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A Study on Endemic Fluorosis in Domestic Ruminants

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Abstract

An epidemiological study was conducted to assess the toxic effect of fluoride in domestic ruminants in the fluoride polluted localities of Seoni district of Madhya Pradesh, India. Sixty animals (20 buffaloes, 20 cattle, and 20 goats) were included in the study in the areas having about 5.0-6.2 ppm fluoride level in drinking water. Dental lesions (clinical score 0 to 5) were the most common clinical signs, followed by bony exostosis and lameness in affected animals. The other signs like emaciation, hoof deformity, hypogalactia, anestrous and repeat breeding were reported by farmers in the animals of fluoride polluted area. High fluoride concentrations were observed in serum samples of buffalo, cattle and goats (0.380±0.022, 0.233±0.022 and 0.181± 0.011 µg/ml) as compared to their respective controls. Haematological parameters in naturally fluoride toxicated animals revealed significant reduction in haemoglobin concentration, packed cell volume, total erythrocyte count and leukocyte count indicative of anemia due to fluoride stress. The differential leukocyte count revealed significantly higher lymphocytes per cent and lower neutrophils per cent in animals of fluoride polluted area as compared to unpolluted area.

Key words: Fluorosis, Epidemiology, Domestic ruminants, Buffalo, Cattle, Goats.

Introduction

Environmental pollution is a major global problem posing serious hazard to human and animals. Chronic fluoride intoxication (fluorosis) is a worldwide health problem and is endemic in those areas where fluoride content is high in drinking water. Over 50% of the groundwater sources were fluoride contaminated (Nandan *et al*., 2007). According to WHO (1984) and Bureau of Indian standard drinking water specification (2003) the highest desirable limit is 1.0 ppm and maximum permissible limit of fluoride in drinking water is 1.5 ppm. Fluoride concentrations above 1.5 ppm in drinking water cause dental fluorosis and much higher concentration skeletal fluorosis (Kumar and Puri, 2012). In Madhya Pradesh 30-50% districts have high water fluoride content 3-15 ppm (Chakma *et al.,* 1997). Perusal of available literature revealed no published data on health status of domestic animals reared in fluoride endemic areas of MP, hence present study was undertaken to assess the endemic flourosis in domestic ruminants.

Materials and Methods

The study was conducted in the Mashool and Dhanora villages of Seoni district of Madhya Pradesh (India) where fluoride contents in water (bore wells and hand pump) is ranging between 5.0-6.2

ppm (Chakma *et al.,* 1997) which is used as drinking water sources for domestic animals. In the present study native domestic animals were included irrespective of age and sex and showing lesions of fluorosis. By door to door survey the animals examined clinically for muscle wasting, progressive emaciation, detection of cardinal signs and lesions of fluorosis, i.e. dental fluorosis lesions were scored on a 0 to 5 point scale as per the classification suggested by Shupe *et al.* (1979) and Choubisa *et al.* (1996). Skeletal fluorosis lesions were lameness scored on a 3 point scale. Physical condition of the animal, status of reproductive health and history of low milk production was recorded.

For the study total 60 animals (20 buffaloes, 20 cattle and 20 goats) were randomly selected from the fluoride polluted areas and noted dental lesions or lameness along with presence of exostosis of bone and hoof deformity, and ten animals housed in fluoride free area served as control. Blood samples were collected for hematological parameters and serum samples were used for estimation of fluoride concentrations by Digital Ion-analyzer equipped with fluoride specific electrode (Orion Research Model 5 Star, Chakma *et al.,* 1997).

Results and Discussion

In the study areas water, soil and plants with natural high fluoride content are the main sources of fluoride toxicity. The varying degree of clinical symptoms and pathological changes observed in affected animals are shown in Table 1. The animals of these areas were chronically ill, the dental

Table 1: Distribution of clinical signs and lesions of fluorosis in buffalo, cattle and goats

Clinical signs/ lesions	Clinical score	Buffalo (%) (N=20)	Cattle (%) (N=20)	Goat (%) (N=20)
Dental lesions	0 (Normal)	11(55)	12(60)	15(75)
	1	05(25)	04(20)	03(15)
	2	02(10)	03(15)	02(10)
	3	01(05)	01(05)	00(00)
	4	01(05)	00(00)	00(00)
	5	00(00)	00(00)	00(00)
	Total 1-5	09(45)	08(40)	05(25)
Lameness	0 (Normal)	12(60)	13(65)	17(85)
	1	05(25)	04(20)	02(10)
	2	02(10)	02(10)	01(05)
	3	01(05)	01(05)	00(00)
	1-3	08(40)	07(35)	03(15)
Bony exostosis/ lesions	Metacarpal/ Metatarsal	04(20)	03(15)	02(10)
	Ribs	03(15)	03(15)	01(05)
	Frontal bones	02(10)	02(10)	01(05)
	Total	09(45)	08(40)	04(20)
Hoof deformity	--	05(25)	04(20)	00(00)
Emaciation	--	09(45)	10(50)	10(50)

Fig. in Paranthes represent per cent distribution.

Table 2: Serum fluoride concentration and mean values of haematological parameters in animals of fluoride polluted (F) and unpolluted localities (C)

Parameter	Buffalo		Cattle		Goat	
	Healthy	Fluorotic	Healthy	Fluorotic	Healthy	Fluorotic
Serum fluoride (µg/ml)	0.093 ± 0.00	0.380 ± 0.022**	0.089 ± 0.00	0.233 ± 0.022*	0.091 ± 0.00	0.181 ± 0.011**
Hb (g/dl)	11.23 ± 0.27	07.31 ± 0.22**	10.90 ± 0.28	07.83 ± 0.26**	11.27 ± 0.42	07.23 ± 0.12**
PCV (%)	34.00 ± 0.73	22.80 ± 0.76**	33.33 ± 0.67	24.80 ± 0.93**	23.83 ± 1.01	18.25 ± 0.24**
TEC (millions/µl)	05.80 ± 0.05	04.80 ± 0.29**	05.71 ± 0.08	04.46 ± 0.12**	10.96 ± 0.06	09.83 ± 0.13**
TLC (thousands/µl)	06.66 ± 0.01	05.88 ± 0.01**	06.68 ± 0.05	05.95 ± 0.01**	11.28 ± 0.07	10.51 ± 0.11**
Lymphocytes (%)	62.33 ± 1.36	70.85 ± 1.27**	61.67 ± 1.28	70.65 ± 1.48*	62.83 ± 1.62	73.30 ± 0.44**
Neutrophils (%)	37.00 ± 1.31	27.80 ± 1.26*	37.67 ± 1.09	28.00 ± 1.47*	36.67 ± 1.38	25.70 ± 0.55**
Eosinophils (%)	00.50 ± 0.34	00.60 ± 0.17	00.33 ± 0.33	00.55 ± 1.48	00.33 ± 0.33	00.40 ± 0.11
Monocytes(%)	00.33 ± 0.21	00.50 ± 0.14	00.17 ± 0.17	00.50 ± 0.11	00.17 ± 0.17	00.45 ± 0.11
Basophils (%)	00.17 ± 0.17	00.20 ± 0.90	00.17 ±0.17	00.30 ± 0.11	00.17 ± 0.17	00.20 ± 0.09

Values within row with *differ significantly at p<0.05, **differ significantly at p< 0.01 between healthy and fluorotic animals.

fluorosis was mostly seen in immature animals as light to deep yellowish brown striated, horizontal lines starting from the base to apex of teeth (Plate 1), chalkiness, pitting of enamel, brown or black discoloration, hypoplasia and excessive attritions. Fluoride adversely affects both amelogenesis and dentinogenesis. The matrix formed by the damaged ameloblasts and odontoblasts cannot accept minerals, resulting into poor and faulty mineralization of teeth and dental lesions. Our findings are in accordance with Shupe *et al.* (1979), Swarup *et al.* (1998) and Muralidhar *et al.* (2000). The prevalence of dental fluorosis in buffaloes was found to be the highest (45%) followed by cattle (40%) and goats (25%). More or less similar observations were also recorded by Patra *et al.* (2000) and Modasiya *et al.* (2014).

Plate 1: Photograph showing dental fluorosis in 6 months old buffalo calf.

The prevalence of skeletal fluorosis was also higher in buffaloes

followed by cattle and goat. Skeletal fluorosis appeared as bony exostosis and swelling at hock joint (Plate 2) in mature animals. Bony exostosis was observed in 45% buffalo, 40% cattle and 20% goat (Table 1). Highest frequency of exostosis was recorded in metacarpal and metatarsal (20% in buffalo, 15% in cattle and 10% in goat) followed by in ribs (15% in buffalo and 15% in cattle and 5% in goats) and frontal bones (10% in buffalo 10% in cattle and 5% in goat). These findings are in agreement with the study of Swarup and Dwivedi (2002) and Modasiya *et al*. (2014). Emaciation, hypogalactia, anestrous, repeat breeding, hoof deformity/lameness and teeth decay are in agreement with the observations of Choubisa (1999) and Ahmed *et al.* (2000).

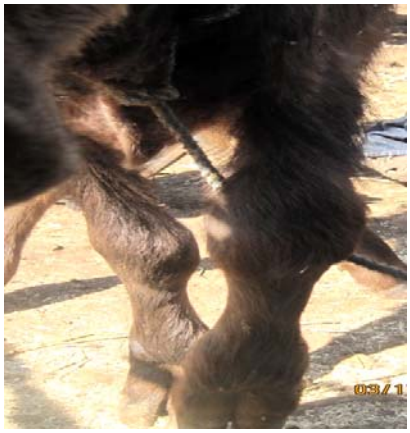

Plate 2: Photograph showing enlarged hock joint in 1 year old buffalo calf.

The mean serum fluoride concentrations in animals and mean values of their various hematological parameters are shown in Table 2. The fluoride concentration in serum was significantly higher in buffalo, cattle and goat (0.380±0.022, 0.233±0.022, 0.181±0.011 µg/ml) with respect to their controls. This can be attributed to rapid gut absorption following excess intake of fluoride through contaminated water, feed and fodder. After ingestion, soluble fluorides are rapidly absorbed primarily from stomach and reach systemic circulation. The high plasma fluoride concentration was also reported in cattle of endemic areas of Karnataka (Muralidhar *et al*., 2000).

Reduced haemoglobin concentration, packed cell volume, total erythrocyte count and total leukocyte count were observed in animals reared in fluoride polluted areas (Table 2). The anemia that developed in these animals was typically normocytic which may be due to excess interaction of fluoride with the iron of haemoglobin and alters its normal process of metabolism. These findings corroborate with Singh *et al.* (1995). This communication is perhaps the first documentation of fluorosis in ruminants from fluoride endemic areas of Madhya Pradesh of India, showing scope for intensive research.

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Conflict of Interest: Authors declare no conflict of interest for this research work.

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