JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Detection of lead in different Ice-cream samples across Mumbai city

Muskaan Mehboob Kazia
MSc Zoology, Department of Zoology, Sathaye College (Autonomous), Vile Parle (East), Mumbai-400057, Maharashtra, India. Email muskaankazi003@gmail.com.

Akanksha Harishchand Jaiswara
MSc Zoology, Department of Zoology, Sathaye College (Autonomous), Vile Parle (East), Mumbai-400057, Maharashtra, India. Email jaiswarakanksha@gmail.com.

Dr Soni Ghumnania
Assistant professor, Department of Zoology, Sathaye College (Autonomous), Vile Parle (East), Mumbai-400057, Maharashtra, India. Email – soni.ghumnani@sathayecollege.edu.in

Abstract:

Lead is a toxic element and can cause severe health issues. In children, it impairs brain and nervous system development. This study evaluated lead (Pb) levels in commercially available vanilla cup ice cream produced in Mumbai, following the Food Safety and Standards Authority of India (FSSAI) guidelines. The research samples included ten different brands of vanilla cup ice cream. These were collected from supermarkets and chemist outlets across various areas of Mumbai between July 2025 and September 2025. The samples were digested using an acid digestion method. Lead concentration was quantified using the Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP-OES) method. The results showed that lead levels were below or within the maximum permissible limit (MPL) of 0.02 mg/kg set by FSSAI for milk-based products. The findings indicate that lead contamination in ice-cream products has significantly decreased compared to earlier reports. This decline is likely due to improved manufacturing practices, cleaner raw materials, and strengthened quality control measures.

Introduction:

Ice cream is a popular milk-based dairy product, enjoyed by all age groups. It is considered nutritious due to its content of proteins, fat, lactose, calcium, phosphorus, essential vitamins, and other ingredients like fruits, eggs, cocoa, dried fruits, and additives (GadAllah *et al*., 2020). Despite its widespread consumption, ice cream may be vulnerable to environmental contamination by lead (Pb). Lead is a persistent toxic metal and enters the environment through human activities, such as mining, fossil fuel combustion, and industries making plastics, paints, ceramics, and batteries (Sani & Amanabo, 2021). Lead exposure happens mainly through ingestion, inhalation, or dermal contact. Residues from the historical use of leaded petrol continue to contaminate soil and air, letting lead enter the food chain and posing risks to food safety and human health (Murata *et al*., 2009).

Chronic lead exposure is associated with adverse health effects, including anemia, neurotoxicity, impaired renal function, and reproductive disorders, while severe exposure may result in irreversible damage to the liver, kidneys, and central nervous system, potentially leading to mortality. Children are particularly vulnerable, as even low concentrations can impair neurodevelopment, reduce cognitive performance, and cause behavioural and growth abnormalities. Given that ice cream is widely consumed, especially by children, the presence of lead in such products represents a significant public health concern (Murata *et al.,* 2009).

Lead contamination has been previously reported in milk, cream, soft cheese, and food-processing water (Singh *et al*., 2020), yet limited data exist regarding processed dairy products such as ice cream, particularly in urban regions like Mumbai. With rising urban pollution and variable food safety monitoring, assessing lead levels in commonly consumed products is essential. This study analysed branded and unbranded vanilla cup ice cream samples from Mumbai and quantified lead concentrations using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES).

Materials And Methods:

1) Sample collection: In our study, vanilla-flavoured industrial cup ice creams were selected from 10 popular commercial brands. Samples were obtained in triplicate, each with a different manufacturing date, to ensure reliability and variability in analysis. The collection was carried out between June and August 2025 from various locations across Mumbai, primarily targeting medical stores and supermarkets. All samples were then used to assess the concentration of lead present in commercially available ice creams.

2) Sample preparation: To perform sample digestion of all types of matrices, nitric acid and H2O2 were used, followed by heating until the matrix completely breaks down. Once cooled, the digested samples were then filtered. The samples were further diluted for analysis.

3) Lead detection: The acid-digested ice cream samples were sent to Testtex India Laboratories for ICP-OES (Inductively Coupled Plasma Optical Emission Spectroscopy) (Agilent 5800, Santa Clara, CA) analysis. This method is based on the excitation of atoms in a high-temperature argon plasma. The liquid sample is nebulised into an aerosol and introduced into the plasma (≈10,000 K), where it is desolvated, vaporised, atomised, and excited. As the excited atoms return to their ground state, photons of characteristic wavelengths are emitted. These wavelengths are then separated by an optical spectrometer, and their intensities are detected to identify the elements present and quantify their concentrations. Different standards of lead were used to detect the concentrations of lead in our samples.

4) Statistical analysis: A one-sample Wilcoxon test was applied to compare the mean lead concentration of the ten ice-cream samples with the FSSAI regulatory limit of 0.02 mg/kg.

Result:

In our present study, samples B, D, F, G, and J had the lowest lead levels and a mean of 0.010 mg/kg for each sample (Table 1), indicating good production hygiene, clean raw materials (inputs), and well-maintained equipment. Samples A, C, E, and H had a slight increase in mean lead concentrations (0.013 mg/kg) (Table 1), which were still low and in compliance with FSSAI (Food Safety and Standards Authority of India). Sample I had the highest mean value at 0.017 mg/kg but was still below the FSSAI permissible limit of 0.02 mg/kg, indicating no health concern. The three readings of each sample demonstrate a high level of precision using the ICP-OES method.

The analysis of lead contamination in different ice cream samples indicated that all samples contained low levels of lead, with mean values ranging from 0.010 mg/kg to 0.017 mg/kg. This range showed overall good quality and

slight exposure to lead in the manufacturing process. These results indicate that all the ice cream samples taken for our study are safe for consumption, with lead levels that meet the regulatory standards of FSSAI.

However, it is important to keep checking raw materials, equipment, and processing conditions to ensure that contamination does not increase over time. The one-sample Wilcoxon signed-rank test demonstrated that the median lead concentration is 0.012 mg/kg, which is significantly lower than the FSSAI permissible limit of 0.02 mg/kg ($W = 0.00$, $p \leq 0.05$). These findings indicate that all analysed samples were well within the acceptable safety range.

Table 1. Quantification of lead in different ice cream samples

Ice cream Sample	Mean (mg/kg)	Standard Deviation
A	0.013	0.0047
B	0.010	0.0000
C	0.013	0.0047
D	0.010	0.0000
E	0.013	0.0047
F	0.010	0.0000
G	0.010	0.0000
H	0.013	0.0047
I	0.017	0.0047
J	0.010	0.0000

Lead concentration of samples (A-J) were measured in mg/kg using the ICP–OES method. Samples were taken in triplicate, and the mean was calculated. $P \leq 0.05$; the result is statistically significant. $W = 0.00$, where W is the Wilcoxon signed-rank statistic (sum of signed ranks).

Discussion:

In the present study, all analysed ice-cream samples exhibited very low lead concentrations, ranging from 0.010 to 0.017 mg/kg, which remain well below the permissible limit of 0.02 mg/kg established by FSSAI, indicating compliance with current safety standards. The consistently low lead concentrations across all samples indicate that manufacturers are using clean raw materials and maintaining proper hygiene during production. The minimal variation among triplicate readings reflects both good sample uniformity and the high analytical precision of the ICP–OES method. Samples B, D, F, G, and J showed the lowest values; A, C, E, and H samples recorded slightly higher concentrations; however, all remained well within the FSSAI permissible limit. Even the highest value, observed in Sample I, was below the permissible threshold, confirming that none of the ice creams poses a health risk.

In the previous studies by Conficoni *et al.* (2017) reported detectable and occasionally excessive lead levels in industrial ice creams in Italy. However, earlier studies in India on buffalo milk and dairy products reported detectable but low levels of lead contamination, which were primarily attributed to environmental pollution, contaminated feed, and water sources rather than manufacturing errors (Kambli et al., 2019). In line with this, our present study showed comparatively lower lead levels, suggesting strengthened quality control practices in the selected urban region.

Overall, the findings show that all samples meet regulatory safety standards, though routine monitoring of raw ingredients, processing equipment, and packaging remains essential to maintain low contamination levels and ensure consumer safety.

Conclusion:

The present study demonstrates that all analysed ice-cream samples contain lead concentrations well below the FSSAI permissible limit of 0.02 mg/kg, confirming their compliance with established safety standards. The consistently low values and absence of any sample exceeding regulatory thresholds indicate effective raw-material selection, hygienic processing, and controlled manufacturing conditions. Comparative assessment with previous studies further highlights substantially lower contamination levels in the current samples, suggesting improved quality control of Ice-creams within the different areas of Mumbai city. Overall, the findings affirm that the tested products pose no significant health risk; however, continued monitoring of ingredients, processing systems, and packaging materials remains essential to ensure sustained consumer safety.

Authors' contribution:

MK and AJ designed the study; MK and AJ performed the experiments. MK and AJ wrote the manuscript; SG reviewed and edited the manuscript; all the authors read and approved the final manuscript.

Acknowledgements:

The authors acknowledge Ms. Ayushi Singh for contributing to the conceptualization of the research idea and Dr. Vishal Kadu for the final review of the manuscript.

Financial support and sponsorship:

This work was supported by financial assistance in the form of an Institutional Research Grant from PTVA Sathaye College, Mumbai.

Conflict of interests:

The authors declare that they have no conflicts of interest.

Reference:

1. GadAllah, A. H., Zied, A. H. M. A., & Fahim, K. M. (2020). Risk Profile of Some Food Safety Hazards Associated with Ice-cream Sold in Egypt. International Journal of Dairy Science, 15(3), 123–133. https://doi.org/10.3923/ijds.2020.123.133
2. Murata, K., Iwata, T., Dakeishi, M., Karita, K., Department of Environmental Health Sciences, Akita University School of Medicine, & Department of Public Health, Kyorin University School of Medicine. (2009). Lead Toxicity: Does the Critical Level of Lead Resulting in Adverse Effects Differ between Adults and Children? In Journal of Occupational Health (Vol. 51, pp. 1–12). *Journal of Occupational Health*, Volume 51, Issue 1, January 2009, Pages 1–12,https://doi.org/10.1539/joh.K8003
3. Rahman, I., Furusho, Y., Begum, Z., Sato, R., Okumura, H., Honda, H., & Hasegawa, H. (2013). Determination of lead in solution by solid phase extraction, elution, and spectrophotometric detection using 4-(2-pyridylazo)-resorcinol. *Open Chemistry*, *11*(5), 672–678. https://doi.org/10.2478/s11532-013-0203-x
4. Singh, M., Ranvir, S., Sharma, R., Gandhi, K., & Mann, B. (2020). Assessment of contamination of milk and milk products with heavy metals. Indian Journal of Dairy Science, 73(6), 668–673. https://doi.org/10.33785/IJDS.2019.v72i06.005
5. Sani, N. A. H., & Amanabo, N. M. (2021). Lead: A concise review of its toxicity, mechanism and health effects. *GSC Biological and Pharmaceutical Sciences*, *15*(1), 055–062. https://doi.org/10.30574/gscbps.2021.15.1.0096

6. Bansal, O. P. & Chemistry Department, D.S. College, Aligarh-202001. (2020). Health impacts of the potentially toxic metals present in milk, dairy products, chocolates, alcoholic and non-alcoholic beverages: A review. In IOSR Journal of Environmental Science, Toxicology and Food Technology (pp. 35–46) [Journal-article]. https://doi.org/10.9790/2402-1407023546

7. Konstantas, A., Stamford, L., Azapagic, A., Sustainable Industrial Systems, School of Chemical Engineering and Analytical Science, & The University of Manchester. (2018). Environmental impacts of ice cream. Journal of Cleaner Production. https://doi.org/10.1016/j.jclepro.2018.10.237

8. Naseem, R., Abbasi, A. M., Ajab, H., Khan, L., F, F., & Yaqub, A. (2024). Quantification of toxic metals contamination and health risk assessment in processed and raw dairy products in Abbottabad city. Journal of Hazardous Materials Advances, 17, 100537. https://doi.org/10.1016/j.hazadv.2024.100537

9. Goswami, K., & Mazumdar, I. (2016). LEAD: THE SILENT KILLER IN OUR FAVOURITE STREET FOOD. Journal of Evidence-Based Medicine and Healthcare, 3(22), 969–971. https://doi.org/10.18410/jebmh/2016/221

10. Tripathi, R. M., Raghunath, R., Sastry, V. N., Krishnamoorthy, T. M., & Environmental Assessment Division, Bhabha Atomic Research Centre, Trombay, Mumbai 400 085, India. (1999). Daily intake of heavy metals by infants through milk and milk products. In The Science of the Total Environment (Vol. 227). https://doi.org/10.1016/S0048-9697(99)00018-2

11. Heavy metal presence in two different types of ice cream: artisanal ice cream (Italian gelato) and industrial ice cream. (2017). In Journal of Food Protection (Vols. 80–80, pp. 443–446) [Journal-article]. https://doi.org/10.4315/0362-028X.JFP-16-291

12. Kiyataka, P. H. M., Dantas, S. T., & Pallone, J. A. L. (2015). Method for Analysis and Study of Migration of Lead, Cadmium, Mercury and Arsenic from Polypropylene Packaging into Ice Cream and Simulant. Food Analytical Methods, 8(9), 2331–2338. https://doi.org/10.1007/s12161-015-0124-8

13. Amer, A. A., & Aiad, A. S. (2012). LEAD AND CADMIUM LEVELS IN SOME DRIED DAIRY PRODUCTS. In Alex. J. Vet. ,Sci. (Vol. 36, Issue 1, pp. 99–106).

14. Angayarkanni, R., Sridevi, G., Mohanambaal, D., Nagamuruga, B., & Sriram Educational Trust. (2019). A perilous consequence of ice cream. In INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH (p. 824). https://www.researchgate.net/publication/336239947

15. Conficoni, D., Alberghini, L., Bissacco, E., Ferioli, M., Department of Animal Medicine, Production and Health, University of Padua, Campus Agripolis, 35020 Legnaro, Padua, Italy, & EPTA NORD–Food Analysis and Consulting Srl, Via Padova 58, 35026 Conselve, Padua, Italy. (2017). Heavy metal presence in two different types of ice cream: artisanal ice cream (Italian gelato) and industrial ice cream [Journal-article]. Journal of Food Protection, 80–80, 443–446. https://doi.org/10.4315/0362-028X.JFP-16-291

16. Aggarwal, A., Verma, T., & Ghosh, S. (2022). Heavy Metal Residues in Milk and Milk Products and Their Detection Method. In IntechOpen eBooks. https://doi.org/10.5772/intechopen.105004

17. Kambli, A., Sole, S., Garud, K., Lonare, S., & Bagal, N. (2019). Quantitative analysis of toxic metals in buffalo milk samples from Mumbai suburban region by ICP-AES. Journal of Animal Health and Production, 7(1), 5−10. https://doi.org/10.17582/journal.jahp/2019/7.1.5.10

18. Sharma, A., Gupta, S., Shrivas, K., Chakradhari, S., Pervez, S., & Deb, M. K. (2025). Heavy metal contamination in cow and buffalo milk from industrial and residential areas of Raipur, India: A health risk assessment. Food and Chemical Toxicology, 196, 115178. https://doi.org/10.1016/j.fct.2024.115178