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GROWTH RESPONSES OF *CATLA CATLA* AND *LABEO ROHITA* UNDER MIXED EXPOSURE OF DIETARY AND WATER-BORNE HEAVY METALS VIZ. Cu, Cd AND Zn

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ABSTRACT

Growth performance of three age groups viz 60-, 90- and 120-day of two important culture-able indigenous fish species Thaila (*Catla catla*) and Rohu (*Labeo rohita*) was studied in glass aquaria under mix exposure of sub-lethal waterborne and dietary metals viz., Cu, Cd and Zn, keeping their control i.e. fish without metal exposure. This experimental trial was run for a period of 90 days at constant temperature (30 ^{o}C), pH (7.0) and hardness (200 mgL^{-1}). The treated fish were fed with a diet having 35% digestible protein, 2.90 kcal/g digestible energy and sub-lethal concentration of each metal. All three age groups of both fish species showed statistically variable responses towards increase in wet weights, feed intake and feed conversion ratios under treated and control regimes against toxicity of metals. The 120-day treated fish revealed significantly better average weight gains than other two age groups. The control fish of both the species showed significantly higher weight gains than the treated fish. Three age groups of treated fish showed variable responses towards Cu, Cd and Zn stresses for their average feed intakes. The overall feed intake of control fish was significantly higher than that of treated fish. Feed conversion ratios (FCR) of both treated and control fish species varied significantly among various weeks of the experimental period and control fish exhibited significantly better FCR than the treated fish.

Key words: acclimation; feed conversion ratio; sub-lethal; satiation; condition factor; LC_{50} ; LD_{50}

INTRODUCTION

Fish can be considered as one of the most significant bio-monitors in freshwater systems (Begum *et al*., 2005). They offer several specific advantages in describing the natural characteristics of aquatic system and assessing changes to the habitats (Lamas *et al*., 2007).

Heavy metals are naturally occurring trace components of the aquatic habitats that have been increased tremendously due to domestic, industrial, mining and agricultural activities (Karbassi *et al*., 2006). The metals are of special concern because of their variable effects and the wide range of concentrations that could cause toxic effects on the aquatic life, including fish. Heavy metals can be taken up by aquatic organisms via several routes (a) directly via the body surface or through respiratory organs, (b) via feed, or by a combination of both (Phillips and Rainbow, 1994). Aquatic organisms such as fish can accumulate metals to concentrations many times higher than those present in water or sediments (Olaifa *et al*., 2004).

At low levels, some heavy metals such as copper, cobalt, zinc, iron and manganese are essential for the activity of many enzymes involved in biological processes but they could become toxic at high concentrations (Bryan, 1976). For the normal metabolic activities, the essential metals like copper and zinc must be taken by the fish from water, food or sediment. Similarly the non-essential metals are also taken up by fish and accumulated in their tissues (Yilmaz, 2006). Copper is essential trace metal in small concentration for several fish metabolic functions because of its specific incorporation into a variety of enzymes that play important roles in physiological processes, as well as, into some structural proteins (WHO, 1998). When exposed to toxic concentrations, organs of aquatic animals may accumulate copper (Mazon *et al*., 2002) that can lead to redox reactions generating free radicals and, therefore, may cause biochemical and morphological alterations (Monteiro *et al*., 2005). Cadmium is a non-essential heavy metal and considered as one of the most toxic water contaminants that could cause toxicity at each trophic level of the ecosystem (Rashed, 2001). Fish exposed to high concentration of cadmium quickly develop lack of calcium and low blood hemoglobin (Roberts, 2003). Zinc at certain concentration is desirable for the growth of freshwater animals but at high accumulation it becomes hazardous to the exposed organisms as the one's consuming them directly or indirectly through food chain (Sultana and Rao, 1998). Zinc is potential toxicant to fish (Everall, 1989) which causes disturbances of acid-base and ion regulation, disruption of gill tissue and hypoxia (Hogstrand *et al*., 1994).

The density of major carps in natural fresh waters has alarmingly been declined due to heavy discharges of un-treated, domestic, sewage and industrial effluents into the rivers bearing high concentrations of heavy metals. Ultimately, the yields of major carps, especially, *Catla catla* and *Labeo rohita* have been reduced in the natural habitats due to exposure of fish to a number of metals. Therefore, in order to suggest remedial measures regarding sustainable conservation of major carps in the river systems of the Punjab, this project was planned to determine the growth responses of *Catla catla* and *Labeo rohita* under mixed exposure of water-borne and dietary Cu, Cd and Zn.

MATERIALS AND METHODS

The present research work was conducted in the wet laboratory at Fisheries Research Farms, Department of Zoology & Fisheries, University of Agriculture, Faisalabad. The growth performance of *Catla catla* and *Labeo rohita* were determined under mixed exposure of water-borne and dietary Cu, Cd and Zn at sub-lethal (1/3 of LC_{50} and LD_{50}) concentrations.

The experiments were conducted with three age groups viz. 60-, 90- and 120-day of each fish species (*Catla catla* and *Labeo rohita*). Prior to this experiment, the fish were kept under laboratory conditions, for two weeks, in 500-liter cemented tanks for acclimation. The fish, in good condition and good state of health after acclimation period, was selected for growth trials in glass aquaria (each with capacity of 70 liter water) under sub-lethal combined exposure of water-borne and dietary concentrations of copper, cadmium and zinc for 90 days. The following sub-lethal concentrations of metals were used to monitor growth of two fish species as determined by Javed *et al*. (2008):

Fish species	Metals	LC_{50} and LD_{50} concentrations		Sub-lethal concentrations	
		Water-borne LC_{50} (mg L^{-1})	Diet-borne LD_{50} (µg g^{-1})	Water-borne (mg L^{-1})	Diet-borne (µg g^{-1})
Catla catla	Copper	58.32	171.18	19.44	57.06
	Cadmium	155.07	173.22	51.69	57.74
	Zinc	51.96	191.82	17.32	63.94
Labeo rohita	Copper	72.72	181.59	24.24	60.53
	Cadmium	153.24	182.07	51.08	60.69
	Zinc	85.44	223.23	28.48	74.41

The stock solutions were prepared by dissolving pure chlorides of copper, cadmium and zinc, separately, in de-ionized water for addition in water medium and feed with desired metal concentrations. Feed (35% DP and 2.90 kcal/g DE) supplemented with desired sub-lethal metal concentrations was offered to the treated fish, to satiation, daily while control fish was fed with metal free diet. Growth experiment was conducted with three replications for each treatment. Constant air was supplied to all the test mediums through air pump with a capillary system. Water temperature (30 °C), pH (7.0) and hardness (200mg L^{-1}) were kept constant throughout the growth trial period of 90 days. To maintain the desired pH value of the test mediums, NaOH (to increase pH) and HCl (to decrease pH) were added as required. However, to maintain the total hardness, the salts of $CaSO_4$ and $MgSO_4$ (to increase hardness) while ethylenediaminetetraacetic acid (EDTA) and its sodium salt were used to decrease the water hardness.

The wet fish body weights of fish were measured at the time of stocking and then on weekly basis to record the weight gains throughout period of this investigation. Feed intake and feed conversion ratios of each fish species, under mixed exposure of water-borne and dietary sub-lethal exposures of each metal, was determined separately.

Determination of Physico-chemical Parameters: Water temperature and pH were determined with the help of electronic thermometers viz., HI-8521: HANNA and HI-8520, respectively. Total hardness of aquarium water was monitored on daily basis by following A.P.H.A. (1998).

Statistical Analyses of Data: Each growth trial was performed with three replications by using Factorial Experiment (RCBD) (Steel *et al*., 1996). The data on growth parameters was analyzed through Micro-computer by using MSTATC and MICROSTAT packages. The comparison of means was analyzed by following Tukey's/ Student Newnan-Keul test.

RESULTS AND DISCUSSION

The growth performances of 60-, 90- and 120-day fish species viz. *Catla catla* and *Labeo rohita* were determined under chronic stress of both water-borne and dietary metals viz. copper, cadmium and zinc in terms of wet weight gains, feed intake and feed conversion ratios during the whole period of investigation.

Increase in Wet Weights (g) of Fish: Table 1 shows analysis of variance on wet weights of treated and control fish species. The growth performance of both the treated and control fish species varied significantly among various weeks of the experimental period of 90 days. The treated (metal-stressed) fish exhibited significantly lower weights than those of control fish. The responses of three age groups of both treated and control fish species were statistically variable. The fish growth results are in line with the findings of Hayat (2009) who reported significantly variable growth patterns in Indian major carps (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) exposed to sub-lethal concentrations of heavy metals viz. Fe, Zn, Pb, Ni, Mn and their mixture for 90 days. He concluded that *Catla catla* and *Labeo rohita* showed significantly lower weight increments under metal mixture exposure than that of individual metals. These results are also in line with the findings of Shafique *et al*.

(2012) who reported statically significant growth variations between the treated and control *Cirrhina mrigala* under combined exposure of water-borne and dietary nickel. During present study treated 120-day fish gained significantly higher average weights than those attained by both 60- and 90-day fish. There existed non-significant difference between treated *Catla catla* and *Labeo rohita* for their overall performances to gain wet weights during the experimental period of 90 days. Regarding control fish, both *Catla catla* and *Labeo rohita* having the age of 120-day exhibited significantly higher weight gains than those of 60- and 90-day fish. However, the difference between 60- and 90- day fish species were statistically at par. Treatments viz. Cu, Cd, Zn and control showed significantly variable responses towards gain in wet weights of three age groups of fish. However, control fish attained significantly higher weights than those of treated fish species.

These findings are also in confirmatory with the results of Ali *et al.* (2003) who studied the effect of different sub-lethal waterborne copper concentrations on the fish, *Oreochromis niloticus*. Weight gains, specific growth rate and condition factor (K) values of treated fish decreased significantly ($p<0.05$) in comparison with the control fish and this decrease was linearly correlated with the increase in copper concentration of the test mediums. De Boeck *et al*. (1997) exposed common carp to three different sub-lethal copper concentrations for 20 days. The result indicated that copper exposure affected the growth rate and feeding behavior of fish. Levesque *et al.* (2002) determined the effects of sub-lethal exposure of heavy metals viz. Cd, Zn and Ni on the growth performance of yellow perch (*Perca flavascens*). The metal exposure-dependant decrease in condition factor was observed in both summer and fall seasons that reflected impaired growth. However, long-term exposure (20 days or more) to waterborne cadmium at sub-lethal concentrations showed decreased growth in juvenile and adult rainbow trout, *Oncorhynchus mykiss* (Ricard *et al*., 1998). Similar results have been obtained during the present investigation. Hayat *et al.* (2007) exposed the fingerlings of major carps (*Catla catla, Labeo rohita* and *Cirrhina mrigala*), to sub-lethal concentrations of manganese for 30 days. During this exposure period, all the three fish species showed negative growth. The present results suggested that Cu reduced the growth rate and there was inverse relationship between growth and Cu concentration of the test mediums as reported by Kim and Kang (2004) who studied the effects of sub-chronic dietary exposure of Cu on the growth performance of juvenile rockfish, *Sebastes schlegeli*, for 60 days. In fish, the toxic effects of heavy metals may influence the physiological functions, individual growth rate, reproduction and mortality (Woodward *et al.,* 1994). Naz *et al.* (2008) conducted 30-day growth trials on major carps (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) exposed to sub-lethal lead concentrations. Lead stressed fish showed significantly ($p<0.01$) lower weights, fork and total lengths as compared to the control.

Feed Intake by Fish: The analysis of variance shows statistically significant difference between treated and control fish for their feed intakes during 12 weeks of the growth period. The control fish had significantly higher feed intake of 1.31±0.70 g than that of treated fish (0.83±0.30 g). Regarding treated fish, there were non-significant differences between two age groups viz. 90- and 120-day for their feed intakes which were statistically higher than those of 60-day both *Catla catla* and *Labeo rohita*. However, the overall feed intake of control fish was significantly higher than that of treated fish. The three age groups of treated fish showed variable responses towards Cu, Cd and Zn stresses for their average feed intakes. Although, there were non-significant differences among Cu, Cd and Zn stresses towards intake of feed by the fish but these intakes were significantly lower than that of control fish. Regarding performances of both *Catla catla* and *Labeo rohita*, under Cu, Cd and Zn stresses, these fish species did not show any significant variations in their feed intakes. However, these feed intakes were significantly lower than that of control fish species (Table 2). Shaw and Handy (2006) fed Nile tilapia (*Oreochromis niloticus*), to satiation, on copper loaded diet for 42 days. The copper exposed fish showed a reduction in feed intake and weight gain by 21 day of exposure as compared to control. Hoyle *et al*. (2007) conducted a 30-day experiment to feed African walking catfish (*Clarias gariepinus*), to satiation, on Cu-loaded and a control diet. It was found that copper exposed fish showed a reduction in feed intake and specific growth rate (SGR) as compared to the control. Mohanty *et al*. (2009) determined the effects of water-borne zinc on the survival, growth and feed intake of Indian major carp (*Cirrhina mrigala*) for 30 days. Feed intakes were significantly ($p<0.05$) reduced in the fish when exposed to 0.10 mg L^{-1} and higher levels of zinc.

Table 1. Analysis of variance on an average increase in wet weights (g) of treated and control fish species.

Treatments	Weeks 1	2	3	4	5	6	7	8	9	10	11	12	*Means
Treated Fish	0.08±0.07 ^{f}	0.17±0.14 ^{de}	0.24±0.16 ^{d}	0.37±0.18 ^{c}	0.49±0.19 ^{ab}	0.59±0.25 ^{a}	0.56±0.21 ^{a}	0.54±0.16 ^{ab}	0.43±0.19 ^{bc}	0.54±0.17 ^{a}	0.49±0.16 ^{ab}	0.55±0.23 ^{a}	0.42±0.17 ^{b}
Control Fish	0.07±0.03 ^{h}	0.20±0.08 ^{gh}	0.40±0.13 ^{fgh}	0.60±0.17 ^{efg}	0.76±0.21 ^{def}	0.91±0.27 ^{cde}	0.96±0.47 ^{bcde}	1.11±0.56 ^{bcd}	1.24±0.64 ^{abc}	1.40±0.81 ^{ab}	1.65±0.88 ^{a}	1.69±1.08 ^{a}	0.92±0.53 ^{a}

			Age groups 60-day	90-day	120-day	*Means	
i. Species×Age groups							
	Treated Fish	*Catla catla*	0.34±0.22 ^{c}	0.42±0.24 ^{b}	0.49±0.24 ^{ab}	0.42±0.08 ^{a}	0.42±0.01 ^{b}
		Labeo rohita	0.33±0.21 ^{b}	0.45±0.24 ^{a}	0.51±0.25 ^{a}	0.43±0.09 ^{a}	
		Means	0.33±0.01 ^{c}	0.43±0.02 ^{b}	0.50±0.01 ^{a}		
	Control Fish	*Catla catla*	0.57±0.34 ^{b}	0.60±0.31 ^{b}	1.37±0.98 ^{a}	0.85±0.45 ^{a}	0.92±0.10 ^{a}
		Labeo rohita	0.82±0.59 ^{b}	0.65±0.30 ^{b}	1.49±0.93 ^{a}	0.99±0.44 ^{a}	
		Means	0.69±0.18 ^{b}	0.63±0.04 ^{b}	1.43±0.08 ^{a}		
ii. Treatments×Age groups							
	Treatments	Copper	0.36±0.24 ^{b}	0.47±0.29 a	0.47±0.21 ^{a}	0.43±0.06 ^{a}	0.42±0.04 ^{b}
		Cadmium	0.32±0.16 ^{b}	0.40±0.21 ^{ab}	0.46±0.25 ^{a}	0.39±0.07 ^{a}	
		Zinc	0.32±0.24 ^{c}	0.43±0.21 ^{b}	0.56±0.26 ^{a}	0.44±0.12 ^{a}	
		Means	0.33±0.02 ^{c}	0.43±0.04 ^{b}	0.50±0.06 ^{a}		
		Control	0.69±0.18 ^{b}	0.63±0.04 ^{b}	1.43±0.08 ^{a}		0.92±0.44 ^{a}
iii. Species×Treatments							
			Treatments Copper	Cadmium	Zinc	Control	
	Fish Species	*Catla catla*	0.44±0.25 ^{b}	0.37±0.19 ^{b}	0.43±0.27 ^{b}	0.85±0.45 ^{a}	
		Labeo rohita	0.42±0.25 ^{b}	0.42±0.24 ^{b}	0.45±0.24 ^{b}	0.99±0.44 ^{a}	
		Means	0.43±0.01 ^{b}	0.39±0.04 ^{b}	0.44±0.01 ^{b}	0.92±0.10 ^{a}	

Means with the same letters in a single row and *column are statistically similar at $p<0.05$.

Table 2.Analysis of variance on feed intakes (g) of treated and control fish species.

Treatments	Weeks 1	2	3	4	5	6	7	8	9	10	11	12	*Means
Treated Fish	0.20±0.14 ^{g}	0.38±0.27 ^{fg}	0.56±0.33 ^{ef}	0.74±0.29 ^{de}	1.01±0.36 ^{abc}	1.15±0.41 ^{a}	1.10±0.37 ^{ab}	1.07±0.32 ^{ab}	0.84±0.36 ^{cd}	1.03±0.33 ^{ab}	0.93±0.30 ^{bcd}	1.00±0.44 ^{abc}	0.83±0.30 ^{b}
Control Fish	0.15±0.52 ^{g}	0.40±0.73 ^{fg}	0.76±0.49 ^{ef}	1.10±0.88 ^{de}	1.36±0.63 ^{cd}	0.54±0.59 ^{bcd}	1.65±0.58 ^{abcd}	1.76±0.73 ^{abc}	1.86±0.84 ^{abc}	1.96±0.95 ^{ab}	2.18±1.02 ^{a}	2.05±0.91 ^{ab}	1.31±0.70 ^{a}

			Age groups 60-day	90-day	120-day	*Means	
i. Species×Age groups							
Treated Fish		***Catla catla***	0.60±0.33 ^{b}	0.97±0.50 ^{a}	0.91±0.43 ^{a}	0.83±0.02 ^{a}	0.83±0.01 ^{b}
		Labeo rohita	0.64±0.34 ^{b}	0.98±0.45 ^{a}	0.90±0.42 ^{a}	0.84±0.18 ^{a}	
Control Fish		**Means**	0.62±0.03 ^{b}	0.98±0.01 ^{a}	0.91±0.01 ^{a}		
		Catla catla	0.93±0.24 ^{b}	0.93±0.41 ^{b}	2.07±0.28 ^{a}	1.31±0.66 ^{a}	1.39±0.12 ^{a}
		Labeo rohita	1.12±0.37 ^{b}	1.19±0.30 ^{b}	2.14±0.46 ^{a}	1.48±0.57 ^{a}	
		Means	1.02±0.13 ^{b}	1.06±0.18 ^{b}	2.10±0.05 ^{a}		
ii. Treatments×Age groups							
Treatments		***Copper***	0.61±0.35 ^{c}	0.92±0.53 ^{ab}	0.86±0.35 ^{b}	0.80±0.16 ^{a}	0.83±0.03 ^{b}
		Cadmium	0.63±0.28 ^{c}	1.05±0.47 ^{a}	0.84±0.45 ^{b}	0.84±0.21 ^{a}	
		Zinc	0.61±0.38 ^{b}	0.95±0.42 ^{a}	1.02±0.45 ^{a}	0.86±0.22 ^{a}	
		Means	0.62±0.01 ^{b}	0.98±0.07 ^{a}	0.91±0.10 ^{a}		
		Control	1.02±0.13 ^{b}	1.06±0.18 ^{b}	2.10±0.05 ^{a}		1.39±0.61 ^{a}
iii. Species×Treatments							
			Treatments Copper	**Cadmium**	**Zinc**	**Control**	
Fish Species		***Catla catla***	0.80±0.44 ^{b}	0.83±0.43 ^{b}	0.86±0.49 ^{b}	1.31±0.66 ^{a}	
		Labeo rohita	0.80±0.43 ^{b}	0.85±0.45 ^{b}	0.87±0.41 ^{b}	1.48±0.57 ^{a}	
		Means	0.80±0.00 ^{b}	0.84±0.01 ^{b}	0.86±0.01 ^{b}	1.39±0.12 ^{a}	

Means with the same letters in a single row and *column are statistically similar at $p<0.05$.

Table 3. Analysis of variance on feed conversion ratios of treated and control fish species.

Treatments	Weeks 1	2	3	4	5	6	7	8	9	10	11	12	*Means
Treated Fish	2.56±0.36 ^{a}	2.42±0.33 ^{b}	2.39±0.35 ^{b}	2.20±0.36 ^{c}	2.11±0.41 ^{cd}	2.03±0.31 ^{de}	2.00±0.34 ^{de}	2.00±0.30 ^{de}	1.97±0.38 ^{e}	1.93±0.41 ^{ef}	1.94±0.36 ^{ef}	1.82±0.29 ^{f}	2.11±0.23 ^{a}
Control Fish	2.11±0.15 ^{a}	2.01±0.12 ^{ab}	1.93±0.09 ^{bc}	1.82±0.04 ^{cd}	1.78±0.03 ^{d}	1.69±0.12 ^{de}	1.76±0.22 ^{d}	1.61±0.16 ^{ef}	1.53±0.17 ^{fg}	1.45±0.23 ^{gh}	1.37±0.22 ^{hi}	1.28±0.23 ^{i}	1.70±0.26 ^{b}

		Age groups 60-day	90-day	120-day	*Means	
i. Species×Age groups						
Treated Fish	***Catla catla***	2.01±0.46 ^{b}	2.48±0.38 ^{a}	1.89±0.21 ^{c}	2.13±0.31 ^{a}	2.11±0.02 ^{a}
	Labeo rohita	2.13±0.37 ^{b}	2.32±0.40 ^{a}	1.86±0.19 ^{c}	2.10±0.23 ^{a}	
	Means	2.07±0.08 ^{b}	2.40±0.40 ^{a}	1.88±0.19 ^{c}		
Control Fish	***Catla catla***	1.80±0.31 ^{a}	1.68±0.36 ^{b}	1.67±0.25 ^{b}	1.72±0.07 ^{a}	1.69±0.04 ^{b}
	Labeo rohita	1.58±0.33 ^{b}	1.84±0.07 ^{a}	1.59±0.27 ^{b}	1.67±0.15 ^{a}	
	Means	1.69±0.16 ^{ab}	1.76±0.11 ^{a}	1.63±0.06 ^{b}		
ii. Treatments×Age groups						
Treatments	**Copper**	2.02±0.61 ^{a}	2.10±0.27 ^{a}	1.86±0.16 ^{b}	1.99±0.12 ^{c}	2.11±0.12 ^{a}
	Cadmium	2.09±0.22 ^{b}	2.76±0.32 ^{a}	1.88±0.16 ^{c}	2.24±0.46 ^{a}	
	Zinc	2.10±0.33 ^{b}	2.34±0.29 ^{a}	1.89±0.27 ^{c}	2.11±0.23 ^{b}	
iii. Species×Treatments	**Means**	2.07±0.04 ^{b}	2.40±0.33 ^{a}	1.88±0.01 ^{c}		
	Control	1.69±0.16 ^{ab}	1.76±0.11 ^{a}	1.63±0.06 ^{b}		1.69±0.06 ^{b}

		Treatments Copper	Cadmium	Zinc	Control
Fish Species	***Catla catla***	1.98±0.46 ^{c}	2.27±0.45 ^{a}	2.14±0.36 ^{b}	1.72±0.07 ^{d}
	Labeo rohita	2.00±0.34 ^{c}	2.22±0.45 ^{a}	2.08±0.32 ^{bc}	1.67±0.15 ^{d}
	Means	1.99±0.01 ^{c}	2.24±0.04 ^{a}	2.11±0.04 ^{b}	1.69±0.04 ^{d}

Means with the same letters in a single row and *column are statistically similar at $p<0.05$.

Pereira *et al*. (2001) reported significant influence of metals (Zn, Cu, Pb, Ni, Cr and Cd) on the feed intake, behavior and growth of *Cirrhina mrigala* when chronically exposed to the medium contaminated with these metals.

Feed Conversion Ratios (FCR) of Fish: Feed conversion ratios of both treated and control fish species varied significantly among various weeks of the growth period. Regarding overall responses of treated and control fish, the control fish had significantly better FCR than the treated one (Table 3). These results are also confirmatory to Hayat (2009) who reported significantly better feed conversion ratio (FCR) in unstressed (control) Indian major carps (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) than those chronically exposed to heavy metals viz., Fe, Zn, Pb, Ni, Mn and their mixture.

Among the treated fish species, 120-day fish performed significantly better regarding their feed conversion ratios, followed by that of 60- and 90-day fish. However, there existed non-significant difference between *Catla catla* and *Labeo rohita* for their overall performances towards FCR values. The control fish viz. *Catla catla* and *Labeo rohita* performed differently with age. The feed conversion ratio of fish varied significantly due to stress of metals viz. Cu, Cd and Zn. However, among the metal stressed fish, Cu-stressed fish showed significantly better FCR, followed by that of Zn- and Cd-stressed fish. Ali *et al*. (2003) also revealed that different sub-lethal concentrations of Cu exerted significantly variable effects on the FCR of the *Oreochromis niloticus*. Sherwood *et al*. (2000) also studied the effects of Cu, Cd and Zn on yellow perch and concluded that higher concentrations of these metals significantly affected the growth rate, feed consumption and FCR of the fish.

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