

Original Research Article

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Effect of Drinking Water Having High F Level on Livestock Health in Mansa and Bathinda Districts of Punjab, India

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ABSTRACT

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Excessive intake of fluoride, mainly through drinking water is a serious health hazard affecting humans as well as livestock worldwide. According to previous researches, the South-western region of Punjab is endemic for hydrofluorosis and the fluoride concentrations beyond the standard level results in dental and skeletal fluorosis. This paper highlights the highest fluoride concentration in drinking water of Mansa and Bathinda districts of Punjab which comes under the South-Western region of Punjab. A total of 220 water samples from 7 villages of Mansa and 3 villages of Bathinda were collected and analysed for F level. It was found that 44.6% water samples from Mansa and 36.2% water samples from Bathinda were having F level above permissible limit (i.e. >1.5 ppm). The highest F level in the drinking water found in Ghele (6.21 ± 0.64) and Gheri (4.1 ± 0.45) village of Mansa and Bathinda district respectively. The clinical manifestations observed in the livestock were dental mottling and lameness in such areas. In village Ghele of district Mansa 25.6% of the dairy animals manifest dental mottling whereas 51.6% of animals showed skeletal fluorosis. Similarly, in Gheri village of district Bathinda, maximum cases of dental mottling (52.6%) and lameness (39.8%) was found in livestock. Besides that, the significant positive correlation of F was observed with water pH and alkalinity was observed.

Introduction

Water is frequently referred as a universal solvent, because of its ability to dissolve almost all substances that comes in its contact. Some elements are essential in trace amount for human being as well as animals while higher concentration of the same can cause toxic effects. Fluoride is one of them which is 13th prevalent naturally occurring element in earth's crust. Since it is most electronegative of all chemical elements, it rarely exists in

elemental form. As the ground water passes through the fluoride rich rocks, it carries fluoride with it, hence most of the fluoride is found in ground water than surface water.

Excess intake of F results in fluorosis which is a chronic condition affecting both humans and animals and is endemic in many parts of the world including India (Khandare *et al.*, 2005). In India, fluorosis is essentially hydrofluorosis and is endemic in parts of Punjab, Haryana, Rajasthan, Bihar, Madhya Pradesh, Orissa and

Andhra Pradesh having high F levels in underground water, soils and forages (Randhawa and Singh 2010). It is observed that fluorosis is most common in south-western sub-region of Punjab, which covers Mansa, Bathinda, Muktsar and parts of Ferozpur districts. Ground water of these regions is highly saline and alkaline and livestock in these areas is highly susceptible to fluorosis.

The hazard for livestock may arise from excessive fluorine from mineral supplements, in contaminated forages by certain industrial processes, in drinking water, in feed concentrates. World Health Organization (1994) has set the upper limit of F concentration in drinking water at 1.5mg/l and the Bureau of Indian Standards (BIS), has therefore laid down Indian Standards as 1.0 mg/l as maximum permissible limit of F with further remarks as “lesser the better” (Arlappa *et al.*, 2013). Water F concentration above 1.5ppm, have been reported to cause osteo and dental fluorosis in a wide range of domestic animals (Modasiya, 2014).

Calcification of certain ligaments rendering movement of joints difficult, is usually associated with at least 10mg/l of fluoride in drinking water (Koli *et al.*, 2017). According to (Sharma *et al.*, 1995) fluoride content in drinking water of fluorotic areas ranges from over 1-9 ppm as compared to 0.4-0.8 ppm in non-fluorotic areas of Punjab.

Fluorine gets deposited in skeletal tissues and produce osteo-fluorotic lesions characterized by overt dental and bone lesions, lameness, deformed hooves, anemia, loss of body condition and emaciation. Higher intake of fluoride via ingestion or inhalation from a variety of sources is toxic to humans as well as animals leading to dental, skeletal and non-skeletal fluorosis (Shahab *et al.*, 2017). The bone lesions are associated with excessive

mobilization of Calcium (Ca) and Phosphorous (P) to compensate for their increased urinary excretion in conjunction with fluorine (Radostits *et al.*, 2007). Being a strong electro-negative ion, F interacts with many other cations like Magnesium (Mg), copper (Cu) and Zinc (Zn) and affects their metabolism negatively. Diagnosis can be done by screening feed and water samples, blood as well as urine sample for F content.

Materials and Methods

The study was conducted in Mansa and Bathinda districts of South-western region of Punjab with the objective of identification of villages of Mansa and Bathinda districts where animals were consuming water with high F concentration. The drinking water was evaluated for the F concentration in the F endemic areas of Punjab.

The research work was carried out in the Department of Veterinary Medicine, Department of the Veterinary Public Health and Epidemiology in the College of Veterinary Science and Department of Aquaculture in the College of Fisheries Science, Guru Angad Dev Veterinary and Animal Sciences University, (GADVASU) Ludhiana, Punjab.

The epidemiological Survey was conducted in 7 villages of Mansa and 3 villages of Bathinda districts of Punjab. The total of 220 drinking water samples was collected from these villages for estimation of fluoride level in drinking water.

Sample collection

Approximately 200 ml of drinking water meant for livestock was collected in the acid washed plastic bottles and stored at room temperature till further analysis and estimated for fluoride concentration, pH and alkalinity.

Method of estimation for fluoride: Digital ion analyser along with Fluoride selective Electrode.

Method of estimation for pH: Professional multi parameter bench top pH meter (AD8000 laMotte, USA).

Method of estimation for alkalinity: Titration method.

Statistical analysis

The data was analysed by using SPSS (Statistical Package for Social Sciences) for Window version 16.0[®]SPSS Inc. USA computer software program. The mean values of various parameters were calculated and presented along with respective standard errors and ranges. Correlation analysis was also calculated, using SPSS (Statistical Package for Social Sciences) for Window version 16.0[®] SPSS.

Results and Discussion

On the basis of survey, it was found that the ground water was the major source of drinking water for livestock in the form of tube well and hand pump water in villages of Mansa and Bathinda districts. In two villages namely, Sardulewala and Mussa in Mansa district, surface water in the form of tap water was used as an alternate source of drinking for livestock. Like many parts of the country, the tradition of animals having water from the village pond was not observed in the area of present studies.

Fluoride (F) level in drinking water for livestock

The overall range of F concentration in drinking water for livestock in Mansa and Bathinda were found to be 0.1-10 and 0-10 ppm respectively as presented in Table 1 and

2. The critical limit of F in drinking water is 1.5 ppm for livestock. The mean concentration of F in the drinking water of village Gehle in district Mansa was 6.21 ± 0.64 , with values ranging from 3-10 ppm. In this village 25.6% of the dairy animals manifest dental mottling whereas 51.6% of animals also showed skeletal fluorosis as well (Fig. 3). Similarly, in Bathinda district highest mean F in drinking water was found in Gheri village (4.1 ± 0.45), ranging from 0-10 ppm and subsequently, maximum cases of dental mottling (52.6%) and lameness (39.8%) in livestock was found in this village (Fig. 1, 2 and 4). Similar observations of presence of hydrofluorosis was reported by (Singh, 2012) in drinking water of Mansa, Bhikhi, Budhlada, Jhunir and Sardulgarh blocks in Mansa district.

Similarly, Sharma *et al.*, (2014) revealed high F level in drinking water of Faridkot and Bathinda districts of Punjab. Their findings suggest that these areas possess significantly higher levels of F in its water sources. Samel *et al.*, (2016) suggested that deleterious effects due to chronic fluorosis are mostly irreversible.

The higher F concentration in the water can be of geogenic origin. The natural F in water is derived from solvent action of water on the rocks and soils of the earth's crust (Smith, 1983). Giri *et al.*, (2013) revealed that the weathering and leaching process by percolating water in soil belts plays an important role in the occurrence of F in groundwater. Chatterjee *et al.*, (2008) and Keesari *et al.*, (2007) suggested that high F in ground water may be due to leaching from fluoride-rich rocks present in the subsurface as well as due to anthropogenic activities. Several other workers (Beg *et al.*, 2011 and Sharma *et al.*, 2004) reported that high F levels in groundwater were largely governed by presence of Ca, Mg, Na, SiO₂, PO₄, pH and alkalinity of the earth's crust.

Table.1 Epidemiological survey of hydrofluorosis in livestock in district Mansa, Punjab

Name of the village		Hydrofluorosis (ppm)	Source of drinking water (%)			Clinical symptoms (%)			
			Hand pump	Tube well	Tap water	Dental mottling	Lameness	lameness + dental mottling	Healthy
Budhlada (N=8)	Mean ± SE	1.40±0.78	75	23	-	-	25	-	75
	Range	0.10- 5							
Ghele (N=14)	Mean ±SE	6.21±0.64	42.9	57.1	-	19.2	41.3	16.7	22.8
	Range	3-10							
Gagowal (N=5)	Mean±SE	2.90±1.18	20	80	-	-	35.5	-	64.5
	Range	0.5-7							
Makha (N=17)	Mean±SE	3.64±0.36	23.5	76.5	-	26.5	38.6	8.7	26.2
	Range	2-6							
Sardulewala (N=50)	Mean±SE	0.31±0.01	68	-	32	-	-	-	100
	Range	0.1-1.2							
Mussa (N=3)	Mean±SE	0.43±0.06	-	-	100	-	-	-	100
	Range	0.3-1.2							
Sardulgarh (N=13)	Mean±SE	3.23±0.64	23.07	76.9	-	4.5	14.3	19.1	62.1
	Range	2-9							

Table.2 Epidemiological survey of hydrofluorosis in livestock in district Bathinda, Punjab

Name of the village		Hydrofluorosis (ppm)	Source of drinking water (%)			Clinical symptoms (%)			
			Hand pump	Tube well	Tap water	Dental mottling	Lameness	Lameness + dental mottling	Healthy
Mehraj (N=47)	Mean ±SE	1.36±0.35	42.6	57.4	-	-	17.1	-	82.9
	Range	0-2							
Kotshmair (N=30)	Mean ±SE	0.54±0.05	26.7	73.3	-	-	-	-	100
	Range	0-1.5							
Gheri (N=33)	Mean ±SE	4.1±0.45	30.3	69.07	-	44.2	24.6	23.6	7.6
	Range	0-10							

Table.3 Coefficient of correlation between Fluoride (F) with pH and alkalinity of drinking water

Variables		r value	
		Mansa	Bathinda
Fluoride	pH	0.21*	0.20*
	Alkalinity	0.594**	0.283**

**Correlation is significant at the 0.01 level.

*Correlation is significant at the 0.05 level.

Fig.1 Lameness and poor body condition



Fig.2 Dental mottling



Fig.3 Clinical manifestation of livestock in district Mansa, Punjab

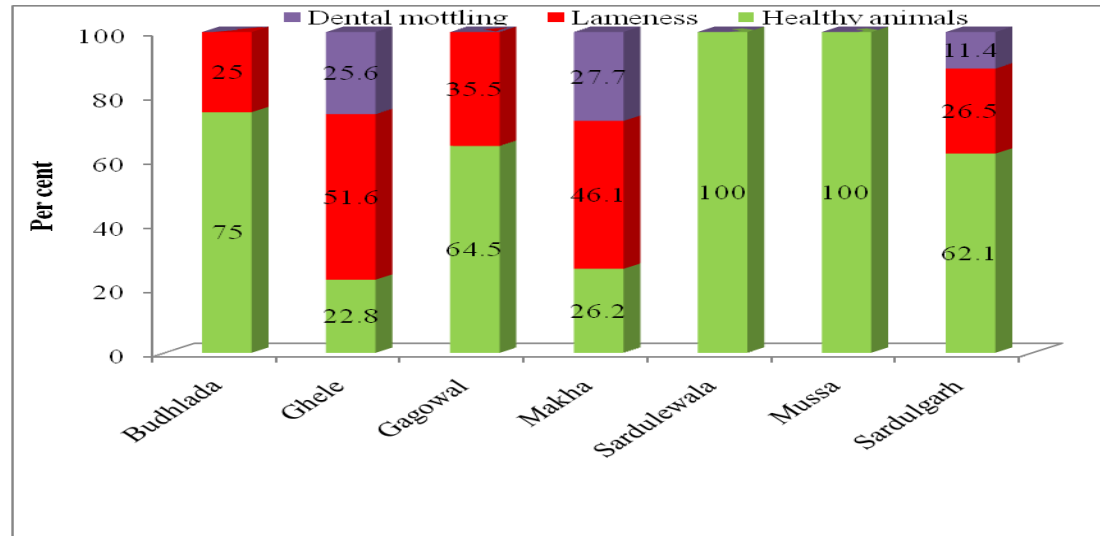
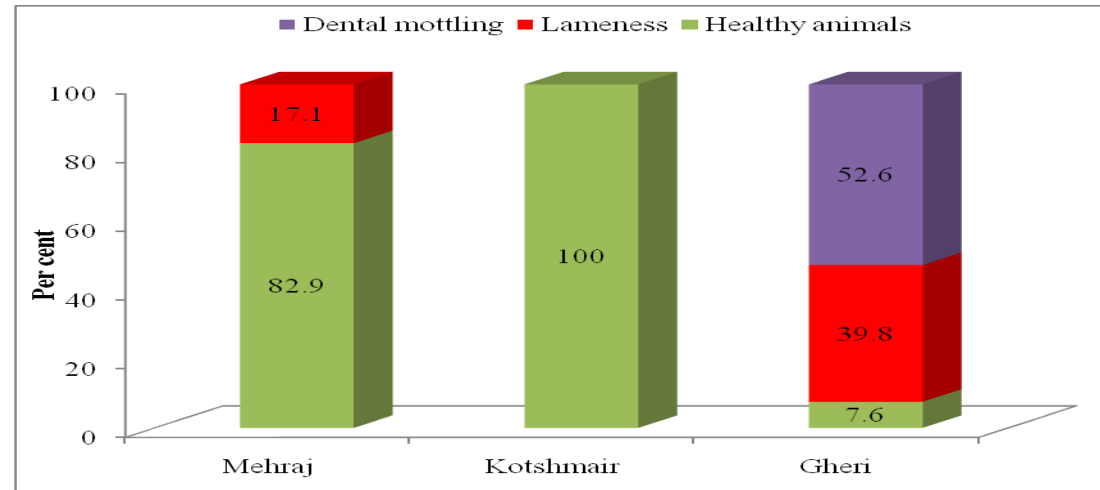


Fig.4 Clinical manifestation of livestock in district Bathinda, Punjab



Positive correlation of F with pH and alkalinity in drinking water for livestock in Mansa and Bathinda districts, Punjab

In the present study it was found that there was a significant positive correlation of F with pH and alkalinity of drinking water in Mansa and Bathinda districts of Punjab (Table 3). Alagumuthu and Rajan (2008) has also observed a positive correlation between F and pH of ground water in Kadayam block of Tirunelveli district, Tamilnadu. Similarly, Nouri *et al.*, (2006) reported the significant positive correlation between F content and alkalinity of groundwater in Iran. The positive correlation between alkalinity and F levels may be due to release of hydroxyl and bicarbonate ions simultaneously during the leaching and dissolution process of fluoride bearing minerals into water increases the F ion concentration with high levels of alkalinity as well. An alkaline environment of circulating water mainly facilitates leaching of F from the soils, contributing to high F containing groundwater (Rao and Devadas 2003). Fluorosis is the condition which is caused by intake of small but toxic amounts of fluoride in feed or drinking water over a long duration of time which is characterized by mottling of teeth and osteosclerosis of skeleton, lameness and is a serious health hazard for humans and animals. In India, fluorosis is endemic in many parts of various states including South-West Punjab where F content in the drinking water of the livestock in some areas is more than 6 times the permissible limits i.e 1.5 ppm. Thus, hydrofluorosis is a major problem in the ground water and is responsible for dental and skeletal fluorosis in the dairy animals.

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