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Sodium Fluoride Toxicity in Freshwater Catfish *Clarias batrachus:* Effect on Body Weight, Gonadosomatic Index, Hematological and Biochemical Parameters

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ABSTRACT

Sodium fluoride is a naturally occurring toxicant that affects aquatic life. The present study was conducted to observe the effect of different doses of sodium fluoride in freshwater fish *Clarias batrachus* with respect to their body weight, gonadosomatic index, haematological and biochemical parameters. In which *Clarias batrachus* was exposed to sublethal concentration of sodium fluoride for 25 days to assess the alterations on the body weight, gonadosomatic index (GSI), hematological and biochemical parameters in blood during different phases of their annual reproductive cycle. Following acclimation, fishes are divided into three groups i.e., Group I (control), Group II (exposure of 2.5 mg/l NaF) and Group III (exposure of 7.0 mg/l NaF). Results of ANOVA shows statistically significant dose dependent alterations in all the parameters, irrespective of phase of annual reproductive cycle. It has also been noticed that with increasing concentration of sodium fluoride, body weight, RBC and hemoglobin content and male gonadosomatic index were decreased but no significant change in female gonadosomatic index. Serum glucose and cholesterol was increased as compared to the control group.

Key word: *Sodium fluoride, Clarias batrachus, Gonadosomatic index, Hematology.*

Introduction

Sodium fluoride is universally distributed in the environment and it is essential for the growth and development of humans and animals (Dhar and Bhatnagar, 2009). In general, fluoride has been suggested as an essential element for sustenance when it is used within optimum range, but its increased or decreased level causes adverse effects on the ecosystem (Semmalar and Nair, 2004). Sodium fluoride enters the biosphere from such sources as coal power production, aluminium smelting, iron and steel operations and phosphate fertilizer manufacturing (Machalinski, 2000, Pain, 2017). The results of chronic fluoride toxicity is dental fluorosis and skeletal rigidity of the joints and emaciation (Kant, 2009, Meena, 2017, Pereira, 2017). Fluoride ions have been reported to act as inhibiting enzyme activities and ultimately, enzymatic poisons, interrupting metabolic processes (FCDSW, 1984). Urinary fluoride levels are substantially higher among individuals across the lifespan living in areas with fluoridated water (Riddell *et al.,* 2021). Therefore, the need to determine the resilience limit of fish to sodium fluoride. In fish, studies have suggested that fluoride impact hematological parameters (Saxena *et al.,* 2001), behavioural and morphological parameters (Tripathi *et al.,* 2004), and cellular architecture

(Gupta, 2003).

Materials and Methods

Collection and acclimation of fish-: During resting phase, live catfish, *C. batrachus* of both sexes (average weight 40-80 gm) were procured from the local market and kept in the stock aquaria. They were exposed to natural photothermal condition for their acclimation to the laboratory condition prior to start each experimental protocol during resting phases of their annual reproductive cycle.

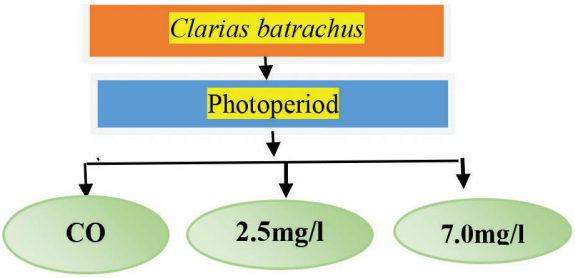

Fig. 1. Experimental protocol, CO= Control group, 2.5 mg/l = Sodium fluoride exposure 7.0 mg/l=Sodium fluoride exposure.

Results

Body weight gain: Under natural photoperiod 2.5 mg/l sodium fluoride exposure has been found to cause significant decrease in body weight gain as compared to control group. Further, a statistically significant decrease in body weight gain was also observed in the group receiving 7.0 mg/l sodium fluoride exposure as compared to control and 2.5 mg/l sodium fluoride exposure group (Table 1 and Figure 2).

Table 1. Effect of sodium fluoride exposure in *Clarias batrachus* during the resting phase of the reproductive cycle. *(F and P values obtained by ANOVA).*

Parameters	F-value	P-value
Body weight gain	6.69	.0044**
Gonadosomatic index (GSI) in male	8.130	.0059**
Gonadosomatic index (GSI) in female	0.2146	.8101ns
RBC	4.82	.0173*
Hemoglobin	17.09	.0000***
Serum glucose	5.40	.0106 *
Serum cholesterol	24.8	.0000***

*, **, ***- Statistical validation at P<0.05, <0.01, <0.001, respectively

Gonadosomatic index (GSI) in male: A statistically significant decrease in male GSI was observed in the group receiving 2.5 mg/l and 7.0 mg/l sodium fluoride exposure as compared to the control group during the resting phase of the reproductive cycle. (Table 1 and Figure 3).

Gonadosomatic index (GSI) in female: No significant change in female GSI could be observed by 2.5mg/l and 7.0mg/l sodium fluoride exposure during the resting phase of the annual reproductive cycle. (Table 1 and Figure-4).

RBC: Significant decrease in red blood cell number was observed with increasing concentration of sodium fluoride as compared to the control group (Table 1 and Figure 5).

Hemoglobin: In addition, haemoglobin content was also decreased with statistical validation in the groups receiving 7.0 mg/l and 2.5 mg/l sodium

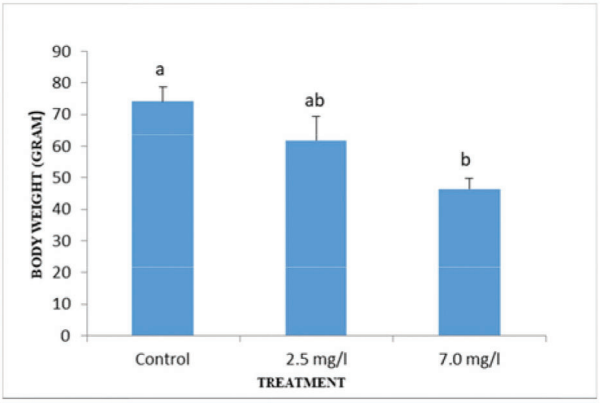

Fig. 2. Effect of different concentration of sodium fluoride exposure on body weight in *Clarias batrachus*. Control group, 2.5 mg/l and 7.0mg/l concentration of sodium fluoride in water.

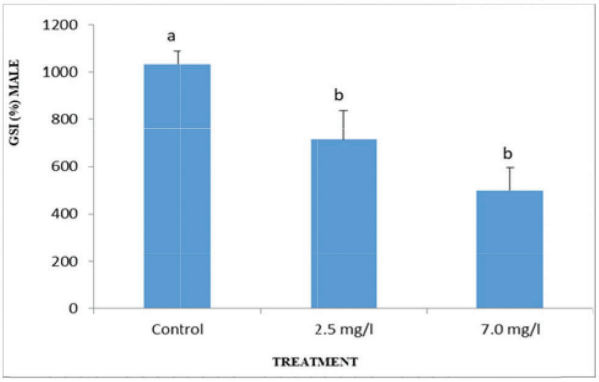

Fig. 3. Effect of different concentration of sodium fluoride exposure on male (♂) gonadosomatic index (GSI) in *Clarias batrachus.*

fluoride exposure as compared to the control group (Table 1 and Figure 6).

Serum glucose: The ANOVA results show that sodium fluoride exposure has a statistically significant impact on the level of serum glucose during the resting period. Serum glucose levels were shown to significantly increase when exposed to 2.5mg/l and 7.0 mg/l of sodium fluoride compared to the control group under the photoperiod compared to the control group. (Table 1 and Figure 7).

Serum cholesterol: A statistically significant increase in the content of serum cholesterol was noticed in the group receiving 7.0mg/l sodium fluoride exposure as compared to the control group. In addition, such an increase was also noticed in the 2.5mg/l sodium fluoride exposure group as compared to the control group (Table 1 and Figure 8).

Discussion

Exposure to sodium fluoride proved to be highly toxic to the freshwater fish, *Clarias batrachus*. Fluoride causes adverse biological effects such as changes in carbohydrate, lipid, and protein metabolism, reproduction, impairment, reduced embryonic and development of life stages, and alteration of size (Agniwanshi *et al.*, 2014). Our findings collaborate with several studies. Higher concentrations of fluoride interfere with various metabolic activities and

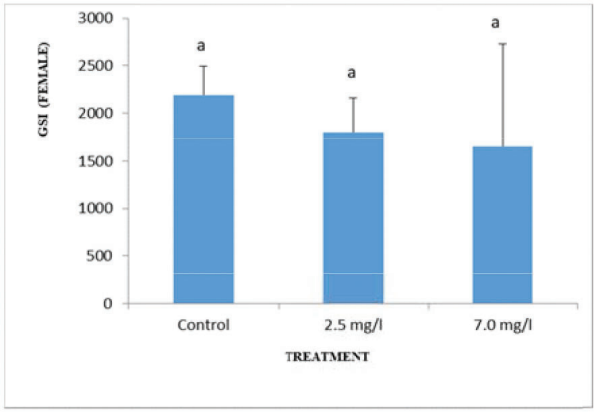

Fig. 4. Effect of different concentration of sodium fluoride exposure on female (♀) gonadosomatic index (GSI) in *Clarias batrachus.*

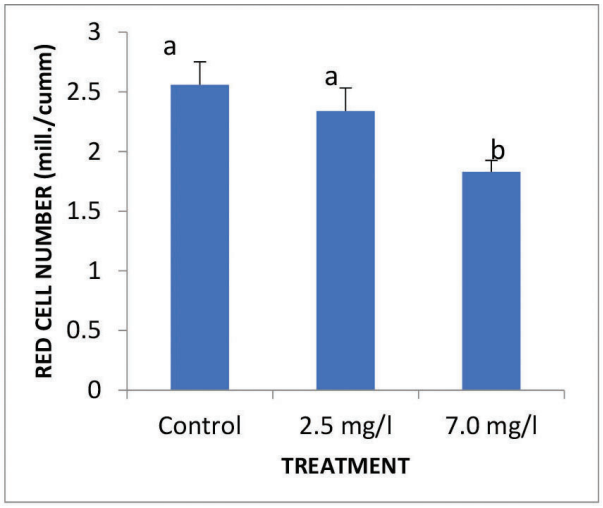

Fig. 5. Effect of sodium fluoride exposure on red blood cell number in *Clarias batrachus* during resting phase of reproductive cycle.

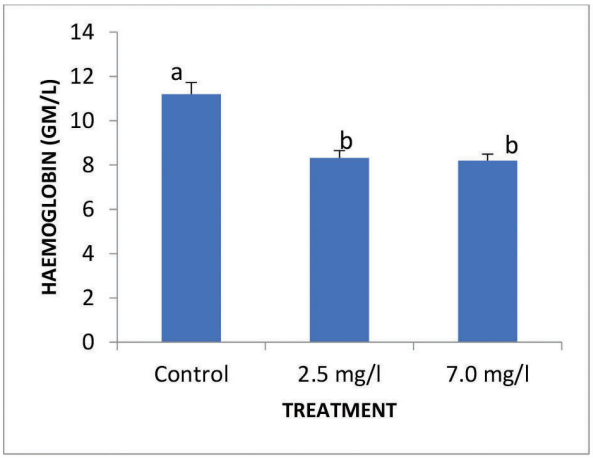

Fig. 6. Effect of sodium fluoride exposure on haemoglobin content in *Clarias batrachus* during resting phase of the reproductive cycle.

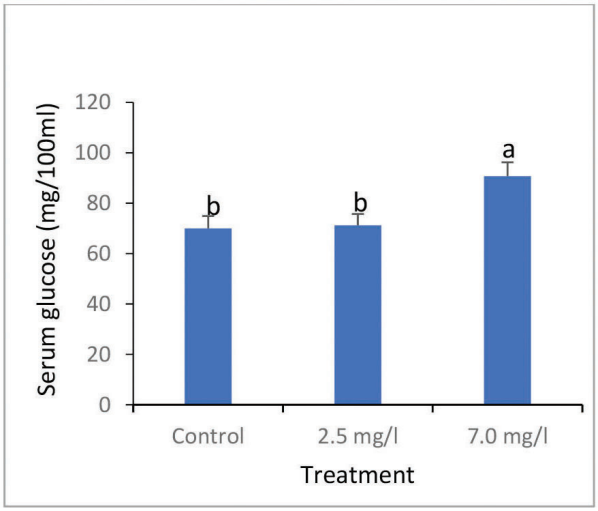

Fig. 7. Effect of different concentration of sodium fluoride exposure on serum glucose in *Clarias batrachus.*

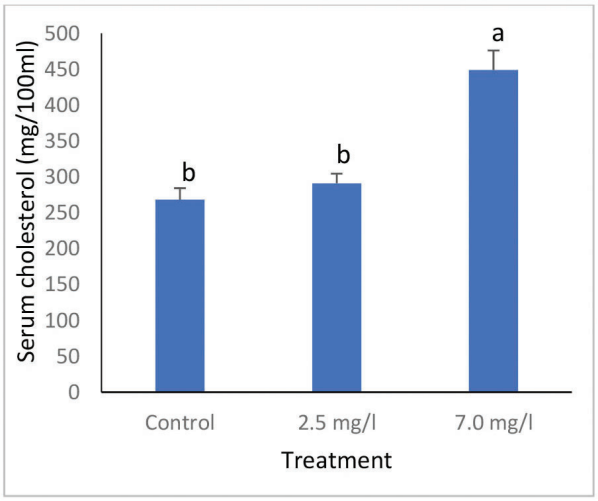

Fig. 8. Effect of different concentration of sodium fluoride exposure on serum cholesterol in *Clarias batrachus.*

alters the levels of protein, lipids, glycogen and cholesterol that inhibit the growth of fishes such as weight, length and of fingerlings of *Heteropneustis fossilis* (Tripathi *et al.*, 2005). Haemoglobin content is an important parameter involved in transporting respiratory gases. The aquatic animals generally maintained a normal state of haemoglobin concentration. The total R.B.C and hemoglobin content were found to be significantly decreased after exposure to sodium fluoride in *Clarias batrachus.* The reduction in Hb may also be responsible for decreased oxygen transport as reported by (Kumar et al., 2010) and the decrease in oxygen uptake may also be due to the interference of the toxicant with Hb lowering its transport efficiency. The increased glycogen level in the fish exposed to fluoride may be due to disturbance of carbohydrate metabolism as it has been observed to affect enzymes involved in glycogen turnover at fluoride concentration (Strochkova and Zhavoronkov, 1983).

Conclusion

It can be concluded that higher concentration of sodium fluoride interferes with various metabolic activities of *Clarias batrachus* that are important in their physiological activities, survival, growth, and reproduction.

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