www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 4390-4393

www.thepharmajournal.com
Received: 26-09-2022
Accepted: 30-10-2022

AD Chikhalikar
Ph.D. Scholar, Mumbai Veterinary College, Parel, Mumbai, Maharashtra, India

BN Ramteke
Professor, Mumbai Veterinary College Mumbai, Maharashtra, India

NR Karambele
Assistant Professor, Department of Animal Nutrition, Mumbai Veterinary College Mumbai, Maharashtra, India

SD Ingole
Professor, Department of Veterinary Physiology, Mumbai Veterinary College Mumbai, Maharashtra, India

MP Sawane
Professor, Department of Animal Genetics and Breeding, Mumbai Veterinary College Mumbai, Maharashtra, India

RJ Zende
Professor, Department of Veterinary Public Health, Mumbai Veterinary College Mumbai, Maharashtra, India

SD Jagadale
Assistant Professor, Department of Animal Nutrition, Mumbai Veterinary College Mumbai, Maharashtra, India

Corresponding Author:
AD Chikhalikar
Ph.D. Scholar, Mumbai Veterinary College, Parel, Mumbai, Maharashtra, India

Assessment of toxic heavy metals content in drinking water for animals from Konkan region of Maharashtra

AD Chikhalikar, BN Ramteke, NR Karambele, SD Ingole, MP Sawane, RJ Zende and SD Jagadale

Abstract
The present study was conducted to assess heavy metals contents like arsenic (As), lead (Pb), cadmium (Cd), mercury (Hg), copper (Cu), chromium (Cr) and zinc (Zn) in drinking water for animals. Total 70 samples were collected from different location under urban, semi-urban and rural areas of Konkan region of Maharashtra. Water samples were taken from a borewell, a well, and a canal/ river and other source like municipal water supply etc. that the animals utilized for drinking water. Inductively coupled plasma mass spectroscopy (ICP-MS) was used to analyse the samples. Results were compared with the standards set by WHO (1998), EU (2020) and BIS (2012). The results indicated that arsenic, lead concentration in water were found to be near to the MRL value quoted by WHO (1998), EU (2020) and well below the levels recommended by BIS (2012). Further the levels of cadmium, mercury, copper, chromium and zinc were below the recommended maximum residual levels of WHO (1998), EU (2020), and BIS (2012) standards. It was also observed that the concentration of heavy metals were significantly higher in water source in urban and semi-urban areas than rural areas. To prevent health risks of dairy animals and ultimately human life it is necessary to monitor the level of heavy metals in water on regular basis.

Keywords: Heavy metals, ICPMS, water source, drinking water, dairy animals

Introduction
Heavy metals have found long lasting negative impacts on human health because they are harmful to living being, if consumed beyond recommended levels and have a tendency to accumulate in plants and animals. Heavy metals can enter the environment through a variety of processes, such as combustion, extraction, agricultural runoff, transportation, etc. Numerous land- and water-based activities, as well as overexploitation, are contaminating ground water sources (Caspers, 1981) [3]. Ground water becomes particularly vulnerable in locations with high population density and extensive human usage of the land. There are numerous industrial processes that have the potential to contaminate ground water by unintentionally or purposely releasing chemicals or trash into the environment (Merkel *et al.*,2022) [11].

Heavy metals as well as other priority hazardous contaminants drastically reduce the beneficial use of water for domestic and commercial uses. Although many other metals including As, Hg, Cd, Cr and Pb have been demonstrated to be hazardous when present in excess, some metals, including Cu, Fe, Mn, Ni, and Zn are required as micronutrients for plants and microorganisms. With significant surface water penetration, heavy metals and other soil contaminants can seep into the groundwater below. Diverse soil types will have different impacts on how heavy metals behave in groundwater.

Rapid industrialization, rapid urbanization and agricultural activities have almost all increased the risk of a spike in pollution levels in natural ecosystems like water, soil, and air (Hassanzadeh *et al.*, 2011) [9]. Due to their extensive spectrum of activities, long environmental persistence, bioaccumulation and high toxicity, heavy metals are among the most hazardous environmental pollutants.

Heavy metals are found in a variety of industrial processes, agricultural practices, household waste, and car emissions. Yet, all environmental components may contain heavy metals that came from anthropogenic sources (El Ayni *et al.*, 2011) [6]. As a result of increasing anthropogenic input of heavy metals into the environment, the study of such pollutants in the environment has gained more attention. (Al-Hobaib *et al.*, 2011) [1].

Heavy metals can be found in practically all types of water and many of them are caused by natural weathering of the earth's surface (Newcomb and Rimstidt, 2002) [14]. In addition to sewage from cities and manufacturers, wastewater used for irrigation can have a significant

impact on water quality. Heavy metals from anthropogenic activities may migrate or infiltrate into aquifers affecting groundwater. (Charlesworth and Lees, 1999) [4]. Therefore the present study was planned to assess the heavy metal concentration in drinking water for animals in Konkan region of Maharashtra.

2. Materials and Methods

The current research focused on determining the As, Pb, Cd, Hg, Cu, Cr and Zn concentrations in water from Konkan region of Maharashtra. Water samples were collected from borewell, well, canal/river and other sources like municipal water supply etc. from where animal drink water. The study was conducted in six district of the region namely Mumbai, Thane, Palghar, Raigad, Ratnagiri and Sindhudurg this divided into urban, semi-urban and rural area based on population density and industrial activities.

The major portion of water samples were collected near industrial zones or from sites where waste water and industrial effluents were disposed off in urban areas. The farms that were selected under semi-urban were from the blocks or talukas located near industrial zones or along the sides of highways and rural areas is completely free from urbanization or industrialization.

Total 70 water samples were collected from the aforementioned locations. Water samples were collected from the organised farms or individual farmers in 10 ml Tarson tubes with tight closures for sample storage. After cleaning the bottles with double-distilled, deionized water, they were rinsed overnight in 10% (v/v) nitric acid. The samples were filtered using Whatmann filter paper 42. To inhibit biological development and metal precipitation, a few drops of strong nitric acid were added to samples to reach a pH of around 2 (Kramer, 1994) [10]. Then samples were immediately transported to the lab in iceboxes at 4^0 C and stored in a deep freezer (-20 ^{0}C) for further investigation.

All samples collected are analysed using inductively coupled plasma mass spectroscopy (ICP-MS) at the Department of Veterinary Public Health at Mumbai Veterinary College Parel, Mumbai.

The data generated for the various heavy metal content in the study was statistically examined as per (Snedecor and Cochran, 1994) [16] and the proper conclusions were drawn.

3. Results and Discussion

Table 1: Overall concentration of heavy metals (ppm) in water samples in Konkan region of Maharashtra

Sr. no.	Metals	Urban area	Semi-urban area	Rural area	CD	Level of significance
1	Arsenic	$0.0161^{a\pm}$0.0013	$0.0135^{a\pm}$0.001	0.0087^{b}±0.00086	0.005	**
2	Lead	0.0120^{a}±0.0006	0.0090^{ab}±0.001	0.0069^{b}±0.005	0.003	**
3	Cadmium	0.00300^{a}±0.0001	0.00199^{b}±0.00005	0.00161^{b}±0.0003	0.001	**
4	Mercury	0.0010^{a}±0.0001	0.0008^{a}±0.00007	0.0004^{b}±0.00002	0.0003	**
5	Copper	0.552^{a}±0.013	0.475^{b}±0.021	0.324^{b}±0.016	0.128	**
6	Chromium	0.0280^{a}±0.001	0.0196^{b}±0.001	0.0157^{b}±0.001	0.007	**
7	Zinc	1.889^{a}±0.070	1.611^{b}±0.042	1.282^{c}±0.055	0.335	**

** - Significant at 1% level

a,b,c… mean with different superscript in a row differ significantly.

The results of the present study as indicated in Table 1 showed significantly (p<0.01) higher concentration of arsenic in drinking water for animals under urban and semi-urban area as compare to rural area. The values of arsenic under urban and semi-urban areas were nearer to the MRL values of water recommended by WHO (1998) [18], EU standard (2020) [7] but well below the standard recommended by BIS (2012) [2]. However the values of arsenic under rural area were well below the MRL values of above mentioned standards. When the concentration of heavy metals compared between district of Konkan region, the levels of arsenic were significantly (p<0.01) higher in Mumbai and Thane district (Table 2 and 3) as compare to rest of the district in the region under urban area of study.

The results of present study are in agreement with Raju *et al.*, (2014) [15] who reported higher levels of arsenic in drinking water of villages of Nellore district of Andhra Pradesh but well below the permissible levels of BIS (2012) [3] standards. Similar results were reported by Cobbina *et al.*, (2015) [5] who observed 0.031 ppm in Nangodi area and 0.002 ppm of arsenic in Tinga area in northern Ghana. However Zodape *et al.*, (2014) [19] reported no detectable level of arsenic in samples of Goregaon sub-urban are of Mumbai.

The concentration of lead in urban and semi-urban areas was significantly (p<0.01) higher than rural area of Konkan region however levels were below the recorded MRL values of WHO (1998) [18], EU standard (2020) [7] and BIS (2012) [2] standards. The level of cadmium, mercury were also significantly (p<0.01) higher in urban and semi-urban area as compared to rural area of Konkan region.

Similar results were reported by Mohan Kumar *et al.*, (2016) [12] who conducted study in Coimbatore district of Tamilnadu in industrial region and found higher level of arsenic, mercury and cadmium in some residential area of Coimbatore. However contrary to present findings Singare and Fern, (2009) [17] reported concentration of lead and mercury in water of Mahim creek near Mumbai above the MRL values of 0.01 and 0.1 ppm set by Central Pollution Control Board (CPCB) of India. Hasan *et al.*, (2016) [8] also reported higher concentration of lead and cadmium in the surface water of Bengal coast in suther part of Bangladesh on the basis of contamination factor and pollution load index values.

The concentration copper, chromium and zinc observed in the urban, semi-urban and rural area of Konkan region were below the MRL values of heavy metals suggested by WHO (1998) [18] , EU standard (2020) [7] and BIS standards (2012) [2] for drinking water. The results also indicated that concentration of copper and zinc were significantly (p<0.01) higher in urban and semi-urban areas as compare to rural area of Konkan region. The district wise concentration of lead indicated that the values were significantly (p<0.01) higher in Mumbai and Thane district (Table 2 and 3) compared with rest of district.

Table 2: District wise concentration of As, Pb, Cd and Hg (ppm) in water samples in of Konkan region of Maharashtra

District	Arsenic			Lead			Cadmium			Mercury		
	Urban	Semi-urban	Rural	Urban	Semi-urban	Rural	Urban	Semi-urban	Rural	Urban	Semi-urban	Rural
Mumbai	0.0250^{a}±0.001	---	---	0.0169^{a}±0.002	---	---	0.00394±0.0005	---	---	0.001467±0.0003	---	---
Thane	0.0215^{ab}±0.001	0.0208^{a}±0.01	0.0143^{a}±0.001	0.0143^{a}±0.01	0.0118±0.0004	0.0092±0.003	0.00370±0.0005	0.00226±0.0002	0.00133±0.0005	0.001318±0.0001	0.00117^{a}±0.0002	0.000342±0.00004
Palghar	0.0180^{bc}±0.0006	0.0172^{ab}±0.02	0.0097^{ab}±0.001	0.0111^{b}±0.01	0.0107±0.001	0.0074±0.001	0.00294±0.0003	0.00211±0.0002	0.00182±0.0006	0.001039±0.0003	0.000967^{a}±0.00001	0.000406±0.00006
Raigad	0.0158^{c}±0.001	0.0145^{b}±0.01	0.0092^{bc}±0.001	0.0106^{b}±0.01	0.0103±0.002	0.0085±0.003	0.00267±0.0003	0.00187±0.0003	0.00155±0.0001	0.000927±0.0004	0.000873^{a}±0.00004	0.000530±0.0001
Ratnagiri	0.0092^{d}±0.0002	0.0083^{c}±0.0007	0.0056^{bc}±0.001	0.0094^{b}±0.006	0.0059±0.001	0.0049±0.001	0.00243±0.0004	0.00189±0.0003	0.00175±0.0003	0.000537±0.00009	0.000391^{b}±0.0001	0.000249±0.00006
Sindhudurg	0.0071^{d}±0.0006	0.0068^{c}±0.0006	0.0046^{c}±0.001	0.0087^{b}±0.004	0.0062±0.001	0.0045±0.001	0.00209±0.0005	0.00182±0.0001	0.00162±0.0006	0.000557±0.0001	0.000454^{b}±0.00004	0.000295±0.0001
Average	0.0161^{a}±0.0013	0.0135^{a}±0.001	0.0087^{b}±0.0008	0.0120^{a}±0.004	0.0090^{ab}±0.001	0.0069^{b}±0.005	0.0030^{a}±0.0002	0.0019^{b}±0.0001	0.0016^{b}±0.0001	0.0010^{a}±0.0001	0.00008^{b}±0.00007	0.00004^{b}±0.00003
CD	0.005	0.007	0.007	0.004	---	---	---	---	---	---	0.0004	---
Level of Significance	**	**	**	**	NS	NS	NS	NS	NS	NS	**	NS

** - Significant at 1% level NS- Non Significant
a,b,c… mean with different superscript in a column differ significantly.

Table 3: District wise concentration of Cu, Cr and Zn (ppm) in water samples in Konkan region of Maharashtra

District	Copper			Chromium			Zinc		
	Urban	Semi-urban	Rural	Urban	Semi-urban	Rural	Urban	Semi-urban	Rural
Mumbai	0.638±0.05	---	---	0.0372±0.001	---	---	2.408^{a}±0.1	---	---
Thane	0.617±0.09	0.611^{a}±0.05	0.439±0.09	0.0307±0.003	0.0250±0.005	0.0210±0.002	2.113^{ab}±0.1	1.92^{a}±0.1	1.495±0.1
Palghar	0.540±0.07	0.537 ^{ab}±0.03	0.346±0.06	0.0281±0.006	0.0212±0.005	0.0181±0.002	1.910^{abc}±0.1	1.734 ^{ab}±0.07	1.254±0.09
Raigad	0.516±0.05	0.428^{bc}±0.05	0.293±0.05	0.0254±0.007	0.0194±0.002	0.0132±0.01	1.715^{bc}±0.3	1.573 ^{abc}±0.3	1.259±0.07
Ratnagiri	0.506±0.04	0.465^{bc}±0.06	0.284±0.08	0.0234±0.004	0.0157±0.002	0.0124±0.003	1.502^{c}±0.03	1.493^{bc}±0.1	1.314±0.2
Sindhudurg	0.475±0.03	0.335^{c}±0.03	0.260±0.04	0.0206±0.003	0.0166±0.001	0.0139±0.003	1.558^{bc}±0.04	1.332^{c}±0.1	1.091±0.3
Average	0.552^{a}±0.01	0.475^{b}±0.02	0.324^{b}±0.01	0.280^{a}±0.002	0.0196^{b}±0.001	0.0157^{b}±0.001	1.889^{a}±0.09	1.611^{b}±0.06	1.282^{c}±0.08
CD	---	0.19	---	---	---	---	0.5	0.3	---
Level of Significance	NS	**	NS	NS	NS	NS	*	*	NS

** - Significant at 1% level * - Significant at 5% level NS- Non Significant
a,b,c… mean with different superscript in a column differ significantly.

The levels of cadmium, mercury, copper, chromium and zinc in the drinking water indicated no significant difference among the different district in Konkan region of Maharashtra. The results of present study with regards to Cu and Zn are in agreement with Nagendrappa *et al.*, (2009) [13] who studied the concentration of copper and zinc in different location around Tumkar district of Karnataka and reported concentration of these heavy metals were within permissible level and suitable for drinking.

4. Conclusion

The results of the study indicated that concentration of arsenic, lead, cadmium, mercury were nearer to the MRL values of WHO (1998), EU standard (2020) of drinking water for animals may be due to industrial activities in urban area creating pollution of the water sources whereas the concentration in semi-urban and rural area were well below of WHO (1998), EU standard (2020) and BIS (2012) standards may be attributed to no contaminating factors of ground water in these areas. Therefore regular monitoring of drinking water sources must be done for the concentration of heavy metals levels required for sound health of animals and ultimately human beings.

5. Acknowledgement

The authors are thankful to PI, ICAR NAHEEP – CAAST, Department of Veterinary Public Health Mumbai Veterinary College, Mumbai for providing all the necessary facilities to carry out the experiment.

6. Reference

1. Al-Hobaib AS, Al-Jaseem QK, Baioumy HM, Ahmed AH. Heavy metals concentrations and usability of groundwater at Mahd Adh Dhahab gold mine, Saudi Arabia. Arabian Journal of Geosciences. 2011;6(1):259-270.
2. Bureau of Indian Standards. Indian standard drinking water specification. 2nd ed. Amendment No. 1 June, 2015. IS10500:2012, p 2-3.
3. Caspers HU, Förstner, Wittmann GTW. Metal Pollution in the Aquatic Environment. With Contributions by F. Prosi an J.H. van Lierde. — With 102 figs., 94 ab., 486 pp. Berlin-Heidelberg-New York: Springer-Verlag; c1979. ISBN -540 (Berlin) 0- 387 (New York) -09307-9 DM 98, Internationale Revue der gesamten Hydrobiologie and Hydrographie. 1981;66 (2):277-277.
4. Charlesworth SM, Lees JA. The distribution of heavy metals in deposited urban dusts and sediments, Coventry. Environmental Geochemistry and Health. 1999;21(2):97-115.
5. Cobbina SJ, Duwiejuah AB, Quansah R, Obiri S, Bakobie N. Comparative Assessment of Heavy Metals in Drinking Water Sources in Two Small Scale Mining Communities in Northern Ghana Int. J. Environ. Res. Public Health. 2015;12:10620-10634.
6. El Ayni F, Cherif S, Jrad A, Trabelsi-Ayadi M. Impact of treated wastewater reuse on agriculture and aquifer recharge in a coastal area: Korba case study. Water Resources Management. 2011;25(9):2251-2265.
7. European Standard. Council Directive 2020/2184 on the quality of water intended for human consumption. Adopted by the Council, on 16 December, 2020. https://www.lenntech.com/applications/drinking/standards/eu-s-drinking-water-standards.htm#ixzz7hbAZoP4c. [Visited on 21 June 2022]
8. Hasan MRMZH, Khan M, Khan S, Aktar M, Rahman Hossain F, Hasan ASMM. Heavy metals distribution and contamination in surface water of the Bay of Bengal coast Cogent Environmental Science, 2016;2:11.
9. Hassanzadeh R, Abbasnejad A, Hamzeh MA. Assessment of groundwater pollution in Kerman urban areas. Journal of Environmental Studies. 2011;36(56):101-110.
10. Kramer KJM. Inorganic contaminants in the water column: sampling and sampling strategy. International Journal of Environmental Analytical Chemistry. 1994;57(3):179-188.
11. Merkel TB, Mulisch HM, Kuperberg M, Wcislo E. WHO Groundwater Monograph World Health Organization, Chapter 11, [http://www.who.int/water_sanitation_health/resourcesquality/en/groundwater11]. [Visited on 24 June 2022]
12. Mohankumar K, Hariharan V, Rao NP. Heavy metal contamination in groundwater around industrial estate vs residential areas in Coimbatore, India. Journal of clinical and diagnostic research 2016;10(4):5-7.
13. Nagendrappa G, Bhaskar CV, Kumar K. Assessment of heavy metals in water samples of certain locations situated around Tumkur, Karnataka, India. E-Journal of Chemistry. 2010;7(2):349-352.
14. Newcomb WD, Rimstidt J. Trace element distribution in US groundwaters: a probabilistic assessment using public domain data. Applied Geochemistry. 2002;17(1):49-57.
15. Raju OVS, Prasad PMN, Varalakshmi V, Reddy YR. Determination of heavy metals in ground water by ICP-OES in selected coastal area of Spsr Nellore District, Andhra Pradesh, India. International Journal of Innovative Research in Science, Engineering and Technology. 2014;3(2):9745-9749.
16. Snedecor GW, Cochran WG. In “Statistical Methods". 9th Edn., Oxford and IBH Publishing House, Calcutta; c1994.
17. Singare PU, Ferns SEL. Study of toxic heavy metals in Mahim creek of Mumbai. International Letters of Chemistry, Physics and Astronomy. 2014;17(1):98.
18. WHO, (World Health Organization). Guideline for drinking water quality; c1998.
19. Zodape GV, Dhawan VL, Wagh RR. Analysis of heavy metals and coliform in samples of drinking water collected from municipal and private schools of Goregaon suburban of Mumbai, India. International Journal of Researches in Biosciences, Agriculture and Technology. 2014;2(2):630-651.