

## Study of the Daily Intake of Cd, Cr and Pb from food items by the inhabitants of Shillong City, Meghalaya India



### Chemistry

**KEYWORDS :** Daily, Food, Intake, Metals, Toxic

**D.G Marbaniang,**

Department of Chemistry, Lady Keane College, Shillong-793001, Meghalaya, India

**C.G.L. Nongpiur**

Department of Chemistry, Lady Keane College, Shillong-793001, Meghalaya, India

### ABSTRACT

*Assessment of the daily intake of toxic heavy metals ( Cd, Cr and Pb) is conducted in this study, Rice is staple to the diet of the inhabitants of Shillong City and the rest of the food items are taken in combination to rice. The concentration of Cd, Cr and Pb in both red rice and white rice variety was found to be low. But, with the elevated consumption rate of 340gm day<sup>-1</sup> for white rice and 200gm day<sup>-1</sup> for red rice, the daily intake of the non-essential Cd Cr and Pb become alarmingly high and may lead to chronic exposure. In this study, it was observed that the average concentration of the different metals follows the order Pb>Cr>Cd. Cereals and pulses group were observed to contain maximum concentration of the different metals. The observed daily intake was compared with the standard recommended values. The daily intake of lead was estimated at 0.3mg, cadmium at 0.308mg and chromium at 1.110 mg. It was concluded, that the diet of the inhabitants of the city of Shillong was contaminated by the metals under investigation.*

### INTRODUCTION

Metals account for a quarter of the Earth's mass, but a lower percentage of its crust. Sea water contains trace amounts of metals, as do all living organisms and even dust particles in the air. Volcanoes and natural weathering can release metals into the environment, but human activities now play the major role in dispersing metals on the earth's surface. Alloway, (1990). The sources of heavy metals in the environment can be both natural and anthropogenic in origin. The man-made sources of heavy metals include sewage sludge, mining and smelting, fertilisers and pesticides, auto emissions and so on. The largest portions of these amounts are due to base metal mining and smelting activities. These contaminants have been discharged into the environment and may possibly have adversely influenced crop yields, animals and human health. (Bowie and Thornton, 1984).

### Role in Biological Systems

Many metals play critical roles in maintaining life. Some are important for the structure of biological materials, as calcium is for bone. Other metals stabilize proteins in unique and active conformations, or structures. Zinc often performs this function. Magnesium in the form of Mg<sup>2+</sup> plays a role in balancing the negatively charged phosphates that serves as the backbone of DNA and RNA. Metals also serve a chemically important role as essential components of many enzymes.

Non- essential elements such as Cd, Cr and Pb are considered to be toxic and their presence in the body can cause profound biochemical and neurological changes in the body. In addition, metals can be toxic or be a micronutrient depending on its chemical form or speciation for example Cr-IV and Cr-III. Biological molecules have specific structures and certain components that are essential for their roles. Proteins, in particular, play an astounding number and variety of roles in living organisms. They are used as structural elements, for sending signals both within and between cells, and as enzymes for the synthesis and degradation of other biological molecules. If a metal ion binds to the amino acids of a protein, the resulting metal-protein complex may lack the protein's original biological activity. For example, certain enzymes contain a cysteine amino acid that contains a sulfur atom necessary for its function. Certain toxic metals have a high affinity for sulfur and will bind tightly to the essential cysteine, inhibiting the enzyme from functioning. One metal may also substitute for another similar metal. For example, the toxic metal, cadmium, can substitute for the essential metal, zinc, in certain proteins that require zinc for their structure or function. This can lead to alterations in that protein that can have toxic consequences. In the same way, lead can substitute for calcium in bone, and in other sites where calcium is required. Metal ions

can also remove an electron from the amino acids of a protein in a redox reaction that disrupts its ability to carry out its biological function. Metal ions can also remove an electron from the bases of DNA. Such oxidative damage to these biological molecules is implicated in the cumulative effects associated with aging and in the mutations associated with cancer. (Santos *et al.* 2004).

### Human Exposure

Food is the major intake route of essential as well as toxic trace metals by human beings. The amount of metals ingested by man is straightly related to alimentary habits and their content in food stuffs. Metal concentration in food item depend on soil characteristics, such as content of organic matter, pH and clay mineralogy, which can affect the bioavailability of metals. Vegetables and animals can take up high amount of metals from contaminated soils, as well as from contaminated water and polluted air. Besides environmental pollution, a matter of concern is the addition of chemicals products such as fertilizers, fungicides, insecticides and herbicides to crops. These products may contain several metals and their additions can increase the metal amounts in soil and water. Furthermore, the physical and chemical forms in which they are dispersed can increase the metal availability for plants and so increase the metal concentration in vegetables (Santos *et al.*, 2004). Since, we are taking food for our survival, so the major route of entry of most metals into the body is through the diet.

Cereals and Pulses, animal meat, meat products, vegetables, eggs, are consumed largely by the inhabitants of the state of Meghalaya in general and Shillong city in particular because of their nutritional value. Also, consumption of Betel leaves, Betel nuts and and CaO mixture is a tradition among the local populace.

Meat is a food material, which is composed mainly of proteins, fats and some important essential elements. Meat is essential for growth and maintenance of good health. Metal can accumulate in animal through direct exposure, polluted water and crops grown on irrigated sewerage water, industrial effluents, vehicular emission and contamination of meat from dirty slaughter houses (Sabir *et al.* 2003).

Vegetables are considered as "Protective Supplementary Food". They contain large quantities of minerals, vitamins, carbohydrates, essential amino acids and dietary fibers which are required for normal functioning of human metabolic processes. They are also important to neutralize the acid produced during digestion, besides being useful "roughage" according to food

experts (Hashmi *et al.* 2007). Metals are non-biodegradable and persistent environmental contaminants, which may be deposited on the surface and then absorbed into the tissues of vegetables. Plant take up metals by absorbing from deposits on the parts of the plant exposed to the air from polluted environments as well from contaminated soils (Sharma *et al.* 2009).

Prolonged consumption of useful concentration of metals through food items may lead to chronic accumulation of heavy metals in the kidneys and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases WHO, (1993). Metals such as Cd and Cr acts as carcinogens and Pb is associated with development of abnormalities in children. It has been reported that long term intake of Cd caused renal, prostrate and ovarian cancer (Sharma *et al.* 2009)

**Objective of the study**

The knowledge of metal concentration in food items can provide important information on the impact of the use of chemical products in crops and on the level of environmental pollution in farms. Furthermore, such survey may indicate local food items that are important to supply essential metals for a population group. Information on these topics is scarce, especially when dealing with developing countries. Thus, a first study on trace metal (Cd, Cr and Pb) concentration in the most frequently consumed food items by the inhabitants of Shillong City was performed, aiming to:

Verify metal levels and variation in different food items.

To make a preliminary estimate on the daily intake doses of trace metals for an adult inhabitant of the city.

To compare the estimated intakes of metals with the Recommended Daily Allowances (NRC, 1989) for essential metals and to the Provisional Tolerable Weekly Intake (PTWI) for toxic metals. (EPA, 2001 and WHO, 1993).

**Sample collection**

“Meghalaya”, the abode of the clouds is a State located in the North Eastern parts of India and is one of the smallest states in India and home to the Khasis. Shillong located at 25.57°N 91.88°E is the capital of Meghalaya and it is the headquarters of the East Khasi Hills district and is situated at an average altitude of 4,908 feet (1,496 m) above sea level, with the highest point being Shillong Peak at 6,449 feet (1,966 m). Shillong is the 330th most populous city in India with population of 143,007 according to the 2011 census. It is said that the rolling hills around the town reminded the European settlers of Scotland. Hence, Shillong is known as “Scotland of the East”. The population density of the state of Meghalaya in the current decade is 342 people per sq mile.



**Fig 1: Map of Meghalaya depicting the location of Shillong City**

For acquiring food samples by market-basket survey, the main market in the city was chosen. Food samples were procured according to their availability comprising a total of 25 samples of vegetables, cereals and pulses, animals and animal products etc. The amount of each product was chosen according to its fresh

mass to ash mass relationship, in order to obtain approximately 20–30 g of ashes.

The twenty five (25) varieties of food items are *Daucus carota* (Carrot), *Allium cepa* (Onion), *Solanum tuberosum* (Potato), *Oryza sativa* (White and Red Rice Variety), *Cucumis sativus* (Cucumber), *Solanum lycopersicum* (Tomato), *Phaseolus vulgaris* (French Beans), *Lens culinaris* (Red Lentils), *Cicer arietinum* (Split Bengal Gram), *Vigna radiate* (Split Green Gram), Milk, Eggs, *Piper Betel* (Betel Leave), *Areca catechu* (Betel Nut), *Sus domesticus* (Pig), *Bos domesticus* (Cow), *Gallus gallus domesticus* (Chicken), *Labeo rohita* (Rohu), *Capra aegagrus hircus* (Goat), Fermented Beans, *Momordica charantia* (Bitter Gourd), *Solanum melongena* (Brinjal), *Capsicum annum* (*Capsicum*), *Brassica oleracea* (Cabbage) were chosen for the study. The different food items were chosen base on the fact that they are available locally and are most frequently consumed by the local populace of the city. All the vegetables were procured from the main market of the City i.e., the Bara Bazar Market.

The 25 selected food items constitute a part of the total number of food items usually consumed by the adult population of Shillong City. Other items on the food chart include green leafy vegetables, tea and most importantly water. The investigation of the concentration of trace metals in different tea brands available in Shillong City and in green leafy vegetables has already been carried out by Marbaniang *et al.* 2011 and Marbaniang *et al.* 2012 respectively.

**Consumption rate of food items**

The rate of consumption of the different food items by the adult population of the City of Shillong was obtained by preparing a questionnaire (Table 1) which was distributed to the students of Lady Keane College, Shillong who are residing in different localities in the city. From this questionnaire, the average consumption rate of the different food items by an adult population of the city was determined (Table 2).

**Sample Pre-treatment and Analysis**

Carrots, Onions, Potatoes, Tomatoes and Cucumber were skinned, washed with distilled water, air dried and ashed at 400°C till white ash is obtained.

French Beans, Cauliflower, Cabbage, Brinjal, Capsicum, Bitter Gourd were washed with distilled water, air dried and ashed at 400°C till white ash is obtained.

**Table 1: Questionnaire on the Rate of Consumption (by an Adult) of Different Food Items Available in Shillong City, Meghalaya**

Sl.No	Food Items	Daily Consumption	FREQUENCY		Number of Family Members	
			In a Week	IN A MONTH	Below 12 Years Old	Above 12 Years Old
1	White Rice					
2	Red Rice					
3	Bitter Gourd					

4	Red Lentil (gm)					
5	Split Green Gram (gm)					
6	Split Bengal Gram (gm)					
7	Potato					
8	Onion					
9	Tomato					
10	Carrot					
11	French Beans					
12	Eggs					
13	Betel nut, leave and CaO mixture					
14	Brinjal					
15	Cabbage					
16	Capsicum					
17	Cucumber					
18	Beef					
19	Pork					
20	Mutton					
21	Chicken					
22	Fish					
23	Milk					
24	Fermented Beans					

**Table 2: Average Daily Consumption Rate of different Food items by an Adult Population of Shillong City, Meghalaya**

Food Items	Consumption rate per day
White Rice (gm)	340
Red Rice (gm)	200
Red Lentil (gm)	20
Split Green Gram (gm)	20
Split Bengal Gram (gm)	6.4
Potato (gm)	100
Onion (gm)	20
Tomato (gm)	20
Carrot (gm)	20
French Beans (gm)	20
Eggs	2 Nos. or 100gm
Betel Nut and Leave & CaO mixture	8 Pieces/Day or 7.937gm
Brinjal (gm)	8

Cabbage (gm)	18
Cucumber (gm)	20
Beef (gm)	40
Pork (gm)	20
Mutton (gm)	9.4
Chicken (gm)	20
Fish (gm)	40
Milk (gm)	160
Fermented Beans (gm)	10
Bitter Gourd (gm)	20
Capsicum	20

Red Lentils, Split Bengal Gram, Split Green Gram, White rice and Red rice were handpicked for stones and other **impurities** soaked in distilled water and washed with distilled water several times as per cooking method and then air dried and ashed at 400°C till white ash is obtained.

Beef, Pork, Chicken, Fish and Mutton meats were washed with distilled water, air dried and ashed at 400°C till white ash is obtained.

Fermented beans paste which is a traditional delicacy was procured from the local market and then directly ashed at 400°C till white ash is obtained.

Eggs were hard boiled, cooled, peeled and then ashed at 400°C till white ash is obtained.

Milk (500ml) was evaporated till almost dryness and then ashed at 400°C till white ash is obtained.

Betel leaves, betel nuts along with 0.1gm CaO were homogenized together. These three items are usually consumed together by the habitants of the City of Shillong.

For total metal extraction, 0.1g each of the ashed food items were accurately weigh and transferred into a 250ml beaker, and to this, concentrated nitric acid (10.0 mL) was added, the beaker was covered with a watch glass and was boiled gently on a hot plate provided with a tunable thermostat until digestion was complete. The complete digestion took about 3hrs. 5.0 mL portion of 70% perchloric acid was then added and gentle heating was continued for another 1hr or till the solution becomes colourless. Small aliquots of ultrapure water were added to prevent dryness due to evaporation and about 3 to 5 drops of hydrogen peroxide were added to discharge any colouration left in the digest. After the digestion, the solution was cooled, and filtered using a Whatman No. 540 filter paper and transferred to a 50 mL volumetric flask pre-soaked in very dilute HNO<sub>3</sub> that has been rinsed with doubled distilled water. Three replicate digestions were made for each sample. The average of blank readings was subtracted from analytical readings of digested samples. All necessary precautions were adopted to avoid any possible contamination of the sample (Marbaniang *et al.* 2011). An Analytik Jena Vario-6 Graphite Furnace - Atomic Absorption Spectrophotometer available at Sophisticated Analytical Instrumentation facility, North Eastern Hill University, Shillong, Meghalaya, India was used for determination of Cr, Mn, Fe, Cu, Zn, Cd and Pb in the different fooditems.

## RESULT AND DISCUSSION

The mean concentration and standard deviation of Cd, Cr and Pb found in different food items are summarized in Table 3.

**Cadmium:** Cadmium (Cd), the second member of the zinc family, resembles zinc in its chemistry in many respects and can replace zinc in enzymes, for example, but because of stronger

bonding and perhaps stereo chemical differences, the function of the enzyme is disrupted. Indeed obtaining zinc free from Cd impurity is difficult. A major chemical difference is a tendency of Cd to form more covalent bonding than does zinc, and more stable complexes. It is extremely toxic and a very hazardous heavy metal; kidney damage, and at high levels bone damage, are the main effects. Cd appears to be bound irreversibly to Thionein, a small sulfur rich protein, the main function of which appear to be to tie up heavy metals as a protective mechanism. It is a possible trace element in marine planktons for a role in carbonic anhydrase enzyme. In Japan, a disease called "itai itai" was caused by mining wastes containing Cd. Bailey, (2012)

The concentration of Cd was not observed in all the different varieties of food items that were sampled. In those food items that it was detected, its minimum concentration was seen in Cucumber (0.01±0.002 µg/g) and the maximum concentration in Eggs (63.21±7.77 µg/g). Among the Vegetable group, the concentration of Cd ranges from a minimum of 0.01±0.002 µg/g (Cucumber) to a maximum of 2.04±0.17 µg/g (Bitter Gourd), among the Cereal and Pulses group, Cd ranges from Below Detection Limit (BDL) (White Rice, Red Lentil and Split Green Gram) to

**Table 3: Concentration (µg/g) of Metals in different varieties of food items frequently consume by the adults of Shillong City**

Food Items	Pb	Cd	Cr
<b>VEGETABLES</b>			
Carrot	1.40±0.20	0.11±0.02	0.91±0.07
Onion	0.22±0.01	BDL	1.51±0.14
Potato	0.93±0.11	0.53±0.09	1.54±0.18
Tomato	2.80±1.45	0.59±0.04	1.45±0.24
Cucumber	1.15±0.20	0.01±0.002	0.79±0.09
French Beans	0.45±0.06	0.11±0.003	1.97±0.21
Bitter Gourd	4.51±1.21	2.04±0.17	5.36±0.76
Capsicum	0.96±0.06	BDL	1.47±0.19
Brinjal	2.29±0.32	BDL	1.93±0.21
Cabbage	2.85±0.31	0.20±0.08	1.72±0.11
<b>CEREALS AND PULSES</b>			
Red Rice	1.57±0.21	0.05±0.04	0.30±0.05
White rice	2.54±0.20	BDL	0.40±0.03
Red Lentil	2.79±0.37	BDL	0.86±0.04
Spilt Green Gram	2.60±0.28	BDL	0.60±0.05
Split Bengal Gram	1.40±0.31	0.49±0.06	0.68±0.07
<b>MEAT</b>			
Chicken	2.28±1.47	BDL	8.19±1.10
Fish	2.92±2.11	BDL	BDL
Mutton	0.42±0.06	0.60±0.05	0.69±0.05
Pork	1.06±0.26	BDL	2.51±0.34
Beef	1.16±0.22	BDL	2.21±0.19

<b>OTHERS</b>			
Milk Dkhar	5.80±0.64	1.16±0.22	1.99±2.11
Eggs	225.75±43.21	63.21±7.77	BDL
Betel Leaves, Betel Nuts & CaO mixture (Pan)	1.00±0.09	BDL	1.69±0.15
Fermented Beans	7.36±0.54	BDL	6.16±0.72

0.49±0.37 µg/g (Split Bengal Gram), among the Meat Product group, the concentration of Cd was observed only in Mutton (0.60±0.05 µg/g), while in the rest of the meat products the concentration was below the detection limit of the instrument. Finally among the other types of food items that were sample the concentration of Cd ranges from BDL (Betel leave, nuts and CaO mixture and Fermented Beans) to 63.21±7.77 µg/g (Eggs).

**Chromium:** Chromium (Cr) is known as an inert metal most familiar for its use for decorative and protective plating, but also with other industrial applications. It is an essential element in trace amounts, being a component of enzyme involved in sugar metabolism, but it is one that cause serious health effects in some forms. Cr in Cr(III) chemical form is comparatively harmless as long as it remains immobilized. Because of its electronic configuration, compounds of Cr(III) tends to be chemically inert. Cr(VI) compounds are encountered as oxo species, which are good oxidizing agents. Cr(VI) is a possible carcinogen, is highly toxic (United States Public Health limit for Cr in water, 0.05mg/L) causing skin lesions upon excessive exposure. Cr is selectively accumulated in liver and kidney. It has been reported to interfere with enzymatic sulfur uptake of cells affecting the lungs, liver and kidney. (Lawrence *et al.* 1993)

The concentration of Cr was observed in all the different varieties of food items that were sampled excepting Fish and Eggs. In those food items that it was detected, its minimum concentration was seen in Red Rice (0.30±0.05 µg/g) and the maximum concentration in Chicken (8.19±1.10 µg/g). Among the Vegetable group, the concentration of Cr ranges from a minimum of 0.79±0.09 µg/g (Cucumber) to a maximum of 5.36±0.76 µg/g (Bitter Gourd), among the Cereal and Pulses group, Cr ranges from 0.30±0.05 µg/g (Red Rice) to 0.86±0.04 µg/g (Red Lentils), among the Meat Product group, the concentration of Cr was observed to range from BDL in Fish to 8.19±1.10 µg/g (Chicken) and among the other types of food items that were sample the concentration of Cr ranges from BDL (Eggs) to 6.16±0.72 µg/g (Fermented Beans). The mean concentration of Cr was highest among the vegetable group compared to the Cereals & Pulses group.

**Lead:** Lead (Pb) is a non-essential element. It is toxic and a cumulative poison. Formerly, Pb additives in gasoline were a major source. Pb-based pigments in paints (mainly old paints), batteries, Pb-pipes in old plumbing, solder, pottery glazes are all potential sources of exposure for Pb poisoning. (Bailey, 2012).

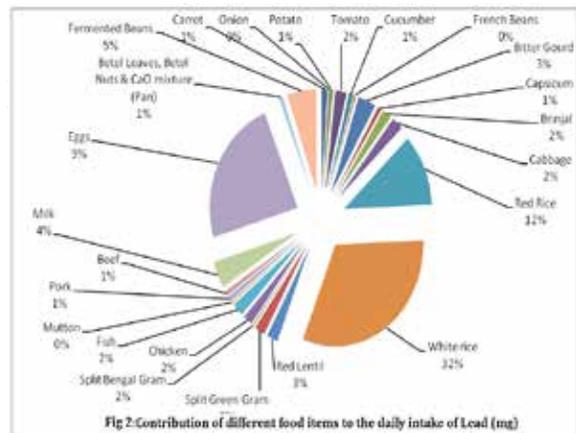
The concentration of Pb was observed in all the different varieties of food items that were sampled. The minimum concentration of Pb was observed in Onion (0.22±0.01µg/g) and the maximum concentration in Eggs (225.75±43.21 µg/g). Among the Vegetable group, the concentration of Pb ranges from a minimum of 0.22±0.01 µg/g (Onion) to a maximum of 4.51±1.21 µg/g (Bitter Gourd), among the Cereal and Pulses group, Pb ranges from 1.40±0.31 µg/g (Split Bengal Gram) to 2.79±0.37 µg/g (Red Lentils), among the Meat Product group, the concentration of Pb ranges from 0.42±0.06 µg/g (Mutton) to 2.92±0.11 µg/g (Beef) and finally among the other types of food items that were samples the concentration of Pb ranges from 1.00±0.09 µg/g (Betel

leave, nuts and CaO mixture) to 225.75±43.21 µg/g (Eggs). The average concentration of Pb was seen to be higher in the Cereals and Pulses group as compared to the Vegetables and Meat groups.

**4.1 Daily Intake of Metals**

The daily intake of metals (µg) through the consumption of the different food items is depicted in Table 4. The most common and favourite food item among the inhabitant of Shillong City is Rice (mostly white rice) along with Lentils, Potatoes, Beef, Onion, Milk and Betel leave, Betel nut and CaO mixture. The other food items are taken as supplements in the daily diet. The daily intake is calculated as per the following formula:

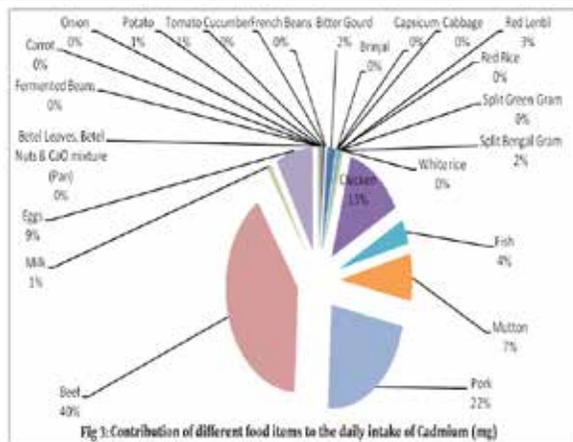
$$\text{Daily Intake} = \text{Metal Concentration in Food Item } (\mu\text{g/g}) \times \text{Consumption Rate (g)}$$



This daily intake value (1.101 mg day<sup>-1</sup>) of Lead from the most common food items was found to be higher than the lead estimates for the consumption of different food stuffs by an adult of Rio de Janeiro city which is 0.028 mg day<sup>-1</sup> (Santos *et al.* 2004). Other workers (Barbera *et al.* 1993; Ikeda *et al.* 2000; Louekari and Salminen, 1986; MAFF, 1997; Watanabe *et al.* 2000) also reported lower Pb ranges i.e., 0.007 – 0.23 mg day<sup>-1</sup>.

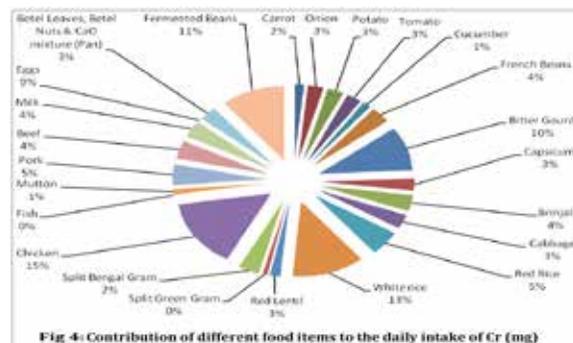
**Cadmium:** The calculated cadmium daily intake from all the food items was estimated as 0.308mg day<sup>-1</sup> which is higher than the allowed dietary intake of 0.20 mg day<sup>-1</sup> as prescribed by FAO/WHO in (FAO/WHO, 2001). The daily estimate for the most commonly consumed food products (White Rice, Lentils, Potatoes, Beef, Onion, Milk and Betel leave, Betel nut and CaO mixture) amounts to 0.034mg day<sup>-1</sup>. This value (0.034mg day<sup>-1</sup>), was found to be lower than the WHO recommended value. From Fig 3, the main contributors to the total daily intake of cadmium were seen to be eggs followed by Milk, Mutton, Bitter Gourd, Tomato and Potato.

This daily intake value (0.034mg day<sup>-1</sup>) of Cadmium from the most common food items was found to be higher than the cadmium estimates for the consumption of different food stuffs by an adult of Rio de Janeiro city which is 0.0018 mg day<sup>-1</sup> (Santos *et al.*, 2004). Comparing our value for the daily intake of cadmium with those reported in literature (Biego *et al.* 1998; Cuadrado *et al.* 1995; Louekari and Salminen, 1986; Tahvonon and Kumpulainen, 1993; Tsoumbaris and Tsoukali-Papadopoulou, 1994) whose range is 0.004–0.084 mg day<sup>-1</sup>, it can be observed that the intake of this metal by the inhabitants of Shillong city seems to fall within the same range



**Chromium:** The calculated chromium daily intake from all the food items was estimated as 1.110mg day<sup>-1</sup> which is much higher than the maximum allowed dietary intake of 0.20 mg day<sup>-1</sup> as prescribed by World Health Organisation in 1996 (WHO, 1996). The daily estimate for the most commonly consumed food products (White Rice, Lentils, Potatoes, Beef, Onion, Milk and Betel leave, Betel nut and CaO mixture) amounts to 0.339mg day<sup>-1</sup>. This value (0.339mg day<sup>-1</sup>), was also found to be higher than the allowed daily intake of 0.20 mg as per WHO recommendations. From Fig 4, the food items which are the main contributor to the total daily intake of chromium by the adult population of Shillong City was seen to be Rice, Chicken, Pork, Beef and Milk and then the rest of the food items contribute to a lesser extent to the daily intake of chromium.

This daily intake value (0.339mg day<sup>-1</sup>) of Chromium from the most common food items was found to be higher than the chromium estimates for the consumption of different food stuffs by an adult of Rio de Janeiro city which is 0.023mg day<sup>-1</sup> (Santos *et al.* 2004).



Anderson and Koslovsky, (1985), Anderson *et al.* (1993), Biego *et al.* (1998), Dang, (1998), FAA, (2002), ICDA, (1996), Kumpulainen, (1992), Schuhmacher *et al.* (1993) all reported Cr values ranging from 0.013 to 0.085 mg day<sup>-1</sup> which is lower when compared with the present study daily intake value (0.339 mg).

**CONCLUSION**

The assessment of the concentration of Cd, Cr and Pb in different food items that are frequently consumed by the population of Shillong City and their daily intake is a first such study to be carried out in the City. Through this study, we were able to ascertain the concentration levels of the selected trace metals in the different food items. Also, data regarding the consumption rate of different food items were established by designing a questionnaire. From the metal concentration values in food items, calculation of their daily intake was performed and established. The generated daily intake data was compared with standard international values (eg: WHO, EPA, etc..).

From this study, we can conclude that the diet of the inhabitants of the city of Shillong is slightly contaminated by lead, cadmium and chromium. The high intake of these metals with a potential to affect the health can be attributed to the high consumption rate of rice which is staple to the diet of the city.

This study provides knowledge about the contribution of the different food items to the daily intake of the selected elements which will greatly benefit the public to understand and know which food item is to be consumed at a normal rate and which food items, the consumption of, should be to reduce.

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#### REFERENCE

1. Alloway, B.J. 1990. Heavy metals in soils. John Wiley and Sons, Inc. New York, ISBN 0470215984 | 2. Bowie, S.H.U and Thornton, I. 1984. Environmental Geochemistry and Health. Reidel, Dordrecht 140: 3187 | 3. Santos, E.E., Lauria, D.C and Porto da Silveira, C.L. 2004. Assessment of daily intake of trace elements due to consumption of foodstuffs by adult inhabitants of Rio de Janeiro city Science of the Total Environment. 327 : 69-79 | 4. Sabir, S.M., Khan, S.W and Hayat, I. 2003. Effect of Environmental pollution on quality of meat in district Bagh, Azad Kashmir. Pakistan Journal of Nutrition 2 : 98-101 | 5. Hashmi, D. R., Ismail, S., and Shaikh, H. 2007. Assessment of the level of trace metals in commonly edible vegetables locally available in the market of Karachi City. Pak. J. Bot. 39(3) : 747-751. | 6. Sharma, R.K., Madhoolika, A. M and Marshall, F.M. 2009. Heavy metals in vegetables collected from production and market sites of a tropical urban area of India Food and Chemical Toxicology. 47 : 583-591. | 7. World Health Organization Evaluation of certain food additives and contaminants. Forty-first report of the joint FAO/WHO expert committee on food additives, WHO Technical series no. 837. Geneva.1993. | 8. EPA Environmental Protection Agency, Integrated Risk Information System. IRIS from US. 2001 Available at <http://www.epa.gov/iris/gloss8.htm> (Access on 29, October 2001). | 9. Marbaniang, D.G., Baruah, P., Decruse, R., Dkhar, E.R., Diengdoh, D.F and Nongpiur, C.L. 2011. Study of Trace Metal (Cr, Mn, Fe, Co, Ni, Cu, Zn and Cd) Composition in Tea Available at Shillong, Meghalaya, India International Journal of Environmental Protection. 1 (1) : 13-21 | 10. Marbaniang, D.G., Baruah, P., Decruse, R., Dkhar, E.R., Diengdoh, D.F and Nongpiur, C.L. 2012. Study of the trace metal concentration in some local vegetables available in Shillong City, Meghalaya, India International Journal of Environmental Protection. 2 (10) : 24-28 | 11. Bailey, R.A. 2012. Chemistry of the Environment. ISBN0323145191, 9780323145190 Elsevier, Science, Chapter 14, The environmental chemistry of some important elements : 361-406 | 12. Lawrence, K.A., Pesce, A.J and Kazmierczak, S.C.1993. Clinical Chemistry, 4th ed., Theory Analysis, Corelation, ISBN )-323-01716-9, Published by Mosby Inc. USA. : 707-721 | 13. FAO/WHO Food additives and contaminants. Joint Codex Alimentarius Commission, FOA/WHO Food Standards Programme, ALINORM 01/12A. 2001. | 14. Barbera', R., Farre', R., Mesado, D. 1993. Oral intake of cadmium, cobalt, copper, iron, lead, nickel, manganese and zinc in the University student's diet. Die Nahrung. 37 :241 -245. | 15. Ikeda, M., Zhang, Z.M., Shimbo, S., Watanabe, T., Nakatsuka, H., Moon, C.S., Inoguchi, N.M and Higashikawa, K. 2000. Urban population exposure to lead and cadmium in east and south-east Asia. Sci Total Environ. 249 : 373 -384. | 16. Louekari, K and Salminen, S. 1986. Intake of heavy metals from foods in Finland, West Germany and Japan. Food Addit Contam. 3 : 355 -362. | 17. Watanabe, T., Zhang, Z.W., Qu, J.B., Gao, W.P., Jian, Z.K., Shimbo, S., Nakatsuka, N.M Inoguchi, K. Higashikawa, H and Ikeda, M. 2000. Background lead and cadmium exposure of adult women in Xian City and two farming villages in Shaanxi Province, China. Sci Total Environ. 247 : 1 -13. | 18. Cuadrado, C., Kumpulainen, J and Moreira, O. 1995. Lead, cadmium and mercury contents in average Spanish market basket diets from Galicia, Valencia, Andaluc'ia and Madrid. Food Addit Contam. 12 : 107 -118. | 19. Tahvonen, R. and Kumpulainen, J. 1993. Lead and cadmium in some cereal products on the Finnish market 1990-91. Food Addit Contam. 10 : 245 -255. | 20. Tsoumbaris, P and Tsoukali-Papadopoulou, H. 1994b. Heavy metals in common foodstuff: daily intake. Bull Environ Contam Toxicol. 53 : 67 -70. | 21. World Health Organization.1996. Trace Elements in Human Health and Nutrition. Geneva, Switzerland: WHO Publications. | 22. Anderson, R.A and Koslovsky, A.S. 1985. Chromium intake, absorption and excretion of subjects consuming self-selected diets. Am J Clin Nutr . 41 : 1177 -1183. | 23. Anderson, R.A., Bryden, N.A and Polansky, M.M. 1993. Dietary intake of calcium, chromium, copper, iron, magnesium, manganese, and zinc: duplicate plate values corrected using derived nutrient intake. J Am Diet Assoc. 93: 462 -464. | 24. Biego, G.H., Joyeux, M., Hartemann, P and Debry, G. 1998. Daily intake of essential minerals and metallic micropollutants from foods in France. Sci Total Environ. 217 : 27 -36. | 25. Dang, H.S., Jaiswal, D.D and Nair, S. 2001. Daily dietary intake of trace elements of radiological and nutritional importance by the adult Indian population Journal of Radioanalytical and Nuclear Chemistry. 249 (1) : 95-101 | 26. FAA Medical virtual flight surgeons Aviation Vitamin Mineral Nutrition Supplen. web-site Available at <http://www.aviationmedicine.com/vitamins.htm>. 2002. (Access on 31.October 2002). | 27. International Chromium Development Association (ICDA). 1996. Available at. <http://www.chromium.com/publications/>Access on 29, October 2001. | 28. Kumpulainen, J.T. 1992. Chromium content of foods and diets. Biol Trace Elem Res. 32 : 9 -18. | 29. Schuhmacher, M., Domingo, J.L., Llobet, J.M and Corbella, J. 1993. Dietary intake of copper, chromium and zinc in Tarragona Province, Spain. Sci Total Environ. 132 : 3 -10. |