



FLUORINE SOURCE AND THEIR IMPACT ON ANIMAL BODY

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ABSTRACT

Fluoride is a mineral known to be safe and effective at preventing tooth decay, but when it is above then 1.3 PPM it will be toxic to animal .in India most of the state around 20 Andhra Pradesh, Rajasthan, Gujarat will suffer from fluorosis so, it is a serious concern because fluorine not only cause dental problem it can also cause the Skelton problem, metabolic disorder (carbohydrate and protein metabolism) and endocrine disorder. The main source of fluorine are drinking water apart from these it will occurred due to ingestion of rock phosphate which contain higher amount of rock phosphate so before use should defluoridated. Some of the tea plant removes the higher amount of fluorine in drinking water by adsorption, ion-exchange, precipitation, coagulation, electrochemical methods, membrane techniques, Microbial degradation, Biotechnological method can be used.

KEY WORDS: fluoride, Skelton, metabolic, sources.

INTRODUCTION

Fluoride is the 13th most abundant element and represents about 0.3g/kg of earth's crust (Whitford, 1983). The permissible limits of fluoride in drinking water vary between 0.6 to 1.2ppm. It is a common constituent of rocks and soil. Total 85 million tons of fluoride deposits on the earth's crust, 12 million are found in India (Teotia *et al.*, 1984). Fluorine is often called as two-edged sword, Excess ingestion of fluoride results in dental and skeletal fluorosis and similarly, inadequate intake of fluoride is associated with dental caries. Fluorosis is wide spread in many parts of India with an estimated 66.62 million people being exposed to fluorosis in various endemic regions with more than half a million people already crippled by it. At least 20 states in India-Andhra Pradesh, Rajasthan, Gujarat (70-100% districts are affected), Bihar, Punjab, Haryana, Karnataka, Maharashtra, Madhya Pradesh, Tamil Nadu, Uttar Pradesh and some parts of Delhi (40-70% districts are affected), Assam, Kerala, Orissa, West Bengal, Jammu & Kashmir (10-40% districts are affected) and even Uttaranchal, Jharkhand and Chhattisgarh- are identified as significantly affected. Important F sources for animals include vegetation/ forage contaminated by fluoride-rich industrial effluents or windblown or rain splashed soil with high fluoride content, water high in fluoride content either naturally or due to industrial contamination, mineral mixtures and other feed supplements containing excess fluoride, vegetation grown on soils high in fluoride content, and a combination thereof (Swarup and Dwivedi, 2002) fluoride is well absorbed by several routes, however, ingestion is the major mode of fluoride uptake for most animals.

SOURCE OF FLUORINE

Forage, Grasses, and Grains

Soil fluoride concentration is believed to have little influence over fluoride concentration in vegetation, in as much as most of the fluoride in soils cannot be assimilated readily by plants. Fluoride in forage increases by 3ppm for each 100 ppm increase in soil F up to approximately 2200 ppm (Mascola *et al.*, 1974. Most of the plants do not accumulate fluoride in toxic concentrations and the level usually remains below 10 mg per kg dry weight. The tea plants (family Theaceae) can exceptionally accumulate high F concentrations. Many plant species, particularly *Acacia georginae* and *Dichapetalum cymosum* can assimilate soil F and convert them into fluoroacetate, which is extremely toxic for animals (Shupe *et al.*, 1984). Grains usually do not contain toxic concentrations of fluoride. Nevertheless, sorghum consumption has been found to increase the risk and severity of osteo and dental fluorosis (Hari-Kumar *et al.* 2007). Sorghum grown in fluorotic areas contains a high molybdenum concentration. Molybdenum reduces urinary fluoride excretion and enhances fluoride retention. A sorghum-based diet therefore increases F retention in human beings and rats (Lakshmaiah and Srikantia 1977) .

Water

Both surface and groundwater may have high F concentration in a particular locality, but the level is often higher in groundwater than the surface water. When groundwater percolates through rocks containing fluoride-rich compounds, fluoride leaches out and concentration may increase far above the safe level. Water having a fluoride concentration up to 1.0 mg/L is safe, levels in between 1.1 and 2.5 mg/L are marginally contaminated.(kumari *et al.*, 2004) studied Thirty ground water samples from Vellore District, Tamil Nadu were analysed for

fluoride content and it was revealed that the fluoride content of 24 samples were over and above the permissible limits.

Mineral Mixture

Rock phosphate which contains approximately 13–14 % phosphorus and 3–4 % fluoride. The rock phosphate is first converted into phosphoric acid which is used for chemical synthesis of various types of feed phosphates. Phosphoric acid is synthesized from rock phosphate either dry process or by wet process. In phosphoric acid produced by the dry heat process, the P:F ratio is usually greater than 2000:1 (Thompson 1980). Cost of production of phosphoric acid by the dry process is almost double that of the wet process. Wet process production methods therefore account for approximately 93 % of the total industrial production of phosphoric acid. The phosphoric acid produced by the wet process should always be defluoridated before use in feed phosphate synthesis. The defluoridation process increases the cost of the feed phosphates, hence some manufacturers skip this step and use the phosphoric acid produced by the wet process directly for synthesis of feed phosphates. This may lead to high fluoride concentrations in mineral mixtures and animal feed supplements. The phosphoric acid which has a P:F ratio of at least 100:1 is considered safe for production of feed phosphates for livestock.

Airborne Fluoride

The mean F concentration in ambient air in unpolluted or nonindustrial areas is generally less than 0.1 µg/m³. The levels may be slightly higher in areas near aluminum smelters or other industries, but should not exceed 2–3 µg/m³.

Industrial Effluents and volcanic ash

More than 28 industries release fluoride-rich fumes and effluents into the environment mainly aluminum industry, steel production plants, superphosphate plants, ceramic factories, coal-burning power plants, brickworks, glassworks, and oil refineries (WHO 1984). Livestock including cattle, buffaloes, sheep, goats and camels) living in the vicinity of such industries often suffer from chronic fluoride toxicity. Pasture contaminated with rock phosphate dust emitted from a fertilizer factory resulted in the occurrence of fluorosis in sheep living in adjoining areas.

Domestic and wild animals often suffer from severe fluorosis by ingestion of water and plants contaminated with volcanic ash, it usually has a very high soluble fluoride concentration and can be deposited over a large geographical area. The fluoride concentration in volcanic ash emitted by the Hekla volcano, Iceland, was up to 2000 ppm and the forage covered by ash had fluoride concentrations of 350–4300 µg/g (Thorarinsson 1979).

Agrochemicals and Household Products

Both organic and inorganic fluoride compounds are used for agricultural and domestic purposes. For example, sodium fluorosilicate can be used as a rodenticide and sodium fluoride as a feed premix for treatment of roundworms in pigs. A few decades back, many fluoride compounds including sodium fluoride, cryolite, and sodium fluorosilicates were widely used for pest control in

agriculture. Accidental exposure to these compounds can cause acute toxicity in man and animals.

EFFECT OF FLUORINE

Skeletal Manifestations

Dental fluorosis affects both the inner and outer surface of teeth. The degree of dental fluorosis depends upon the amount of exposure in the early stages of life. Skeletal fluorosis affects the bones and skeleton of the body, movements become painful and walking laborious as the neck, hip, shoulder and knee joints become progressively stiff. Eventually, chronic fluoride intake may even lead to osteosarcoma, a rare bone cancer (Strunecka *et al.*, 2007). (Modasiya *et al.*, 2014) studied the Toxic effects of chronic fluoride (F) exposure in which 85 domesticated animals living in Bikaner district of Rajasthan, where fluoride (F) in drinking water sources (bore wells) varies between 1.6 ppm and 2.2 ppm. These animals included cattle, goat and sheep . Among immature animals the highest prevalence of dental fluorosis was found in calves (41.0%) followed by lambs (28.5%) and kids (20.0%), while among mature (adult) animals, highest prevalence of dental fluorosis was observed in cows (17.8%) and lowest in goats (13.3%). However, no sign of skeletal fluorosis was observed in sheep.

Non-skeletal Manifestations

Fluoride in excess amount causes several ailments viz, physiological and metabolic disturbances as well as endocrine dysfunctions in the body.

Physiological disturbances

It was found that fluoride not only affects the protein synthesis in gastrointestinal organs but also causes alterations in the membrane permeability and membrane bound enzymes activities, especially in the intestinal cell lining (Rastogi *et al.*, 1987). Besides, it has been reported that formation of hydrofluoric acid in the gut appears to be associated with fluoride poisoning and could account for symptoms of nausea, vomiting, abdominal pain and diarrhea as well as widespread damage to the stomach mucosa (Susheela, 1992). It was also shown that acute exposure to higher fluoride concentrations or fluoride exposures for longer periods result in kidney damage leading to decreased fluoride excretion, increased retention of fluoride content in bone and a decrease in collagen content (Susheela) 2007).

Metabolic disturbances

Carbohydrate metabolism

Fluoride induces dramatic changes in carbohydrate metabolism by inhibiting the key enzymes involved in glycolysis and TCA cycle .Fluoroacetate is converted in vivo in mitochondria into fluorocitrate through condensation of fluoroacetyl-Co-A with oxaloacetate by the enzyme citrate synthetase which normally supplies acetyl-Co-A into the citric acid cycle. Fluorocitrate is a strong inhibitor of aconitase, which is an important enzyme of the Krebs cycle. Thus fluorocitrate inhibits the biochemical pathway for energy production in the organism (Patocka and Strunecka 2002). A diminished activity of G6P-dehydrogenase and decreased turnover of glycogen has also been reported (Carlson and Suttie, 1966). A recent study indicated that exposure to fluoride lowers the insulin secretion and that it could be one of the

reasons for increased blood glucose levels in fluoride intoxicated animals.

Protein metabolism

Fluoride is known to reduce the protein synthesis in various tissues and organs of mice and rats. Fluoride toxicity is reported to cause an increase in serum urea and significantly elevate the activity of glutamate dehydrogenase in the liver indicating an increased deamination of amino acids in the liver (Birkner *et al.*, 2000). In fluoride endemic areas of Gujarat and Karnataka fluoride toxicity resulted in decreased haemoglobin content and serum protein levels (Shivashankara *et al.*, 2000).

Lipid and antioxidant metabolism

Fluoride ions inhibit many enzymes involved in lipid metabolism for e.g. lipases and phospholipases which are capable of hydrolyzing the fatty acids from phospholipids (Shashi, 1992). Fluorosis also resulted in hypercholesterolemia, and hypertriglyceridemia in rabbits indicating an enhanced lipid biosynthesis in response to fluoride toxicity. Experimental evidences indicated that chronic fluoride intake enhances the oxidative stress as evidenced by a significant increase in malondialdehyde (MDA) content and also causes hepatic damage in terms of significant increases in the activities of serum glutamate oxalate-, glutamate pyruvate-, serum aspartate- and alanine-transaminases (Bouaziz *et al.*, 2006).

Endocrine dysfunctions

It has been found that increased intake of fluoride results in thyroid enlargement, reduced thyroid adenylate cyclase and decreased blood thyroxine and tri-iodothyronine levels. Fluoride is known to stimulate parathyroid gland and thereby enhances the circulating parathormone levels (Teotia and Teotia, 1973). Significant increases in plasma epinephrine levels have been found due to fluoride toxicity resulting in hyperglycemia.

Summary and conclusions

Excess fluoride concentration in water, feed and mineral mixture are a problem for India. It can cause skeletal problems, metabolic disorder (carbohydrate and protein metabolism) and endocrine disorder. It can be overcome by different methods by

I. Removal from drinking water

Adsorption, ion-exchange, precipitation, coagulation, electrochemical methods, membrane techniques

II. Enzymatic system in body

Majority of fluoroacetate is defluorinated within the liver by an enzyme termed fluoroacetate specific defluorinase

III. Microbial degradation

Some microbes have the ability to degrade fluoroacetate by dehalogenation

IV. Biotechnological method

Recombinant *Butyrivibrio fibrisolvens* containing dehalogenase gene from *Delftia acidovorans* can actively dehalogenate fluoroacetate. Phytoconstituents like phytosterols, saponins, polyphenols, flavonoids can ameliorate the toxicity

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