IJAIR
International Journal of Agriculture Innovations and Research
Volume 3, Issue 2, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 22/08/2014 | Accepted on : 02/09/2014 | Published : 10/09/2014

Lead Poisoning and Some Commonly used Spices: An Indian Scenario

Prof. K. Goswami
Professor, Deptt. of Biochemistry,
Sarder Rajas Medical College, Hospital & Research Centre,
Jaring, Odhisha

Dr. I. Mazumdar
Asst. Professor, Deptt. of Biochemistry,
KPC Medical College & Hospital, Jadavpur, Kolkata
Email: mazumdaripsita@gmail.com

***Abstract* – Lead (Pb) is a heavy metal with wide applications in many fields, because of its broad range of industrial usage. It is also a common occupational and industrial hazard throughout the world. The toxicity of Pb remains a matter of public health concern, and the awareness about its toxic effects at exposure levels has gained a lot of importance over recent years. There has been a growing interest in monitoring heavy metal contamination in spices. The present study has been conducted to determine the concentration of Pb in eleven commonly used spices available in local Indian markets. The samples have been processed, digested and finally analyzed using Atomic Absorption Spectrophotometry.**

The levels of Pb in most spices were found to be within acceptable reference limits with the exception of cardamom, cinnamon, cloves, coriander, fenugreek, and ginger. In 20 gm of each of these spices the Pb level was found above the maximum permissible limit (MPL) as proposed by WHO/FAO and US, FDA. Generally, most of the spices available in the market are safe for human consumption, as far as Pb poisoning is concerned, in the amount of 20 gm. But excessive consumption, in concentrated form, is inadvisable over a long period of time, as it has potentials to cause harmful accumulation of Pb in the body. As for cardamom, cinnamon, cloves, coriander, fenugreek, and ginger, the daily consumption level should be curtailed to avoid long term health hazards due to Pb poisoning.

***Keywords* – Lead, Spices, Food Condiments, Atomic Absorption Spectrophotometry.**

I. Introduction

Lead has been one of the most important heavy metals with wide applications for many centuries, because of its broad range of industrial usage in the manufacture of batteries, fuel additives, pipes, pigments, solders, shielding etc. it is a common occupational and industrial hazard throughout the world. The toxicity of Pb remains a matter of public health concern due to its pervasiveness in the environment and the awareness about its toxic effects at exposure levels lower than what was previously considered harmful. [1]

In recent years, there has been a growing interest in monitoring heavy metal contamination in spices. ‘Spices’ can be defined as the dry part of a plant such as roots, leaves and seeds, which impart a food a certain flavor and pungency. They have been used for several purposes since ancient times. Many common spices have outstanding antimicrobial effects also. On the other hand, the process of preparation and handling can make them a source of food poisoning [2]. Natural food spices have been reported to contain significant quantities of some heavy metals like Pb. The addition of spices that may be contaminated with trace and heavy metals to food as a habit may result in accumulation of these in human system leading to different health troubles. [3]. Environmental pollution is the main cause of heavy metal contamination in the food chain and Pb is potentially of major concern. Such exposure can also affect the fetus leading to abortion and preterm labor, and may produce mental retardation in children as well. Adults may suffer from multiple organ injury [4].

The objective of this study is to accurately analyze the levels of toxic heavy metals like Pb that might be present in some major spices available in local markets in the states of Odhisha and West Bengal in India, and to cross reference these measured levels with the recommended limits specified by the international health related organizations like WHO, FAO and US, FDA.

II. Materials and Methods

Samples of common spices were collected from the local markets and classified according to the part of the plant used, with their common, scientific and local names. [Table I]. Origin of sample is not specified. Samples were packed in polythene bags and kept in cool dry cardboard prior to analysis.

Table I: Classification of spice samples

Spice	Scientific Name	Family	Part Used
Black pepper	Capsicum nisrum	Piperaceae	Seeds
Cardamom	Elettaria cardamonum	Zingiberaceae	Seeds
Cinnamon	Cinnamonum zylanicum	Lauraceae	Bark
Cloves	Syzygium aromaticum	Myrtaceae	Bud
Coriander	Coriandium sativum	Umbellifeae/Apiaceae	Seeds
Cumin	Cuminum cyminum	Umbellifeae/Apiaceae	Seeds
Fenugreek	Trigonella foenumgraecum	Legomnosea	Seeds
Garlic	Allium sativum	Allium sativum	Bulb
Ginger	Zingiber afficenalis	Zingiberacea	Rhizome
Thyme	Thymus vulgaris	Labiatae	Leaves
Turmeric	Cuccuma longa	Zingiberacea	Rhizome

Samples were cleaned and oven dried at 80^0 C for 12 hours before chemical analysis. The dried samples were ground in a hand mortar till fine, and the powder was sieved with a 0.5mm nylon mesh before analysis.

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 ground 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. [5],[6]. A 100 ppm 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 comparison with the maximum permissible limits (MPL) on the basis of international food standards. [7].

The daily intake (µg/kg/day) was calculated based on the following assumptions:-

1. The average weight of the person was thought to be 50kg.
2. The average spice intake is 20gm/day

The daily intake (µg/gm/day) = metal concentration in spice x 20/1000/50.

Descriptive statistical parameters (mean±SD) were calculated using the Excel computer program.

III. Results and Discussion

The spices that were used for the study were obtained from local markets of Bhabanipatna, Odisha and Kolkata, West Bengal. The content of Pb has been analyzed in 11 local spices, and the outcome presented in Table II

Table II: Concentration of Lead (µg/gm dry wt) for common spices

Spices	Pb in µg/gm
Black pepper	0.397 ± 0.002
Cardamom	0.672 ± 0.006
Cinnamon	0.961 ± 0.019
Cloves	0.290 ± 0.003
Coriander	0.299 ± 0.014
Cumin	0.289 ± 0.017
Fenugreek	1.461 ± 0.131
Garlic	0.277 ± 0.016
Ginger	1.156 ± 0.290
Thyme	0.462 ± 0.019
Turmeric	0.296 ± 0.005

Values represent mean ± SD

The values of Pb concentration were compared with maximum permissible standard concentration of 10mg/kg as recommended by WHO 2005. [8]

Pb exposure has been shown to cause adverse effects on the nervous, haemopoietic, renal, gastro-intestinal, cardiovascular, and musculoskeletal and immune systems, as well as fetal developmental processes. [4]. Low levels of Pb in some samples indicated that these products meet the safety limits for toxic elements specified by most food related standards for Pb. According to the Codex Alimentarius Commission (FAO/WHO) the maximum permissible limit for Pb is 0.30 µg/gm. It also states that the major exposure of Pb by foods is through fruits, vegetables and grains. [7]. However, the results of this study show that there are relatively significant levels of Pb in some of the spices sampled. Cardamom, cinnamon, fenugreek, ginger and thyme have 0.672, 0.961, 1.461, 1.156 and 0.462 µg/gm of Pb respectively, which are way above the maximum permissible limits. Such levels might have been the result of accumulation through air pollution, distribution process, and from some pesticides containing Pb such as Lead arsenate, applied during cultivation. Consumption of such spices regularly, over a prolonged period of time, in a concentrated manner, can cause Pb accumulation in the body. It has been reported to competively inhibit PB uptake in cells [9]. Pb forms complexes with oxo groups in enzymes to affect virtually all steps of haemoglobin synthesis and porphyrin metabolism. [9], [10]. Lead poisoning can affect all vital organs in myriad ways and halt or disturb cellular processes in the body to alter physiological functions. [9]. The risk of toxicity based on the daily consumption of 20 gm of spices by a 50 kg person is shown in table III.

Table III: Accumulation of Pb (µg/kg/day) through consumption of 20gms of spices in a 50 kg person

Spice	Pb content (µg/kg/day) of spice	Effect on human
Black pepper	0.0002	No effect
Cardamom	0.0003	Acute
Cinnamon	0.0004	Acute
Cloves	0.0003	Acute
Coriander	0.0003	Acute
Cumin	0.0001	No effect
Fenugreek	0.0006	Acute
Garlic	0.0001	No effect
Ginger	0.0005	Acute
Thyme	0.0002	No effect
Turmeric	0.0001	No effect
Minimal risk levels	0.0002	No effect

Table 3 shows that there is no apparent risk from some of the spices under study; if the daily ingestion is limited within 20 gm. However, danger signs come from cardamom, cinnamon, cloves, coriander, fenugreek, and ginger. According to ATSDR, the minimal risk levels for hazardous Pb through oral route, having acute effect, is 0.0002 µg/kg/day. [11].

The available literature data about the content of lead in spices is scanty. A Polish study found elevated amounts of Pb in cinnamon (6.24 mg/kg), basil (2.25 mg/kg) and savory (1.29 mg/kg). [12]. Increased levels of Pb in these spices might indicate that those plants are more prone to accumulate environmental Pb in their edible parts.

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.

IV. Conclusion

On the basis of the findings it can be concluded that the majority of spices used commonly by us are not contaminated with lead except for some cases. However, the quantity of spices used for the study must be noted, and the consumer made aware of these facts. In view of the flavor imparting and traditional use of spices in India, not to mention their medicinal properties as well, it is never advisable, nor practical, to completely avoid spices in the cuisine. Also the normal need for spices is so minimal that there should ideally be no risk of Pb poisoning from the spices studied here. But excessive consumption, in concentrated form, as in some pickles or dried and commercial snacks, should not be advisable over a long period of time, as it has potentials to cause harmful accumulation of Pb in the body.

References

[1] Goswami K, Ali S, Bhattacharya B, Banerjee S.K, Lead toxicity in jewellery workers of Bangladesh, Bangladesh J. Pathol, 1999, 14(2): pp 3-5.

[2] Sherman, W.P, Billing J. Antimicrobial functions of Spices: Why like it hot. Quarterly Review of Biology, 1998,73(3):pp1-47.

[3] Al Eed, M.A.Assubale F.N, El-Garawany M.M, El-Hamshary H, EI Tayeb Z.M, Determination of heavy metals in common spices. J.Agric.Sci, Mansoura Univ. 1997, 22(5): 1685-1692.

[4] Goswami K, Gachhui R, Bandyopadhyay A, Hepatorenal dysfunctions in lead pollution, J. Environ. Sci. Eng, 2005, 47(4): pp 75-80.

[5] Jones J.B, Case V.W, Sampling, handling and analyzing plant tissue samples. In: Westerman R.L. (ed.), Soil Testing and Plant Analysis, Madison, 1990: pp 404-409.

[6] Kalra, Y.P, Handbook of reference methods for plant analysis, CRC Press, Science, 1998: pp 57.

[7] Codex Alimentarius Commission: Joint FAO/ WHO Food Standards Program Rome: Food and Agricultural Organization, Geneva: World Health Organization, 1984.

[8] World Health Organization, Quality control methods for medicinal plant materials, 2005.

[9] Goswami K, Banerjee S.K, Ali S, Bhattacharya B, Ascorbic acid therapy in lead exposed jewellery workers of Bangladesh, Showa Univ. J. Med. Sci, 2001, 13(1): pp 11-16.

[10] Ademorati, C. M. Environmental Chemistry and Toxicology pollution by Heavy Metals. Foludex Press Ltd. Ibadan, 1996: pp 171-172.

[11] ATSDR. Agency for toxic substances and disease registry. http://www.atsdr. cdc.gov/mrls.html, 2001.

[12] Bulinski R, Bloniarz J, Studieson some trace element content in vegetable spices and their blends. Bromat Chem. Toksykol, 1995, 27(2): pp 133.

Author's Profile

Prof. Krishnajyoti Goswami

was born in Kolkata, India on 6th April,1965. His educational qualifications include :

1. Doctor of Science in Medical Biochemistry- Rajiv Gandhi Medical University, Bangalore, Karnataka, India; 2003.
2. Master Degree in Biochemistry- University of Kalyani, Kolkata, West Bengal, India; 1989
3. Doctor of Philosophy (Science) in Biochemistry-Jadavpur University, Kolkata, West Bengal, India; 2006.
4. Chartered Chemist- institution of chemists(india), kolkata, west bengal; 2002.

His major field of study is Medical Biochemistry.

He has a work experience of more than 25 years in the field of biochemistry. At present he is PROFESSOR OF BIOCHEMISTRY in Sardar Rajas Medical College, Jaring, Odhisha,since November 2013 till date and also VISITING PROFESSOR (Biochemistry), Faculty of medicine & health sciences, Lincoln University College, KL, Malaysia, since March 2013 till date. Previously he has worked as Professor of Biochemistry in ESIC HOSPITAL & ODC(EZ), Joka, Kolkata and Ramakrishna Mission Seva Pratishthan & Vivekananda Institute Of Medical Sciences, Kolkata. He has about 152 presentations in scientific meetings, seminars, conferences throughout India & abroad. In 20 years of research career in the field of clinical assessment and assessment of lead poisoning. His latest achievement has been the findings that the metabolic derangement associated with lead toxicity could be partially restored to normalcy with dietary supplementation of ascorbic acid. (patent also). Interrelationship between lead and ascorbic acid was not reported earlier anywhere else.

Dr Goswami has many professional memberships that include: President, Association of Clinical Biochemists of India (ACBI), 2009; Member, International Federation of Clinical Chemistry (IFCC); Member, Asian Pacific Congress of Clinical Biochemistry (APCCB) ; Member, American Association of Clinical Chemistry (AACC); and Country Representative, World Association of Societies of Pathology and Laboratory Medicine (WASPaLM) Asian Pacific Congress of Clinical Biochemistry has awarded its Regional Service Award for the contribution to environmental research in 2002 & IFCC Young Scientist Award (International contributor) in 2004

Dr. Ipsita Mazumdar

was born in Kolkata, India on 16th December, 1976. Her educational qualifications include:

1. Doctor in Medicine (M.D) Biochemistry- Mamata Medical College & Hospital, Khammam, Andhra Pradesh, India; 2010.
2. Diplomate of National Board (DNB) Biochemistry, India; 2014.
3. MBBS, North Bengal Medical College & Hospital, Darjeeling, West Bengal, India; 2001.

She is presently working as ASSISTANT PROFESSOR OF BIOCHEMISTRY in KPC Medical College & Hospital since 2011 till date. She is also working part time as CONSULTANT BIOCHEMIST & QUALITY MANAGER in Eastern Diagnostics India Ltd, Kolkata, India. She has over 10 publications both nationally & internationally. Her research interests include heavy metal poisoning and oxidative stress.

She is the State Representitive of Association of Clinical Biochemists of India (ACBI).