



# Study of Histopathological Changes in Kidney after Acute and Chronic Concentration of Sodium Fluoride (NaF) in *Labeo rohita* and *Cirrhinus mrigala*

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## Abstract:

The present study was conducted to investigate the histological structures of the kidney of fresh water fish *Labeo rohita* *Cirrhinus mrigala* after short (96 hrs) and long term exposure (30 days) in sodium fluoride (NaF) (46.75ppm). Several histological alternations were obtained in the selected tissues, such as enlarged Bowman's space, Bowman's capsule showed connective tissues near epithelial lining, proximal and distal tubular epithelium showed necrotic changes while lumen of the tubules was shrunken in acute concentration. In chronic the lumen of the renal tubules was shrunken with destruction of brush border. Bowman's space showed connective tissue and degenerative epithelial cells.

**Keywords:** Sodium fluoride; *L. rohita* and *C. mrigala*; histopathology; kidney.

## Introduction

The sodium fluoride, through the aquatic organism is entering into the body of terrestrial animals including human and showing many hazardous effects. Global prevalence of fluorosis is reported to be about 32% in the world. In India, about 17 states and Union Territories are endemic to fluorosis. Several million people are using drinking water and consuming a food source, that possess a potential risk for fluorosis. In 1993, a report regarding fluoride pollution in India was published by Rajiv Gandhi Drinking Water Mission. According to it, fluorosis is a condition resulting from ingestion of large amount of fluoride, chiefly through drinking water. About 20 million people are suffering from fluorosis, while about 42 million people are exposed to the risk of endemic fluorosis. Fluorosis causes difficulty in movement (rheumatoid), mental depression, vascular disturbances, abnormal reproduction and abnormal behaviour. Vital organs such as liver, kidney, reproductive organs and endocrine glands are reported to be adversely affected by high fluoride intake (Chinoy, 1991; ATSDR 2001). Several metabolic activities are also disturbed due to alteration in regulatory enzymes and biomolecules (Chitra et al., 1983; Kumar et al., 2007) after exposure to fluoride. Recently Sarkar et al., (2004) and Tripathi (2007) have presented an elaborate account of severity of fluorosis. Considering the importance of aquatic life, especially fish, fulfilling the need of food for the mankind, a thorough investigation of the toxicity is needed. In keeping these view, planned to study, at least partly, to investigate the toxicity of sodium fluoride to freshwater fish species such as *Labeo rohita* and *Cirrhinus mrigala* these species are commonly consumed as a food in different region in India. The study emphasizes the investigation of toxic effect on important organs of the selected fish species. www.ijcrt.org © 2021 IJCRT | Volume 9, Issue 8 August 2021 | ISSN: 2320-2882 IJCRT2108080 International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org a664 Sources of sodium fluorides:

- i) Natural Sources: Fluoride, is released into the environment by the natural weathering of rocks, mineral dissolution, emission from volcanic activities and aerosols.
- ii) Anthropogenic Sources: The fluoride is also released into the environment via coal combustion, processing of water, various industrial processes of steel manufacturing, primary aluminium, copper and nickel production and phosphate fertilizer production. The decomposition of pesticides, fluoridation of drinking water supplies also contribute to the release of fluoride from anthropogenic sources. Sodium fluoride (NaF)

is used in fluoridation of drinking water, as a preservative in glues, glass, in enamel production, as flux in steel and aluminum production, as an insecticide and as a wood preservative.

Aquatic animals such as fish and invertebrates can take up fluoride directly from the water or via food (Hemens and Warwick, 1972; Nell and Livanos, 1988). Fluoride tends to be accumulated in the exoskeleton of invertebrates and in the bone tissue of fishes. Fluoride toxicity depends upon increasing fluoride concentration in the aquatic medium, exposure time and water temperature (Neuhold and Sigler, 1960; Angelovic et al., 1961; Hemens and Warwick, 1972).

Sodium fluoride is the most common inorganic fluoride used in aquatic toxicity studies (Damkaer and Dey, 1989; Camargo, 1991). Sodium fluoride interrupts metabolic process such as glycolysis, lipid and protein synthesis in fishes (Camargo, 2003). Inorganic fluoride toxicity is negatively correlated to water hardness and positively correlated to temperature (Pimentel and Bulkley 1983). Fluorine interferes with various metabolic activities and alters the levels of protein, lipids, glycogen, and cholesterol of fish (Kumar et al., 2007). The present studies was under taken to evaluate the toxic effect on sodium fluoride on histopathological changes in kidney of fresh water carp *Labeo rohita* and *Cirrhina mrigala*.

Kidney is responsible for excretion of polluting agents brought after detoxification in liver. Such metabolites reaching the kidney must be causing extra stress. Mathur (1969) and Holden (1972) are of similar view that, if the pollutants are in low concentration, the changes are less acute while, at higher concentrations the changes are drastic. Lantz *et al.*, (1987) reported that fluoride toxicity may lead to osteosclerosis and end stage with renal failure. These may finally lead to the failure of kidney and death.

### Material and Methods:

Normal histological appearance of any organ reflects normal physiological condition of any animal during toxicological and pathological studies. The variation in the histology is used for the evolution of physiological state of the animals. Therefore kidney were dissected out and cut into pieces and fixed in Bouins fixative. The tissues were processed for wax sectioning. The sections were cut at 5.0  $\mu\text{m}$  and stained with hematoxylin and eosin. The observations were made under Olympus Microscope.

### Result and Discussion:

The histological changes in the kidney of fish *Labeo rohita* and *Cirrhinus mrigala* are shown in Plate I and II. The fig. 1 showed normal structure (control) of kidney during experimentation. A control of both experimental fish showed a normal architecture of Bowman's capsule enclosing in tuft of blood capillaries and glomerulus. Proximal and distal tubules showed normal distribution with clear brush border. A distal tubules end in collecting duct has shown well developed epithelium.

### Acute:

The changes in tubular epithelium could be observed after (910 ppm)  $\text{LC}_0$  exposure of sodium fluoride in the kidney of experimental fishes. Tubular epithelium showed necrotic changes characterized by karyorrhesis and karyolysis at the nuclei of the cells. Lumens of the tubules were found invariably dilated. Interstitium was markedly infiltrated with mononuclear cells (Fig. 2).

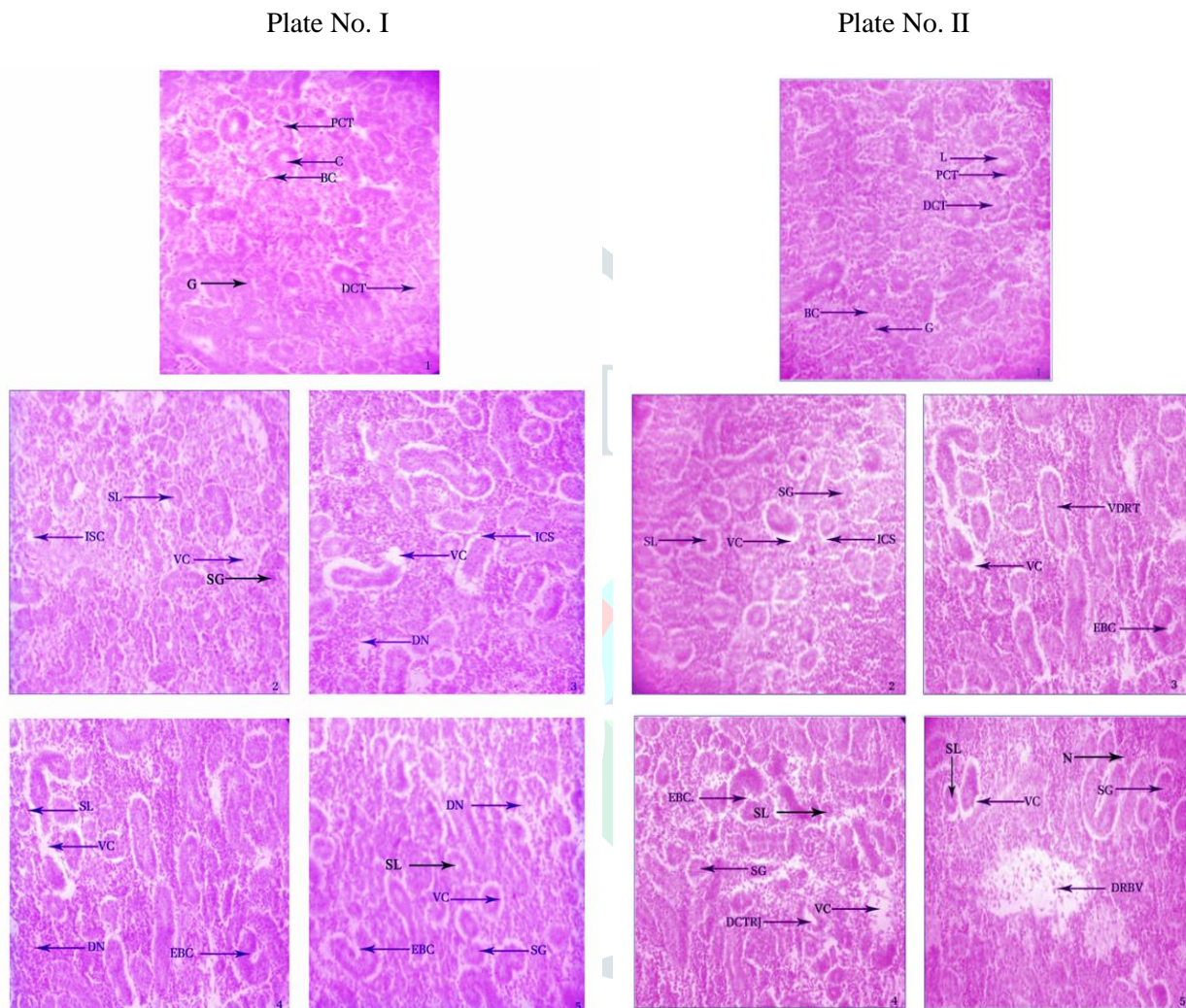
The histopathological changes in kidney at (935ppm)  $\text{LC}_{50}$  concentration of sodium fluoride were severe as compared to  $\text{LC}_0$  exposure. Bowman's capsule showed irregular arrangement of tuft. Necrotic cells were also observed in Bowman's capsule. Proximal and distal tubular epithelium showed necrotic changes characterized by karyorrhesis and karyolysis at the nuclei of the cells. The renal tubules exhibit shrinking of lumen and vacuolation of cytoplasm. Brush border of proximal and distal tubules were disturbed (Fig.3).

### Chronic:

The exposure of experimental fishes to  $1/20^{\text{th}}$  of  $\text{LC}_{50}$  concentration (46.75 ppm) of sodium fluoride for 30days showed thick lining of Bowman's capsule. Epithelial cells in the Bowman's capsule showed necrosis. Proximal and distal tubular epithelium showed shrunken lumen, vacuolated cytoplasm and disintegration with chronic necrotic changes. Few epithelial cells in the proximal and distal tubules showed intensely stained nucleus. Lumen of the tubules was shrunken with complete destruction of brush border (Fig. 4).

The exposure to  $1/10^{\text{th}}$  of  $\text{LC}_{50}$  concentration (93.50ppm) of sodium fluoride for 30 days was more intense than  $1/20^{\text{th}}$  does. A thick lining of Bowman's capsule, shrunken glomerulus, increased capsular space with swelling, sloughing off the epithelium of the capsule cells with necrotic changes were observed. Proximal and distal tubules showed intensely

stained nucleus. The renal tubule exhibit shrunken lumen and vacuolated cytoplasm with complete destruction of brush border (Fig. 5).



### Plate I and II

Microphotographs of *L. rohita* and *C. mrigala* kidney after acute and chronic exposure to sodium fluoride are presented to (Fig. 1 to 5).

Fig. 1: Section passing through kidney of fish *L. rohita* and *C. mrigala* from control group (40 X).

Fig. 2: Effect of 910 ppm NaF on kidney of *L. rohita* and *C. mrigala* after 96 h exposure (40 X).

Fig. 3: Effect of 935 ppm NaF on kidney of *L. rohita* and *C. mrigala* after 96 h exposure (40 X).

Fig. 4: Effect of 46.75 ppm NaF on kidney of *L. rohita* and *C. mrigala* after 30 days exposure (40 X).

Fig. 5: Effect of 93.50 ppm NaF on kidney of *L. rohita* and *C. mrigala* after 30 days exposure (40 X).

PCT- Proximal tubule ;DCT- Distal tubule ;BC- Bowman's capsule; G- Glomerulus;ICS- Increased cellular space; L- Lumen of tubule; SG- Shrunken Glomerulus; VC- Vacuolated cytoplasm; N- Necrosis; PN- Pyknotic nucleus; SL- Shrunken lumen; DNC- Degenerative necrotic changes; DRBV- Dilated blood vessel  
VDRT- Vacuolated degenerating renal tubule; EBC- Edema in Bowmans capsule

### Conclusion

In present study, acute (96 h) toxicity experiments were conducted on the fingerling of the freshwater fish *L. rohita* and *C. mrigala* by exposing them to sodium fluoride concentrations. The result indicate that sodium fluoride inhibit the number of activity of fish. The sodium fluoride toxicity on aquatic animals are depends on the number of factors such as size, density of fish per volume of aquarium, water temperature and many other water quality variables. The inorganic fluoride as negatively correlated to water hardness and positively correlated to temperature. In chronic studies, the fish were exposed to sodium fluoride for 30 days period. It is evident from the result that there was no



mortality, drastic deleterious effect were recorded on histological aspect kidney. The rate of distribution may be depends on the blood flow to the tissues. Consequently, steady-state fluoride concentration is achieved more rapid between plasma and well perfused tissues kidney of fish exposed to acute and chronic concentration of sodium fluoride shows several drastic histopathological alterations. The result indicates these drastic degenerative changes will finally leads to malfunctioning of that organ. The changes in the cellular architecture cannot be attributed to a single factors and may be dependent on cumulative effects of many factors induce by presence of sodium fluoride in the body tissues of the fish. The present investigation reveals that sodium fluoride toxicity induced changes in histopathological architecture in kidney in acute and chronic concentrations. Damage to the kidney corresponding with increase in the concentrations of sodium fluoride. The common alterations found in both experimental fish were severe degenerative and necrosis changes in the renal tubule with focal area of necrosis, haemorrhage between renal tubule and edema in Bowman's capsule with atrophy in the glomeruli. The necrosis of the renal tubule affects the metabolic activities and promotes metabolic abnormality have been observed. Kidney is responsible for excretion of polluting agents brought after detoxification in liver. Such metabolites reaching the kidney must be causing extra stress. Sodium Fluoride toxicity may lead to osteosclerosis and end stage with renal failure. These may finally lead to the failure of kidney and death.

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#### References:

1. Angelovic, J. W., Sigler, W. F. and Neuhold, J. M. (1961) Temperature and fluorosis in rainbow trout. *J. Water Pollut. Control Fed.*, pp. 371–381.
2. Camargo J. A. (2003) Fluoride toxicity to aquatic organism: A review. *Chemosphere*, 50(3):251-64.
3. Camargo, J. A. (1991) Eco-toxicological analysis of the influence of an industrial effluent on fish population in a regulated stream. *Aquacult. and fish. Manage.*, 22:509-518.
4. Camargo, J. A. and Tarazona, J. V. (1991) Short term toxicity of fluoride ion (F<sup>-</sup>) in soft water to rainbow and brown trout. *Chemosphere*, 22: 605-611.
5. Damkaer, D. M. and Dey, D. B. (1989) Evidence for fluoride effect on salmon passage at John Day Dam, Columbia River, 1982-1986. *N. Am. J. Fish. Managt.*, 9(2): 154-162.
7. Hemens, J. and Warwick, R. J. (1972) The effects of fluoride on estuarine organisms. *Water Res.*, 1301–1308.
8. Kumar, A., Tripathi, N. and Tripathi, M. (2007) Fluoride induced biochemical changes in freshwater catfish (*Clarias batrachus*, Linn.). *Fluoride*, 40(1): 37–41
10. Lowry, O. H., Rosebrough, N. J, Farr, A. B. and Randall, R. J. (1951) Protein measurement with folin-phenol reagent. *J. Bio. Chem.*, 193: 265-275.
11. Mishra, P.C. and Mohapatra, A. K. (1998) Haematological characteristics and bone fluoride content in *Bufo melanostictus* from an aluminum industrial site. *Environ. Pollut.*, 99 (3): 421-423.
12. Nell, J. A. and Livanos, G. (1988) Effects of fluoride concentration in seawater on growth and fluoride accumulation by Sydney rock oyster (*Saccostrea commercialis*) and flat oyster (*Ostrea angasi*) spat. *Water Res.*, 22, 749–753.
13. Neuhold, J. M. and Sigler, W. F. (1960) Effect of sodium fluoride on carp and rainbow trout. *Trans. Am. Fish. Doc.*, 89: 358-370.
14. Pandit, C. G. and Narayana, R. D. (1940) Endemic fluorosis in south India: Experimental production of chronic fluorine intoxication in monkey (*Macaca radiata*). *Ind. J. Med. Res.*, 28:559-74.
15. Pimentel, R., and Bulkley, R. V. (1983) Influence of water hardness of fluoride toxicity to rainbow trout. *Environ. Toxicol. Chem.*, 2: 381-386.
16. Reddy, S. L. N. and Venugopal, N. B. R. K. (1990) Effect of fluoride on acetylcholinesterase activity and oxygen consumption in a freshwater field crab, *Barytelphusa guerinii*. *Bull. Environ. Cont. and Toxicol.*, Vol.45 (5): 760-766.
17. Samal, U. N. (1994) Effect of fluoride on growth of certain freshwater fishes. *Environ. Ecol.*, 12(1): 218-220.
18. Sashi, Singh J. P. and Thaper, S. P. (1989) Effect of fluoride in excess on lipid constituents of respiratory organs in albino rabbits. *Fluoride*, 22(1):33-9.
19. Sigler, W. F., and Neuhold, J. M. (1972) Fluoride intoxication in fish: a review. *J. Wild. Dis.*, 8: 252-254.
20. Sirvastava, N., Kaushik, N. and Gupta, P. (2002) Zinc induced changes in the liver and muscle of fish *Channa punctatus* (Bloch). *J. Ecophysiol. Occup. Hlth.*, pp197-204.
21. Woodiwiss, F. S. and Fertwell, G. (1974) The toxicity of sewage effluents, industrial discharge and some chemical substance to brown trout (*Salmo trutta*). In the Trent River authority area. *Water pollut. Cont.(G.B.)*, 73:396