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Effect of chronic fluoride toxicity on blood parameters of cattle and buffaloes in brackish water zone of Punjab, India

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Abstract

Chronic fluoride intoxication is a worldwide health problem in humans and animals. The present research work was aimed to assess the effect of fluorosis on blood parameters of fluorotic cattle and buffaloes in brackish water zone of Punjab. The study was conducted in villages of district Muktsar, a brackish water zone, of Punjab state. Cattle(n=103) and buffaloes (n=42) showing signs of dental lesions or lameness, from the villages with water fluoride concentration more than 1 ppm, were selected for the study whereas cattle (n=98) and buffaloes (n=48) from villages with water fluoride concentration less than 1 ppm and with no clinical signs served as control. Blood samples collected from both the groups were analysed for blood parameters viz., haemoglobin (Hb), total erythrocytic count (TEC), total leucocytic count (TLC), packed cell volume (PCV) and erythrocytic values viz., mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). Lower haematological values were observed in cattle from hydrofluorotic areas, except MCV. Comparison among the two groups revealed significant variation in PCV and MCV and non-significant variation in Hb and TEC. Similarly, lower haematological values were observed in buffaloes from hydrofluorotic areas though the variations in all the haematological parameters were non-significant. Present study indicated anaemia in animals of fluorotic region and such changes might have occurred due to decrease in erythropoietic activity as a result of the damage to bone marrow and/or reduced blood folic acid activity resulting from prolonged exposure to increased fluoride concentration in serum.

Keywords: Blood parameters; Buffaloes; Cattle; Fluorosis.

Chronic fluoride intoxication is a worldwide health problem and is endemic in those areas where the fluoride content in drinking water is relatively high. Cattle and buffaloes reared in fluoride enzootic areas of India for a long time show clinical signs of osteo- and dental-fluorosis (Choubisa *et al.*, 2011). Mechanisms of chronic toxicity are not clearly understood. Many studies on fluoride intoxication in experimental and naturally affected animals have revealed alternation in blood minerals and blood parameters (Ranjan *et al*., 2008; Rao and Vidyunmala, 2010; Vinay *et al*., 2009) but there seems to have paucity of reports on the status of blood parameters of buffaloes and cows naturally affected with chronic fluoride toxicity in brackish water zone. Brackish water is water that has more salinity than fresh water, but not as much as seawater. Salinity of water and water logging are common problems especially in southwestern districts of Punjab (Rahi, 2011). The present research work was aimed to assess the status of blood parameters viz., haemoglobin, total erythrocytic count, total leucocytic count, packed cell volume and erythrocytic values viz., MCV, MCH and MCHC of fluorotic dairy animals in brackish water zone of Punjab.

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Materials and Methods

The study was conducted in villages of district Muktsar, a brackish water zone, of Punjab state. Fluoride concentration of drinking water of different villages was estimated and buffaloes of the region were examined for various signs of fluoride toxicity. The villages with water fluoride concentration more than 1 ppm and buffaloes showing signs of dental lesions or lameness were considered enzootic for fluorosis whereas villages with water fluoride concentration less than 1 ppm and buffaloes with no clinical signs were considered fluorosis free.

For the estimation of Hb, PCV, TEC and TLC two ml of blood was collected in plastic vials containing K_3 EDTA as anticoagulant from buffaloes (n=42) and cattle(n=103), showing signs of fluorosis, in heparinised mineral free glass vials. Similarly, blood samples were collected from apparently healthy buffaloes (n=48) and cattle (n=98) reared in villages free from fluorosis, with no signs of fluorosis, to serve as control. Red cell parameters

of haemoglobin was estimated by cyanomethaemoglobin method, PCV by microhematocrit, TEC, TLC and erythrocytic values viz., mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) were calculated as per standard methods (Marjory et al., 2022).

F levels in plasma and water samples were estimated by using Digital Ion-analyzer (Orion 4 Star pH. ISE Benchtop) equipped with fluoride specific electrodes. The statistical significance of the differences among mean was compared by using SPSS for Windows (version 16.0; Microsoft).

Results and Discussion

South-western region of Punjab in India is known for its brackish water and high fluoride content in underground water (Sharma *et al*., 1995). In the present study, high water fluoride concentration was recorded in hydrofluorotic block (1.447 ± 0.03 ppm) of the district whereas lowest concentration (0.727 ± 0.004 ppm) was recorded in non-hydrofluorotic block (Fig. 1). Intake of fluoride from water led to high plasma fluoride in cattle and buffaloes of the region. Significantly higher fluoride concentrations were observed in cattle and buffaloes of fluorotic region in comparison to healthy control animals (Fig. 1).

Mean Hb, PCV and TEC values were lower in cattle of hydrofluorotic region in comparison to healthy control animals (Table 1) whereas MCV concentrations were significantly higher in the former group. Comparison among the two groups revealed significant variation in PCV and MCV and non-significant variation in Hb and TEC. Similarly, lower haematological values were observed in buffaloes from hydrofluorotic areas though the variations in all the haematological parameters were non-significant (Table 1).

Variations in fluoride concentrations from block to block may be due to various causes for such variations such as use of phosphate fertilizers, different geo-chemical conditions. Moreover, fluoride concentrations were also reported to increase with salinity (WHO, 2002). Serum fluorine reflects the fluorine status of current diet rather than cumulative effect of fluorine exposure (Suttle, 2010).

Significant decrease in PCV was observed in cattle from hydrofluorotic region in comparison to those from non-hydrofluorotic regions. The decreased hematocrit levels may be attributed to decrease in size of erythrocytes due to stressful conditions (Soivio *et al*., 1974). Varying degrees of anaemia had been reported in fluorotic mice, cattle and humans (Machalinski, 2000; Rao and Vidyunmala, 2010; Sharma *et al*., 1995). Anaemia in fluoride intoxication might have occurred due to decrease in erythropoietic activity as a result of the damage to bone marrow resulting from prolonged exposure to increased fluoride concentration in serum (Wheeler & Fell, 1983). Reports have also shown disorders in human hematopoietic progenitor cells due to fluoride toxicity (Machalinski *et al*., 2000).

In the present study, increased total leucocytic count has been observed in both cattle and buffaloes. This increase in TLC might have occurred as fluoride being a foreign body evoked the immune response through the lymphocytes (Kumari and Kumar, 2011).

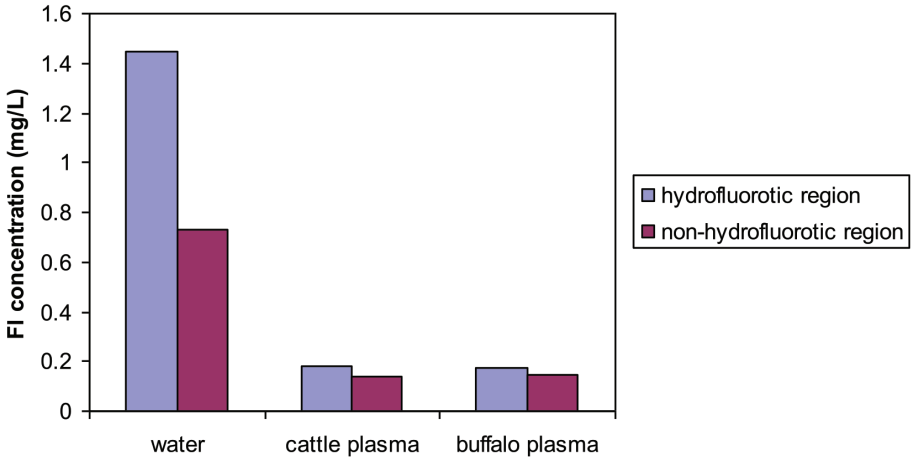

Fig. 1. Water and plasma fluoride levels

Table 1. Haematological values in cattle and buffaloes from hydrofluorotic and non- hydrofluorotic areas of Muktsar district

Parameter	Cattle Non Hydrofluorotic area (N= 98)	Cattle Hydrofluorotic (N= 103)	Buffaloes NonHydrofluorotic area (N= 48)	Buffaloes Hydrofluorotic area (N= 42)
Hb (g %)	9.44 ± 0.14	9.13 ± 0.21	11.11 ± 0.24	11.00 ± 0.27
PCV (%)	25.60 ± 0.39	24.22 ± 0.57 *	30.22 ± 0.75	28.62 ± 0.69
TEC (x 10^6/µl)	6.06 ± 0.10	5.93 ± 0.14	6.60 ± 0.18	6.30 ± 0.16
MCV (fl)	40.72 ± 0.56	42.23 ± 0.45*	45.17 ± 1.08	45.21 ± 0.68
MCH (pg)	15.55 ± 0.22	15.91 ± 0.17	17.82 ± 0.41	17.75 ± 0.31
MCHC (g/dl)	37.80 ± 0.19	37.31 ± 0.14	38.58 ± 0.29	38.70 ± 0.21
TLC (× 10^3 µ/L)	8.44 ± 0.27	8.83 ± 0.25	9.38 ± 0.27	9.74 ± 0.35 **

* Significant difference ($P < 0.05$)
** Significant difference ($P < 0.01$)

Increase in MCV was recorded in the cattle and buffaloes of hydrofluorotic region and it might be due to the fact that one of the adverse reactions of fluoride consumption known to occur in cells and tissues is reduced blood folic acid activity (Susheela, 2010) and elevation of MCV is the earliest sign of folic acid deficiency (Aslinia *et al*., 2007).

Thus, it can be concluded that chronic fluorosis has adverse effects on various blood parameters in dairy animals and such changes might have occurred due to decrease in erythropoietic activity as a result of the damage to bone marrow and/or reduced blood folic acid activity resulting from prolonged exposure to increased fluoride concentration in serum.

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