Natural amelioration of fluoride toxicity (fluorosis) in goats and sheep

Chronic exposure of fluoridated groundwater causes a health problem not only to human beings, but also in domestic animals in the form of fluorosis[1–5]. Its primary manifestations are mottling of teeth (dental fluorosis) and osteosclerosis of the skeleton (skeletal fluorosis). Besides these, non-skeletal fluorosis or toxic effects of fluoride (F) in soft tissues, viz. gastro-intestinal discomforts, neurological disorders, impaired reproductive functions and teratogenic effects have also been reported in man[6] and animals[7]. The prevalence and severity of these chronic effects have also been reported and found much more influenced by a number of determinants such as F amount and its duration and frequency of intake, age, sex, nutrition, habits, nature of work, genetics and dissolved salts (alkalinity, total hardness, pH, etc.) in drinking water besides the stress factors, difference in the biological responses of individual, local environmental factors and involvement of fluoridated food chains[6,7].

Chronic F toxicity in the form of dental, skeletal and non-skeletal fluorosis has been studied mostly in cattle (*Bos taurus*), buffaloes (*Bubalus bubalis*), horses (*Equus caballus*), donkeys (*Equus asinus*) and camels (*Camelus dromedarious*)[7–10]. In India natural F toxicity in small ruminants, goats (*Capra hirus*) and sheep (*Ovis aries*) has not been reported anywhere previously. Although several states are hyperendemic for fluorosis[11–13], Choubisa[8] attempted to study chronic F intoxication in more than 2000 goats and sheep living in F endemic areas of southern Rajasthan, but none of these animals or their lames was found to be affected with chronic F intoxication[14]. Later he traced few isolated cases of fluorosis in these animals of the same F endemic areas, but its severity was found to be relatively less compared to bovines (cattle and buffaloes) of the same F endemic areas. It is evident that F toxicity occurs in any animal drinking fluoridated water but its toxicity varies among species. To find out possible causes or determinants of this discrimination or to ameliorate the F toxicity in goats (caprines) and sheep (ovines) the present study was again undertaken.

For the study, three tribal villages, viz. Fatehpura, Devala and Dhunda of Aspur Panchayat Samiti of Dungarpur district of Rajasthan were selected as they have F concentration in the range of 1.5–3.5 ppm in drinking water sources (hand pumps and dug wells[15]). Osteodental fluorosis was observed[8,9] in native mature and immature goats and sheep, who had been in these villages since birth. For this house-to-house surveys were made in the early morning and late evening hours when the animals are available, and in herds during the day times. Simultaneously, cattle and buffaloes of these areas were also examined for chronic F intoxication for further evidence of endemic F toxicity in these villages and also for comparison of its severity. In these animals F estimation in urine and blood was not made. Findings on osteodental fluorosis were based on clinical signs only. However, goats showed relatively higher prevalence of these chronic F effects as compared to sheep.

Among 229 mature goats and sheep and 112 bovines, 43 (19.0%) and 78 (70.0%) respectively were found to be afflicted with dental fluorosis (Figure 1 *a–d*). Among these, bovines showed relatively high (37.5%) incidence of skeletal fluorosis as compared to their counterparts (Table 1). Immature bovines also showed relatively a high (87.5%) incidence of dental fluorosis. None of the immature caprines and ovines revealed evidence of dental and skeletal fluorosis. In general, prevalence and severity of osteodental fluorosis in these small ruminants were found relatively less in comparison to bovines.

It is well known that F toxicosis is greatly varied between individuals, places and species living in the same F endemic areas and its severity is also influenced by several factors or determinants besides concentration, exposure and frequency of F intake[8,14]. In both mature and immature goats and sheep the severity of F toxicity is relatively less. It indicates, besides the F factor in drinking water, other factors are also involved to counteract or ameliorate the F effects which are present naturally in their foods or food chains. Caprines and ovines always feed on small delicate fresh leaves, pods and small fruits of trees and shrubs. In areas studied the most common trees and shrubs are ber (*Ziziphus jujube*, *Z. mauritiana* and *Z. nummularia*), khejri (*Prosopis cinearia*), vilayati babool (*P. juliflora*), babool (*Acacia nilotica*),

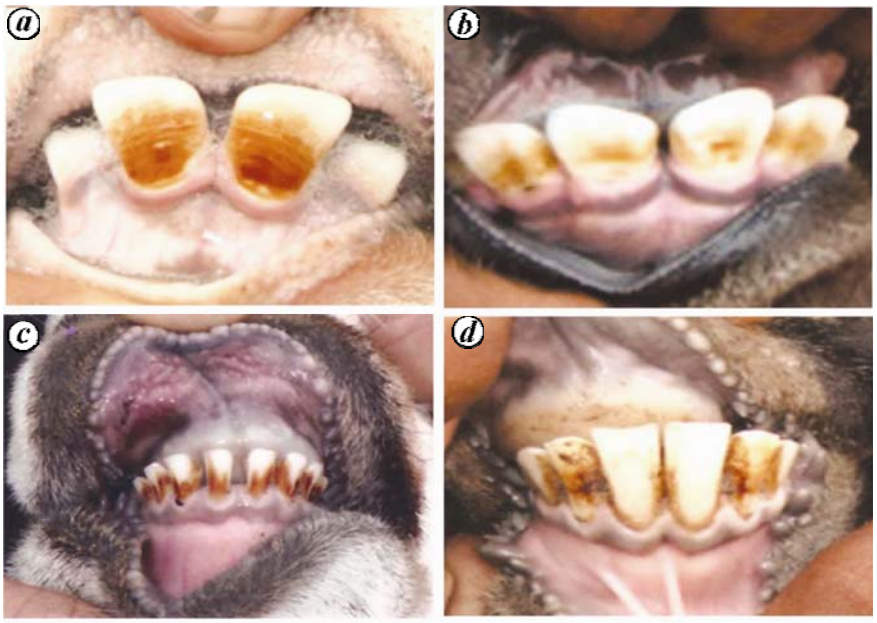

Figure 1. Different forms and severity of dental fluorosis in domesticated animals. Bilateral, regular, horizontal and striated deep yellow pigmentation on mandibular incisor teeth of calf of (***a***) cattle (one and half month age) and (***b***) buffalo (< 2 months age) but irregular, vertical and non-striated light to deep yellow pigmentation on mandibular front teeth appeared in mature/old (***c***) goat and (***d***) sheep animals.

Table 1. Prevalence of dental and skeletal fluorosis in goats, sheep and bovines of F endemic areas of Dungarpur district of Rajasthan, India

Animal	No. of animals examined	Dental fluorosis	Skeletal fluorosis
Mature animals			
Goats (>1 year)	132	27 (20.0)	16 (12.1)
Sheep (>1 year)	97	16 (16.5)	9 (9.2)
Bovines (>3 years)	112	78 (70.0)	42 (37.5)
Immature animals			
Goats (< 1 year)	14	NF	NF
Sheep (< 1 year)	11	NF	NF
Bovines (< 3 years)	18	15 (87.5)	3 (17.0)

NF, not found; Figures in parantheses indicate percentage.

kher (*Acacia senegal*), kikar (*Pithecellobium dulce*), anjeer (*Ficus carica*), bargad (*F. bengalensis*), pipal (*F. religiosa*), thapadia thore (*Opuntia dellenii*), thore (*Euphorbia cadusifolia*), imali (*Tamarindus indicus*), etc. on which these animals depend for their food. Edible parts; leaves, pods and small fruits of these plants are very rich in calcium (Ca) and ascorbic acid (vitamin C) nutrients[16–23]. Both these nutrients interfere with the F metabolism and ultimately reduce the F toxicity[1,2,24,25]. Similarly, in camels F toxicity is also less due to high content of Ca and vitamin C nutrients in their natural foods or food chains[10]. However, reversibility of dental fluorosis by supplement of Ca and vitamin C in humans is still controversial, but its further advancement can be checked[13]. This indicates that both these nutrients counteract or ameliorate F effects. Furthermore, immature animals have greater sensitivity and susceptibility and less tolerance to F[8,14], but none of the immature goats and sheep studied was found to be afflicted with dental and skeletal fluorosis. It can be concluded that goat and sheep are protected naturally from F toxicity due to the presence of ample calcium and vitamin C nutrients in their feed. However, difference in the prevalence of osteodental fluorosis between goats and sheep is due to difference in sensitivity to toxic effects of F and in the frequency of F intake. Sheep are well adapted to desert ecosystem and require relatively less water for their survival. Hence they have less and irregular F exposure resultant to lower F toxicity as in the case of dromedary camels[10].

The significance of the present study is that it reports evidence for natural chronic F intoxication or fluorosis in goats and sheeps and findings are useful in control of fluorosis in both man and animals. These findings contribute significantly to our knowledge of F toxicosis in animals. However, more surveys in different areas having different F levels in their drinking waters involving a large number of mature and immature goats and sheep are required. It is also recommended that during the identification of skeletal fluorosis in these animals signs of non-skeletal fluorosis such as gastrointestinal discomforts, neurological disorders, teratogenic effects and impaired reproductive functions[7,10] should be noted for further confirmation of F toxicosis. Indeed, diagnosis of skeletal fluorosis in goats and sheep is not as easy as in other domestic animals (cattle, buffaloes, horses, donkeys and camels).

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