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Lead and Cadmium in Raw Milk of Cow and Buffalo from Villages Adjacent to Rairu Industrial Area, Banmore, India

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Abstract

In the present study, heavy metal residual concentrations of *Cadmium* (Cd) and *Lead* (Pb) in cow and buffalo milk samples collected from 6 villages near Rairu Industrial area districts of Gwalior, M.P. state were determined from April 2018 to March 2019. Heavy metal (Cd and Pb) residues in milk samples were determined using the Atomic Absorption Spectrophotometer (AAS). The average (mg/l) of Pb and Cd in the milk of buffalo were found to be 0.003±0.002, 0.008±0.003, 0.02±0.005, 0.019±0.009, 0.024±0.013, 0.004±0.003 and 0.023±0.002, 0.017±0.001, 0.04±0.017, 0.036±0.011, 0.023±0.004, 0.005±0.01 from Zinavali, Niravali, Tilagana, Beelpura, Milavali and Banmore gaon respectively. Similar values for cow milk were 0.015±0.001, 0.002±0.001, ±0.012±0.002, 0.004±0.01, 0.017±0.01, 0.001±0.001, and 0.033±0.01, 0.039±0.011, 0.091±0.01, 0.055±0.009, 0.026±0.005, 0.003±0.002 from Zinavali, Niravali, Tilagana, Beelpura, Milavali and Banmore gaon respectively. The inter species comparison between cow and buffalo milk demonstrated that the higher Cd contents were reported in cow milk however Pb in buffalo milk. This was due to drinking of contaminated ground water from wells and bore-wells as well as water bodies.

Keywords: Milk; Lead; Cadmium; Ground water; Season

Introduction

Trace elements are categorized based on environmental pollutants owing the toxic effect on plant, animals as well as health of mankind through the food chain and food web. Phyto-accumulation is the method by which the plant absorbed heavy metals from the environment [1]. These plants are feed by the green fodder. Such types of plant are the major source of toxicity in animals. In the animal physiological system, trace elements entered through the feeds, green fodder, drinking water, and surface water. Food, milk, contaminated water, coal burning, cigarette is the most important source of cadmium [2-4], and it is interacted with many types of minerals mainly Zn, Fe, Cu, Se, Mn due to the chemical similarities and completion for binding stage. Food is one of the principle environmental sources of cadmium [5]. Lead (Pb) and Cadmium (Cd) are considered as the common form of poison for farm animals due to the natural curiosity, licking habits, and lack of oral discrimination in the domestic animals [6]. Due to intake of smaller amount leads to their higher accumulation in tissues, bones, blood significantly enhanced excretion in milk, their food and food products [7-9]. Milk is produced by the epithelial cells of mammary gland of lactating cattle. Milk secretion depends upon the blood flow and the composition and uptake of blood constituents by the mammary gland [10]. Dey et al. [11] examined the fodder samples in a polluted area and recorded an average Pb concentration in forages as 706 ppm and Cu, Pb, Cd concentration in forages as 1.116, 46, 1.075 ppm respectively. The presence of heavy metals and trace elements in milk and dairy products has been reported in different countries and regions [12-17]. No systematic study has been carried of Pb and Cd in milk in Gwalior region. Therefore, this study was conducted to enumerate the concentrations of heavy metals in cow and buffalo milk.

Material and Methods

The 100 ml milk samples from buffalo and cow were collected from the six villages (Zinavali, Niravali Tilagana, Beelpura, Milavali, Banmore gaon) of adjoining area of Rairu distillery and Banmore industrial area of district Gwalior during April 2018 to March 2019. Samples were stored in 100 ml clean sterilized bottles. Before collection of samples, the bottles were properly washed with distilled water and autoclaved at 120 °C and 15 psi. Total 36 milk samples from each season were collected, out of them 30 samples from contaminated area and 6 samples from control area. After the collection of samples, the samples were immediately transported to the laboratory in a cooler with ice packs and were stored at 20 °C until analysis. Milk samples (2 mL or g) were digested with nitric and perchloric acid mixture (HNO_3:$HClO_3$ = 4:1 v/v) until a transparent solution was obtained [18]. After digestion, samples were filtered and diluted to a suitable concentration. The blank samples were run simultaneously with each batch of the digestion. Working standard solutions of Pb and, Cd were prepared by dilution of certified standard solutions to desired concentration. All reagents used were of analytical reagent grade. Ultra-high purity water was used for all were run simultaneously with each batch of the digestion. Ultra-high purity water was used for all dilutions. All glass and plastic wares were washed and kept overnight in 10% [v/v] nitric acid solution. Afterwards, it was rinsed thoroughly with ultra-pure water and dried. The heavy metals lead and cadmium in the digested samples were measured using Flame Atomic Absorption Spectrophotometer (Perkin Elemer-700) at wave lengths of 283.3 and 228.8 nm. The detection limits were 0.001 and 0.001 ppm for lead and cadmium.

Results and Discussion

The water quality characteristics of borehole water at six villages have been analysed including pH, colour, turbidity, total dissolved solids, biochemical oxygen demand, chemical oxygen demand, lead, and cadmium. The average values of various physio-chemical characteristics have been given in Table 1. During present investigation, lead and cadmium concentration was studied in buffalo's and cow's milk at various 6 villages. The concentrations of Pb and Cd in raw milk reported in Tables 2-3 respectively. Both metals were detectable in all the samples and their concentrations were in the order of Pb < Cd in cow milk and Cd < Pb in buffalo milks. Highest concentration of Cd was reported in cow milk as compared to buffalo milk. The level of Pb in milks of buffalo and cow samples were in the ranges of 0.001 to 0.006 mg/l with mean of 0.003±0.002 mg/l, 0.001 to 0.034 mg/l with mean concentration 0.015±0.001 mg/l at Zinavali, 0.001 to 0.015 mg/l with mean concentration 0.008±0.003 mg/l 0.001 to 0.003 mg/l with average 0.002±0.001 mg/l at Niravali , 0.01 to 0.026 mg/l with mean 0.02±0.005 mg/l, 0.004 to 0.021 mg/l with mean 0.012±0.002 mg/l at Tilagana, 0.001 to 0.029 mg/l with mean 0.019±0.009 mg/l, 0.001 to 0.008 mg/l with mean 0.004±0.01 mg/l at Beelpura, 0.001 to 0.045 mg/l with mean 0.024 ±0.013 mg/l, 0.001 to 0.025 mg/l with mean 0.017±0.01 mg/l at Milavali and 0.001 to 0.011 mg/l with mean 0.004±0.003 mg/l and it was not detected in cow milk at Banmore gaon respectively (Table 2, Figure 1). Cadmium concentrations in buffalo and cow milk samples were in the range of 0.019 to 0.027 mg/l with mean 0.023±0.002 mg/l, 0.011 to 0.026 mg/l with mean 0.017±0.002 mg/l, 0.022 to 0.073 mg/l with mean 0.04±0.017 mg/l, 0.02 to 0.057 mg/l with mean 0.036±0.011 mg/l, 0.016 to 0.028 mg/l with mean 0.023±0.004 mg/l and 0.001 to 0.009 mg/l with mean 0.005±0.01 mg/l in buffalo milk and in cow milk it was ranged from 0.022 to 0.048 mg/l with mean of 0.033±0.01 mg/l, 0.025 to 0.061 mg/l with mean of 0.039±0.011 mg/l, 0.075 to 0.115 mg/l with mean 0.091±0.01 mg/l, 0.04 to 0.071 mg/l with mean 0.055±0.009 mg/l, 0.016 to 0.033 mg/l with mean 0.026±0.005 mg/l, 0.001 to 0.007 mg/l with mean 0.003±0.002 mg/l at Zinavali, Niravali, Tilagana, Beelpura, Milavali, and Banmore gaon respectively (Table 3, Figure 2). Toxicity through the milk is the more serious concern as compared to additional foods due to high utilization of milk by the most vulnerable age groups that is infants and mature peoples [19], which are itinerary of admission in body, age, and sex of the exposed people intake and the state of metal and its rate of absorption [20]. In present study, similar observations were reported by several authors in Pakistan, Serbia, Bangladesh, Shri Lanka, Ethiopia, Mexico, and Slovakia. [14] was reported Pb content in cow milk up to 0.047 mg/kg, [21] up to 0.17 mg/kg, [22] up to 0.074 mg/kg, [23] up to 0.046 mg/kg, [24] up to 0.153 mg/kg [25] up to 0.30 mg/kg. During the study period, more concentration of Pb and Cd in buffalo milk as compared to cow milk was reported. Present study is also agreed with finding of [26]. In the present study, the concentration range of Cd in buffalo and cow milk were observed to 0.001 to 0.073 mg/l and 0.001 to 0.115 mg/l with mean concentration of 0.04 and 0.091 The observed concentration of Cd was found to be lower than those reported in milk of cattle as 1.532±0.124 mg/l by [27] in raw milk collected from Iraq, 4.16 mg/l by [28] in Kaduna Metro area, Nigeria, 0.416 mg/l by [29] in Egypt and 0.532 mg/l by [30] in Thessaloniki, Macedonia. The permissible limit of Pb in milk is recommended by [31-33] is 0.02 mg/ml. Maximum permissible limit for Cd in milk recommended by FAO/WHO (Codex Alimentarius Commission, 1999) is 0.01mg/ml. According to [34], the maximum permissible limits for Pb in milk are 0.02 and 0.1mg/ml.

Conclusion

The present study gives significant information on the levels of heavy metals (lead and cadmium) in milk samples. Lead and Cadmium were the metals detected at highest levels in in cow milk sample, while they were the lowest in buffalo milk at all milk samples. Bioaccumulation of lead and cadmium through the food chain and intake from other food stuff should also be taken concern. Extraordinary awareness should be given to heavy metals as once they are present in concentrations greater than the acceptable daily intake of water and fodder then they can cause harm to the living system.

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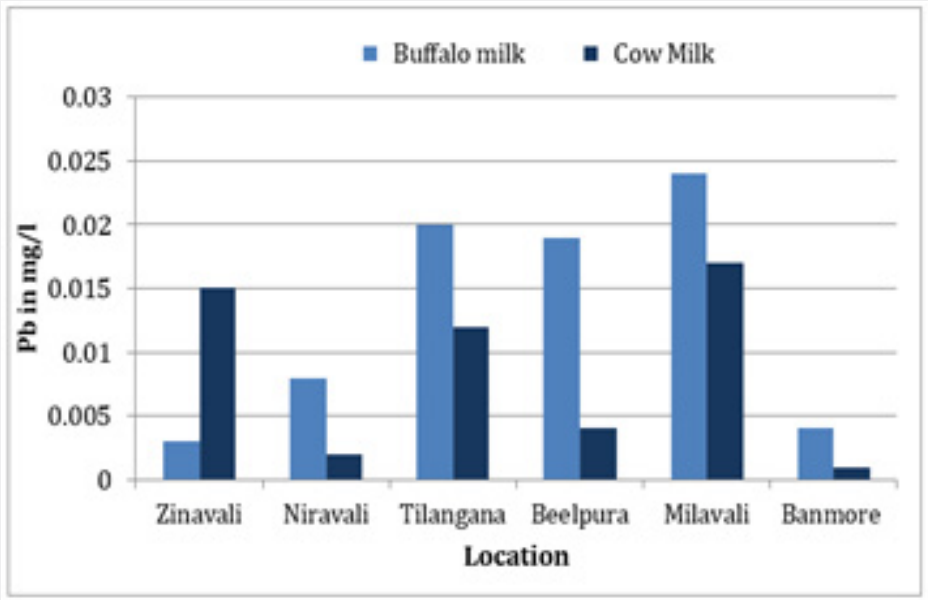

Figure 1: Levels of Lead in Buffalo and Cow milk. Values were expressed in mean.

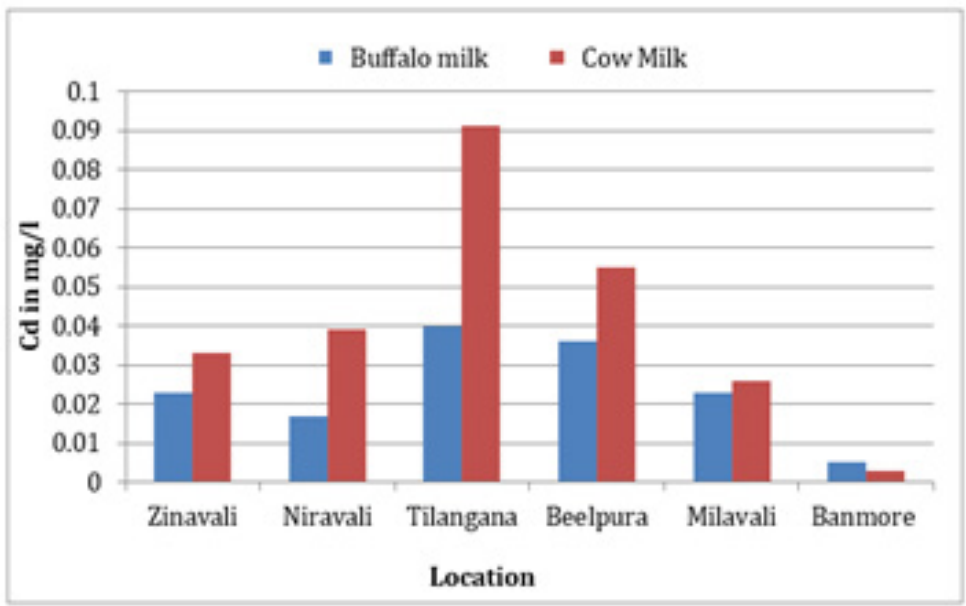

Figure 2: Levels of Cadmium in Buffalo and Cow milk. Values were expressed in mean.

Table 1: Average values of Physico-chemical parameters at different location during one year of study

SN	Parameters	Locations						IS: 10500:2012	
		Beelpura	Milavali	Tilangana	Niravali	Zinavali	Banmore gaon	Acceptable limit	Permissible limit
1.	pH	7.6	7.45	7.66	7.74	7.47	7.32	6.5-8.5	-
2.	Color, Hazen	9.7	4.87	22.8	4.02	7.03	4	5	12

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3.	Turbidity, NTU	1.63	1.1	7	1.5	1.84	2.37	1	5
4.	TDS, mg/l	567.3	414.7	732	706.7	520	607.3	500	2000
5.	BOD, mg/l	5.14	2.24	7.58	3.1	2.32	2.38	-	-
6.	COD, mg/l	32.4	20.97	57.8	33.1	20.9	25.5	-	-
7.	Pb, mg/l	0.038	0.239	0.174	0.07	0.051	0.01	0.01	0.05
8.	Cd, mg/l	0.001	0.001	0.046	0.047	0.049	BDL	0.001	-

Table 2: Concentrations of Lead in raw milk of buffalo and cow during entire period of study

Location	Buffalo Milk			Cow Milk		
	Lead concentration (mg/l)					
	Min	Max	Mean ± SE	Min	Max	Mean ± SE
Zinavali	0.001	0.006	0.003±0.002	0.001	0.034	0.015±0.001
Niravali	0.001	0.015	0.008±0.003	0.001	0.003	0.002±0.001
Tilangana	0.01	0.026	0.020±0.005	0.004	0.021	0.012±0.002
Beelpura	0.001	0.029	0.019±0.009	0.001	0.008	0.004±0.01
Milavali	0.001	0.045	0.024±0.013	0.001	0.025	0.017±0.01
Banmore	0.001	0.011	0.004±0.003	0.001	0.001	0.001±0.001

Table 3: Concentrations of Cadmium in raw milk of buffalo and cow during entire period of study

Location	Buffalo Milk			Cow Milk		
	Cadmium concentration (mg/l)					
	Min	Max	Mean ± SE	Min	Max	Mean ± SE
Zinavali	0.019	0.027	0.023±0.002	0.022	0.048	0.033±0.01
Niravali	0.011	0.026	0.017±0.002	0.025	0.061	0.039±0.011
Tilangana	0.022	0.073	0.040±0.017	0.075	0.115	0.091±0.01
Beelpura	0.02	0.057	0.036±0.011	0.04	0.071	0.055±0.009
Milavali	0.016	0.028	0.023±0.004	0.016	0.033	0.026±0.005
Banmore	0.001	0.009	0.005±0.01	0.001	0.007	0.003±0.002

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