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Editorial

Are bovine calves safe in India from drinking water in case of fluoride poisoning?

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EDITORIAL

In India, animal husbandry is primarily practiced in rural areas. This not only positively impacts people's economic well-being but also strengthens the rural economy. Most middle-class villagers raise cows (*Bos taurus*) and female water buffaloes (*Bubalus bubalis*) to increase milk production and earn more income. Their meat, leather, and dung also provide substantial income to livestock farmers. According to the 20th Livestock Census (2019), the total livestock population in the country is 535.78 million. Of this, approximately 145.12 million are female cattle (cows) and 55.0 million are female buffaloes, totalling approximately 200.12 million female cattle and buffaloes. Thousands of calves are born to these female bovines every year. These calves become a source of income for cattle farmers. Although cattle farmers pay special attention to their health, most don't know whether the water they provide is suitable for their health.

In most rural areas of the country, calves of these animals are typically fed water from hand- pumps, bore-wells, and deep dug- wells. However, when these animals are out grazing, they also drink water from surface water or freshwater sources such as ponds, pools, rivers, and lakes. However, these sources of water are not necessarily safe for their health. Research studies show that fluoride is found in water from hand- pumps, bore-wells, and deep dug- wells in most rural areas of the country. The fluoride content in water from these sources has been found to exceed the safe limit (1.0 ppm or 1.5 ppm) [1-3], which is harmful not only to human health [1, 4-7] but also to the health of these domestic animal species [8-12]. Many rural areas in the country also have varying levels of fluoride in freshwater sources [13-16]. Drinking such water repeatedly over a long period of time can cause fluoride poisoning in these animals, leading to a dangerous disease called fluorosis [1, 11, 12]. However, most livestock owners and villagers are unaware of the causes of fluoride poisoning in their pets.

Freshwater habitats are also not safe for the health of domesticated bovines in terms of food-borne trematodiases [17]. People are also unaware about these parasitic diseases, such as fascioliasis, amphistomiasis, schistosomiasis, etc. developed in their reared animals due to these freshwater sources. In fact, these freshwater habitats harboured a variety of snail (Mollusca: Gastropod) species, such as *Lymnaea acuminate* f. *patula, L. acuminate* f. *chlamys, L. acuminate* f. *typica, L. acuminate* f. *rufescens, L. luteola* f. *australis, L. luteola* f. *typica, L. luteola* f. *impura, Gyraulus convexiusculus, Planorbis (Indoplanorbis) exustus, Faunus ater, Melania (Plotia) scabra, Thiara (Tarebia) lineata, Melanoide striatella tuberculata, Vivipara bengalensis* race *gigantica, V. bengalensis* race *mandiensis*, etc. [18,19]. These snails are also habitat-specific, serving as bio-indicators for different freshwater habitats and trematodiases [20]. In fact, these freshwater snail species are intermediate hosts for digenetic trematode parasites, completing their life cycle.

In most villages across the country, the main source of fluoride poisoning in bovine calves is groundwater from hand- pumps, bore-wells, and deep dug- wells, which are almost naturally contaminated with fluoride through geogenic processes [21, 22]. In some rural areas, several freshwater bodies are also located near or adjacent to coal-fired brick kilns and coal-fuelled thermal power stations, and industries producing

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aluminum, steel, phosphate fertilizer, cement, etc. Fluoride emissions from these industrial sources also contaminates these surface water sources [23].

Once fluoride enters the calf's body, it is absorbed by its digestive system, which then carries it through the blood circulation to various organs and tissues throughout the body. More than 50% of the fluoride absorbed from the digestive system is excreted through excretory products (faeces and urine) and sweat, while the remainder remains in the body where it gradually accumulates in various organ systems. However, due to its higher affinity for calcium, it accumulates to a greater extent in calcified tissues, such as osteal and dental tissues, than its counterparts. Biological accumulation of fluoride ultimately interferes with or alters various biological or physicochemical activities in different organs, leading to various pathological changes. These fluoride-induced toxic changes are collectively known as fluorosis [24]. These changes caused by drinking fluoridated water are commonly known as hydrofluorosis, which is widespread in the country. These pathological changes in teeth and bones are known as dental and skeletal fluorosis, respectively.

Fluoride poisoning in cow calves less than two months of age, in the form of osteo-dental fluorosis, usually occurs when they drink water with fluoride levels of 1.0 or 1.5 ppm [1,8,11,12]. Fluoride toxicity becomes more severe as bovine calves age and the fluoride level in drinking water increase [25]. However, in rural areas of the country, hydrofluorosis is very common in both humans [26-32] and various species of domestic animals [33-44].

Although hydrofluorosis has been studied in bovine calves in India, these studies are still very limited [44-47]. Therefore, to understand the fluoride toxicity, detailed research studies are needed in different regions of the country where fluoridated water is found. Any livestock farmer can easily identify chronic fluoride poisoning in their bovine calves. If the calves have light or dark horizontal yellow-brown streaks or spots on their teeth, it definitely indicates that they are suffering from fluoride poisoning (**Figure 1**). These marks on the teeth are the first clinical sign of fluoride poisoning [48]. This is also called dental fluorosis. Dental fluorosis in calves does not necessarily have a brown-yellowish in colour; the teeth can also be deep blackish (**Figure 1**). The highest prevalence (100%) of dental mottling or dental fluorosis in bovine calves was observed at a fluoride concentration of 4.7 ppm in drinking water [9]. At below the maximum permissible limit of fluoride (1.0 ppm) concentration, 42.66% prevalence of dental fluorosis in bovine calves has been reported [49]. This finding suggests that fluoride poisoning in bovine calves can occur at concentrations as low as 1.0 and even below 1.0 ppm fluoride. This suggests that calves are at greater risk of fluoride poisoning than older animals. Therefore, they are ideal bio-indicators of chronic fluoride poisoning [50,51]. The prevalence of dental fluorosis in animals is not necessarily the same in different provinces with the similar fluoride concentration in drinking water. In fact, the prevalence and severity of dental fluorosis or fluoride poisoning depend largely on many factors, such as the chemicals present in drinking water, environmental factors, the duration of fluoride exposure, age, genetics, individual response or susceptibility, and more [52-57].



Figure 1. Bovine calves with moderate (c) to severe (a, b, and d) dental fluorosis, characterized by dark brown (a, c, and d) and black staining (b) with striated and horizontal stripes on the front teeth.

Whatsoever, dental defects in cow calves are of significant importance. In fact, it is one of the leading causes of early calf mortality. When dental fluorosis becomes more severe, it can impair grazing and chewing, leading to starvation and weakness in calves [1, 58]. Early calf mortality due to dental fluorosis results in significant economic losses for livestock farmers.

The most dangerous aspect of chronic fluoride poisoning in calves is bone damage called skeletal fluorosis. In fact, long-term exposure to fluoride from drinking fluoridated water negatively impacts bones and joints. Fluoride accumulation in the osteal tissue of bones causes various pathological changes to the bones, as well as the muscles and ligaments attached to them. These damages are dangerous and extremely painful, ultimately leading to reduced mobility and lameness in calves. Excessive fluoride accumulation in bones hardens bones, increases bone mass and density (osteosclerosis), but also makes them more brittle, weak, and porous (osteoporosis). Fluoride deposition causes their surface to become irregular and rough, leading to varying degrees of bone growths or spurs (exostosis and osteophytosis) [59, 60]. These changes manifest clinically as severe pain, stiffness, and rigidity in the neck (cervical vertebrae), back (vertebral column), and hip (pelvic girdle) regions, as well as in various bone joints. In calves, at a fluoride concentration of 1.0 mg/L in potable water, a 16.2% incidence of skeletal fluorosis was detected in the country [33, 61].

Fluoride-induced bone changes typically result in stiffness and varying degrees of lameness. Calves with severe skeletal fluorosis typically exhibit a weak body, stunted growth, weakened muscles, inactivity, and difficulty standing (**Figure2**). Calves with skeletal fluorosis have also been reported to have a lowered neck and a clicking sound in their feet while walking [45,46]. Excessive bone growths on the ribs, femoral, fibular, metatarsal, and other bones can be easily identified by palpation as a result of excessive fluoride accumulation in the bones. The severity of these osteal deformities increases with age in calves. Furthermore, skeletal fluorosis in calves also impacts the economy of livestock farmers, as lame fluorosed calves generally have lower market values.

In addition to causing fluoride poisoning in teeth and bones, it also affects various organs such as the digestive tract, bowel and reproductive organs, endocrine glands, etc. The symptoms or adverse effects caused by fluoride toxicity in these organs are generally referred to as non-skeletal fluorosis. The most common symptoms of chronic fluoride poisoning in calves are stomach and intestinal problems, such as loss of appetite, abdominal pain, constipation, increased gas formation, and watery dung. Frequent urination and water drinking are more common in fluoridated calves. Such calves are found to have weak body muscles (**Figure 2**). Such health problems have also been reported in naive horses [34]. However, these health problems caused by fluoride are temporary and can resolve after removing the fluoride exposure source or shifting the calves from a fluoridated area to a non-fluoridated area. It is not necessary that all these symptoms appear simultaneously in calves. However, these symptoms are important and useful to indicate that the calves are suffering from chronic fluoride poisoning [48].

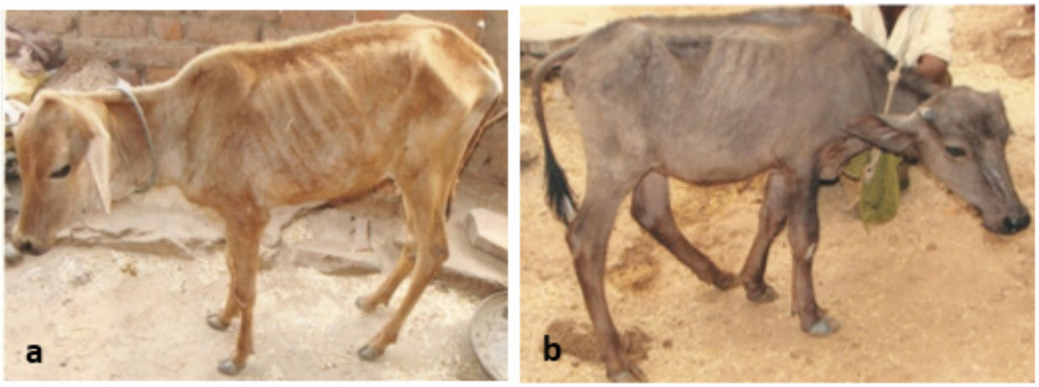


Figure 2. Cattle (a) and buffalo (b) calves suffer from severe skeletal fluorosis, characterized by weak body, lethargy, loss of body muscles, raised lesions on the legs and ribs, and lameness in the hind legs.

CONCLUSIONS

In most rural areas or villages in India, various sources of groundwater (hand-pumps, bore-wells, and deepdug-wells) and freshwater (ponds, pools, rivers, and lakes) are not safe for the health of domestic bovine calves in terms of fluoride poisoning as they are contaminated with varying amounts of fluoride. Most of these contain fluoride above the permissible limit of 1.0 ppm or 1.5 ppm. If calves and their mothers drink this fluoridated water for a long time, they develop fluoride poisoning in the form of osteo-dental fluorosis. Principally, fluoride poisoning causes tooth and bone damage and also causes lameness in calves. In the rural areas of the country, at the 1.0 ppm fluoride concentration in drinking water 42.66% and 1.16% bovine calves found to be affected with dental and skeletal fluorosis, respectively. Due to fluoride poisoning in bovine calves, economic losses in livestock owners are also possible. In addition to fluoride poisoning, these calves can also develop various trematodiases because most of freshwater sources are contaminated with larvae of digenetic trematode parasites. To protect calves from fluoride poisoning, providing fluoride-free drinking water is the best solution.

Conflict of interest

There is no conflict of interest of the author.

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