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Toxicity of chromium on *Macrobrachium rosenbergii*

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ABSTRACT

The toxicity of chromium was conducted on *Macrobrachium rosenbergii*. Chromium is an important compound used in cosmetics and pharmaceutical products. Nowadays, the concentration is increasing in the environment. The toxicity of chromium to the freshwater prawn *Macrobrachium rosenbergii* revealed that the 48-hr LC50 was 425 µg/l. Prawn juveniles were exposed for 45 days to sublethal doses (210, 300, 325 and 375 µg/l) equivalent to LC10, LC20, LC30 and LC40, respectively. The results showed that juvenile prawns with an initial weight of 0.255±0.097 g, in higher concentration (375 µg/l), had significantly decreased from the control in final mean weight, weight gain, percentage and survival. This study indicated that Macrobrachium rosenbergii is sensitive to this compound.

Key Words - Chromium, *Macrobrachium rosenbergii*, toxicity, survival, growth rate,

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INTRODUCTION

Pharmaceutical and personal care products (PPCPs) are the artificial compounds used for the health improvement of humans and livestock through drugs used in cosmetics and the agricultural industry to maintain the health of plants (Nikolaou *et al.,* 2007). Scientific advancement in pharmaceutical therapies and personal care products has done much to improve the overall health of the world's population. However, the widespread use of pharmaceuticals and other personal care products (PPCPs) has increased concerns about concentrations of these substances in the water cycle, including surface and ground waters, waste water and drinking water, due to untreated waste effluents in many areas of the world. Approx. 10–90% of the administered doses of PPCPs are excreted from the human body, while the rest are excreted as metabolites and or in conjugated forms. Contamination of aquatic environments by the emission of considerable industrial wastes poses a significant threat to aquatic organisms and the whole ecosystem. The bioavailability of metal is, in turn, a function of many environmental and biological factors and may vary widely.

Chromium is considered non-essential for plants but an essential trace element for animals (APHA, 2012). Chromium is essential for basal metabolism. Chromium is generally used in alloys, electroplating, and pigments. Chromate compounds frequently are added to cooling water for corrosion control.

Macrobrachium rosenbergii has been one of the main species used in freshwater prawn farming. The success of this activity is directly related to the water quality in the culture ponds. The use of various pesticides in agriculture has undoubtedly contributed to an increase in the crop-yield but has also produced adverse effects on the natural environment (Lombardi *et al.,* 2001). Other studies on heavy metal toxicity focus on freshwater prawns and other crustaceans (Liao & Guo, 1990; Vagenase *et al*., 1997). Over the last decades, the detrimental effects of pollution caused by heavy metal accumulation have been repeatedly documented. Since then, heavy metal pollution and its acute

effects on aquatic life have become a focus of discussion and research. At the sublethal level, heavy metals may affect the growth, reproduction and other physiological functions of aquatic animals (Liao & Hsieh, 1988; Ghazy, 2002).

Furthermore, heavy metal pollution generates public health problems. Crustaceans differ in their trace metal accumulation patterns among various taxa (Rainbow and white, 1989) between taxa. Decapods usually regulate their body concentration of the essential elements Zn, Cu, and Fe to approximately constant levels (Rainbow and white 1989), while they are net accumulators of the non-essential elements Cd and Pb. At present, bioassays are increasingly used as sensitive indicators of pollutant toxicity since they are rapid, inexpensive, applicable to various toxicants, and allow several acute and chronic endpoints to be assessed simultaneously. The analysis of the potential toxicity of chromium was conducted to evaluate lethal and sublethal effects on *Macrobrachium rosenbergii*.

MATERIALS AND METHODS

Experiments with Juvenile prawns of *Macrobrachium rosenbergii* (de Man) used in the present study were obtained from the local market of Saharsa, Bihar. In glass aquaria, the prawn juveniles were acclimatized to laboratory conditions for about two weeks. The prawns were fed on 35.0% protein commercial pellets during this period. Ten juvenile prawns of *Macrobrachium rosenbergii* with a mean length of 3.1±0.552 cm and a mean weight of 0.255±0.097g was randomly distributed in triplicate (for each treatment and control) of rectangular-glass aquaria, Each containing 5L of water. Air pumps and individual stone diffusers provided aeration. Mortalities were recorded after 48hr of exposure, and the criterion for death was judged as total immobility in response to gentle touching with a glass rod. The juvenile prawns were fed daily with commercial feed pellets (35% protein) at a rate of 5% biomass. The remaining feed, faecal materials, and dead organisms were removed regularly from the test solution every morning, and a quarter of the water volume was changed. The water was replaced completely once every ten days. At 15 days intervals, survival and prawn measurements weight, length, and weight gain were estimated. The experiments ended after 45 days.

RESULTS AND DISCUSSION

Table 1: Growth of *Macrobrachium rosenbergii* in different concentrations of chromium

Growth parameters	Concentration of Chromium (µg/l)				
	Control	210	300	325	375
Initial weight	0.25±0.8	0.25±0.8	0.25±0.8	0.25±0.8	0.25±0.8
Final weight	0.83±0.06	0.54±0.02	0.36±0.06	0.33±0.2	0.26±0.01
Weight gain	0.58	0.29	0.11	0.08	0.01
Weight gain in %	232	116	40	32	4

Table 2: Toxicity of chromium to *Macrobrachium rosenbergii* in different concentrations of chromium

	Duration of exposure		
Toxicity(LC)	48 hrs exposure	21 days exposure	45 days exposure
LC10	210 µg/l	140 µg/l	170 µg/l
LC20	270 µg/l	200 µg/l	230 µg/l
LC25	300 µg/l	240 µg/l	270 µg/l
LC30	325 µg/l	275 µg/l	300 µg/l
LC40	375 µg/l	350 µg/l	360 µg/l
LC50	425 µg/l	430 µg/l	440 µg/l

The excreted PPCPs reach the wastewater treatment plants (W.T.P.s), where effluents are discharged as raw or treated into the groundwater, rivers, lakes, oceans, and soil. PPCPs have been detected in the environment worldwide over the last 40 years, but their wide distribution has been reported only in the past few years. The unintentional presence of PPCPs in various compartments of the aquatic environment (e.g. water, sediments and biota) at different concentrations can cause detrimental effects on aquatic organisms and human health, increasing day by day. This is a significant concern because PPCPs are extensively and increasingly used in human and veterinary medicine, resulting in their continuous release to the environment.

The lethal concentrations (48-hr LC50) of chromium to Macrobrachium rosenbergii were 425 µg/l (Tables 1&2). Magliette *et al.* (1995) reported that white shrimp, *Penaeus setifefus*, was also susceptible to the toxic effects of zinc than *Daphnia* and *Ceriodaphnia* , whose 48-hr LC50 values were 1.22 and 0.32mg/L, respectively. There was no significant difference in LC50 values as the exposure time of prawns increased from 48hr to21 day, but as time increased from 48hr to 45 days, the LC50 was 440 µg/l. The periodic moulting of *M. rosenbergii* accompanied by loss of exuvia may lead to a more excellent absorption through the body surface of the toxic materials in solution, which may increase the vulnerability of these animals to heavy metals (Gulati, 1988). Even to the same organism, metal toxicity can vary widely in different waters because of the influence of water chemistry and metal speciation on metal bioavailability. In previous studies on the toxicity of various metals to Z.X. magna where the dilution water was the same medium as that used in the present study, the following order of toxicity of heavy metals was observed: copper > cadmium> zinc. Table 1 summarizes the effect of different concentrations of chromium (0, 210, 300, 325 and 375 µg/l) on the growth of the freshwater prawn, *Macrobrachium rosenbergii*, after 45 days of exposure. It was found that prawns in zero concentration (control group) showed the best growth in the final weight, weight gain and per cent weight gain. It is found that the prawn in the highest concentration of chromium (375 µg/l) showed a significant decrease in growth, final weight, weight gain and per cent weight gains, which are represented by 0.270 g3, 0.015 and 1.928, respectively. There was no significant difference in growth between the three groups of prawns living in higher concentrations (300, 325 and 375 µg/l). This finding was in favour of Chen (1975), Conner (1972) and Wisely and Blick (1967), who found that the toxicity of the heavy metals increases with their increased concentrations, and this affects the growth of aquatic animals. Moreover, the heavy metal ions dissolved in water permeate through the gill surface incessantly (Bryan, 1976). They are then transported through the blood to each part of the body, producing their toxic effect. The Food conversion ratio (F.C.R.) increased gradually from the control group until it reached the highest concentration. This may be due to the toxic effect of feed utilization, so a group of prawns in control convert the feed more efficiently, showing the best growth (higher value) and improvement of F.C.R. (lower value) than those reared in other treatments. Furthermore, the lowest survival rate of prawns at the highest concentration of chromium (375 µg/l) was represented by 4 %. After about 15 days, nearly half of the prawns died at this concentration, while the control group showed the best significant survival, represented by 73.3% at the end of the experiment. This may be due to the higher concentration of toxicant leading to its higher accumulation in different tissues of prawns, which affected the absorption and assimilation of food, causing inhibition of growth and survival. Also, prawns in the highest metal concentrations showed marked toxicity symptoms such as black spots on the shell, especially cephalothorax, and abnormal behaviour before death, as Liao and Hsieh (1990) reported.

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