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Assessment of Fluoride Effects on Essential Trace Elements of the Rat, *Rattus rattus* (Wister)

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Abstract

Fluoride causes serious health problems, as it is well determined non-biodegradable pollutant. The present study was designed to investigate the changes in the concentration of essential trace elements in kidney of rat after exposing them to sodium fluoride. At the end of the experiment, we found that excess fluoride intake disturbs concentration of essential trace elements like iron, zinc, copper and manganese in all exposed rats. Alterations of trace elements in rat were observed all experimental groups as compare to control group. This showed significant result as compare to control group.

Keywords: *Sodium fluoride, Iron, Zinc, Copper, Manganese.*

Introduction

Fluorine is estimated to be the seventeenth most abundant element[1]. Because of its extreme reactivity, it is nearly found as the fluoride ion or combined in inorganic complexes. Various fluoride compounds occur naturally and are recovered or released during the manufacture of rock phosphate fertilizer, aluminum smelting, and during the combustion of coal. Fluoride is part of the minerals fluorspar and cryolite [2].

Fluoride has been known as strong, hard anion and cumulative toxic agent [3] occurs naturally mostly distributed in the rivers, lake and seas around the world.

Fluoride is a cumulative toxin and the most damaging environmental pollutant, has affinity to accumulate in the tissues of organisms, making adverse effects to aquatic life at very low levels of exposure [4-6]. Fluoride when absorbed is rapidly distributed by systemic circulation into the intracellular and extra- cellular water of tissues. More than 90% of the total body burden is retained in bones and teeth. The concentration of fluoride in soft tissues is reflected by that in blood. Fluoride is distributed from the plasma to all tissues and organs. The rates of delivery are generally determined by the blood flow to the tissues in question. Consequently, steady state fluoride concentrations are achieved more rapidly between plasma and well-perfused tissues, such as liver and kidney. The major route for the removal of fluoride from the body is by the kidney. Urinary fluoride is regarded as the best indicator of exposure to fluorine compounds, and usually it correlates well with the level of fluoride in drinking water [7]. Fluoride in soft tissues is associated with structural changes and disorders in their function [8-11]

Materials and method

Chemicals: Sodium fluoride (NaF) were obtained from Chaiga traders.

Experimental Animals: 20 Adult albino rats, 60-day-old (weighing 250-300g) were obtained from wadhwani pharmacy Collage Yavatmal. The animals were kept under standard laboratory conditions at 21± 2 °C, fed with balanced diet and water ad-libitum and exposed to 12h light / 12 h dark cycle for one week prior to the start of the experiments. The rats were housed in cleaned and husk filled sterilized polypropylene cages and fed with pellet feed and purified water *ad libitum*. The temperature and humidity were maintained at 23±2^{o}C and 50 to 70%, respectively. The present study was approved by the Institutional Animal Ethics Committee and conducted as per the guidelines of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA). 20 albino wister rats were divided into four groups, Control groups given deflouridated, deionized water, while experimental groups 2, group 3, and group 4 administered sodium fluoride (Naf) of different concentration for 35 days. At the end of the experiment, animals were sacrificed and their kidney and thigh muscles, will quickly excised. Metal concentrations in the tissue digested and determined by Atomic absorption spectrophotometer.

Assessment of Minerals: Tissue samples were blotted to remove extra water, weighed, and wet digested by heating below 80^{o}C.12. The digested samples were cooled, and diluted with triple glass-distilled water to a final volume 5.0 mL. The concentrations of Zn, Cu, Fe, and Mn were measured with an atomic absorption spectrophotometer.

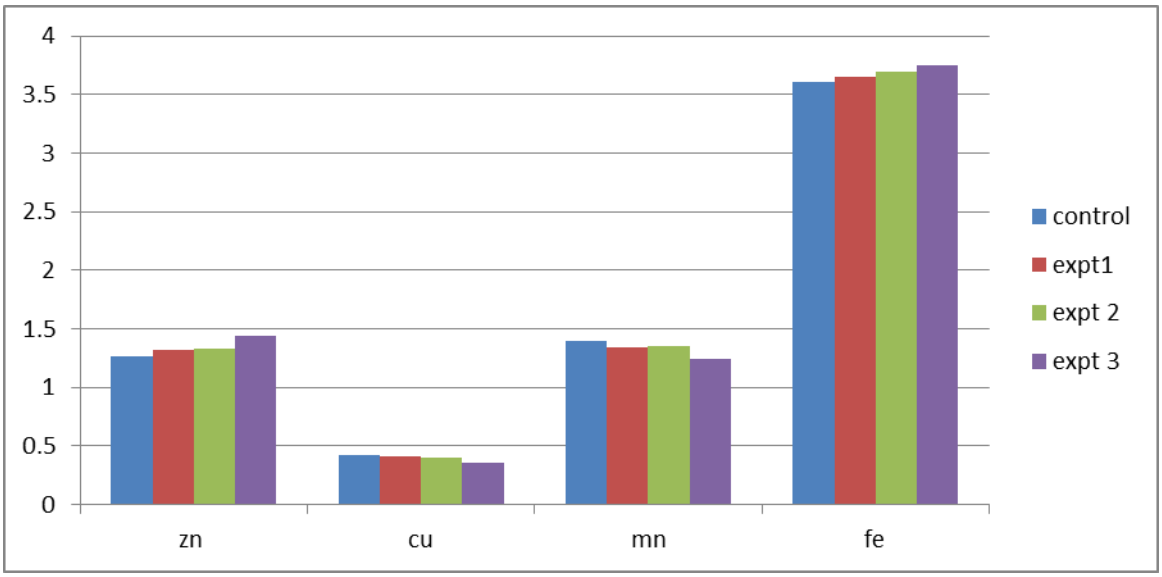
Statistical Analysis

Statistical analysis of the mean and standard deviation of treated and control groups were done by one way ANOVA without replication and student t test for estimation of significant results in experimental and control group of rat. P value of <0.05, 0.01 and 0.001 were considered as significant.

Results and Discussion

Table and Fig. 1 Alteration in trace elements (Zn, Cu, Mn and Fe) in Kidney of rats intoxicated by various concentration of sodium fluoride for 35 days.

Parameters	Control	Expt- 1	Expt- 2	Expt- 3
Zinc	1.60±1.26	1.76±1.32*	1.78±1.33**	1.82±1.34***
Copper	0.182±0.42	0.176±0.41	0.165±0.40**	0.136±0.36**
Magnese	1.95±1.39	1.80±1.34	1.82±1.35**	1.55±01.24**
Iron	13.06±3.61	13.32±3.65**	13.75±3.70***	14.08±3.75***



Fluoride is also known to cross cell membranes and to enter into soft tissues such as the liver, brain, and kidneys [12, 13] Impairment of soft tissue function has been demonstrated in fluoride-intoxicated animals [14, 15]. The kidney is well recognized for its histopathological and functional responses to excessive amounts of fluoride [16]. Iron is also associated with effective immune competence of the body. In the present study iron content was increasing in kidney of rat which signifies an altered state of iron metabolism, which might have been triggered by fluoride ions. Similar result observed by Bhatnagar *et al.,* [17], he studied that trace element concentration in various tissues of female mice like brain, liver, kidney and muscles following fluoride administration. They reported significant depletion in concentration of iron in kidney and muscle, but brain and liver showed significant increase of iron. Fluoride is reported to increase the membrane permeability of cells because of its inhibition of pyrophosphate activity [18].

Copper is present in every tissue of the body, but is stored primarily in the liver, with fewer amounts found in the brain, heart, kidney, and muscles. In present study Cu decreased significantly in kidney. Mn is associated with bone development, and with amino acid, lipid, and carbohydrate metabolism. Mn level depleted in kidney of rat. Excess of zinc is reported to cause electrolyte imbalance, lethargy, muscular coordination, reduced copperabsorption and renal failure [19]. Level of Zn increased in kidney. Kanwar and Singh [20] studied trace element concentration in various tissues following fluoride administration and reported altered levels of zinc, copper and manganese. Significantly reduced concentration of copper, manganese and zinc in kidney and liver and level of zinc in hair has been reported by Singh [21].

Conclusion

Due to high fluoride intoxication, deficiency or excess storage of trace elements occur infrequently in animals, but the evidence of close links between disturbances in trace element concentration and various biological activities and related disorder are observed through above experiment. Interaction of fluoride with various trace elements and their metabolism shows significant result in respect to all experimental animals. Altered level of trace element influences systemic biochemical homeostasis in experimental animals.

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Conflicts of interest: The authors stated that no conflicts of interest.

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