Incidence of hydrofluorosis and its adverse effects on animal health in Durg district, Chhattisgarh

Water is the prime natural resource and physiological necessity for mankind. India is plagued with numerous water quality problems due to prolific contaminants mainly of geogenic (those from soil) origin[1] and also from increasing industrialization. Fluoride is one such chemical which is a major contaminant of groundwater in some parts of India. According to WHO[2], the safe fluoride level in drinking water is 1–1.5 ppm. Fluoride toxicity is increasingly becoming a matter of concern in many countries, which have been declared endemic for fluorosis. In the global scenario, 23 nations have the problem of hydrofluorosis[2]. In India, 20 states and Union Territories have fluoride-affected sectors[3]. Heavy economic losses in livestock occur in terms of reduced productivity and the animals survive in a precarious condition till death due to fluorosis[4]. Using these facts and unpublished data on fluoride concentration from Durg district, Chhattisgarh, the results from an environmental survey have been reported here.

A cross-sectional survey was undertaken with an objective to detect the status of fluoride in water samples during February and March 2011. There were 12 blocks in Durg district at the time of sampling. A total of 168 water samples (7 groundwater samples and 7 surface water samples from each block) were collected in clean polypropylene bottles of 100 ml capacity.

Fluoride concentration in the water samples was measured according to the standard method[5] with slight modification using Digital Ion Analyser equipped with a fluoride-selective electrode (Orion Research, Model 701A, Massachusetts). Briefly, the electrode was prepared by pouring the filling solution up to at least 2.5 cm above the level of sample in the polypropylene beaker. The quality control criterion was met using repeated standard solutions and slope determination[2]. Electrode operation (slope) was checked and the instrument was calibrated using 1 and 10 µg/ml fluoride standard solutions each time before estimation. For estimation of fluoride in water samples, 1.0 ml of water was mixed with 1.0 ml of total ionic strength adjustment buffer (TISAB) II in a polypropylene beaker and the electrode was placed inside. The reading was noted when it became stable.

The data obtained were subjected to *t* test for studying the significance of difference between fluoride level of groundwater and surface water in a block[6]. The results have been expressed as mean ± SE.

The results revealed that the fluoride content in surface water samples was significantly ($P \leq 0.01$) lower than the deep groundwater samples in all the blocks. Maximum fluoride concentration was observed in the Doundi block (13.2 ± 1.2 ppm). The fluoride concentration (mean ± SE) in water samples of Durg district ranged from 0.2 ± 0.02 ppm to 13.2 ± 1.2 ppm (Figure 1).

Based on the results and the prescribed maximum permissible limit (1.5 ppm) of fluoride in drinking water[2,7], the blocks have been classified into four categories, viz. low (0.1–0.6 ppm), medium (0.6–1.5 ppm), high (1.5–3 ppm) and very high (3 ppm and above; see Table 1).

During our survey several cases of dental and skeletal lesions were observed in livestock population of the localities having higher fluoride levels in water samples. The animals were handled for photography keeping the ethical points under consideration. There was excessive wearing of incisors giving a wavy appearance of table surface (Figure 2 *a*) along with varying degrees of brown discolouration and mottling of teeth (Figure 2 *b*) in cows, buffaloes and goats. Apart from dental lesions, skeletal lesions like bony exostosis from long bones, lameness and stunted growth were also observed. Besides these, there were problems related with reduced milk production, infertility, hoof deformity and decreased draught power in the domestic ruminants of the high fluoride areas. Similar findings have also been reported in the literature[3,8,9].

The results of the present study are in accordance with the previous report of endemic fluorosis in Tamnar area, Raigarh district, Chhattisgarh[9]. Beg *et al.*[9] recorded high fluoride in water sample in nearly 18% of the sampled wells, with the highest value of 8.8 ppm, which they considered to be geogenic. The concentration of fluoride in 80% of the total 180 groundwater samples in Agra district of Uttar Pradesh, was found to be between 0.1 and 14.8 ppm (ref. 7).

Additional factors causing variation in fluoro-toxicosis in the animal population and augmenting the prevalence and severity involve age, health, stress and biological response of individuals, the local environment (temperature and humidity) and other dissolved salts in drinking water[10].

Higher concentration of fluoride in most blocks of Durg district might be due to geogenic contamination. The weathering and leaching process by percolating water in soil belts plays an important role in the occurrence of fluoride in groundwater. In addition, the very high fluoride level in Durg block may

Table 1. Categorization of the blocks in Durg district according to the permissible range of fluoride concentration in drinking water

Category	Class and range of fluoride concentration (ppm)	Block	
		Surface water	Groundwater
Less than permissible range	Low (0.1–0.6)	Bemetara, Saja, Navagarh	Nil
Permissible range	Medium (0.6–1.5)	Berla	Bemetara
Greater than permissible range	High (1.5–3)	Gurur, Doundi	Navagarh, Saja, Berla
	Very high (3 and above)	Patan, Balod, Durg, Gunderdehi, Dhandha, Doundi-Lohara	Gurur, Patan, Balod, Doundi-Lohara, Dhamdha, Durg, Gunderdehi, Doundi

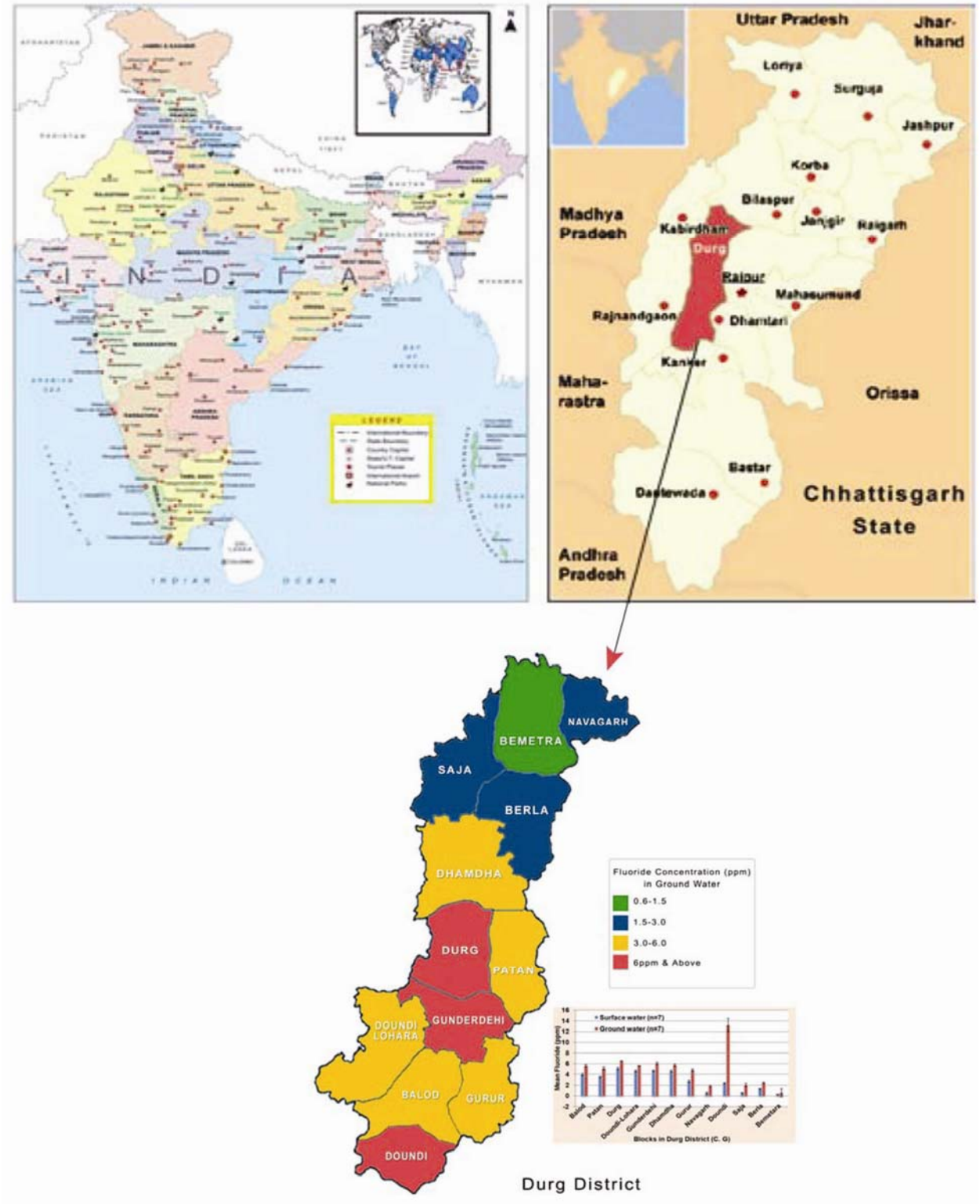

Figure 1. Map of the study area, i.e. Durg district, Chhattisgarh and concentration of fluoride in different blocks of the district.

also be due to contamination from industries, phosphate fertilizer factory and the brick kilns[11]. Perusal of the available literature also shows that high fluoride concentration in groundwater is largely governed by the presence of Ca, Mg, Na, SiO_2, PO_4, pH and alkalinity of the Earth's crust[9,12,13].

It can be concluded that Durg district possesses significantly higher levels of fluoride in its water resources. Validation of some useful defluoridation methods

Figure 2. ***a***, Excessive wearing of incisors giving a wavy appearance of table surface in a 6-year-old cow. ***b***, Brown discolouration and mottling of teeth in a cow.

needs to be carried out. Moreover, additional epidemiological study of fluoride-affected animal population of Chhattisgarh aiming at surveillance of fluoride level in various body fluids of animals, soil, plants and water is also suggested.

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