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Lead: A Silent Menace in Household Spices of India?

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Abstract:

In recent years, there has been a growing interest in monitoring the heavy metal Lead (Pb) concentration in spices. Spices can improve the taste of food and can also be a source of many bioactive compounds, but, unfortunately, can also be contaminated with potentially dangerous substances like the heavy metal lead (Pb). This study was conducted to investigate Pb contamination in selected spices commonly consumed in India. Samples of Black Pepper powder, Chat Masala, Chili powder, Curry powder, Garam Masala and Turmeric powder from 15 selected stores across Kolkata, India, were collected using the Market Basket survey method and tested using Atomic Absorption Spectrophotometry for the level of Pb in each sample. Samples were found to have Pb levels below the FAQ/WHO levels of 0.3µg/gm except for Turmeric powder and Chili powder. The highest levels of Pb was found in Chili powder and Turmeric powder, which greatly exceeded the permissible amounts. Since these spice powders have widespread and very common uses across India, chronic and long term exposure can lead to elevated blood lead levels and cause hazardous accumulation of Pb in body.

Keywords: Spice powder, Lead, Atomic Absorption Spectrophotometry, Heavy metal poisoning

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Introduction:

Environmental pollution is the main cause of heavy metal contamination in food chain. The heavy metal lead (Pb) contents of individual foods varies and depends upon the Pb introduced in the growing, transport, processing and fortification of food. The other technological processes used to bring the food to the consumer can significantly increase the total heavy metal content of the food [1]. There is no known biological function of lead and its toxic effects are numerous, including musculoskeletal, renal, ocular, immunological, neurological, reproductive and developmental effects [2]. Chronic exposure of children to even small amounts effects intelligence [3].

Spices are being used as diet components often to improve color, aroma, palatability and acceptability of food. Beside these flavoring components, every spice contains the usual components like special alkaloids, tannins, or polyphenols.

Spices are now considered a potential source of lead poisoning within aarently lead-safe home environments, a place taken up previously by non-refined automobile petrol and house wall paints. [3] The risk increases with an increased propensity to consume food items, specially snacks which contain an abundance of several flavoring condiments together, in form of commercially available spice mixes.

The objective of our investigation was to determine the prevalence of Pb contamination among various commercially available spices sold in stores in the local retail markets in our area of study.

Materials and Methods:

The commonly used commercial spice mixtures sold in local markets viz. , turmeric powder, Chili powder, curry powder, chat masala, garam masala, and black Pepper powder, all locally made, were analyzed for concentration of Pb in them. Samples were collected using market-basket survey method from 15 randomly selected stores in Kolkata, India. The name, manufacturer's location, packaging location, lot number, expiry date, store name and purchase date were recorded whenever available.

The study focused on the contamination assessment of spices that were traded in Indian markets during 2013-14. For determination of Pb concentrations a wet digestion of the dry samples

was done using concentrated H_2SO_4 and 30% H_2O_2 mixture. 0.5 gm of dry powder sample was placed in 100 ml beaker with 3.5ml 30% H_2O_2 and the content was heated to 100^0 C. Temperature was gradually increased to 250^0 C and the whole mixture was left at this temperature for 30 min. The beaker was cooled then and again 1ml of 30% H_2O_2 was added to the digestion mixture and the contents reheated. The digestion process was repeated till a clear solution was obtained. The clear solution was transferred to a 50ml volumetric flask. A blank digestion solution was made for comparison without the spices. [4,5]. A 100 m standard solution for lead under investigation was prepared by dissolving 1.5980 gm of lead nitrate in 100ml of demonized water (Type1 water from Elix 15 Millipore filtration system) and used for calibration. The measurements were done by Perkin Elmer AAS 2380 Atomic Absorption Spectrophotometer with double beam and background deuterium correction. Hollow cathode lamp of Pb was used at 283.3 nm wavelength. For flaming air-acetylene was used. Measurements were done against standard solutions.

The validity of the developed method has been ensured by incorporating various quality control (QC) checks and analysis of certified reference materials (CRM).

The laboratory obtained acceptable recovery for the analyzed metal Pb (z-score values in acceptable limits). The results were expressed in µg/gm of dry weight and evaluated by comparing with the maximum permissible limits (MPL) on the basis of international food standards given by FAQ/WHO, which is 0.03µg/gm [6].

Results:

The spices that were used for the study were obtained from local markets of Kolkata, West Bengal. The content of Pb has been analyzed in 6 local spice powders, and the outcome presented in Table I.

Mean and standard deviation were computed using SAS statistical software and the Duncan's multiple range test (MRT) [7].

Table I- Mean concentration of Lead and their range in spice mixtures

Product	No of samples	Lead in µg/gm (mean± SD)	Range µg/gm
Black Pepper powder	38	0.39 ± 0.03	0.11-0.42
Chat Masala powder	38	0.26± 0.09	0.07-0.40
Chili powder	48	2.6 ± 1.15	0.8-7.6
Curry powder	38	0.37 ± 0.05	0.29-0.42
Garam Masala powder	38	0.27 ± 0.07	0.06-0.41
Turmeric powder	52	3.2 ± 1.73	2.94-9.21

It can be observed from the table that a significant number of spices, including Curry Powder, Chat Masala Powder, Garam Masala Powder, and Black Pepper Powder contain Pb values within the maximum permissible limits ascertained by FAQ/WHO[6]. However, a statistically significant ($p<0.001$) increase in Pb contamination was seen in cases of Turmeric Powder and Chili Powder obtained for the study.

Discussion:

The presence of Pb in spices has been reported from several geographical locations. [8] Contamination may occur accidentally through contaminated irrigation water and fertilizer or deliberately when weight and color of the products are deceptively enhanced for profit through adulteration. Daily exposure to low level of Pb through food additives can result in chronic subnormal level ingestion and over time, may act in a cumulative fashion to produce exposure effects. This is of particular concern because recent literature report significant reduction in the safe blood Pb level in paediatric population. Spices imported from India were reported to be the cause of toxic levels of Pb in blood of children and adults in USA. [9]

Market Basket Survey was the allied sample collection method. This methodology enables systematic study of food items consumed in the community for assessment of food availability, cost and quality at individual household, community or national levels. [10, 11]

Increased levels of Pb in these spices indicate that the plants are prone to accumulate these elements from the environment. The results obtained from the present study indicate that some spices exceeded the permissible levels of Pb, therefore, like other food products; they should be under continual scrutiny. Though it is suggested that accumulation rate of Pb is higher in the leaves of plants than other parts, which might indicate that atmospheric contamination is more a source of toxicity than uptake from soil or water, some toxicity could be attributed to the use of highly contaminated irrigation water and addition of

fertilizers and pesticides in uncontrolled manner. Added to these are sewage sludge, industrial activities, fuel and automobile exhaust etc, which are all potential sources of toxicity [12].

Pb is among the most toxic heavy metals owing to the fact that it accumulates in biological tissues and keeps on increasing in tropic levels; a phenomenon known as 'bio-magnification [13]. Pb damages health in two ways: Disruption of normal cellular processes leading to toxicity, and bio-accumulation, particularly in liver and kidney, in which the rate of excretion is much slower than rate of uptake [14].

Few studies have been conducted on the level of heavy metals in spices and vegetables. [8,9, 11,12] They have demonstrated excessive amount of Pb in spicy food condiments. They affirmed that the heavy metal contents in spices varied depending on the country of origin, environmental pollution levels, plant part associated and technological processing. Also several recent food borne incidents have involved adulteration, both accidentally and with an intention to improve colors of consumable spices and herbs. Keeping such facts in mind, it is important to evaluate the levels of Pb in milled spices consumed regularly by a majority of population [15].

The Pb content in spices reflects environmental pollution levels, bio-accumulation in plant tissue, alication of materials containing Pb such as arsenate based pesticides for higher production. Hence the high level of Pb could be due to the indiscriminate use of fertilizers to boost up production, or due to the practice of growing plants with the help of sewage sludge or near area containing high risk of contamination, i.e. near plastic or rubber manufacturing plants [16].

Conclusion:

The present investigation confirmed spices sold in Kolkata, India, to contain low concentrations of Pb for Black Pepper powder, Chat Masala, Curry powder, and Garam Masala, with detected Pb levels well below the stipulated Codex standard for spices (0.3 µg/gm), although the FDA has no recommended maximum level of Pb for spices. But high level of Pb was detected in Chili powder and Turmeric powder. Their availability and widespread use across different regions and cultures through India opens up a new avenue for chronic Pb toxicity and public health risk. Further studies should be conducted to estimate intake of Pb through this route and to ascertain possible health hazards.

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