International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 4 Issue 3, March 2017

ISSN: 2394-4404

Fluoride Intoxication And Possible Changes In Trace Elements Of Kidney And Thigh Muscles In Rats

Bhavana S. Pillai

Santosh S. Pawar

Ahmed Shahzad

Smita B. Patil

Dipali D. Pillewar

***Abstract:** Fluoride is an essential oligo-element, beneficial for growth, reduction of bone fractures and promoting the development of bones and teeth. Moderate fluoride (0.5–1.5 mg/L) in drinking water is beneficial. However, excessive intake of fluoride is toxic as it is highly electronegative anion with cumulative toxic effect from prolong ingestion can cause several disorder in the organ of the animal. Aim of the present study is to investigate the changes in the concentration of the trace element such as Zn, Mn, Fe, and Cu in kidney and thigh muscles of rat. For the present experiment, healthy Albino rats were intoxicated to fluoride water (0.02, 0.04 and 0.06 gm/body weight) at different concentration for 56 days. The data reveals that excess fluoride intake disturbs concentration of essential trace elements in the body these changes are related with elimination or accumulation of specific element in the tissue may implicate various disorder.*

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

I. INTRODUCTION

Fluoride is an essential trace element from the halogen group that has protective effects against bone mineral loss. Also, it can prevent caries and enamel fluorosis. Sodium fluoride is commonly added to drinking water, tooth pastes and some mouth washes as decay preventive ingredient (Chouhan and Flora, 2010). Consumption of 1mg fluoride per day is essential for humans as fluoride is safe and effective when consumed properly (Jha *et al*., 2013). If fluoride is consumed in high quantities, it can cause severe damage to most tissues including primarily the dental and skeletal systems (Ricomini Filho *et al*., 2012). Trace element regulation is important for metabolic and endocrine functions. Several studies have shown the essential role of chromium, zinc, magnesium, selenium, iron and manganese in insulin secretion and carbohydrate metabolism (Zargar et al. 2002).The kidney is a well recognized organ to be affected for its histopathological and functional responses to excessive amounts of fluoride. Many studies have shown that elevated concentrations of fluoride can occur in the kidney as it has a major route in removal of fluoride from the body (Hodge and Smith, 1965; Ehrnebo and Ekstrand, 1986; Whitford, 1996; Shashi et al., 2002 and Inkielewicz and Krechniak, 2003). Fluoride nephrotoxicity causes pathological changes in the glomeruli and in the proximal, distal, and collecting tubules of experimental animals (Bouaziz et al. 2007). Biochemical roles of trace metals, such as copper and zinc, which are important mammalian enzyme regulators and essential components in gene expression (Uauy et al. 1998). Trace metals make up less than 0.01 % of body mass (Chan 2008). Most trace metals are considered essential because the body cannot synthesize them, and yet the body depends on them for health, growth and tissue repair; hence, they have also been categorized as micronutrients. Deficiency or toxicity may result in

ISSN: 2394-4404

detrimental consequences; therefore, maintaining proper body homeostasis is pivotal to human health (Samman 2002).

II. MATERIAL AND METHODS

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±2ºC 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 72 days. At the end of the experiment, animals were sacrificed and their kidney and thigh muscles, will quickly excised. Metal concentrations in the tissue digest will be determined by Atomic absorption spectrophotometer at the following wavelength Zn-213.8nm; Cu-324.8nm; Fe-248.3nm; Mn-279nm.

III. RESULT AND DISCUSSION

Parameters	Control	Expt- 1	Expt- 2	Expt- 3
Zinc	1.48±1.21	1.62±1.27*	1.81±1.34**	2.07±1.44***
Copper	0.135±0.36	0.129±0.35	0.112±0.33*	0.105±0.32
Magnese	1.211±1.10	1.193±1.09*	1.093±1.04***	0.989±0.99***
Iron	13.11±3.62	14.11±3.75***	15.21±3.90***	16.04±4.00***

Table 1: Changes in level of trace elements (Zn, Cu, Mn and Fe) in Kidney of rats giv en varied concentration of sodium fluoride in drinking water

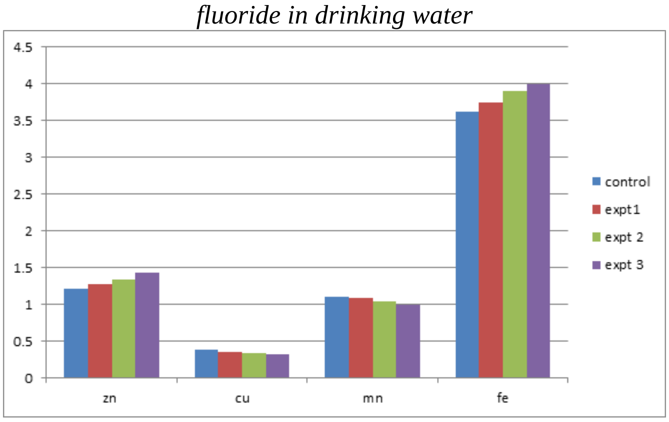

Figure 1

Parameters	Control	Expt- 1	Expt- 2	Expt- 3
Zinc	2.50±1.58	2.20±1.48***	1.80±1.34**	1.56±1.25***
Copper	0.084±0.29	0.095±0.30	0.105±0.32*	0.133±0.33***
Magnese	1.13±1.06	1.33±1.15**	1.53±1.23**	1.99±1.41***
Iron	12.92±3.59	12.98±3.60***	13.00±3.60***	13.98±3.73***

Table 2: Changes in level of trace elements (Zn, Cu, Mn and Fe) in Thigh muscles of rats given varied concentration of sodium fluoride in drinking water

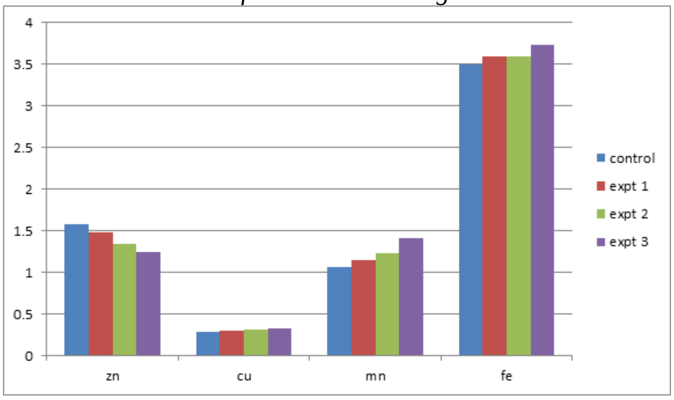

Figure 2

Deficiency or excess storage of these trace elements occurs infrequently in animals and Humans beings but evidence of close links between disturbance in the trace element concentration and various biological activities and related disorders are available in literature. (Krasowaska and Wlostowaski 1992; Vohra *et al.*, 1999; Hameed and Vohra 1990)

In soft tissues of control animals the highest mean fluoride concentration occurred in kidney tissue, which is consistent with data reported by other authors. (Whiford, 1996) The kidney represents the major route for the removal of fluoride from the body, and fluoride is concentrated to much higher levels in the kidney tubules than it is present in plasma.

Copper proteins have diverse roles in biological electron transport and oxygen transportation, processes that exploit the easy interconversion of Cu(I) and Cu(II) (Lippard and Berg 1994). Copper is also important for the production of the thyroid hormone thyroxine. Copper is normally present in higher concentration in kidney therefore copper deficieny is rare occurrence in these organs, but in the present study Cu fell significantly in kidney while increased in muscles similar results were observed by (M. Momtaz et al.,2000)

Zinc is involved in numerous aspects of cellular metabolism (Classen et al., 2011). In the brain, zinc is stored in specific synaptic vesicles by glutamatergic neurons and can modulate brain excitability (Bitanihirwe and Cunningham 2009). It plays a key role in synaptic plasticity and so in learning (Bitanihirwe and Cunningham 2009; Hambidge and Krebs 2007; Nakashima and Dyck 2009). It also can be a neurotoxin, suggesting zinc homeostasis plays a critical role in normal functioning of the brain and central nervous system (Bitanihirwe and Cunningham 2009). Level of Zn fell significantly in muscles but increases in kidney. This observation are consistent with the ealier reports (Kang and Harvey 1977; Cotzias *et al.*, 1968). Zn deficiency and congenital malformation of central nervous system have been also reported (Cotzias *et al.*, 1968).

Fe level increases significantly in kidney and muscles similar reports observed by Bhatnagar *et al.*, 2003. Fe is important in formation of haemoglobin molecule. It is essential consitituent of myoglobin and repiratory enzymes. Deficiency of Fe is related to restlessness, tiredness and imbalances in brain iron homeostasis during development which result into symptoms of neurodegenerative (Vaderveer, 1990)

Mn level fell in kidney but it significantly increases in muscles. (Bhatnagar *et al.*, 2003). Mn also catalyzes synthesis of haemoglobin. Mn also plays very important function in brain by stabilizing the membrane excitability, which otherwise result into epileptogenic lesions to increase the seizures activity (Papavasiliou et al., 1979; Hazell et al.,1999).

IV. STATISTICAL ANALYSIS

Statistical analysis of the mean and standard deviation of treated and control groups was done by one –way ANOVA without replication. Data related to trace metal concentration in control and experimental tissue are summarized in Table 1 and 2 changes observed in Cu, Mn, Fe and Zn level in kidney and muscles of the rat intoxicated by fluoride.

V. CONCLUSION

The present study was determined the level of zn, cu, mn and fe in soft tissue such as kidney and thigh muscles at different level of fluoride intoxication in rat, from the observation it demonstrated that there is a close link between excess fluoride intake and possible consequences via imbalance in trace element of kidney and muscles. Disturbance in trace element observed in these study id very intresting as fluoride taken in excess causes both bone and dental fluorosis. role of fluoride in disturbing trace element concentration is due to its highly electronegative and thus form complex with proteins alternatively it binds with Cu, Zn, Mn and Fe to form complexes resulting in alterating in level of respective element. In the present study result also indicated dose- dependent manner in most of the trace element .The dose responce relationship showed a linear pattern and changes were more prominent in most of the tissues of rat exposed to higher level of fluoride intake. The study shows, that excess fluoride intake disturbs essential trace elements homeostasis in body.

ACKNOWLEDGEMENT

One of the author, Bhavana S Pillai is highly thankful to UGC for the financial assistance through Rajiv Gandhi Fellowship for Disabilities (RGNFD) and also thank full to guide Dr. S. S. Pawar, Associate Professor in the department of Zoology, G.V.I.S.H. Amravati.

REFERENCES

[1] Ali, A. S., (1997). Effect of lead on the body weight of earthworms, *Indian J. of Zoological Spectrum* Vol.8 (2)47-49.

[2] Anonymous, (2005). United States Environmental Protection Agency Technical Report.

[3] Arias-Estevez, M. Lopez-Periago, E and E. Martinez-Carballo, (2008). The mobility and degradation of pesticides in soils and the pollution of groundwater resources. Agriculture, Ecosystems and Environment 123(Review), 247-260. *Eurasian Soil Science* 39, 1271-1283.

[4] Baker, G., Buckerfield, J. and R. Grey-Gardner, (1992). The abundance and diversity of earthworms in pasture soil in the Fleurieu peninsula, South Australia. *Soil Biol. Biochem*. 24: 1389-1395.

[5] Balthazor, T. M and L. E. Hallas, (1985). Glyphosate – degrading microorganisms from industrial activated sludge Applied and Environmental Microbiology, *Bol*. 51, 432-434.

[6] Baxter, R. A., Gilbert, R. E., Lidgett, R. A., Mainprize, J. H. and H. A. Vodden, (1975). The degradation of PCBs by microorganisms, Sci. Toatal Environ. 4, 53-61.

[7] Buchatsky, Leonid., Olga. Filenko and Olga Zaloilo, (2007). Effects of A-8 insecticide on earthworm (*Eisenia foitida*). Proceedings of the fourth *International Iran and Russia Conference.20-25.*

[8] Cao, X., Song, Y., Fan, S., Kai, J. and X. Yang, (2013). Optimization of Ethoxyresorufi n-O-deethylase determination in the microsomes of earthworms and its induction by PAH. Soil, Air, Water 41: 1–5.

[9] De Silva, P. M., Pathiratne, A and C. A. M. Van Gestel, (2009). Influence of temperature and soil type on the toxicity of three pesticides to *Eisenia andrei*. Chmosphere; 76(10):1410-5.

[10] E. E. C., (1985). EEC Directive 79/831. Annex V. Part C. Methods for the determination of ecotoxicity. Level I. C(II)4: Toxicity for earthworms. Artificial soil test. DG XI/128/82.

[11] Feng, X., Simpson, A. and M. Simpson, (2006). Investigation the role of mineral-bound humic acid in phenanthrene sorption, Environmental Science and Technology 40, 3260-3266.

[12] Fingerman, M. (1984). Pollution our enemy-Keynote address, Proc. Symp. Physiol. Res. Animal pollution, 1(VI).

[13] Giri, S., Prasad, S. B., Giri, A. and G. D. Sharma, (2002). Genotoxic effects of malathion: an organophosphorous insecticide, using three mamalian bioassays in vivo. Multation Res. 514: 223-231.

[14] Gosselin, R. E., Smith, R. P., Hodge, H. P. and J. E. Braddock, (1994). Clinical toxicology of Commercial Products. Fifth Edition. Williams and Wilkins, Baltimore, M.D. pp. 11-298.

[15] ISO, (1993). “Soil quality—e ffects of pollutants on earthworms (*Eise- nia fetida*)—part 1: determination of acute toxicity using arti- ficial soil substrate,” ISO 11268-1, *International Organization for Standardization, Geneva, Switzerland*.

[16] Kahn, E., Berlin, M., Deane, M., Jackson, R. J. and J. W. Stratton, (1992). Assessment of acute health effects from the medfly eradication project in Santa Clara Countary. CA. Arch. *Environ. Health.* 47(4): 279-284.
[17] Kovilpathu, Senthil., Kumar, Abbiramy., Pankiras, Ronald Ross. and Jyothi Pillai Paramanandham, (2013). Assessment of acute toxicity of superphosphate to *Eisenia foetida* using paper contact method. *Asian Journal of Plant Science and Research*, 3(2):112-115 7.
[18] Kuhr, R. J. and H. Tashiro, (1978). Distribution and persistence of chlorpyrifos and diazinon applied to turf. Bull. Environ. Contam. Toxicol. 20: 652-656.
[19] Kurawar, R., (2009). Effects of few pesticides on Earthworm activity and soil fertility. Ph. D. Thesis, M. L. S. University, Udaipur.
[20] Mackinson, F. W., Stricoff, R. S. and C. J. Portridge, (EDS) (1981). Occupational Health Guidelines for chemical hazards. National Institute for Occupational Safety and Health. U.S. Department of Health and Human Services. Washington, D.C.
[21] MEPPRC, (1990). (Ministry of Environment Protection of the People's Republic of China), 1990. Safety evaluation of chemical pesticide. *Pesticide Science and Administration.* (2): 1–9.
[22] OECD, (1984). Earthworm, acute toxicity tests', OECD Guideline for Testing of Chemicals 207, OECD, Paris, 1–9.
[23] Rao, K. R and K. T. Rao, (2004). Influence of fertilizers and manures on populations of coccincllid beetles and spiders in a ground nut ecosystem. *Ann Plant Prot Sci 9: 43-46.*
[24] Robidoux, P. Y., Hawari, J., Thiboutot, S., Ampleman, G. and G. I. Sunahara, (1999). "Acute toxicity of 2,4,6-trinitrotoluene in earthworm (*Eisenia andrei*)," *Ecotoxicology and Environmental Safety, vol*. 44, no. 3, pp. 311–321.
[25] Satchell, J. E., (1967). Soil biology, Academic press, London and New York, 259-322.
[26] Udovic, M. and D. Lestan, (2010). *Eisenia fetida* avoidance behavior as a tool for assessing the efficiency of remediation of Pb, Zn and Cd polluted *soil. Environ. Pollut. 158: 2766–2772.*
[27] Van Gestel, C., Van, Dis. W., Van. Breemen, E. and P. Sparenburg, (1988). Comparison of two methods for determining the viability of cocoons produced in earth worm toxicity experiments. Pedobiologia.; 32(5):367-71.
[28] Wang, J. H., Zhu, L. S., Jun. Wang, W. L. and Hui. Xie, (2012). Biochemical responses of earthworm (*Eisenia foetida*) to the pesticides chlorpyrifos and fenvalerate. Toxicology Mechanisms and Methods. Vol. 22, No. 3, Pages 236-241 (doi:10.3109/15376516.2011.640718).