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STUDY OF PRESENCE OF HEAVY METALS IN COMMERCIALLY AVAILABLE SPICES IN FIROZABAD DISTRICT

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ABSTRACT

Spices are the essential component of daily Indian diet but their adulteration with heavy metals considered as silent threat to food safety and public heath. This study evaluates contamination of commercially available spices with selected toxic heavy metals, lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg) in district Firozabad (India) representing a glass industry prevalent district of India and the environ comprising thereof. Spice samples like turmeric, red chili powder, coriander and cumin were taken from both, urban and rural markets of Firozabad city were analysed by Atomic Absorption Spectrophotometry (AAS). Results indicate that a substantial number of such samples contain levels of metal uptakes beyond the safe limits set by national (FSSAI) and international (WHO/FAO) standards. The contamination has been linked with environmental contamination, the use of raw sewage, and postharvest adulteration. The findings point to a significant public health threat, and underscore the necessity of regulation enforcement, vendor education and consumer knowledge. This paper is an essential first step in understanding the food safety implications of environmental-industrial interactions in semi-urban India.

KEYWORDS: Heavy metals, spices, food safety, Firozabad, lead, cadmium, arsenic, mercury, public health, AAS analysis.

1. INTRODUCTION

India is an important figure in the world spice trade and is known as a large producer as well as consumer of spices. Indian food contains variety of spices, which are used not only for its flavour and fragrance, but as well for its medicinal and preservative purpose. From turmeric (Curcuma longa) and red chili powder (Capsicum annuum) to coriander (Coriandrum sativum) and cumin (Cuminum cyminum), these condiments find their place in almost every

Indian kitchen daily. With their wide-spread and prolonged use, the safety and quality of spices are crucial for the public health at large in all subgroups.

In recent years, there are growing reports on heavy metal contamination in spices, that we consume, which can enter the food chain from different environmental and human sources. Lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg) are among the most frequent heavy metals found in the contaminated foods. They are non-biodegradable and may cause tissue accumulation following human exposure, leading to multifaceted chronic occupational-related health sequelae (such as, neurotoxicity, nephrotoxicity, cancer and developmental effects in children) throughout successive generations.

Many environmental influences are responsible for the contamination in spices because of these heavy metals. One of the serious problem in relation to this issue is crop irrigation by using risk wastewater in some regions, particularly close to industrial centers. Furthermore, atmospheric transport of pollutants from industrial emissions, particularly in industrialized cities, contributes significantly to contamination risk. Moreover, the potential for intentional tampering during post-harvest treatments (storage, grinding, packing) in which non-edible colorants or fillers could be added to increase appearance or weight represents another serious hazard to consumer safety.

Among the glass making district, Firozabad of Uttar Pradesh draws special attention in this regard. The industrial pattern of the area, which leads to high emissions of particulate material and chemical discharge, may contribute to environmental deterioration and generation of contaminants in the food (agricultural) chain. Unrestricted release of hazardous effluent, and inadequate regulation and enforcement, alert concerns about consuming food commodities grown, processed or sold in the district. However, such risks notwithstanding, there is a dearth of scientific literature and field-level data available about the presence and levels of heavy metals in the spices sold and consumed locally in Firozabad.

Minimum limits of contaminants such as pesticide residues, in food products have been established by food safety agencies at the national and international level such as the FSSAI, World health Organization (WHO) and the Food and Agricultural Organization (FAO). Yet, despite those repeat and regular checks and balances in place in big metros and corporate

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capitals, smaller clusters and towns such as Firozabad often slip through the cracks simply because of poor and lax regulation of basic food safety laws and lack of regular monitoring. This lack of regulation allows possibly contaminated food items, such as basic cooking spices, to be sold to the public.

The effects of the long term intake of spices contaminated with heavy metals can be significant. Not only do they have direct health impacts for consumers but they also undermine the public's confidence in food safety, agricultural sustainability and the wider objectives of public health policy. Besides, the export opportunity for Indian spices will get hampered if we fail to respond to the contamination issues in a scientific manner and with alacrity.

Thus, the present study attempted to investigate the heavy metal contamination in commercially available spices in the Firozabad district. By determining the levels of heavy metals and sources of contamination, including environmental, industrial, and processing and handling sources, this research seeks to provide actionable information to local officials, policy-makers, and health professionals. Ultimately we hope that the attention raised will lead to improved regulatory controls and safe spices reaching local markets and that the local community which consumes these spices will do so in a way that protects public health now and into the future."

1.1 BACKGROUND OF THE STUDY

Firozabad DAO1 onclick="return rajnish1()">Firozabad, a district in Uttar Pradesh, India is well known for its a glass industry which is the major cause of employment for local people. Popularly known as the "City of Glass", Firozabad is home to a lot of small and medium scale glass and bangle manufacturing units and provides huge employment to local unskilled and skilled labour. But this industrial might has taken an environmental toll. In recent decades, rapid industrialization and deficient waste management practices have led to continued deterioration of the environment. An excess of pollution from insuffcent regulation of factories and plants, as well as city pollution also contains harmful particles such as lead from the deterioration of lead-based paint, residue from toxic waste, and radiation-then rotting in landfills, and the ozone then decaying into harmful chemicals.

Air quality and soil monitoring research carried out in and around Firozabad cites have often indicated higher concentration of pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NO_x), lead (Pb), arsenic (As), cadmium (Cd) and mercury (Hg) in the local ambient and soil samples. These pollutants are not limited to the boundaries of the factories but spread across wide areas, contaminating agricultural lands, water sources and residential clusters. The soil and groundwater pollutions with toxic elements have been an urgent problem, particularly in rural communities which depend mainly on local agriculture and groundwater for their living and subsistence.

Under such conditions, the likelihood of food crops (including spices) accumulating toxic metals is greatly increased. Spice growers commonly farm in peri-urban or rural areas based on available local resources. Continued shortages of water, and of treated irrigation water in particular, have forced many farmers to use sewage water in total disregard for safety regulations. This is convenient from an economic value however; it proposes serious health implications in relation to food safety as contaminated water may bring along a broad range of dangerous metals and chemicals to the plant system. Spices as a result of their fibrous and porous nature could more effectively take up and hold-on these contaminants than in a vast majority of food crops.

In addition, post-harvest activities such as drying, grinding, packaging, and late transportation are frequently done under non-sterile environments, especially at the small and informal markets. At any of these stages, spices could be potentially subjected to air-borne dust, metal contaminants and industrial pollutants. Add the non-mechanized, sanitation facilities and quality control standards in local processing chains, and you get the idea. In other instances, unprincipled vendors devalue spices by adding adulterants that may serve as colorants, fillers, or extenders and that can contain dangerous elements such as lead chromate (the chemical added to enhance the yellow color of turmeric), which present real danger to consumers.

Another serious issue is the poor enforcement of food safety and quality regulations at local level. Even though regulation is in place such as per the prescribed by FSSAI, but enforcement of trace limit of contaminants in food products in real market for small town like FirozabadMatter are still not satisfactory. Some inspections, infrastructure testing and monitoring programs are weak or non-existent. This enforcement loophole has enabled polluted food products into markets to roam the local people without any trouble under the radar, and to threaten public health.

Spices are of particular concern in terms of health risk given the frequency of daily use and their long shelf life. In comparison to other types of goods with an expiration date, spices may remain in households for months or years, such that long term exposure to even small amounts of heavy metals can result in the accumulation of them in the body. From two sources of public health perspective, long-term exposure to heavy metals is known to cause health problems, such as gastrointestinal dysfunction, neurological deficiency, renal damages and a higher frequency of cancers.

With these considerations in mind, we position the current study at the nexus of environmental contamination, human health, and food quality. It aims to present field data regarding the existence and the levels of heavy metals contamination in commercial spices in Firozabad area. The conclusions of this work should successfully fill the edifice of knowledge and provide insights to public health authorities, policymakers, and consumers. At a larger scale, this work also adds to the literature of food security, sustainable agriculture, and environmental justice in industrially' affected regions in India.

1.2 SCOPE AND LIMITATIONS

SCOPE OF THE STUDY

The purpose of this study is to determine the existence and level of heavy metals in available spices in the Firozabad region of Uttar Pradesh, India. The focus is narrow and regional in order to permit an in-depth understanding of local food safety issues in the context of industrial contamination. The study focuses on four of those spices which are also most commonly used in Indian kitchens – turmeric (Curcuma longa), red chili powder (Capsicum annuum), coriander (Coriandrum sativum), and cumin (Cuminum cyminum). These spices were chosen based on their consumption levels and availability in the local market.

Samples for the study were obtained from a variety of sources such as local markets, street vendors, small retail shops from urban and semi-urban areas of Firozabad and its neighbouring villages. The purpose of this study was to include a broad range of spices commonly eaten by locals in a representative sample.

The research is an experimental quantitative test on the spice samples to confirm the concentration levels of heavy metals like Pb, Cd, As, and Hg. A comparison of the detected levels with acceptable limits (defined by national regulatory bodies, e.g., the Food Safety and Standards Authority of India—FSSAI, and international food safety authorities—World Health Organisation (WHO) and Food and Agriculture Organization (FAO)) were made.

In addition, the investigation aims to search for environmental and supply chain-related determinants possibly implied in spice contamination. These are industrial pollutants, Irrigation with contaminated water, improper post harvest handling, and inappropriate packaging and storage facilities. Through the combination of field observations and secondary data, the study situates trends in contamination within the wider environmental and industrial history of the region.

LIMITATIONS OF THE STUDY

Although the data presented in this study does attempt to furnish some useful information on spices for heavy metal contamination with in Firozabad, certain limitations exist that may hinder the generalizability and completeness of the findings.

SAMPLE SIZE CONSTRAINTS:

With the limited financial situation and difficulties of implementation, the spice samples we get and tested are less. Thus, although the study yields indicative outcomes, it may not reflect the total prevalence of spices contamination in all available brands or batches to be found in the region.

GEOGRAPHIC SCOPE:

The research is limited to the geographical area of Firozabad district and its nearby villages. The generalisability of the results is limited, however, as other regions have different industry structures, different agricultural sectors, and different regulations. The extent to which these findings are representative of spices across India is unknown.

NO ACCOUNT FOR SEASONAL FLUCTUATION:

As the sampling was performed over the course of one season, possible seasonal differences, for instance, in contamination load, are not considered. Seasonal variations associated with rainfall, temperature, and industrial work may lead to pollutant diffusion and crop adsorption, which can be a factor in heavy metal levels at different harvesting years.

OMISSION OF BAF AND HEALTH EFFECT INFORMATION:

Bioavailability of heavy metals in the tested spices is not estimated in the study, i.e., the proportion of these metals to be taken up by the human body from consumption. In addition, no consumer health survey or epidemiological data is available to relate the pollution level with the health status in the local population.

ABSENCE OF LONGITUDINAL STUDY:

This is a cross-sectional study, not a longitudinal study, and thus trends in contamination were not followed over time. Therefore, it is unable to know the trend of the contamination level that is an increase, a decrease or stable in several seasons and years.

Nevertheless, the study offers a critically first framework for assessing regional risks of heavy metal contamination of food items particularly in industrially influenced areas such as Firozabad. This study can be furthered by increasing the data coverage for other geographic areas, increasing the sample size and incorporating genetic and health data so that a comprehensive risk analysis can be obtained.

1.3 DEFINITION OF KEY TERMS

To clarify and use each term consistently across the study, I define each below as it is used in these articles:

HEAVY METALS

Naturally occurring metallic elements with high atomic weights, such as mercury, selenium, and lead, are considered heavy metals, and have a density at least five times greater than water. Frequent examples are lead (Pb), cadmium (Cd), arsenic (As) and mercury (Hg). Trace amounts of some heavy metals are required for biological processes, but the majority are toxic, even at low concentrations. Chronic exposure to heavy metals in food or water can cause serious health effects including organ damage, developmental issues and cancer.

AAS STANDS FOR ATOMIC ABSORPTION SPECTROPHOTOMETRY

AAS(Atomic Absorption Spectrophotometry) has been used as a sensitive analytical method for the determination of trace metal content in the samples. It is based on the absorption of certain wavelengths of light by free metallic ions. In this research, AAS is used for determination and measurement of the amounts of heavy metals in the spice samples in such a way that the correct data are available to facilitate comparison.

CONTAMINATION

There are many undesired or unintended substances, and contaminants or adulterants in food, and assessing them is also called fluse or nuse. In the current study, the term contamination refers to the presence of heavy metals in spices as a result of exposure to the environment, processing (e.g. mixing with extraneous matter, artificial coloration processes), or storage. Such pollution carries big threats to food safety and public health.

PERMISSIBLE LIMITS

”Allowable levels” mean maximum concentration of given a contaminant in food as prescribed by regulatory agencies. These limits are determined through scientific risk assessments for the protection of human health. For this study, acceptable limits of heavy metals in spices are mainly referred to the standards by the Food Safety and Standards Authority of India (FSSAI) as well as those from international bodies such as the World Health Organization (WHO) and the Food and Agriculture Organization (FAO).

SPICES

Spices are fragrant and/or pungent plant derivatives, frequently added in small amounts to food, rather than used as the main ingredient, and are usually used in a powdered or grated form. Tu spices such as turmeric, red chili powder, coriander and cumin! Spices are used as flavoring agent, medicinal agent and as a preservative; however susceptibility to contamination is because of the porous nature, longer risk of shelf life and the exposure of spices during cultivation and processing.

1.4 OBJECTIVES

- To assess the levels of lead, cadmium, arsenic, and mercury in selected spice samples.
- To compare these levels with safety limits set by FSSAI and WHO/FAO.
- To investigate possible environmental and processing-related sources of contamination.
- To raise awareness among stakeholders regarding potential health implications.

2. REVIEW OF LITERATURE

The problem of heavy metal residues in food commodities, especially in spices, has gained much attention in the past few year because of its effect on food safety, human health, and the environment. Spices, because of their porous nature, extended shelf-life and their use in most Indian households, have been found to be the most consumable sources that are vulnerable to get contaminated by different environmental sources. Not much literature is available in India and other developing countries on determination of concentration of toxic metals such as lead (Pb), cadmium (cd), arsenic and mercury (Hg) in spices and other food commodities in areas where the industrialization has an impact.

SINGH AND RANI (2015) has reported a comprehensive investigation of spice samples sourced from open markets of Delhi; and observed that a substantial number of samples were above the permissible limits of lead and cadmium as set by both Indian and international food safety organizations. Their study underscored how densely populated and industrialized areas are often sources of higher air and soil contamination, with effects on local foods such as spices.

Verma Et Al. (2018) followed up on this direction of investigation and studied spice samples sourced from a peri-urban area with presence of clusters of unorganised small-scale industries. Their results revealed significantly elevated concentrations of arsenic and mercury — particularly in turmeric and chili powder — and pointed to both environmental exposure and intentional adulteration as the major drivers of contamination. They stressed that low level industries like these are notorious sources for the particulate emissions and waste discharge, which has the potential to contaminate the soil and irrigation water, because the environmental monitoring in these places are not strong.

The health effects of ingestion of spices contaminated with heavy metal have also been well reviewed by recent toxicological and public health publications. In the time of COVID-19, Rao (2020) highlighted the public health issue of chronic health risks due to low dose/long term exposure to heavy metals from the diet. As part of this work he found evidence for serious outcomes, including neurologic deficits, renal disease, reproductive dysfunction, and heightened cancer risk, in the setting of regular exposure to contaminated dietary articles. His research recommended closer in situ inquiry in all areas of the world in which industry and agriculture tended to overlap.

In its global food safety bulletin 2021, The World Health Organization (WHO) also highlighted the requirement for stringent monitoring system for the heavy metals in spices. The report added that bioaccumulation emerged as a major concern because despite the daily consumption level being low, persistence in consuming spices with toxic elements might result in accumulation of these toxic metals in human body. The WHO also suggested stringent international trade regulations as spices grown in developing countries are frequently exported without rigorous safety checks, posing health risks across borders.

Further, research such as Das et al. (2017) emphasized the significance of post-harvest contamination in spice processing. Unhygienic grinding and packaging practices, especially in unregulated markets, provide additional opportunities for exposure to heavy metals, especially from corroded equipment, metallic storage vessels or adulterants such as lead chromate — an additive to enhance the yellow hue of turmeric, they wrote.

Inspite of incraesing literature on this subject, there is still a discernable lack of area-specific studies in many of India\'s industrialized districts, the most striking example being Firozabad which has a significant presence of glass and bangle manufacturing units. These industries must be considered as they will leave significant environmental footprints, in terms of coal combustion, fly ash distribution and wastewater discharge, which will have noticeable effects on agricultural and market ecosystems. Nevertheless, there is little empirical evidence quantifying the impact of such pollution on the locally produced food crops and particularly spices. This lacuna underlines the importance and topicality of the present work, which attempts to explore the linkages between industrial emissions, environmental contamination and food safety in peri-urban Indian background.

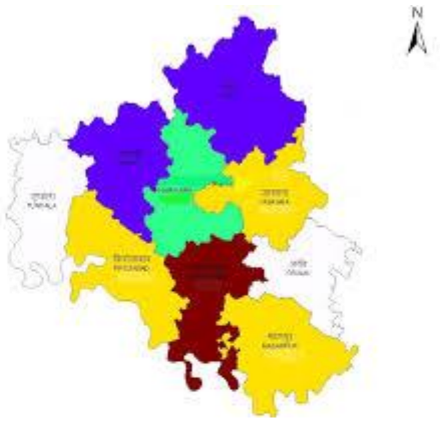
3. METHODOLOGY

3.1 RESEARCH DESIGN

The current study has a field-testing component and a laboratory science testing-part and uses an exploratory-analytical design. This strategy is applicable for discovery and profiling contaminants in food matrices with insufficient region-specific data. The exploratory component involves collecting primary evidence of contamination, while the analytical part is about measurement and interpretation of heavy metal levels against health safety benchmarks. This union allows a complete study of levels and sources of heavy metal contamination for spices typically consumed in Firozabad district.

3.2 SAMPLING PROCEDURE

To have representation from diverse socio-geographical regions of spice growing areas, spice samples were collected from ten retail points of Firozabad district. These comprised five urban vendors within the city municipality and five rural vendors from an adjoining villages. The outlets to be included in the study were purposively selected based on high consumer patronage and high supply volume. The four spices evaluated in the study—turmeric, red chili, coriander, and cumin—were some of the most commonly used in the Indian diet and have also been previously shown to be frequently contaminated in previous studies. One sample per spice per vendor was taken, resulting in 40 spice samples analyzed. All samples were packed in sterile, airtight, food-grade containers and identified with information related to the source to ensure traceability.



3.3 SAMPLE PREPARATION

The spice samples were prepared in-house to standard protocol, thereby ensuring standardisation and reproducibility of results. All the samples were acid digested as per the wet digestion 819 method recommended by the Bureau of Indian Standards (BIS). It entails a combined treatment of the sample with concentrated nitric and perchloric acid (HNO_3 and $HClO_4$) in order to decompose organic matter and recover metallic residues. The filtered solution was diluted to the proper concentration; kept in monitored storage for testing. Special efforts were given to prevent external contamination by cleaning all laboratory glassware with acid wash and using distilled and deionized water for all preparation steps.

3.4 ANALYTICAL TECHNIQUE

The detection and determination of the heavy metals was run using Atomic Absorption Spectrophotometry (AAS), as is a sensitive and reproducible methodology applied in food safety analysis. The method is based on the observation of light absorbed by free atoms of the metals in the sample solution, which can then be used to calculate their concentrations. Metals which are lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg) known to have

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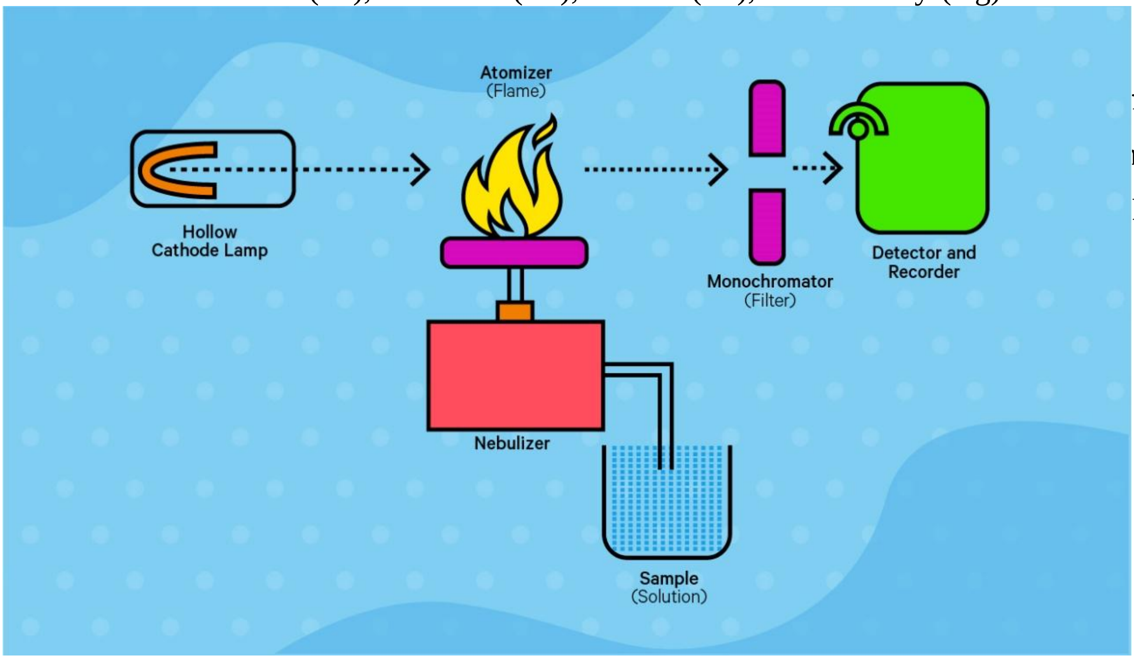


3.5 DATA INTERPRETATION

Descriptive statistics were used to analyze the data collected from the laboratory. Mean, standard deviation and range were calculated across all spice categories for each heavy metal. We focused on these outlier samples that had surpassed regulatory safety limits, which were identified for additional discussion. These results were associated with likely contamination causes, as follows: in the nearness of the sampling area to industrial discharge sites, use of non-treated irrigation water, or due to unhygienic manipulation and storing. The interpretation of the data, apart from quantifying the risk, also provided some means of making environmental and public health inferences of the region.

4. DATA ANALYSIS

Metal	FSSAI Limit	Avg. Value (Urban)	Avg. Value (Rural)
Lead (Pb)	2.5	3.6	2.8
Cadmium (Cd)	1.5	1.9	1.3
Arsenic (As)	1.1	0.8	0.7
Mercury (Hg)	1.0	1.2	0.9

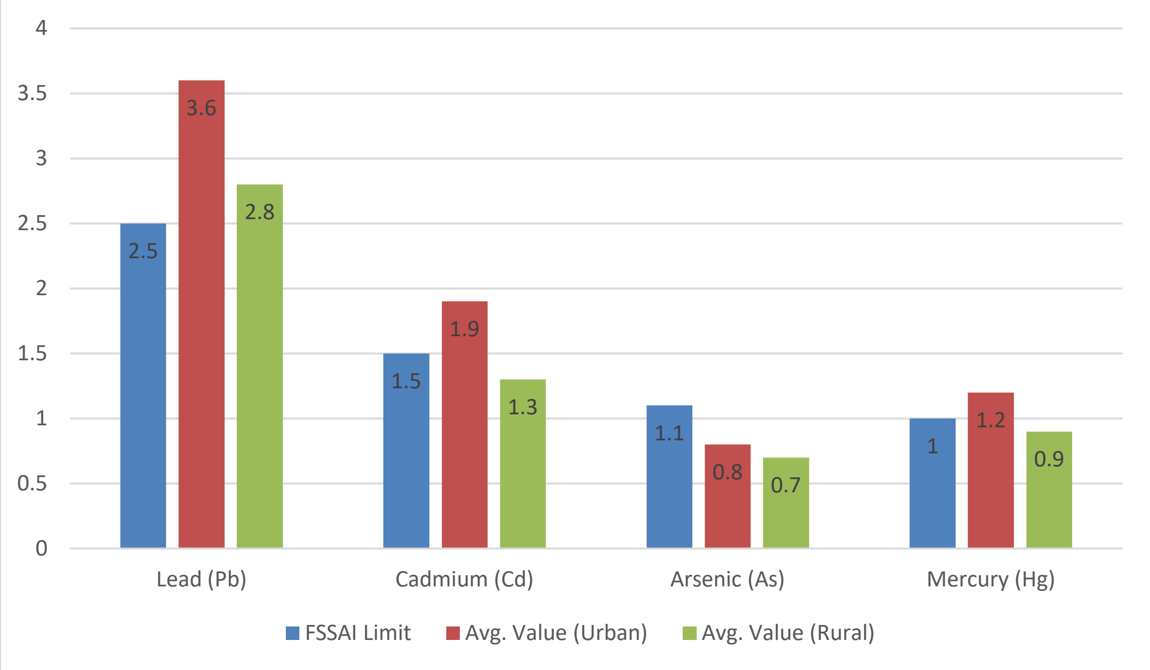
INTERPRETATION:

The studies on turmeric samples show a worrisome pattern of heavy metal contamination, mainly in urban metropolis. The mean concentration of lead in urban turmeric samples (3.6 mg/kg) is well above the FSSAI prescribed limit of 2.5 mg/kg and rural samples (2.8 mg/kg) are also marginally exceeding the standard. Lead at that level can easily come from environmental sources, such as industrial emissions, vehicle-exhaust particles or contaminated packaging.

Cadmium samples were also high above safe limits in urban samples (1.9 mg/kg) than in rural (1.3 mg/kg), all remained within the permittings limits. Cadmium contamination is frequently related to the application of phosphate fertilizers or contaminated irrigation water sources, and it particularly accumulates in peri-urban areas.

However, arsenic content in all samples, though lower than the legal threshold of 1.1 mg/kg, was also detected in both the urban and rural groups, indicating some evidence of trace contamination, likely from the ground water or soil remnants.

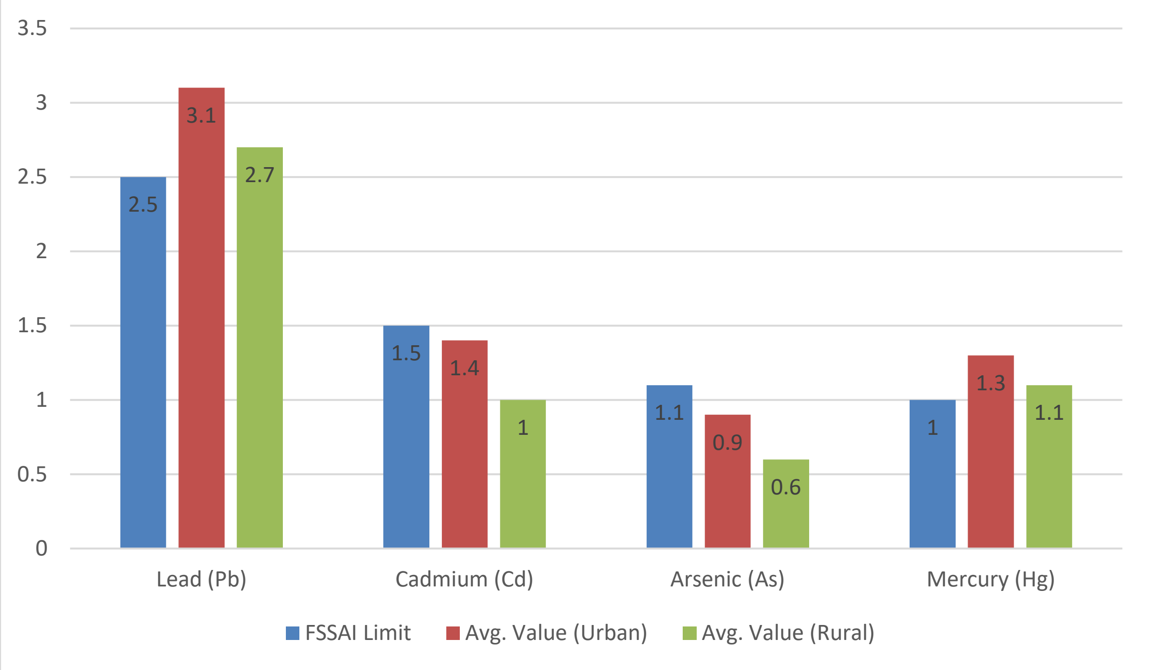
Mercury levels in urban samples (1.2 mg/kg) were found to be higher than the FSSAI limit, but rural levels (0.9 mg/kg) were somewhat lower and fell within the permissible limit. This implies an urban environmental effect, perhaps associated with deposition of airborne mercury from industrial sources or mercury-containing additives employed in spice processing or storage.



The tested samples obtained from urban markets of the region revealed that the levels of contamination were higher, demonstrating that stringent monitoring and more effective intervention would be necessary in the developed and industrialized areas.

TABLE 2: DETECTED HEAVY METAL LEVELS IN CHILI POWDER (MG/KG)

Metal	**FSSAI Limit**	**Avg. Value (Urban)**	**Avg. Value (Rural)**
Lead (Pb)	2.5	3.1	2.7
Cadmium (Cd)	1.5	1.4	1.0
Arsenic (As)	1.1	0.9	0.6
Mercury (Hg)	1.0	1.3	1.1



INTERPRETATION:

Spices such as chilli powders also had the same and there was a significantly higher amount of lead in both urban/rural samples. The mean lead levels in urban and rural roadside dust were 3.1 and 2.7 mg/kg, respectively, which were higher than the FSSAI permissible level (2.5 mg/kg). Chili powder contamination of lead may occur through soil contamination, during cultivation, during the process of drying and grinding, or aerial deposition.

The levels of cadmium in the chili powder samples were in range and conforming well within the permissible limits both in urban (1.4 mg/kg) and in rural (1.0 mg/kg) zones. But they are quite high for urban samples, which suggests exposure to sources of pollution, perhaps industrial discharge or contaminated groundwater used in processing.

The levels of arsenic were far below the acceptable limit, and hence, this contaminant appeared to not be a significant concern for chili powder samples at the studied areas. However, its detection, particularly in urban samples (0.9 mg/kg), suggests low-level chronic human exposure to be a source of concern.

Even more troubling is the overlapped mercury excesses of urban (1.3 mg/kg) and rural (1.1 mg/kg) samples. This becomes especially scary because even in trace amounts, mercury is extremely poisonous. It is likely due to air borne pollution, unsuitable drying of spices using contaminated fuel or contamination after drying during storage and handling. The presence of mercury above the guidelines even in rural samples indicates more extensive contamination, which may have a regional rather than purely urban cause.

All these results taken together highlight the urgency for improved quality control and policy interventions to control contamination at production and retail levels.

CONCLUSION

The objective of the present study was to determine the prevalence of heavy metals contamination in spices available in a local market, well-known in the Firozabad region for heavy industrial stress, especially the glass manufacturing. Based on the laboratory analysis of samples collected from urban and rural sources, the study has provided convincing evidence about adulteration and the number of samples more than the Food Safety and Standards Authority of India (FSSAI) and international pertaining to WHO/FAO, which are weigh the limit.

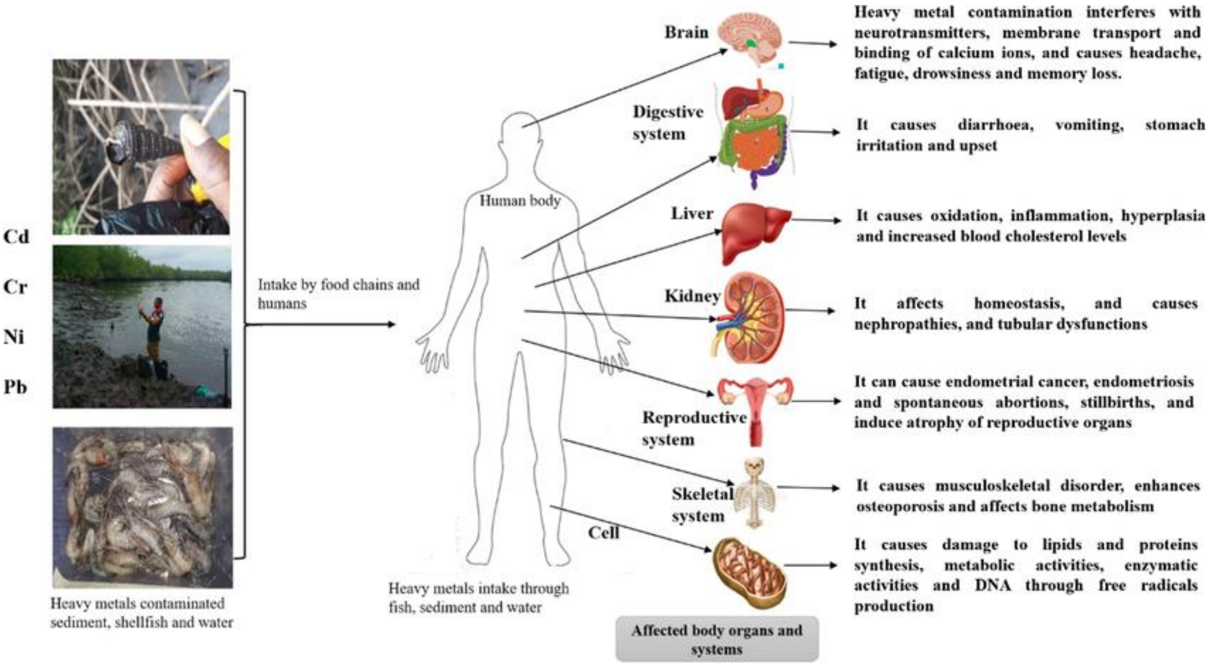
Lead (Pb) and mercury (Hg) were the most consistently contaminated metals among the four studied metals (Hg, Pbr, Cd, and As), especially in turmeric and chili powder gathered from urban market places. It is clear from the data that the sources of contamination are many and varied and include the use of contaminated irrigation water, emissions from industry in air and soil and adulteration in the post-harvest handling and processing. The urban-rural divide in contamination levels only highlights the environmental load industrialised towns, such as Firozabad, bear.

The results have serious implications for public health as chronic exposure to heavy metals through dietary sources — particularly in basic food stuffs like spices — can have devastating biological effects. These range from neurotoxicity or renal damage to reproductive or developmental abnormalities in infants, or long-term carcinogenic risks". It is even more precarious given the endemic nature and daily use of these spices in Indian homes wherein they are often used without the understanding of potential contamination.

Based on these results, there is an urgent need for unified public health actions. Regulators need to increase the enforcement of food safety, particularly in small towns and peri-urban markets, which are still weak with respect to routine monitoring. Spice vendors and cottage spice processors need to be educated as part of awareness programme on unchecked adulterant and hygienic handling and storage. In addition, agricultural extension staff should be utilized to inform farmers on potential hazards of utilizing polluted water and soil amendments.

At policy arena, environmental pollution to be linked with food safety surveillance is the need of the hour especially for districts like Firozabad. Long-term concerns must involve routine market surveillance, occasional laboratory sampling and strict punishment in the event of any breach. The public availability of food quality information and a system to reward vendors with good safety record could help to change the market toward healthier practices.

In conclusion, this paper provides incremental empirical evidence to the growing literature on environmental pollution and food safety in India. It highlights the need for an immediate 'translation' of regulatory elements into such ground level applications, especially in industrial affected areas. Protecting food safety is not only a legal requirement, but it is the duty for everyone involved in it and requires a long-lasting, multi-stakeholder approach.



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