The Pharma Innovation Journal 2018; 7(11): 215-217

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(11): 215-217

www.thepharmajournal.com
Received: 13-09-2018
Accepted: 17-10-2018

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A demographic study on cadmium level in blood of bovine

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Abstract
Cadmium (Cd) concentration in blood of bovine was studied in different areas of Jabalpur city, Madhya Pradesh, India. Total of 65 blood samples were collected from three different zone i.e. industrial, urban and rural areas of the city. All the samples were acid digested and Cd concentration was detected by using ICP-OES. As a result toxic concentration of cadmium observed in all blood samples. Demographically, significant difference was observed into cadmium concentration. Quite significant percentage of bovine blood samples were exposed with high toxic level of Cd concentration. No Statistical significant difference observed in Cd concentration in relation to species, sex and age of bovine.

Keywords: Cadmium, Toxic pathology, Blood, Bovine, ICP-OES

1. Introduction
Cadmium is a universal cause of toxicity in domestic animals throughout the world. It affects all domestic animals including bovine, horses, birds/poultry and dogs, amongst them, cattle are considered to be one of the most susceptible. Human activities spreading the cadmium widely throughout the environment including air, water, soil, plants, animals and humans as well. Cadmium concentration affects cattle of all ages and is a multi-systemic toxin affecting mainly the hepatic, renal and reproductive systems in the body (Patrick, 2003 and EFSA, 2009) [5, 12].
Animals may gain access to excess of cadmium from phosphate fertilizers and sewage water in agriculture soil and vegetation contaminated with industrial and automobile emissions. Cattle reared near the industrial area had approximate five times higher blood and tissue cadmium level (Patra *et al*., 2005 and Darwish *et al.,* 2015) [3, 11].
Jabalpur region of Madhya Pradesh has various defence activities like Ordinance Factory and Vehicle Factory which are manufacturing/ using the raw materials containing cadmium. Phosphate mixed fertilizers and sewage water also exist as a nonstop causes of cadmium augmentation which makes the city prone for cadmium pollution. Recent studies by the workers have pointed increased level of heavy metals in different water bodies and bovine reared around the Jabalpur region (Singh *et al.,* 2013 and Anil, 2017) [1, 14].

2. Materials and methods
2.1 Collection of blood samples
10 ml of blood was collected aseptically from the jugular vein of 65 bovine which were reared near the high ways as well as various industrial, urban and rural areas (Table 1). These samples were transferred into heparin coated vacutainers for cadmium detection.

Table 1: Details of blood sample collection

Area	Buffalo	Cattle	Total
Area 1	08	14	22
Area 2	12	11	23
Area 3	05	15	20
Total	25	40	65

Area 1, comprises the industrial area, Area 2 comes under urban areas and Area 3 comprises the rural areas.

2.2 Processing of blood for estimation of cadmium level

Blood samples were acid digested, briefly, 1.5 ml of blood sample taken into a conical flask and mixed with 6 ml of concentrated HNO_3 and 2 ml of hydrogen peroxide. The mixture was transferred to microwave digestion tubes and digested in Microwave digester (ETHOS UP) for 45 minutes. The digested sample was rinsed with distilled water and the volume was made upto 10 ml. The samples transferred to 25 ml tarson tubes and stored at -20 ºC till further analysis of cadmium level (Welna *et al*., 2011) [16].

2.3 Estimation of cadmium by inductively coupled plasma optical emission spectroscopy (ICP-OES)

Inductively coupled plasma optical emission spectroscopy (ICP-OES) (Thermo scientific; iCAP 7000 series) was used for the estimation of cadmium in the samples. Argon flame was used as a fuel. Processed samples of blood and tissues were thawed to room temperature. Calibration of instrument was achieved with 6 standards of known concentrations (5, 10, 25, 50, 75 and 100 ppb) prior to analysis of unknown sample. Sample analysis was done by making work list in attached computer. Concentrations of cadmium in the samples were obtained in ppb which further converted to ppm for data presentation. The below mentioned operating conditions was applied for estimation of Cadmium.

Product type	iCAP 7400 ICP-OES DUO
Gas	Argon
Wavelength (nm)	228.802
Acquisition parameter	Microelement, axial view
No. of wavelength selected	02
Sample uptake time	45 seconds
Standard (ppb)	5, 10, 25, 50, 75, 100

2.4 Statistical analysis

Data gathered from the study were tabulated and analyzed using statistical one way analysis of variance (ANOVA), followed by Fisher pair wise comparison as described by Snedecor and Cochran (1994) [15].

3. Results and Discussion

3.1 Blood cadmium level in cattle and buffalo

In the present study cadmium level observed all studied bovine blood samples. Cadmium level ranged from 0.099 to 0.685 ppm in cattle whereas in buffalo from 0.131 to 0.359 ppm in blood. High blood cadmium noted in present study, the observed mean value were above the minimum toxic dose of 0.040 ppm (Puls, 1994) [13]. Mean blood cadmium levels observed in our study are presented in Table 02.

Table 2: Mean blood cadmium level (ppm) in cattle and buffalo (Mean±SE)

Species	No. of animals	Blood cadmium level (ppm)
Cattle	40	0.260±0.017
Buffalo	25	0.259±0.012
Total	65	0.260±0.012

Similar to our findings various workers reported the high blood cadmium level in bovine. Lopez *et al.* (2000) [8] reported mean Cd concentrations of 0.37 and 0.45 µg/l in blood of cows. Patra *et al.* (2005) [11], observed mean cadmium level of 0.232±0.016 µg/ml from steel manufacturing plant. Dhaliwal and Chhabra (2016) [4] observed 0.12±0.02 ppm of cadmium level in blood samples of bovine and Nwidu and Ohemu (2017) [10] who recorded 0.111 to 0.984 ppm cadmium in abattoir cows.

3.2 Demographic distribution of blood cadmium level

In the present study blood samples were collected from different areas of Jabalpur. Statistical significant difference was recorded in blood cadmium level between the three studied areas. Significantly increased level of cadmium in blood samples of bovine from area 1 and area 2 were recorded as compared to the area 3 which is the rural areas of Jabalpur district (Table 03).

Table 3: Mean blood cadmium level (ppm) in bovine from different areas (Mean±SE)

Area	No. of samples	Blood Cadmium level (ppm)
Area 1	22	0.348^{a}±0.020
Area 2	23	0.256^{b}±0.007
Area 3	20	0.167^{C}±0.007

Means with different superscripts in column differed significantly (p<0.01)

The high cadmium level in blood of bovine reared near the highways, industrial and urban areas might be because of industrial and urban waste being channelized from these areas into the nearby water reservoirs and soils, which could have further contaminated the fodder. Considerably high cadmium content in soil, fodder and hay were reported near the polluted areas (Patrick, 2003) [12]. Comparatively lower level of blood cadmium in bovine from rural areas, might be because of their locations away from industrial, urban areas thus, minimizing the chances of contamination of environment with heavy metals and industrial wastes. Our finding were in relation with Lopez *et al.* (2000) [8], Miranda *et al.* (2001) [9], Patra *et al.* (2005) [11], Leonidis *et al.* (2010) [7], and Nwude *et al.* (2011), who also reported the high blood cadmium level in animals reared near various industrial and polluted area as compared to non-polluted area.

3.3 Cadmium level in bovine of different age and sex

In the present study we did not find any influence of age and sex in cadmium concentration of blood and visceral organ. Similar to our findings Patra *et al.* (2005) [11] did not find any effect of sex and age in blood cadmium level whereas Lopez *et al.* (2000) [8] reported high cadmium concentration in female than the male animals.

3.4 Distribution of cadmium level in blood of bovine

To understand the exposure of cadmium to the animals, blood cadmium level were classified under three category, where 31% of bovine blood samples had blood cadmium in low toxic range (0.04 to 0.19 ppm), 35% samples had moderate toxic cadmium concentration (0.20 to 0.29 ppm) and 34% blood samples had high toxic level of cadmium which was > 0.3 ppm (Table 04).

Table 4: Mean cadmium level (ppm) in blood of bovine (Mean±SE)

Groups		Blood cadmium level		
		N	%	ppm
Group I	Low (0.04 to 0.19 ppm)	20	31%	0.167^{a}±0.007
Group II	Moderate (0.2 to 0.29 ppm)	23	35%	0.256^{b}±0.007
Group III	High (>0.3 ppm)	22	34%	0.348^{c}±0.020

Means with different superscripts in column differed significantly (p<0.01)

High blood cadmium points toward recent exposure of cadmium as stated by ATSDR (1997) [2] and Jarup (2003) [6]. Being a cumulative poison, Cd bioaccumulate in animal, as evident by the exponential increment of blood cadmium level

in our study. Similarly toxic blood cadmium was reported by the various workers in India (Dogra *et al.*, 1996; Patra *et al.*, 2005; Swarup *et al.*, 2007; Patra *et al.*, 2008 and Dhaliwal and Chhabra, 2016) [4, 11].

4. Conclusion

In the present study alarmingly high cadmium concentration noted in blood of cattle and buffaloes. The concentration of cadmium was above the minimal toxic dose of 0.040 ppm as per the Puls criteria. High exposure of blood cadmium in industrial and urban areas points towards cadmium pollution, require the attention of society to avoid worsen situation near future.

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