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Editorial

How Can Fluorosis in Animals be Diagnosed and Prevented?

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Abstract

Prolonged fluoride (F) exposure in domestic and wild mammalian animals either through fluoridated drinking water or/and industrial F pollution or airborne F emission causes a serious F poisoning in the form of fluorosis disease. This dreaded disease is a worldwide health problem in both man and animals and endemic in several countries. Thousands of domesticated animals (bovines, flocks, equines, camels, etc.) in the world are suffering with fluorosis due to drinking of water having F >1.0 or 1.5 mg/L and chronic exposure to industrial F emission. In this disease, mainly in the teeth and bones, many types of permanent and irreversible deformities develop one after the other, which are very painful and dangerous for the animal health. But this disease also affects other parts or soft organs of the animal body. F-induced toxic effects or anomalies in teeth, bones, and soft organs are generally referred as dental, skeletal, and non-skeletal fluorosis, respectively. Nevertheless, skeletal fluorosis is most dangerous in animals, due to which animals become victims of lameness at an early age. Fluorosis can be easily diagnosed when it is an advanced stage, but it is a bit difficult to diagnose when it is in its early stages. Nevertheless, on the basis of appearance of its main clinical or pathognomonic signs and careful physical examination, the presence of this disease in the animal can be confirmed or diagnosed. In present editorial, for researchers and investigators, some helpful and important parameters for the diagnosis of fluorosis in domesticated animals such as history, diverse clinical or pathognomonic signs, and the testing of biological samples, blood serum and urine for evidence of F have been highlighted. Simultaneously, different possible or feasible ways for the mitigation or prevention of chronic F poisoning in domestic animals have also been discussed. Along with this, those simple measures how to save animals from getting fluorosis have also been described well in this editorial.

Keywords: Animals; Bio-indicators; Bio-markers; Dental fluorosis; Diagnosis; Drinking water; Fluoride; Humans; Industrial fluoride pollution; Non-skeletal fluorosis; Prevention; Skeletal fluorosis

Introduction

Fluoride (F) is found naturally in water, air, and soil in varying amounts [1]. In groundwater it occurs due to weathering and leaching of F-bearing minerals from rocks and sediments [2]. Air-born F emission or industrial F pollution also contaminates the surface water, soil, environment, vegetation, agriculture crops, and food chains and webs [3]. Though F is not an essential element for growth and development and for most organisms in the environment [4] and is also an undesirable substance in animal feed [5]. However, it has vital role or contribution in strengthening and mineralization of teeth and dental enamel. In some animals, F is considered to be an essential element, as diets low in F impaired fertility and development [5]. When F is ingested in a small quantities then it becomes beneficial for dental health by reducing the dental caries, whereas higher concentrations, >1.0 or 1.5 mg/L or ppm [1] may cause fluorosis in both humans [6-12] and diverse species of domestic and wild mammalian animals [13-30].

Chronic F poisoning or fluorosis is a worldwide health problem and endemic at least in 25 countries. The principal cause of fluorosis in domesticated and wild animals is the prolonged exposure of F through fluoridated drinking water [1,26,31]. However, industrial F emission and F contaminated foods are also potential sources of F exposures for the genesis of fluorosis in animals [3,16,25]. As per guidelines of the World Health Organization (WHO) the F in the drinking water should not be higher than 1.5 mg/L [1]. Above this limit, it becomes toxic and injurious for health and causes permanent and irreversible different forms of teeth and bones deformities. Based on occurring of F induced changes in hard and soft organs, fluorosis has been categorised into three forms: (i) dental fluorosis, (ii) skeletal fluorosis, and (iii) non-skeletal fluorosis. All three forms may occur in the same animal. The diagnosis of fluorosis in animals could be done on the basis of history, clinical or pathognomonic signs, and testing of biological samples, blood serum and urine for evidence of F. Animals can be saved from the ill effects of fluorosis. For this it is important that F has to be prevented from entering the body of animals under any circumstances. For this it is necessary to provide F free water and food to the animals. The effect of F can also be prevented to a great extent by giving nutritious food to domesticated animals. General awakening in animal keepers and collective efforts are also important

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Figures 1-10: Appearance of moderate to severe dental fluorosis in bovine calves and juvenile (Figures 1-3 and 7), young and old flocks (Figures 4-6), and old bovines (Figures 8-10) characterised with deep brownish staining on anterior teeth, excessive irregular wearing of teeth, and recession and swelling of the gingival tissues. These clinical or pathognomonic signs are the resultant of drinking of fluoridated water.

and highly needed in the prevention of fluorosis in animals. Present editorial will be useful for researchers and investigators in the diagnosis and prevention of fluorosis in domestic animals.

Once F enters the body it is absorbed by the digestive and/or respiratory systems. Then absorbed F finally reaches to each part of the body through blood circulation. More than 50% absorbed F is excreted in the form of stool, urine, and perspiration, while rest is retained in the body where it accumulates in diverse organs. However, its maximum accumulation is found in the calcified organs, bones and teeth compared to non-calcified soft organs. Nevertheless, the bio-accumulation of F in growing calves and juvenile animals is relatively higher than adult animals [5]. Hence, calves and juveniles generally revealed an earlier signs of chronic F poisoning that is dental fluorosis [28].

The bio-accumulation of F causes interference in various physiological and metabolic processes and then ultimately triggers the genesis of adverse reversible and non-reversible health effects or pathological changes. These F-induced health effects are collectively known as fluorosis [1]. Various F-induced pathological changes in both teeth and bones are permanent, irreversible and untreatable and can be easily identified visually, whereas in soft tissues or organs these health effects are generally reversible and disappeared after the removal or check the F exposure. Nevertheless, the prevalence and severity of fluorosis in animals is much more depend on the concentration of F in drinking water and its duration or frequency of F exposure, density of bio-accumulation of F, food nutrients, chemical constituents of drinking water, species, age, environmental factors, individual F susceptibility or tolerance, genetics, etc. [32-37].

Dental Fluorosis

The earliest and most recognizable clinical sign of chronic F poisoning is dental defragmentation or mottling (dental fluorosis) which could be seen by necked eyes. In fact, dental fluorosis is sensitive, indexive, and rampant in the F endemic areas. Dental fluorosis in animals such as cattle (*Bos taurus*), water buffaloes (*Bubalus bubalis*), camels (*Camelus dromedarius*), sheep (*Ovis aries*), goats (*Capra hircus*), horses (*Equus caballus*), donkeys (*Equus asinus*), etc., is generally, characterised with bilateral, striated, and horizontal compact streaks stained with light to deep brownish in colour on enamel of teeth [18-26]. In general, these pigmented or stained streaks are more contrast, regular, condensed, and sharply visualized on anterior teeth (incisors) in calves and juveniles or immature animals as compared to old animals (Figures 1-10). In some cases, dental fluorosis is also appeared in the form of white or light to deep brownish spots, patches, and fine dots or granules on the enamel of teeth. In severe dental fluorosis, pronounced loss of the tooth-supporting alveolar bone occurs with recession and swelling of the gingival tissues and excessive abrasion or irregular wearing of the teeth (Figures 4, 8 and 10).

Skeletal Fluorosis

An excessive F ingestion or exposure for prolonged period alters the equilibrium between formation and resorption of bones. This biological process is accomplished by involvement of certain regulatory determinants and signalling pathways, thereby leading to various pathological changes in diverse bones known as skeletal fluorosis. In fact, an excess accumulation of F in bones of skeletal and attached muscles and ligaments causes mild to severe deformities which are dangerous and highly painful which is depend on the F concentration and its duration of exposure. This entity of chronic F intoxication is very painful and more dangerous than dental fluorosis and is highly significant since it diminishes the mobility at a very early age by producing gradually varying changes in bones such as periosteal exostosis, osteosclerosis, osteoporosis, and osteophytosis [38,39]. These changes appear clinically in the form of vague aches and pains in the body and joints which are associated with rigidity, lameness, diminutive body growth, and detectable bony lesions. These bony changes are progressive and irreversible and become severe with advancing of age of animals and the increasing of duration or frequency of F exposure as well. Intermittent lameness, enlarged joints, debility, invalidism, hoof deformities, wasting of body muscles and bony lesions in the mandibles, ribs, metacarpus, and metatarsus regions are well recognized in animals afflicted with severe skeletal fluorosis (Figures 11-16). In few fluorosed cases ankylosis deformity is also possible. However, this entity is rare in animals suffering with chronic F poisoning. The excess accumulation of F in muscles also

Figures 11-16: Severe skeletal fluorosis in bovine calves (Figures 11 and 14), juveniles (Figures 13 and 16), old buffalo (Figure 12), and old flock (Figure 15) characterised with lameness in hind legs, enlarged joints, debility, invalidism, wasting of body muscles, and bony lesions in ribs, metacarpus and metatarsus regions. These clinical or pathognomonic signs are the resultant of drinking of fluoridated water.

diminishes the movements and the condition leads to lameness in animals (Figures 11, 13 and 16).

Non-Skeletal Fluorosis

This form of fluorosis is the resultant of F- induced various histological, biochemical, and physiology changes in the soft organs of animals [19,20,26] and this is an initial stage of chronic F poisoning in animals. In fact, several health complaints in animals such as gastrointestinal discomforts (intermittent diarrhoea or constipation, abdominal pain, flatulence, etc.), urticaria, frequent tendency to urinate (polyurea), excessive thirst (polydipsia), lethargy, muscle weakness, irregular reproductive cycles, abortion, still birth, etc. [26] are the resultant of chronic F toxcosis. These toxic or health effects are temporary and can be reverse in few days after the removal of source of F exposure. This is not necessary that all these F induced health consequences are found at the same time in the animal. Nevertheless, the magnitude of fluorosis is relatively more depending on the density and rate of bio-accumulation of F [40].

How to Diagnose of Chronic F Poisoning or Fluorosis in Animals

For the correct diagnosis of chronic F poisoning or fluorosis in animals requires basic knowledge of physiology of F toxicosis, taking a relevant history, consciousness of the clinical features of the condition, proper physical examination, and relevant investigations. Whether fluorosis is endemic in any area can be detected by the presence of F in the animal's blood serum, urine, and milk. In fact, these biological samples are also bio-indicators of F toxicocsis [40]. Nevertheless, among these, urine is the most ideal bio-marker for the assessment of F toxicosis because at the spot, it can be easily recollected noninvasively and systematically. In fact, the level of F in the urine gives the best indication of the presence of fluorosis and revealed its current status. In the healthy humans, the normal range of F ion in serum and urine is reported as 0.02-0.15mg/L and 0.1-1.0 mg/L, respectively [41,42]. But the normal faithful value of F ion in blood serum and urine in diverse species of domestic and wild animals are still needed. The estimation of F in environmental samples such as forage and fodder indicates the persistence of F contamination in the environment. Fluorosis in any area and its intensity can also be predicted by the amount of F in drinking water. Therefore, the estimation of F level in drinking water is more useful and highly significant.

Whether the animal is suffering from fluorosis or not can be easily diagnosed on the basis of the basic clinical or pathognomonic signs of dental and skeletal fluorosis present in the animal. Morning to afternoon (9 a.m. to 3 p.m.) is the best time to recognize and see these toxic signs in animals. During this time keeping the animal keeper together also makes it easier to handle the animals. Secondly, there is no danger of the animal becoming aggressive. Sometimes young animals get angry on seeing strangers. For the diagnosis of dental fluorosis bovine calves or immature animals are the better options for investigators as these animals are relatively highly sensitive and ideal bio-indicators for chronic F poisoning or fluorosis [43,44].

Skeletal fluorosis is easily diagnosed in young and old animals. Downward bending of the neck while walking, limping, swelling or bulging of the joints of the legs, tendonitis, and excess bony growth on the surface of the different bones of different regions are the basic clinical signs of skeletal fluorosis in animals. Bony out growth can be determined by gentle palpation. However, based on radiological findings (periosteal exostosis, osteosclerosis, osteoporosis, and osteophytosis) skeletal fluorosis can also be confirmed. Though, the diagnosis of non-skeletal fluorosis is difficult. However, it can be presumed by taking of animal history from the animal keepers. The history (gastrointestinal discomfort, loss of appetite, nausea, chronic constipation, intermittent diarrhoea, excessive thirst, frequent urination and chronic headache indicates, etc.), carefully physical examination, and measuring of F level in urine and serum are useful and important basic ways in diagnosis of chronic F poisoning or fluorosis in the animals.

Prevention of Fluorosis

Once dental fluorosis and skeletal fluorosis develop in animals, then these are not cured by any treatment. These dental and bone deformities not only cause a lot of trouble to the animals, but they also cause economic loss to the livestock owners [29]. But the occurrence of fluorosis disease in animals can be prevented. For this, it is necessary to prevent the entry of F in the animal or protecting animals from any of F exposure. It is possible by giving F free water to

domesticated animals and/ or preventing animals from entering the areas of factories emitting F.

Though, numerous defluoridation techniques are also available for defluoridation of fluoridated water. However, Nalgonda defluoridation technique is an ideal and low cost technique for defluoridation of fluoridated water [45] and it can be used at both domestic and community level. However, to get regular F free water for animals, rainwater harvesting is the one of the ideal and suitable ways. Unpolluted water from perennial fresh surface water sources (ponds, reservoirs, lakes, rivers, etc.) is also an alternative way for domesticated animals for drinking as water of these sources contains traces of F, 0.01–0.3 ppm [1]. As far as possible, water of deep borewells and any other groundwater sources should be avoided for drinking for these animals. Since, ground-drinking waters are mostly contaminated with F. Shifting of animals from F endemic areas to non F endemic areas is also effective way for the prevention from flourosis. In F endemic areas, feeding nutritious foods to domesticated animals also helps in controlling dreaded fluorosis disease. Simultaneously, villagers, herdsmen and veterinarians should be well educated about the general awareness and preventive measures of fluorosis.

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