DOI: 10.22055/ivj.2025.512578.2781

The Impact of Nutritional Management, Herd Size, and Geographical Location on Heavy Metal Concentrations in Livestock Products: A Case Study in Dairy Farms of Isfahan Province

Saeed Jalali Jalalabadi[1], Arash Omidi[2*], Aria Rasooli[3], Mehdi Mohebbi-Fani[2] and Behnam Keshavarzi[4]

[1] PhD student of Feed Hygiene, School of Veterinary Medicine, Shiraz University, Shiraz, Iran
[2] Professor, Department of Animal Health Management, School of Veterinary Medicine, Shiraz University, Shiraz, Iran
[3] Associate Professor, Department of Animal Health Management, School of Veterinary Medicine, Shiraz University, Shiraz, Iran
[4] Professor, Department of Earth Sciences, College of Sciences, Shiraz University, Shiraz, Iran

Received: 15.03.2025 Accepted: 05.05.2025

Abstract

Pollution caused by heavy metals such as lead (Pb), cadmium (Cd), and arsenic (As), particularly due to industrial activities and poor management practices, poses a significant threat to human and animal health. This study evaluates the impact of nutritional management, herd size, and distance from industrial areas on heavy metal concentrations in samples of milk, water, animal feed, feed supplements, manure, and hair from 30 dairy farms located in Isfahan Province. Samples were collected from dairy farms with diverse characteristics, and the concentrations of heavy metals were measured using Atomic Absorption Spectroscopy (AAS). The results indicated that regarding nutritional management, 30% of the farms were rated as poor (Level 1), 50% as moderate (Level 2), and 20% as good (Level 3). The average scores for nutritional management were 45% for Level 1, 70% for Level 2, and 90% for Level 3. Larger herd sizes (over 600 heads) were associated with an increase in cadmium concentrations in manure (P=0.041), while poor nutritional management was significantly correlated with higher lead concentrations in milk (P=0.032). Additionally, the concentration of arsenic in animal feed was influenced by proximity to industrial areas (r=0.019, P=0.67). The median lead concentration in milk was 0.028 mg/L, which exceeds the permissible limit of 0.02 mg/L. The Lead levels in feed were measured at 1.98 mg/kg, cadmium in manure at 0.06 mg/kg, cadmium in hair at 0.102 mg/kg, and arsenic in feed at 0.62 mg/kg, all of which were below the permissible limits. The poor quality of animal feed significantly contributes to the increased concentration of lead in milk. Improving management practices and utilizing high-quality feed resources ara essential. It is recommended that continuous monitoring of the quality of food and water resources should be conducted to reduce the risks associated with heavy metals and ensure public health.

Key words: Pollution, Herd size, Heavy metals, Dairy farming, Management

[*] **Corresponding Author**: Arash Omidi, Professor, Department of Animal Health Management, School of Veterinary Medicine, Shiraz University, Shiraz, Iran
E-mail: aomidi@shirazu.ac.ir

Refrences

Abid, K., Shams, Z. I., Tahir, M. S., & Zubair, A. (2024). Determination of heavy metals in cow's and buffalo's fresh raw milk from different areas of Pakistan. *Arab Gulf Journal of Scientific Research*, 42(3), 757-770.

Abdeljalil, N. A., Benkhayal, A. A., Ahmida, M. H. S., El Sharaa, I. A., & Ahmida, N. H. (2021). Determination of lead and cadmium in different types of milk samples collected from different markets in Benghazi-Libya.

Abou Arab, A., Abou Donia, M., & Enb, A. (2024). Lead levels in milk and its products from various environments in Egypt.

Adamse, P., Van der Fels-Klerx, H. J., & de Jong, J. (2017). Cadmium, lead, mercury and arsenic in animal feed and feed materials–trend analysis of monitoring results. *Food Additives & Contaminants: Part A*, 34(8), 1298-1311.

Afzal, A., & Mahreen, N. (2024). Emerging insights into the impacts of heavy metals exposure on health, reproductive and productive performance of livestock. *Frontiers in Pharmacology*, 15, 1375137.

Bagheri, Z., Mohammadzadeh, A., Bahari, A., Mohammadi, A., & Sharifi, A. (2024). A molecular survey for detection of Mycoplasma bovis in bovine bulk milk samples of dairy farms in Hamedan, Iran. *Iranian Veterinary Journal*, 19(3), 14-22

Boudebbouz, A., Boudalia, S., Bousbia, A., Habila, S., Boussadia, M. I., & Gueroui, Y. (2021). Heavy metals levels in raw cow milk and health risk assessment across the globe: A systematic review. *Science of the Total Environment*, 751, 141830.

Cowan, V., & Blakley, B. (2016). Acute lead poisoning in western Canadian cattle—A 16-year retrospective study of diagnostic case records. *The Canadian Veterinary Journal*, 57(4), 421.

Järup, L. (2003). Hazards of heavy metal contamination. *British Medical Bulletin*, 68(1), 167-182.

Jeng, S. L., Lee, S. J., & Lin, S. Y. (1994). Determination of cadmium and lead in raw milk by graphite furnace atomic absorption spectrophotometer. *Journal of Dairy Science*, 77(4), 945-949.

Jin, M., Yuan, H., Liu, B., Peng, J., Xu, L., & Yang, D. (2020). Review of the distribution and detection methods of heavy metals in the environment. *Analytical methods*, *12*(48), 5747-5766.

Hasan, S., & Faroque, M. O. (2020). Determination of Selected Heavy Metals in Food and Water Consumed by Households. *Int. J. Sci. Basic Appl. Res. Int. J. Sci. Basic Appl. Res*, *53*(2), 117-128.

Hosseini, N. S., Sobhanardakani, S., Cheraghi, M., Lorestani, B., & Merrikhpour, H. (2020). Heavy metal concentrations in roadside plants (Achillea wilhelmsii and Cardaria draba) and soils along some highways in Hamedan, west of Iran. *Environmental Science and Pollution Research*, 27, 13301-13314.

Irshad, M., Malik, A. H., Shaukat, S., Mushtaq, S., & Ashraf, M. (2013). Characterization of Heavy Metals in Livestock Manures. *Polish Journal of Environmental Studies*, *22*(4).

Ivanyos, D., Monostori, A., Németh, C., Fodor, I., & Ózsvári, L. (2019). Relationship between herd size, milking technology and milk production parameters on large-scale Hungarian dairy farms. *The Animal Biology*, 21(2), 32–34.

Khan, S., Cao, Q., Zheng, Y. M., Huang, Y. Z., & Zhu, Y. G. (2008). Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China. *Environmental Pollution*, 152(3), 686-692.

López-Alonso, M., Miranda, M., Castillo, C., Hernández, J., García-Vaquero, M., & Benedito, J. L. (2007). Toxic and essential metals in liver, kidney and muscle of pigs at slaughter in Galicia, north-west Spain. *Food Additives and Contaminants*, 24(9), 943-954.

Madani Borujeni, M. A., Ghorbanpoor, M., Mokhtari, A., Khosravi, M., & Fallah, A. (2024). Prevalence of subclinical streptococcal mastitis in dairy cows in Chaharmahal and Bakhtiari province. *Iranian Veterinary Journal*, 20(3), 68-75.

Madani-Tonekaboni, M., Rafiei Nazari, R., Mirzamohammadi, S., Abdolshahi, A., Abbasi-bastami, N., & Arabameri, M. (2019). Monitoring and risk assessment of lead and cadmium in milks from east of Iran using Monte Carlo simulation method. *Nutrition and Food Sciences Research*, 6(2), 29-36.

Mahdinezhad Hargalan, Y., Alizadeh Sani, M., Shariatifar, N., Khaniki, G. J., Nazmara, S., Mohammadpourfard, I., & Arabameri, M. (2024). Determination of elements in raw and industrial milks from Tehran city. *International Journal of Environmental Analytical Chemistry*, 1-15.

Mandal, P. (2017). An insight of environmental contamination of arsenic on animal health. *Emerging Contaminants*, 3(1), 17-22.

Monteverde, V., Camilleri, G., Arfuso, F., Pennisi, M., Perillo, L., Patitò, G., & Piccione, G. (2022). Heavy metal levels in milk and serum of dairy cows from different farms located near an industrial area. *Animals*, 12(19), 2574.

Nachman, K. E., Graham, J. P., Price, L. B., & Silbergeld, E. K. (2005). Arsenic: a roadblock to potential animal waste management solutions. *Environmental Health Perspectives*, 113(9), 1123-1124.

Parween, R., Shaukat, S. S., Yasmeen, K., & Ara, D. (2016). Evaluation of Environmental Impact on Heavy Metal Load in Cattle Milk. *Polish Journal of Environmental Studies*, 25(3).

Razooqi, M. A. (2022). Risk exposure of dairy cows to environmental contamination of brick kilns on milk content of antioxidants and heavy metals in Al-Nahrawan region, Iraq. *Caspian Journal of Environmental Sciences*, 20(3), 491-502.

Safonov, V. (2020). Assessment of heavy metals in milk produced by black-and-white Holstein cows from Moscow. *Current Research in Nutrition and Food Science Journal*, 8(2), 410-415.

Seifi, M., Mahvi, A. H., Hashemi, S. Y., Arfaeinia, H., Pasalari, H., Zarei, A., & Changani, F. (2019). Spatial distribution, enrichment and geo-accumulation of heavy metals in surface sediments near urban and industrial areas in the Persian Gulf. *Desalination and Water Treatment*, 158, 130-139.

Sharifi, S., Sohrabvandi, S., Mofid, V., Javanmardi, F., Khanniri, E., & Mortazavian, A. M. (2022). The assessment of lead concentration in raw milk collected from some major dairy farms in Iran and evaluation of associated health risk. *Journal of Environmental Health Science and Engineering*, 20(1), 181-186.

Singh, S., Yadav, R., Sharma, S., & Singh, A. N. (2023). Arsenic contamination in the food chain: a threat to food security and human health. *J Appl Biol Biotechnol*, 11, 24-33.

Şahin, E., Sarıkaya, H. A., Çınar, M., & Yıldırım, E. (2022). The occurrence of arsenic, cadmium, and lead residues in cattle feed collected in Kırıkkale, Türkiye: A preliminary study. *Livestock Studies*, 62(2), 81-85.

Szkoda, J., & Zmudzki, J. (2005). Determination of lead and cadmium in biological material by graphite furnace atomic absorption spectrometry method. *Bull Vet Inst Pulawy*, 49(1), 89-92.

Tumbo, M., & Chacha, N. (2011). Assessment of diffusion of best environmental management practices in Tanzania.

Tripathi, R. M., Raghunath, R., Sastry, V., & Krishnamoorthy, T. M. (1999). Daily intake of heavy metals by infants through milk and milk products. *Science of the total environment*, *227*(2-3), 229-235.

Wu, Y. (2014). General standard for contaminants and toxins in food and feed. *Codex Stan*, 193-1995.

Zyambo, G., Yabe, J., Muzandu, K., M'kandawire, E., Choongo, K., Kataba, A., & Ishizuka, M. (2022). Human health risk assessment from lead exposure through consumption of raw cow milk from free-range cattle reared in the vicinity of a lead–zinc mine in Kabwe. *International Journal of Environmental Research and Public Health*, *19*(8), 4757.