Effect of heavy metal nickel on proein alterations in the fish *Mugil cephalus*

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ABSTRACT **:** Effect of heavy metal nickel is common pollutants of freshwater ecosystems where they induce adverse effects on the aquatic biota. Estuarine fish, *Mugil cephalus* is an important fish species in Tamil Nadu region having good nutritional values. Fishes living in close association with may accumulate pesticides and heavy metals. In the present study, the toxic effects of the heavy metal nickel LC_{50} 25 mg/L on total protein in gill, liver and muscle tissues of estuarine fish, *Mugil cephalus* were estimated. There is decreased in all tissues on comparison with control. These results indicated the toxic nature of the heavy metal nickel.

Index Terms*: *Estuarine fish, Mugil cephalus, Nickel, Protein

1. INTRODUCTION

Heavy metals occur naturally in traces under aquatic environments, presently their levels have increased due to industrial, agricultural and mining activities. Resultantly the aquatic life has become prone to the toxic effect of heavy metals[1] (Kalay and Canli, 2000). Among contaminants, the heavy metals are considered to be most hazardous at global level with reference to their toxicity[2] (Vuren *et al*., 1999).

Nickel (Ni) is a transition metal relatively abundant in the Earth's crust. It is of significant economic importance and is widely mined[3] (Eisler, 1998). Various anthropogenic processes, including mining, smelting, refining, and the manufacture of stainless steel and nickel batteries have resulted in nickel contamination in many aquatic areas[4&5] (Bielmyer *et al*., 2013; Jayaseelan *et al*., 2014). However, nickel concentrations in superficial natural freshwater scan reach 100 mg/L[6] (CETESB, 2014). High nickel levels (upto135 mg kg^{-1}) have also been detected in the muscle tissue of various fish species collected from a Brazilian river basin with high levels of many heavy metals[7] (Meche *et al*., 2010).

Nickel is well established as an essential nutrient for plants and terrestrial animals and evidence is mounting to suggest that nickel is probably essential to fish[8] (Pyle and Couture, 2012). However, at elevated concentrations, it can be harmful[4] (Bielmyer *et al*., 2013). It can significantly affect the physiology of aquatic organisms [9&10] (Pane *et al*., 2003; Alsop *et al*., 2014) and oxidative stress is thought to be one possible mechanism of Ni induced toxicity [11, 12&13] (Parthiban and Muniyan, 2011; Kubrak *et al*., 2013;

Zheng *et al*., 2014). Nickel is a heavy metal element whose presence in traces is necessary for the growth of all living entities, whether motile or immotile on the earth. When the amount exceeds the tolerance limits of that particular living being, then the resultant effect creates impediments in the growth or even leads to fatal consequences.

II. MATERIALS AND METHODS

Estuarine fish, *Mugil cephalus* were collected from Thengaithittu estuary Puducherry India and were brought to the laboratory in large plastic troughs and acclimatized for one week. Healthy, fish having equal size (length 10 to 12 cm) and weight (50 to 100 g) were used for experimentation. Stock solution of heavy metal nickel was prepared by dissolving appropriate amount of salt in distilled water. Physico-chemical characteristic of test water have analyzed regularly during the test periods following the standard method describe by APHA[14] (1998). Batches of 10 healthy fishes were exposed to different concentrations of heavy metal nickel to calculate the medium lethal concentration LC_{50} value (25 mg/L) using probit analysis Finney method [15] (1971). Fishes (Four groups) were exposed to the two sublethal concentrations ($1/10^{th}$ and $1/30^{th}$ mg/L) of heavy metal nickel for 5, 00 and 15 days respectively. Another group was maintained as control. At the end of each exposure period, fishes were sacrificed and tissues such as gill, liver and muscle were dissected and removed. The tissues (10 mg) were homogenized in 80% methanol, centrifuged at 3500 rpm for 15 minutes and the clear supernatant was used for the analysis of total proteins. Total protein concentration was estimated by the method of Lowry [16] (1951).

III. RESULTS

Median lethal concentration (LC_{50})

Heavy metal nickel caused 50% mortality of fish *Mugil cephalus* at 96 hours was 25 mg/L. The LC_{50} values of copper heavy metal for 24, 48, 72 and 96 hours were 22, 23, 24 and 25 mg/L respectively.

In the present study, alteration in total protein content of gill, liver, and muscle tissues of estuarine fish, *Mugil cephalus* exposed to acute concentrations of heavy metal nickel was studied along with control fish. The data was supported by various statistical analyses and the standard deviation of the mean was calculated. Changes in the total protein in different tissues such as gill, liver and muscle of fish *Mugil cephalus* exposed to two sublethal concentrations of heavy metal nickel for the period of 5, 10 and 15 days respectively (Table 1 and Fig. 1 to 3).

Gill Protein

Fish *Mugil cephalus* treated with sublethal concentrations of heavy metal nickel on 10% & 30% showed a decreasing trend in the gill protein when compared to control (Table 1 and Fig. 1). Protein values

of control fish were recorded from 5.32, 5.36 and 5.38 mg/g. The 10% sublethal concentration of gill protein values were noted from 5.24, 4.72 and 4.17 mg/g, and the 30% sublethal concentration of gill protein values were recorded from 5.05, 4.41 and 4.06 mg/g after exposure of 5, 10 and 15 days respectively.

Liver Protein

Estuarine fish *Mugil cephalus* treated with sublethal concentrations of heavy metal nickel on (10% & 30%) showed a decreasing trend in the total liver protein compared to control (Table 1 and Fig. 2). The 10% sublethal concentration of liver protein values were recorded from 7.37, 6.68 and 5.85 mg/g and the 30% sublethal concentration of liver protein values were estimated from 7.07, 6.39 and 5.37 mg/g respectively. Liver protein of control fish tissues was noted from 7.64, 7.66 and 7.68 mg/g after exposure of 5, 10 and 15days respectively.

Muscle Protein

Fish *Mugil cephalus* treated with sublethal concentrations of heavy metal nickel on 10% and 30% showed a decreasing trend in the muscle protein when compared to control (Table 1 and Fig. 3). Control fish muscle protein values were noted from 9.52, 9.56 and 9.52 mg/g. The 10% sublethal concentration of muscle protein values were recorded from 9.41, 8.85 and 8.15 and the 30% heavy metal nickel sublethal concentration of muscle protein values were reported from 9.24, 8.49 and 7.82 mg/g after exposure period of 5, 10 and 15 days respectively.

Table 1 : Total protein content (mg/g) in wet weight tissues of estuarine fish, *Mugil cephalus* exposed to two sublethal concentrations (10% and 30%) of heavy metal nickel.

Days	Exposure	Gill	Liver	Muscle
5 days	Control	5.32 ± 0.14	7.64 ± 0.12	9.52 ± 0.22
	10 % SLC of Nickel	5.24 ± 0.11	7.37 ± 0.23	9.41 ± 0.12
	30 % SLC of Nickel	5.05 ± 0.07	7.07 ± 0.02	9.24 ± 0.07
10 days	Control	5.36 ± 0.14	7.66 ± 0.14	9.56 ± 0.08
	10 % SLC of Nickel	4.72 ± 0.18	6.68 ± 0.12	8.85 ± 0.11

	30 % SLC of Nickel	4.41 ± 0.14	6.39 ± 0.15	8.49 ± 0.22
15 days	Control	5.38 ± 0.09	7.68 ± 0.18	9.52 ± 0.15
	10 % SLC of Nickel	4.17 ± 0.08	5.85 ± 0.13	8.15 ± 0.09
	30 % SLC of Nickel	4.06 ± 0.04	5.37 ± 0.09	7.82 ± 0.12

Means ± SD (N=3) - SLC – Sublethal concentration

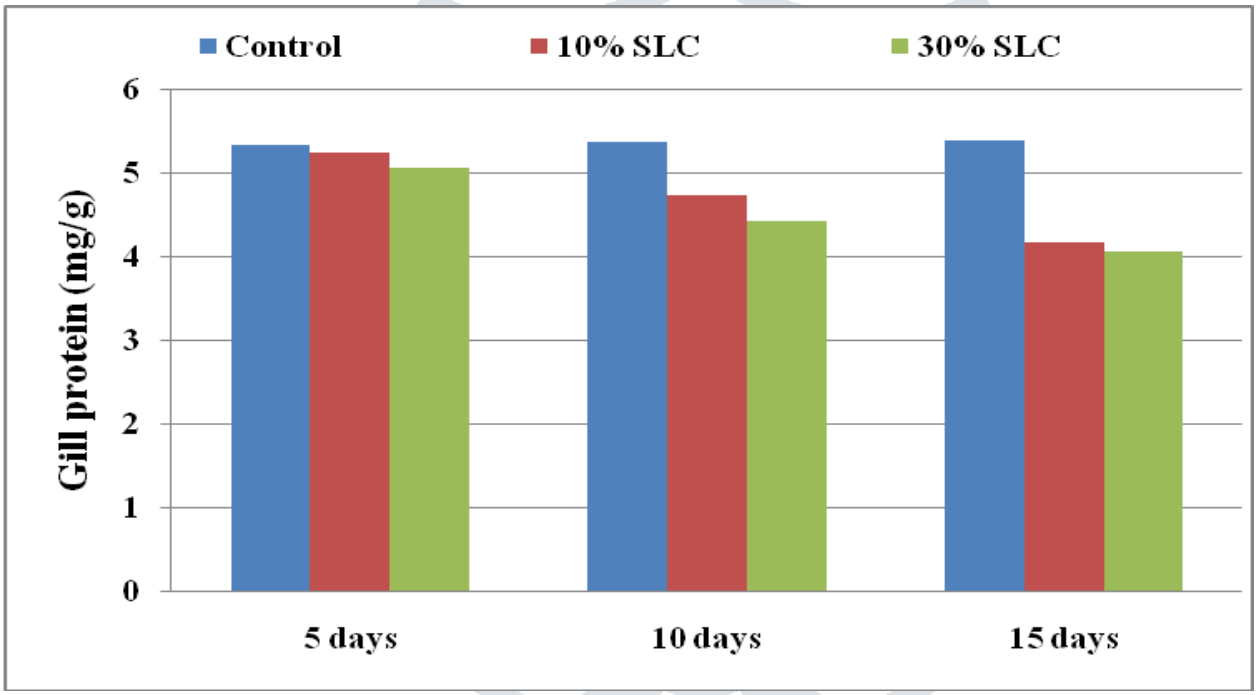

Fig. 1. Total protein content in gill tissues of fish *Mugil cephalus* exposed to sublethal concentrations of heavy metal nickel.

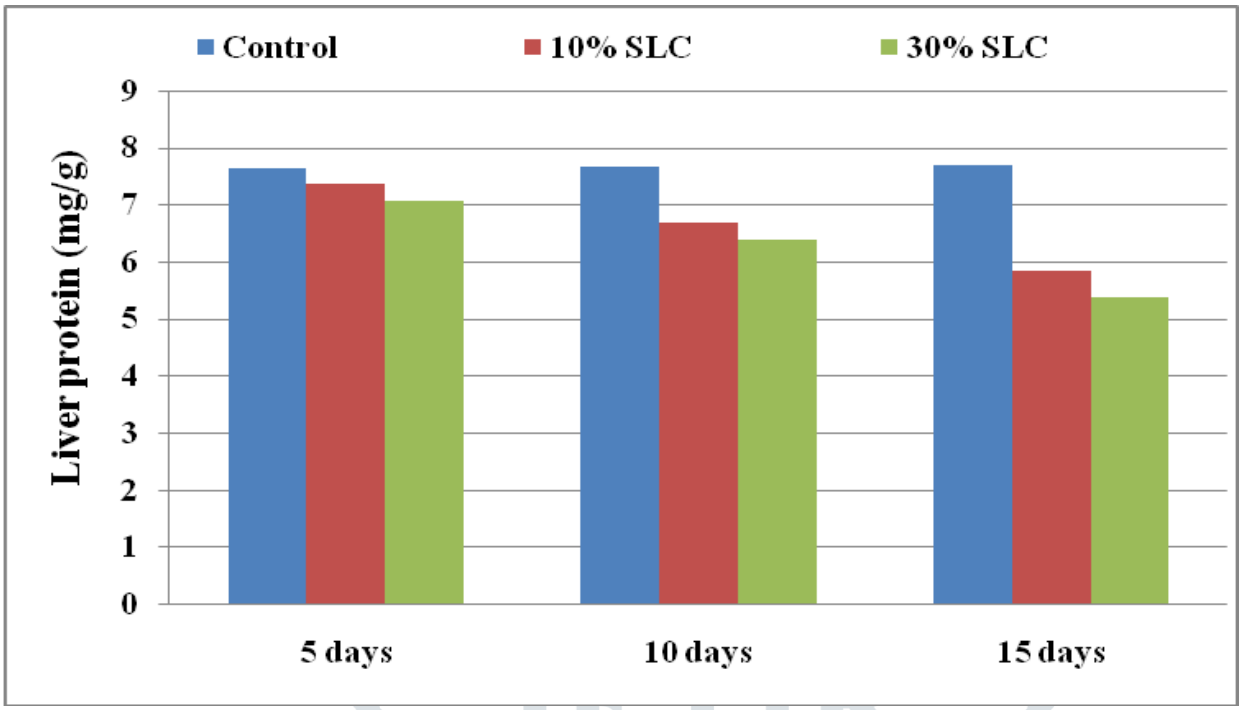

Fig. 2. Total protein content in liver tissues of fish *Mugil cephalus* exposed to sublethal concentrations of heavy metal nickel.

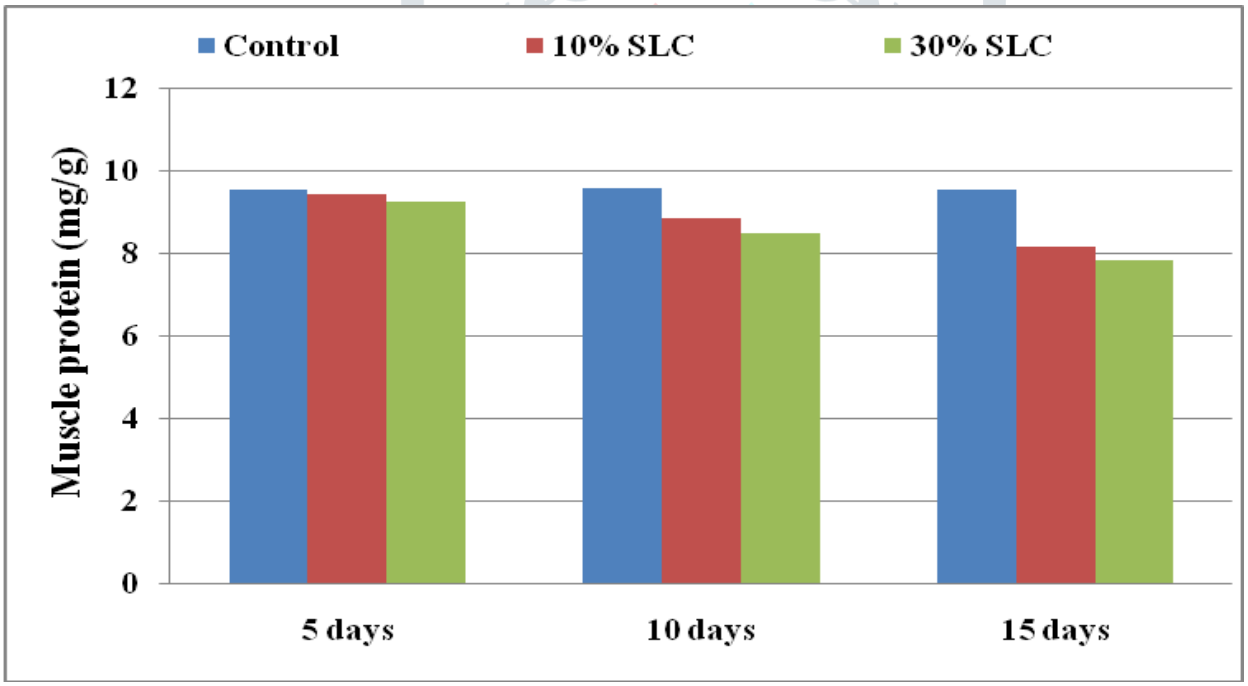

Fig. 3. Total protein content in muscle tissues of fish *Mugil cephalus* exposed to sublethal concentrations of heavy metal nickel.

IV. DISCUSSION

In the present investigation carried out biochemical alterations in total protein content of gill, liver, and muscle tissues of estuarine fish, *Mugil cephalus* exposed to two sublethal concentrations of heavy metal

nickel was gradually decreasing with increasing exposure periods of 5, 10 and 15 days respectively. Maximum decrease of protein content was observed in liver tissue of fish exposed to 30% sublethal concentration of nickel reared for 15 days and minimum decrease was noted in gill tissue of fish *Mugil cephalus* exposed to 10% sublethal concentration of nickel reared for 5 days.

Nickel concentrations in the tissues showed that the highest accumulation is in the kidney, followed by the liver, gills and muscle. Accumulation of nickel in fish tissues is commonly rather tissue specific and each tissue type has specific affinities for accumulation of different elements [17&18] (Ptashynski *et al*., 2001; Ptashynski and Klaverkamp, 2002).

Mahajan and Zambare [19] (2001) reported decrease in protein contents in the freshwater bivalve *Corbicula striatella* after heavy metal stress most of the time. Kumar *et al.* [20] (2012) reported that sodium arsenide decreased in the concentration of protein in catfish *Clarius batractus.* Krishnamoorthy and Subramanian [21] (1995) reported a decrease in the protein content during the process of copper accumulation in freshwater prawn *Macrobrachium lamerrei lamerrei.*

V. CONCLUSION

Present study indicates that presence of low concentration of nickel in the water is toxic to fishes and alters the protein of the fish tissues. This result indicates that the usage of the heavy metal nickel in the agriculture fields may be a threat to aquatic fauna and flora as well as humans. Therefore, the information obtained may be useful for management and monitoring of agricultural insecticide contamination in aquatic ecosystem .

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