

Why desert camels are least afflicted with osteo-dental fluorosis?

Prolonged consumption of fluoride through drinking water and food can result in dental mottling (dental fluorosis) and bone deformities (skeletal fluorosis) in both man^{1,2} and animals^{3,4}. In animals, skeletal fluorosis often diminishes mobility as a result of bone damage due to exostosis, osteosclerosis and osteoporosis and osteophytosis⁵. In addition to these osteal abnormalities, non-skeletal disorders like gastro-intestinal disturbances, neurological disorders, reproductive dysfunctions, apoptosis, excitotoxicity, genotoxicosis and teratogenic effects have been observed in fluorosed domestic and experimental animals⁶.

In India, Rajasthan is among the few states that has relatively high fluoride content in its groundwater in all the districts⁷. Extensive work has been carried out earlier on natural fluoride intoxication in the form of dental, skeletal and non-skeletal fluorosis on different species of domestic animals, viz. cattle (*Bos taurus*), buffaloes (*Bubalus bubalis*), donkeys (*Equus asinus*), horses (*Equus caballus*), dromedary camels (*Camelus dromedarius*), sheep (*Ovis aries*) and goats (*Capra hircus*), living in humid areas with varying fluoride levels in the drinking water^{8,9}. Results of these studies indicate that grazers (bovines and equines) are severely afflicted by fluoride toxicity when compared to browsers (sheep, goats and camels). An earlier study had reported prevalence of dental mottling in camels living in areas with high fluoride content in drinking water, but the study had a low sample size^{10,11}. The present study was therefore initiated in order to determine the prevalence and severity of osteo-dental fluorosis in dromedary camels.

The study was carried out between 2011 and 2012 in three villages (Badopal, Paliwala and Thakruwala) of Hanuman district and six villages (Bhompura, Kinkrawali, Lalgargh, Morzonda, Nathawali and Panswarsar) in the Sriganganagar district in the Thar Desert in western Rajasthan. The fluoride levels in the drinking water sources (groundwater) in these areas have been reported to be between 2.0 to 5.7 ppm (ref. 12). Pathogenomonic signs for dental and skeletal fluorosis were examined among 194 adult (>5 years old) and 43 juvenile/sub-adult (<5 years) dromedary camels. It

was also verified that the camels examined were born and raised in the same village that was being surveyed. House-to-house surveys were conducted in the mornings and evenings in the selected villages when the camel herds were present. Along with this, 210 adult and young bovines (cattle and buffaloes) and 218 local residents, including children were examined for signs of fluorosis to provide further support and evidence of chronic fluoride intoxication in the surveyed areas.

Results indicate that among the total adult and sub-adult camels examined, 13.8% and 9.3% respectively were found to be afflicted with mild to moderate forms of dental fluorosis (Figure 1a) and

10.2% and 2.3% from moderate forms of skeletal fluorosis. However, in bovines and humans the prevalence of osteo-dental fluorosis was found to be much higher and more severe than in camels (Table 1; Figure 1b and c). There also appears to be a difference in the appearance of dental fluorosis between camels and bovines. In bovines affected with dental fluorosis, the enamel of the anterior teeth was found to be striated with horizontal deep-brown stains, whereas in camels it was non-striated and vertical with homogenous light-brown stains.

Fluorosis affects all animal species, though the degree might vary depending on the influence other biological and non-biological factors have on an indi-

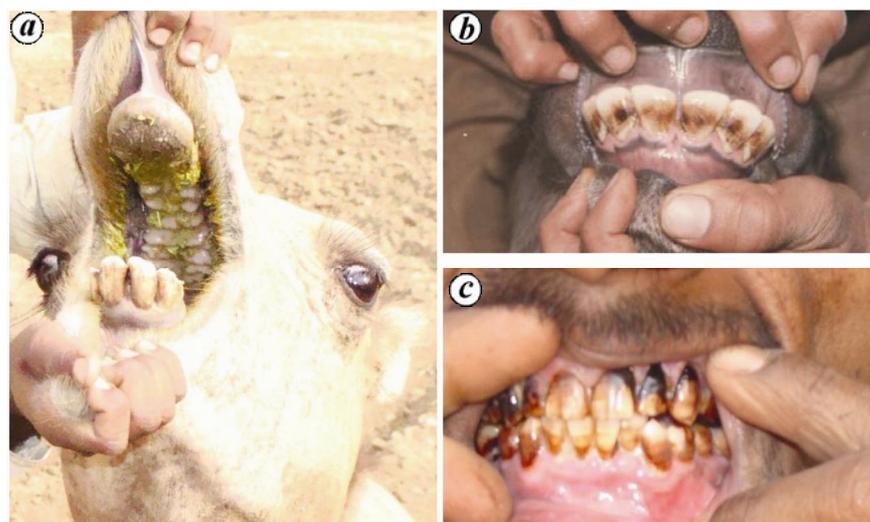


Figure 1. a, Moderate form of dental mottling in adult camel characterized by non-striated, light-brownish staining and abrasion of lower anterior teeth. b, Severe form of dental fluorosis in buffalo calf characterized by horizontal striated, deep-brownish staining of enamel of lower anterior teeth and recession and swollen gingiva. c, Severe form of dental fluorosis in young man characterized by horizontal striated, deep-brownish staining of enamel of upper and lower anterior teeth and recession and swollen gingiva.

Table 1. Relative prevalence of dental and skeletal fluorosis in camels, bovines and humans living in desert environment with fluoride in drinking water in the 2.0–5.7 ppm range

	Number examined	Adults exhibiting		Young/juveniles exhibiting	
		DF (%)	SF (%)	DF (%)	SF (%)
Camels	238	27/195 (13.8)	20/195 (10.2)	4/43 (9.3)	1/43 (2.3)
Bovines*	210	77/168 (45.8)	69/168 (41.0)	26/42 (61.9)	12/42 (28.5)
Humans	218	78/160 (48.7)	78/160 (48.7)	34/58 (58.6)	30/58 (31.0)
Total	666	182/523 (34.7)	167/523 (31.9)	64/143 (44.7)	43/143 (29.4)

*Indicates both cattle and buffaloes. DF, Dental fluorosis; SF, Skeletal fluorosis.

vidual^{4,5}. Young and juvenile animals are relatively more sensitive and highly susceptible to fluoride toxicosis than the adults^{13,14}. However, in the present study, a low prevalence of dental (2.3%) and skeletal (9.3%) fluorosis exists in camel calves, whereas the young individuals in bovines exhibited mild to severe intermittent lameness, restricted movement in hind legs, stiff tendons in the lags and wasting of mass in the hind quarters and shoulder muscles, snapping sounds from joints, lowering of neck while walking and diffused to well-marked periosteal exostoses on mandibular regions, ribs, metatarsus and metacarpus bones. With ageing, these symptoms were found to be more severe and conspicuous. From the above results, it can be concluded that desert camels are less susceptible to fluoride toxicosis compared to bovines and human beings. This is because camels are morpho-anatomically and physiologically adapted to arid environments characterized by high temperature and water scarcity. Camels are known to survive in hostile environmental conditions without having the need to drink water for more than 30 days¹⁵. They are also adapted physiologically to obtain and retain water from their food resources, which reduces the intake of fluoride-rich drinking water. Bovines and humans on the other hand, lack such adaptations. The severity of fluorosis has been found

to be directly proportional to the frequency of fluoride intake¹⁴. Another possible reason for camels being less susceptible to fluorosis might be because of the high amount of calcium and ascorbic acid (vitamin C) in their diet^{16,17} which neutralizes the effect of excess fluoride content^{1,18}. However, more studies are needed to arrive at any definite conclusion.

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SHANTI LAL CHOUBISA

Post Graduate Department of Zoology,
Government Meera Girls College,
Udaipur 313 001, India
e-mail: choubisasl@yahoo.com