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Acute toxicity of nickel to *Heteropneustes fossilis* (Bloch)

Mukul Sinha and Sadguru Prakash

Abstract
In the present study, *Heteropneustes fossilis* was exposed to Nickel for 24, 48, 72 and 96 hrs. The median lethal concentration (LC_{50}) of nickel to *Heteropneustes fossilis* for 24, 48, 72 and 96 h of exposure were 10.66 mg/l, 8.708 mg/l, 7.431 mg/l and 6.005 mg/l, respectively. The heavy metal, nickel produced lethality at smaller doses. Behavioural responses like rapid opercular movement and frequent gulping of air was observed during the initial stages of exposure after which it became occasional. All these observations can be considered to monitor the quality of aquatic ecosystem and severity of pollution.

Keywords: Nickel, acute toxicity, *Heteropneustes fossilis*

Introduction
Acute toxicity is an adverse effect induced in an organism within a short time of exposure to a chemical or toxicant. It is expressed as the median lethal concentration (LC_{50}) i.e. the concentration of toxicant in water which kills 50% of a test aquatic animals within a continuous period of exposure which must be stated. Fishes have direct economic importance and are quite sensitive to the wide array of pollutants discharged in the aquatic ecosystems. Fishes are widely used to assess water quality of aquatic ecosystems because they serve as pollution bioindicators.

Pollution of the aquatic ecosystems by heavy metals is a worldwide problem and its contamination severely interfere with ecological balances of an ecosystem and produces devastating effects on environment quality anthropogenic inputs like waste disposal directly adds to the burden of environmental degradation (Farombi *et al*., 2007) [3]. The heavy metal concentration in the body of fish depends upon feeding habits, trophic status, and food availability, physico-chemical properties of water, and metabolic rate of animal and toxicity of heavy metals (Maret and MacCoy, 2002) [5].

Assessment of toxicity on particular organism exposed to a particular toxicant will reveal facts regarding the health of given ecosystem and would eventually help us to propose policies to protect the ecosystem. Toxicity tests will reveal the animal's sensitivity to a particular toxicant that would help us to determine the permissible limit of a toxicant in an ecosystem. Heavy metals such have gained wide interest in the scientific community in recent years due to their potential human health hazards (Shuhaimi-Othman *et al*., 2010) [7].

Human activities are major responsible for water pollution. Water pollution affects fisheries and aquaculture industries. The changes in the quality of water alter the behaviour of fishes besides causing mortality. The behavioral changes in fishes have been considered to be sensitive indicators of toxicity and among aquatic fauna, fishes are more sensitive to pollutants (Sharma, 1999) [6]. Metals are the common pollutants of the lotic waterbody that entered into them with industrial and municipal waste waters. The heavy loads of metals in the rivers have adversely affected the original fish fauna, including major carp's *viz*. *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* as well as cat fishes like *Heteropneustes fossilis, Clarias batrachus* and *Mystus vittatus* etc. that are on the verge of loss in the aquatic habitats. Therefore, heavy metals are considered as chief environmental pollutants and have long been known as settled contaminants of aquatic environments. The aim of the present research work was to find out acute toxicity and LC_{50} value of Nickel for a fresh water catfish, *Heteropneustes fossilis*.

Materials and Methods
The fresh water catfish, *Heteropneustes fossilis* (average length 6-7 cm and average weight 7-9 gm) were collected from local fish form and dip in 0.1% of potassium permanganate solution for 2 minute.

The fishes were acclimatized in laboratory conditions for 10 days in a glass aquarium filled with dechlorinated water. During acclimatization the fishes were fed with commercial diet, egg albumin and small insects. The feeding of Fishes were stopped before experiment. The mortality was recorded after a period of 24, 48, 72 and 96 h and dead fishes were removed immediately after death during observation. Stock solution of Nickel sulphate of various concentrations were prepared and 10 fishes was kept in each rectangular glass aquaria separately to estimate mortality between 0% and 100%. For 96h LC_{50} test, separate 10 concentrations of nickel sulphate taken to find out the narrow range of concentrations.
Stock solutions of Nickel sulphate of various concentrations was prepared by dissolving nickel sulphate ($NiSO_4$) in distilled water and 10-10 individuals of experimental fish was kept separately in each rectangular glass aquaria to estimate mortality between 0% and 100%. For 96h LC_{50} test, separate 10 concentrations of nickel were taken to find out the narrow range of concentrations. Acute Toxicity test was conducted in accordance with standard methods (APHA, 2005) [2]. Probit analysis was carried out as suggested by Finney (1971) [4]. Regression lines of probit logarithmic transformations of concentrations were made and confidential limits (Upper and Lower) of the regression line with Chi-Square test were calculated by SPSS software.

Result and Discussion

Quatic ecosystems are sensitive to exposure of toxic contaminants and heavy metals. Among the aquatic organisms, fish is most vulnerable to these contaminants (Alinnor, 2005) [1]. In the present investigation acute toxicity of nickel showed that mortality is directly proportional to the concentration of the heavy metal nickel while the percentage of mortality is virtually absent in control. Results show that the median lethal concentration (LC_{50}) of nickel to *Heteropneustes fossilis* for 24, 48, 72 and 96 h of exposure were 10.66 mg/l, 8.708mg/l, 7.431mg/l and 6,005 mg/l, respectively. Observations on the upper and lower confidence limits revealed a decreasing trend from 24h to 96h. From the fitted regression equation, it is evident that an increase in exposure period influences an increase in mortality (Table 1). Abdulla and Javad (2006) reported the 96h LC_{50} of Nickel for 30 days *Catla catla* fingerling was 11.83 mg/l. Susceptibility of *Heteropneustes fossilis* to the impact of nickel toxicity was found to increase in mortality with an increase in the concentration of nickel, whereas in the control mortality was virtually absent. Observations on the upper and lower confidence limits revealed a decreasing trend from 24h to 96h. From the fitted regression equation, it is evident that an increase in exposure period influences an increase in mortality (Table 1). From the derived LC50 values, it is quite clear that, the toxic effect increased with dose and duration. Stebbing and Fandino (1983) [8] reported that, the adverse biological effects of heavy metals in the aquatic environment are mainly due to their complex nature. When the toxicant concentration in the water body is very high, it results in the death of fish.

Table 1: LC_{50} (With 95% confidence limit) of *Heteropneustes fossils* for Nickel sulphate

Exposure Period (Hours)	LC_{50}	Confidence Limit		Regression Equation	Chi Square value	Coefficient of determination (R^2 Linear)
		Lower Limit	Upper Limit			
24	10.660	9.415	11.917	Y= -7.05+6.83X	1.552	0.003
48	8.708	7.402	9.940	Y= -5.43+5,79X	1.021	0.991
72	7.431	6.129	8.699	Y= -4.47+5.13X	1.390	0.973
96	6.005	4.611	7.602	Y= -2.37+2.95X	3.615	0.929

Table 1: Behavioural responses of *Heteropneustes fossilis* exposed to sublethal concentration of Nickel sulphate at different exposure periods

Exposure Period	Behavioural Responses					
	Surface visit	Jumping	Fast swimming	Mucous secretion	Air gulping	Opercular movement
24	++	++	+	-	++	++
48	++	+	+	+	++	++
72	+	-	-	+	+	++
96	+	-	-	+	+	++

Notes: none, + mild and ++ moderate

In the present study fish in the control group was found to be active and healthy with normal swimming behaviour. When the fish were exposed to sublethal concentration of nickel sulphate they slowly moved to the bottom of the aquarium. The schooling behaviour of the fish was disrupted. They were spread and found swimming independently. Fishes increased their visit to the surface of water and tried to jump out of water. Surface visit was found to be moderate for 24 and 48 hours and mild for 72 and 96 hours. The tendency to jump out of the aquarium and fast swimming were observed for the first two days. From the second day of exposure, fishes secreted mucous all over the body, more profusely in the gill region. The physiological responses recorded during the exposure period were gulping of air and opercular movement. The gulping of air was found to be moderate and mild while the opercular movement was moderate throughout the experimental period.

Conclusion

The present investigation concluded that nickel is a toxic heavy metal for fishes when these are exposed to acute concentration of the metal in water bodies. This is evidenced by the fact that a slight higher concentration of nickel sulphate in the medium causes death of a much higher percentage of fish. Such type of toxicological studies will be useful for conservation and protection of aquatic organisms and ultimately safeguarding the interest of man in long run as a food supply.

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