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RESEARCH ARTICLE

OBSERVATIONS OF FLUOROSIS IN DOMESTIC ANIMALS OF THE INDIAN THAR DESERT, RAJASTHAN, INDIA

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Abstract

Toxic effects of chronic fluoride (F) exposure in the form of osteo-dental and non-skeletal fluorosis were observed in 85 domesticed animals living in Udasar village, Bikaner district of Rajasthan, India located in the That desert of India where fluoride (F) in drinking water sources (bore wells) varies between 1.6 ppm and 2.2 ppm (mean 1.9 ppm). These animals included cattle (*Bos taurus*), goat (*Capra hircus*) and sheep (*Ovis aries*). Among immature animals the highest prevalence of dental fluorosis was found in calves (41.0%) followed by lamps (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%). Their anterior teeth showed light to deep yellowish staining and striated lines. In severe forms of dental fluorosis, recession of gingival swelling and irregular wearing of teeth were also present. Among 28 cows and 15 goats, rate of the skeletal fluorosis was 7.1% and 6.6% respectively. However, no sign of skeletal fluorosis was observed in sheep. On the contrary, among young animals 12 calves, 10 kids and 7 lamps, rate of skeletal fluorosis was reported to be 16.6%, 10.0% and 14.2% respectively. Results of the present study suggest that ground water fluoride play a role in pathogensis of chronic fluoride intoxication.

Introduction

In India, 20 states and Union Territories have fluoride-affected sectors (Susheela, 2001). Rajasthan is one of the highest endemic states suffering from the presence of high fluoride contents in the underground waters in most of the districts. As per a survey carried out by Public Health Engineering Department in the year 1991-93, for status of water supply in the villages / habitations, nearly 16560 (about 20%) villages/habitations were found to be affected by excess fluoride (more than 1.5 ppm), out of which 5461 villages /habitations had fluoride more than 3 ppm (PHED Survey, 1991-93).

Chronic exposure to fluoride (F) in groundwater causes adverse health problems not only in humans, but also in various species of domestic animals in the form of fluorosis. The primary manifestations are mottling of teeth (dental fluorosis), and osteosclerosis of the skeleton (skeletal fluorosis) (Choubisa, 2012 and Choubisa *et al*., 2012). In India, most studies on F toxicosis in domestic animals have been conducted on buffaloes (Bubalus bubalis), camels (*Camelus dromedarius*), cattle (*Bos taurus*), donkeys (*Equus asinus*), goats (*Capra hircus*), horses (*Equus caballus*), and sheep (*Ovis aries*) living in areas with high F (>3.0 ppm) in the drinking water (Choubisa, 2010 and 2013**).** Among these animals, the prevalence of osteo-dental fluorosis varies greatly.

The present study deals with the state of Rajasthan in India, which is divided into two distinct geographical regions by the Aravali mountain range (Figure 2). In the Northwest region a perfect desert environment exists where drinking water of animals contains very high levels of F ranging between 12.0 and 90.0 ppm (Choubisa, 2001)**.** In the other part, i.e., in Southeastern Rajasthan, where a semi-arid or humid ecosystem persists, a relatively lower

range of F (1.44 to 28.1 ppm) in groundwater has been reported (Choubisa, 2001)**.** The present pilot investigation of chronic fluorosis in domestic animals was undertaken and conducted in the Udasar village of Bikaner district, Rajasthan, in the Thar desert of India.

Material and methods

The Udasar village in Bikaner Tehsil of Bikaner district in the Indian Thar desert of Rajasthan was selected for the present pilot study. Rajasthan is the largest state of India (Figure 1), lying between 23º3' and 30º12' N latitude and 69º30' and 78º17' E longitude with its 342,239 km^2 being 10.4% of the area of the country. The region has a typical arid and hot climate with low and irregular rainfall. In general, the annual rainfall is in the range of 260–440 mm, and the temperature ranges from 1ºC to 48ºC.

In the present study, it was found that most people use the drinking water sources for domestic animals are bore wells. The water samples from these sources were collected in polythene bags and brought to the laboratory. The F concentration of the samples was estimated spectrophotometrically using an alizarin method employed earlier (Choubisa, 2013, Choubisa, *et al*. 1995 and 2001**.** It varied from 1.6 to 2.2ppm (mean 1.9 ppm).
To derive estimates of the relative prevalence of dental and skeletal fluorosis in cattles (cows), flocks (sheep and goats), house-to-house surveys were conducted in the morning and evening hours when the animals were generally available. Animals fulfilling above selection criteria were examined clinically for the presence of clinical signs and lesions suggestive of fluorosis. For dental fluorosis, the teeth of the domestic animals were carefully examined for any signs of dental mottling; for skeletal fluorosis, poor body condition, lameness, reluctance to move or stiffness, skeletal deformities, bony exostoses, muscle wasting, and a snapping sound from the feet during walking were looked for (Choubisa, *et al*., 1996, Shupe, 1972, Singh and Swarup, 1994). The animals were handled for photography keeping the ethical point of view under consideration.

Results

It is observed in the Udasar village of Bikaner Teshil that the drinking water sources like bore wells has a contribution of fluoride ranging from 1.6 ppm to 2.2 ppm (mean 1.9 ppm). Among mature domestic animals 17.8% cows, 13.3% goats, and 15.3% sheep were having dental fluorosis evident by light to a deep yellowish staining and striated lines. In a few cases recession of the gingival swelling and irregular wearing of teeth were also seen (Table 1). Careful examination of immature animals, 41.0% calves, 20.0% kids (goat) and 28.5% lamps showed signs of dental fluorosis (Table 1 and figure 3 a-e).

Among the mature animals, the prevalence of skeletal fluorosis was higher in cows (7.1%) followed by goats (6.6%). In the present pilot study, no signs of skeletal fluorosis observed in sheep. However, the prevalence of skeletal fluorosis in calves, kids and lamps was 16.6%, 10.0% and 14.2%, respectively (Table 1 and figure 4 a-b). These animals were physically weak, indolent, and reluctant to move or stand. In these animals, mild to severe intermittent lameness and snapping sounds, especially in the hind legs, stiffness of leg tendons, and wasting of the main mass of hind quarters and shoulder muscles were also observed.

Table:- 1 Prevalence of dental and skeletal fluorosis in domestic animals fluoride endemic area of Udasar village, Bikaner District, Rajasthan.

	Mature animals (spp.)		Immature animals (spp.)	
Animals (spp.)	**DF***	**SF***	**DF***	**SF***
Cow (***Bos taurus***)	5/28 (17.8)	2/28 (7.1)	5/12 (41.0)	2/12 (16.6)
Goat (***Capra hircus***)	2/15 (13.3)	1/15 (6.6)	2/10 (20.0)	1/10 (10.0)
Sheep (***Ovis aries***)	2/13 (15.3)	-/13 (0.0)	2/7 (28.5)	1/7 (14.2)
	9/56 (16.0)	3/56 (5.3)	9/29 (31.0)	4/29 (13.7)

*In Figures indicate percentage of Dental Fluorosis (DF) and Skeletal Fluorosis (SF)

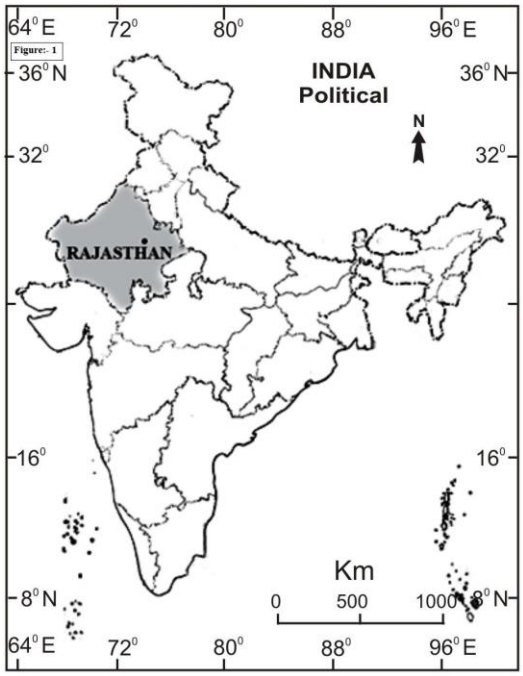

Figure:- 1. Rajasthan state status in India, where ground/drinking water contains fluoride in almost all districts.

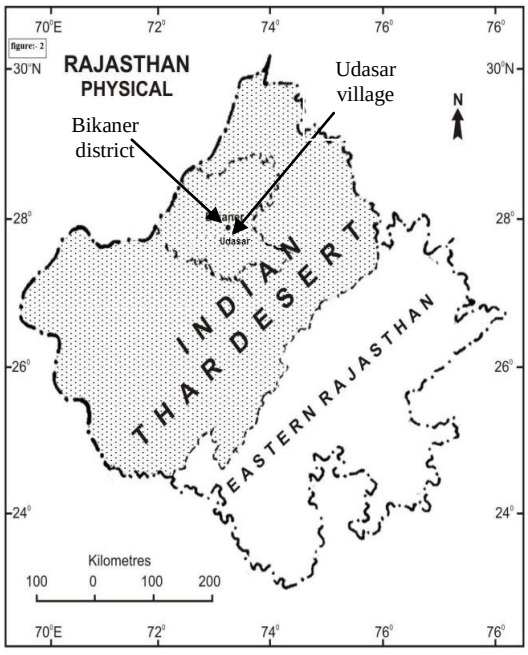

Figure:- 2. North- West Rajasthan where study area, Udasar village is located in Bikaner district.

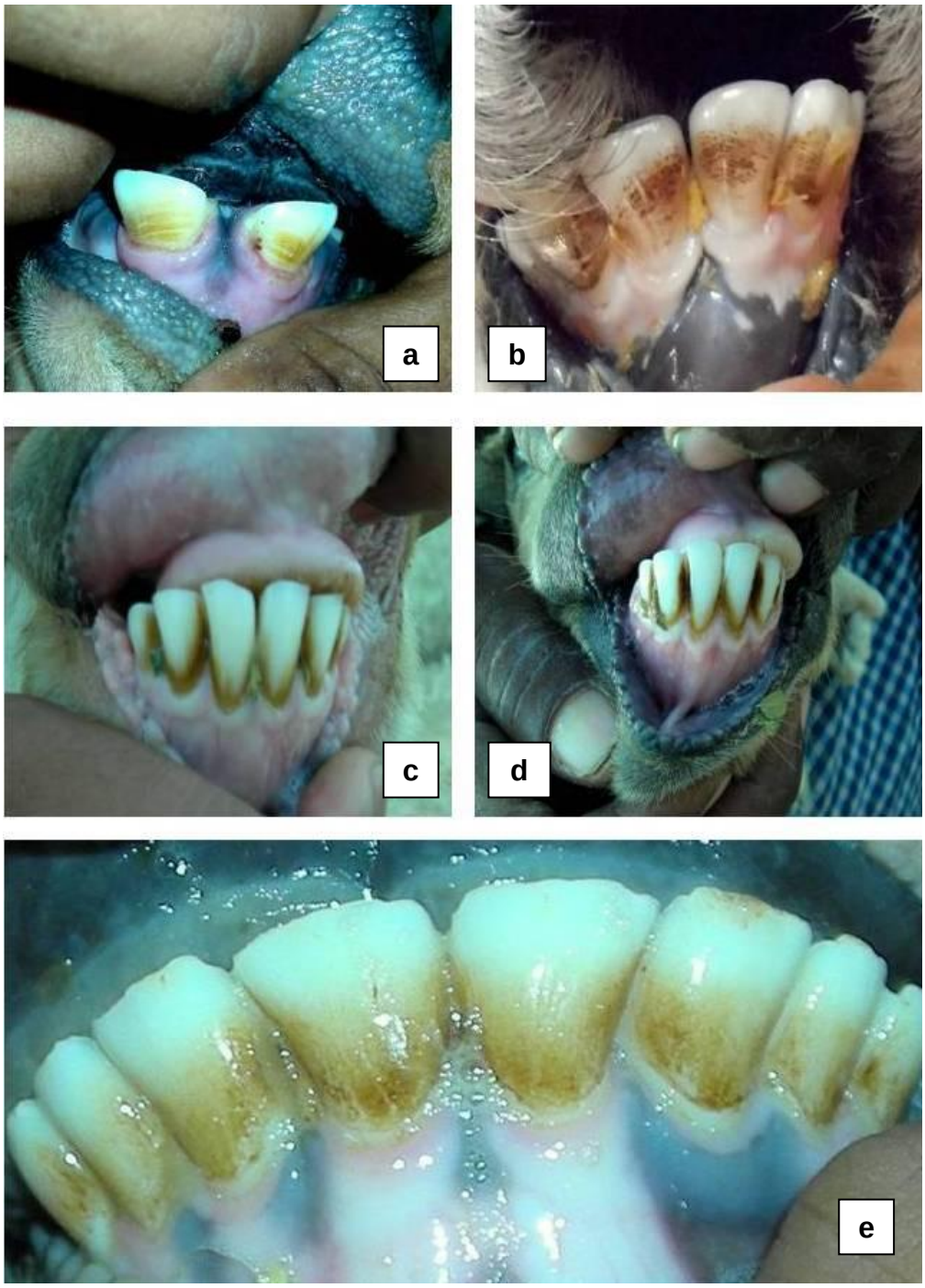

Figure:-3 (a-e) Different grades of dental fluorosis in domestic animals (a) one month old calf (b) Six month old calf (c) Mature Goat (d) Mature Sheep (e) Mature cow

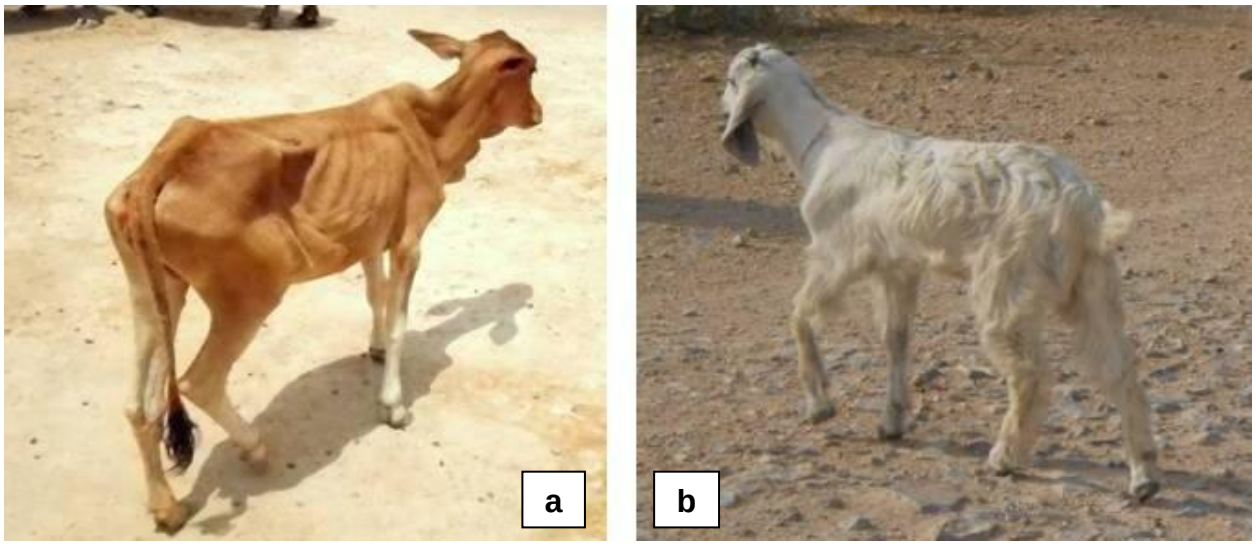

Figure:-4 (a-b) Skeletal fluorosis in different domestic animals (a) One month calf affected with skeletal fluorosis and lameness in hind leg. (b) Kids of goat affected with moderate skeletal fluorosis.

Discussion

Water, soil and plants with natural high fluorine (F) content are usually the main cause of fluorosis. The most important effects are seen in the wild and domestic animals that are exposed for long periods to excess fluorine due the industrial pollution (WHO, 1984; Gu, *et al*., 1990). In a number of small villages in Sicily, Turkey and India there is naturally occurring fluoride in the water ranging from 0.7 to 5.4 ppm. The villagers and their livestock are chronically ill, while neighboring villages with no fluoride have no such illnesses. Lower milk production has been described, amongst cattle. Cows which were exposed to inorganic fluoride in drinking water at concentrations of 5, 10 or 12 mg F/kg produced significantly fewer calves than the controls. This effect preceeded the development of clinical symptoms of fluorosis in domestic as well as wild animals (Shupe *et al*., 1972).

In case of animals, dental fluorosis is generally characterized by the presence of various enamel defects and lesions such as mottling, hypoplasia, hypocalcification and increased wear. Mottled and defective enamel is believed to be solely an indication of inorganic fluoride exposure during the development of the teeth. Other symptoms of the disease are lameness, hyperostosis and exostosis of the long bones, tendon calcification, and a systemic effect on ration intake, usually have not been seen until the ration contains in excess of 40 ppm F (Suttie, 1980).

Skeletal fluorosis is one of the crippling endemic diseases which is widely distributed all over the world in high fluoride areas. Skeletal fluorosis which is characterised by the inhibition of joint movement due, for example, to the presence of nodules of excess bone or to the calcification of the ligaments surrounding joints (Teckle-Haimanot, 2006).

Endemic skeletal fluorosis was reported from India in the 1930s. It was observed first in Andhra Pradesh bullocks used for ploughing, when farmers noticed the bullocks inability to walk, apparently due to painful and stiff joints. Several years later the same disease was observed in humans (Shortt *et al*., 1937). Choubisa *et al*., (1997) examined the prevalence of skeletal fluorosis in Rajasthan in adults exposed to mean fluoride levels of 1.4 and 6 mg /1. At 1.4 mg /1 over 4 per cent of adults were reported to be affected, while at 6 mg /1, 63 per cent of adults were reported to be affected. The prevalence was found to be higher in males and increased with increasing fluoride levels and age.

Chronic toxic effects of fluoride (F) as osteo-dental and non-skeletal fluorosis were reported in 99 domesticated cattle (*Bos taurus*), out of 24 calves (<2 years age) and 75 cows (>3 years age), 10 (41.7%) and 28 (37.3%), respectively, exhibited mild to severe dental mottling from Chani village, Bikaner district of Rajasthan which is a part of Thar Desert in India, where fluoride in drinking water sources, e.g. bore wells of this village varies between 1.5 and 2.5 ppm. (Choubisa *et al*., 2012).

In the present study, calves exhibited the greater prevalence of fluorosis and this may be because calves are more sensitive and susceptible and less tolerant to fluoride (Shupe, 1980). This fluoride toxicosis in the form of osteo-dental fluorosis was observed among immature herbivorous domestic animals living in areas with approximately 1.9 ppm fluoride in the drinking water. These animals included cattle (*Bos taurus*), goats (*Capra hircus*), and sheep

(*Ovis aries*). The teeth of bovines were the most severely affected. The appearance of pathognomic signs of dental fluorosis in calves and cows of Indian desert is almost similar to those reported in bovines of semi- arid or humid ecosystem of South- East Rajasthan (Choubisa, 1999a, 1999b, 2008 and Choubisa *et al*.,1996) and other parts of India (Choubisa *et al*., 2012 and Choubisa, 2010).

The prevalence of dental fluorosis in calves (<6 month) was greater than in adult goats viz. 36.8% and 14.2%, respectively in Shivpuri, Madhya Pradesh (Narwaria and Saksena, 2013). Boddie (1955) also observed dental lesions 33.3% and 46.6% in males and females respectively, in sheep grazing on pasture having eight ppm fluoride content. Singh (1994) reported the intoxication of fluoride in either sex of sheep and goat, among the affected animals, 57% animals were of above three years of age and this might be due to ingestion of excessive amounts of fluoride over a prolonged duration.

But in present study, domestic animals showed comparatively very high prevalence and severity of osteo-dental fluorosis at a low fluoride concentration (mean 1.9 ppm) in drinking water. This indicates that besides the fluoride concentration other factors, desert environment/ ecosystem has a significant contribution in increasing the prevalence and severity of fluoride toxicosis. Moderate lameness and stiffness in hind legs, wasting of body muscles, and bony exostoses as pathognomic signs of osteo-dental or skeletal fluorosis were also found in the domestic animals.

Conclusions

Environmental awareness program for the health implications due to fluoride should be emphasized through public education and rural community participation. Rural people need the make aware of the effects of fluorosis. The significance of the present study is that report is evidence for natural chronic F intoxication or fluorosis in domestic animals (cows, goats, and sheep) and these findings are useful in the control of fluorosis in both man and animals.

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