

Behavioural study of freshwater fishes *Rasbora daniconius* and *Puntius saphore* exposed to sodium fluoride

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Abstract

Fishes are considered as good indicators of aquatic pollution. They are highly sensitive to the alterations in the quality of water. Aquatic ecosystems are ultimate sinks for agricultural residues as well industrial pollutants and it has become a global environmental problem in recent days. Fluoride is considered to be a pollutant if it exceeds beyond the normal permissible limits. It occurs naturally in all forms of the life including the aquatic ecosystem. The Fresh water fishes, *Rasbora daniconius* and *Puntius saphore* were exposed to sub lethal dose of sodium fluoride for 30 days to study the impact on the behavioral study. The behavioral patterns including swimming and surfacing activity, opercular movements, and feeding habits were observed. Alterations in behavioral patterns were well marked during the period of the experiment. Initially fishes appeared lethargic and showed dose dependent erratic swimming movements. They developed nausea for food and accelerated opercular movements.

Keywords: Behavioral study, freshwater fishes, Sodium Fluoride

Introduction

Fish is among the healthiest foods on the planet. It is the most important protein source in many developing countries. Fish growth is affected by physicochemical parameters such as temperature, light and water. The water quality in general causes health problem of fishes. Freshwater fishes dominate global aquaculture production.

Aquatic environment can be polluted by a variety of pollutants that originate from natural and anthropogenic sources which are toxic to the aquatic organisms including fishes. Fluoride is one of them. Fluorides are properly defined as binary compounds or salts of fluorine. The fluoride minerals, fluoride-rich minerals in the rocks and soils getting their final way into the water bodies are the main cause of high fluoride contents in water bodies. Anthropogenic sources of fluoride are industries, cosmetics and various products of day to day use [1] Fluoride naturally enters the aquatic system through weathering of alkalic and silicic igneous and sedimentary rocks, primarily shales, as well as from emissions from volcanic activity. Fluoride is typically found in freshwater at concentrations less than 1.0 mg/L, however, natural concentrations may exceed even 50.0mg/L [2]. It is one of the major pollutants in ecotoxicological studies.

Human activities results in substantial fluoride input to the aquatic environment. Exposure of living organisms to abnormal levels of fluoride may result in an alteration of the organism's behavior, biochemistry, histology and electrolyte compositions.

Growth [3] stated that freshwater organisms are evolved in an environment, almost fluoride free, thus they are not well equipped to tolerate. Fluoride levels contaminated in polluted streams. Carpenter [4] stated that slight increase in fluoride in fresh water becomes toxic to the organisms.

Several authors have reported the major effects of a number of pollutants such as fertilizers, heavy metals, industrial effluents and pesticides of fishes [5,6,7,8]. The fishes are possessing nutritive value and also serve as a better bioindicator of freshwaters. As behavioural alterations form sensitive indicators of chemically induced stress in aquatic organisms, the present work has been planned to study various behavioural aspects in the freshwater fishes *Rasbora daniconius* and *Puntius saphore* on exposure to sodium fluoride.

Methodology

The fresh water fish, *Rasbora daniconius* and *Puntius saphore* were collected from Wadali reservoir, Amravati in the year 1999 to 2002. They were disinfected in 1% KMNO₄ solution to avoid infection and then maintained in glass aquaria (183x38x38cm) for two weeks. After acclimation healthy and active fishes of uniform size (*Rasbora daniconius* 08-12cm and 22-29gm) (*Puntius saphore* 9-10cm and 9.0-9.7gm) were stored out and kept in separate aquaria for experimental work. Chlorine free aged tap water was used in both control as well as experimental aquaria. Fishes were kept away from mechanical disturbances. Fish were fed with Tykio feed, and the aquaria water was renewed on alternate days and supplemented with a fresh dose of NaF. The physio-chemical characteristics of water were analysed by APHA [9].

Table 1: Physio-chemical characteristics of water.

S. N.	Parameter	Result
1	pH	8.2 + 0.2
2	Temperature	25 + 2 °C
3	Dissolved Oxygen	6.6 mg/lit
4	Total Hardness	276 mg/lit
5	Alkalinity	312 mg/lit
6	Fluoride	0.6 mg/lit

The sodium fluoride (NaF) was used as toxicant. That was obtained from Qualigens Fine Chemicals, Mumbai. The concentration 100mg/l and 200mg/l of sodium fluoride containing 45.22 and 90.45 fluoride respectively were selected for the study. In these concentrations, no fish mortality was seen even after 30 days. The experimental fish, *Rasbora daniconius* and *Puntius saphore* was treated with sodium fluoride for 30 days. During the experiment, the water in the aquaria was changed every 24 hr to maintain the appropriate concentration of F in the test solutions.

Experimental set up: The fishes were divided into three groups

Group I: Consisting of control fishes maintained in aged tap water (pH 8.3) in large aquarium

Group II: Consisting of 25 experimental fishes exposed conc.(100mg/l) of sodium fluoride for 30days.

Group III : Consisting of 25 experimental fishes exposed conc.(200mg/l) of sodium fluoride for 30days.

Behavioral responses and mortality of the fishes were recorded at the interval of 1hrs, 24 hrs, 10day 20day and 30days. The alterations of behavioral characteristics were recorded. The significance of the results were calculated by using student 't' test.

Results and Discussion

The fishes *Rasbora daniconius* and *Puntius saphore* appeared lethargic after exposure to the selected doses of NaF. Initially after introduction of the fishes to NaF containing water, both the fishes showed dose dependent erratic swimming movements and tried to jump outside the aquaria, however after 10 to 15 minutes of exposure, they stopped erratic movements and assumed a medium position in the aquarium showing accelerated opercular beating. None of the fish showed secretion of mucus over their body and showed

just lethargic nature. *Rasbora* showed comparatively little movements from mid if the aquaria to the surface, but the fish *Puntius* preferred steady position in mid column of water in aquaria till day 30 of the experimental period. After 22 to 25 days they developed nausea for food and the food added in the aquarium was left unconsumed.

Immediately after one hour of exposure to 100mg/l of sodium fluoride accelerated opercular movements were seen. The mean opercular beating was 202 and 292 beats/minute in *Rasbora* and *Puntius* respectively as against their control values 74 and 63 respectively. Then after 24 hours of exposure, the opercular beating rate decreased and was 180 and 240 beats/ minute respectively (Table:1). After 10, 20, and 30 days of exposure the record of opercular beating pep minute were taken and are as shown in Table 1. After 30 days of exposure the percent increase in opercular beat/ minute was 159.45 and 330.15 in the fishes *Rasbora daniconius* and *Puntius saphore*. (Fig:1)

Similar type of increase in opercular beating was seen in the fishes under investigation when they were exposed to 200mg/l. After one hour of exposure the opercular beats/minute were found to be 306 and 342 (Table:2).

Table 1: Frequency of opercular beating in the fishes *Rasbora daniconius* and *Puntius saphore* exposed to 100mgNaF/l for 30 days.

Fish	Control	100mg NaF/l				
		1 Hour	24 Hour	10 Day	20 Day	30 Day
<i>Rasbora daniconius</i>	74	202 (+172.97)	180 (+143.24)	135 (+82.43)	179 (+141.89)	192 (+159.45)
<i>Puntius saphore</i>	63	292 (+363.49)	240 (+280.95)	98 (+55.55)	149 (+136.50)	271 (+330.15)

Table 2: Frequency of opercular beating in the fishes *Rasbora daniconius* and *Puntius saphore* exposed to 200mgNaF/l for 30 days.

Fish	Control	200mg NaF/l				
		1 Hour	24 Hour	10 Day	20 Day	30 Day
<i>Rasbora daniconius</i>	74	306 (+313.51)	210 (+183.78)	174 (+135.13)	207 (+179.72)	232 (+213.51)
<i>Puntius saphore</i>	63	342 (+442.85)	300 (+376.19)	106 (+68.25)	228 (+261.90)	292 (+363.49)

All values are average of opercular beating/minute of five fishes from each group of exposure. Figures in parenthesis indicate percent increase in opercular beating over control.

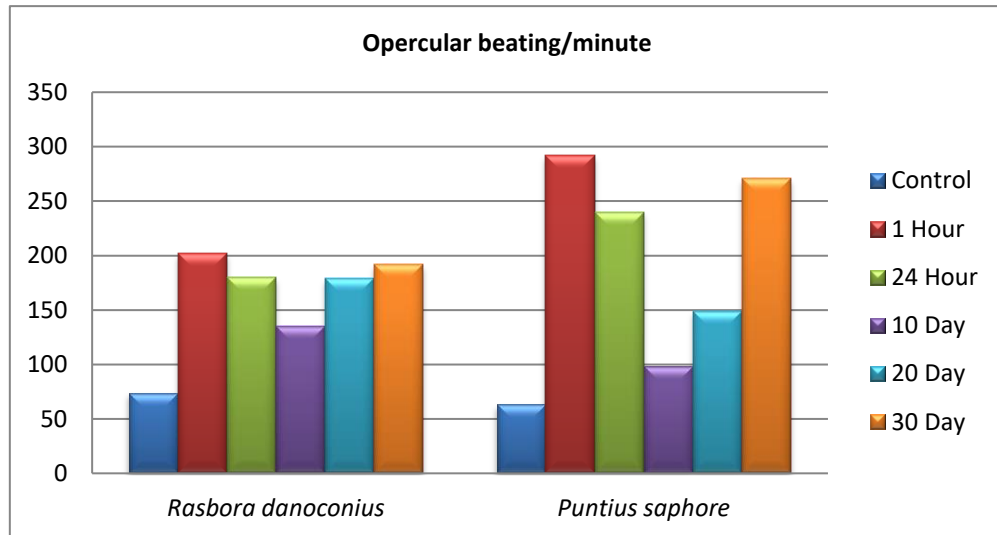


Figure 1 : Effect of NaF toxicity (100mg/l) on frequency of opercular beating.

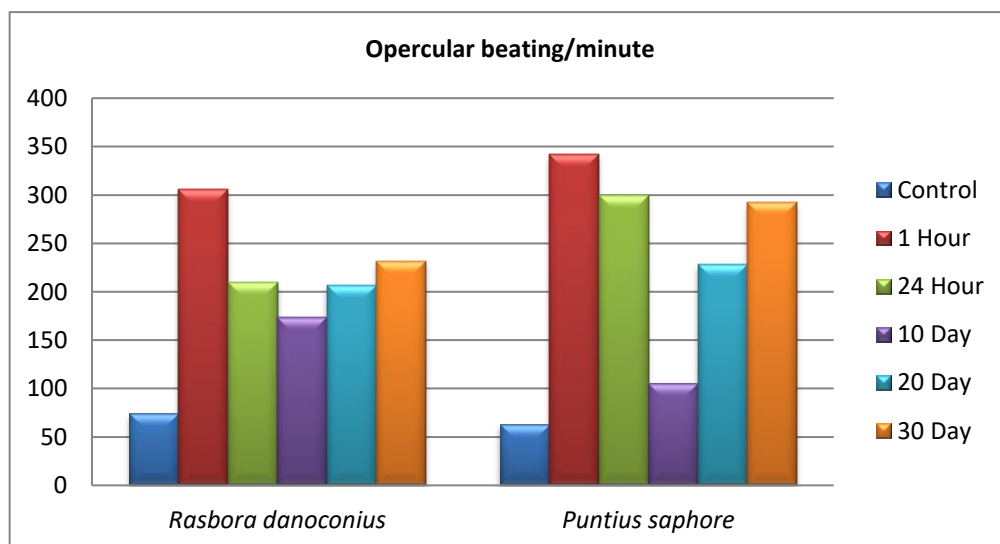


Figure 2 : Effect of NaF toxicity (200mg/l) on frequency of opercular beating.

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After 30 days the percent increase in opercular beats was 213.51 and 363.49 in respective experimental fishes (Figure 2).

Discussion

Behavioural alteration can be taken as sensitive indicators of environmental stress. Many workers have studied about behavioural changes in aquatic organism caused by pollutants and concluded that all behavioral changes associated with metabolic. [10] Fluoride induces change in behavior of fresh water fishes reported from different studies [11]. Narwaria *et al.* [12] and Kaur *et al.* [13] recorded as the behavioral responses including habit, body position, opercular movement, food sensitivity and swimming movements induced by sodium fluoride. Singh and Tripathi [14] have also reported the same behavioral abnormalities.

Behavioral changes are the most sensitive indication of potential toxic effects. [15, 16]. Behavior is considered a promising tool in ecotoxicology [17]. The experimental fish were more active and restless as compared to the control group. The control fish were calm and quiet and preferred to confine themselves to the bottom of the aquarium, whereas the experimental fishes were found hanging most of the time in a column of water. Behavioral changes in feeding activity, jumpy and erratic swimming movements, and orientation of body, opercular motion, and surfacing activity were observed when the fish were exposed to various F concentrations. In experimental fishes, these swimming activities and opercular beating were found to increase in comparison to the control group (Table 1 and 2). These observations are well supported by earlier findings from other toxicity studies, including a mostly vertical swimming pattern toward the surface compared to controls of fish.

Conclusion

From the present investigation we conclude that the sodium fluoride (NaF) alters the normal behavioral function and physiological activities of the experimental

freshwater weed fishes *Rasbora daniconius* and *Puntius saphore*. The fish *Rasbora* is more sensitive to NaF as compared to *Puntius*.

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