)

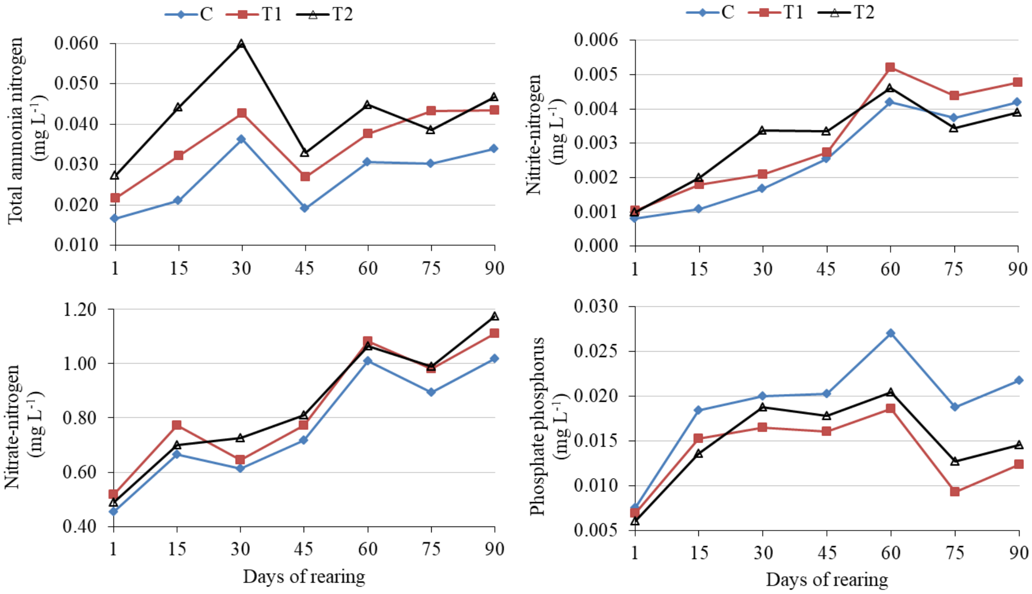

Fig.2 Different nutrient levels in tank water during the seed rearing (n=3)

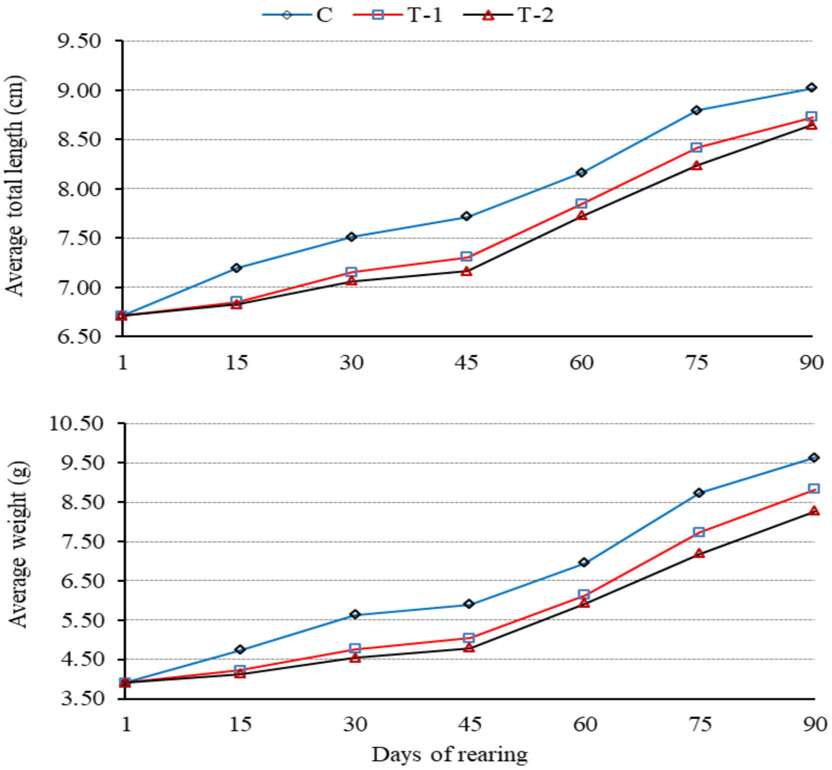

Fig.3 Growth curves of catla fingerling subjected to stunting process using varied alkalinity (n=3)

Therefore, catla seems to be sensitive to higher water alkalinity during larval phase as reported by many authors in other fish species (Rojas *et al.*, 2001; Rojas and Rocha, 2004; Andrade *et al.*, 2007; Cavalcante *et al.*, 2014).Thus, increasing of water alkalinity could be used as a tool for seed stunting in catla.

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