Dietary Intake of Heavy Metals on Consumption of Amaranthuspolygonoides- Sirukeeraicultivated At Different Sites of Coimbatore

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Abstract- *India's, dietary practices - green leafy vegetables plays an important role as they are the most in expensive source of micronutrients like vitamins and minerals. A hue of green leafy vegetables adds varity to the pallets with its unique flavour and tastes. To assess the mean daily dietary intake of heavy metals from the consumption of Sirukeerai a total of 75 women between the age group of 30-35years weighing between 50-55kgs comprising 25 women each who purchased Sirukeerai exclusively from the identified three markets were selected through purposively sampling.A well-structured questionnaire was constructed to collect background information and using the questionnaire the investigator also collected information on the consumption pattern of green leafy vegetables and the knowledge of heavy metals contamination. Contamination of heavy metal was assessed using standard procedures in a spectrophotometry .The readings were noted at wavelength of 425.4nm for chromium 405.4nm for lead and 213.9nm for zinc with a slide width of 0.1nm. On the whole irrespective of the place of cultivation, Sirukeerai was highly contaminated with chromium (Saibaba Colony-183.4, Ukkadam-103.7, Organic store-75.55) and Zinc (Saibaba Colony-60, Ukkadam-72.5, Organic store-57.5). Contamination of lead was below detectable in Sirukeerai in all the three sites of cultivation. The mean daily intake of heavy metals was also found to be high than the recommended permissible level significant at 1% level of significance.*

Keywords- Sirukeerai, Amaranthus, heavy metal contamination, green leafy vegetables, Analysis, dietary intake of greens. Chromium, Zinc, Lead

I. INTRODUCTION

India's, dietary practices - green leafy vegetables plays an important role as they are the most in expensive source of micronutrients like vitamins and minerals. A hue of green leafy vegetables adds varity to the pallets with its unique flavor and tastes. Green leafy vegetables are often referred as "poor person's food" is packed with phytochemicals and antioxidants.(Gupta S and Prakash J,2009) They are also a rich source of dietary fibers. Amaranth, radish leaves, gogu, shepu, methi, rajgira, hakkaraki, onion leaves, coriander leaves, curry leaves, palak and mint are the commonly available green leafy vegetables in the dry and transitional regions of India (Jyoti T Sajjan (2008).In the southern part of India particularly in Tamil Nadu different varieties of Amaranthus like *Amaranthusdubius*-arakeerai, *Amaranthuspolygonoides*- Sirukeerai*Amaranthusgangeticus* - Mullaikeerai, *Amaranthuscaudatus* -Thandukeeraietc are grown and cultivated regularly irrespective of climatic conditions. Keerai in Tamil refers to greens. Next to *Amaranthdubius* (arakeerai), *amaranthpolygonoide* (sirukeerai) is consumed by a large population either in the form of gravy or poriyal(a semi dry preparation of greens prepared by combining onions, green chilies spluttered with mustard).

Humans consuming green leafy vegetables are exposed to heavy metals by ingestion (drinking or eating foods that are grown in the polluted fields or on water beds) or inhalation (breathing). Working in or living near an industrial site which utilizes heavy metals like Cr, Pb, Zn, Cd, Cu, Ni and Mn and their compounds increases ones risk of exposure, as does living near a site where these metals have been improperly disposed. (BiswadeepGhatak,2016)

Subsistence lifestyles can also impose higher risks of exposure to these heavy metals.(FAO report, 2006,)Coimbatore a city in the state of Tamil Nadu- India which is known for its dual role in agriculture and industrial activities is selected for the conduct of the study since the region has more chances of heavy metal pollution.*Amaranthuspolygonoides*- Sirukeerai cultivated on the banks of sewages and sludge's, in proper agricultural field and organic stores was procured from three different markets of Coimbatore (Saibaba colony- sells greens from agricultural fields,Ukkadam- sells greens grown on bank of sludge's and sewages, and Murugan mills- greens from organic farms) and was analyzed for the contamination of heavy metals and

subsequent dietary intake of heavy metals to test the following hypothesis

1. **Hypothesis I-** There is no contamination of chromium, lead and zinc in Sirukeerai cultivated at different site of Coimbatore namely Saibaba Colony, Ukkadam and Murugan Mills.

2. **Hypothesis II-** There is no difference in the mean daily intake of heavy metals by the subjects who consumed Sirukeerai procured from Saibaba Colony market, which was grown in the agricultural fields with that of permissible levels recommended by WHO

3. **Hypothesis III-** There is no difference in the mean daily intake of heavy metals by the subjects who consumed Sirukeerai procured fromUkkadam market which was grown in the contaminated waterbed of sewages and sludge's with that of permissible levels recommended by WHO

4. **Hypothesis IV-** There is no difference in the mean daily intake of heavy metals by the subjects who consumed Sirukeerai procured fromMurugan Mills which was grown in the organic farms. with that of permissible levels recommended by WHO

II. RESEARCH DESIGN

The study was carried out in two phases.In phase I the mean daily intake of Sirukeerai was assessed and in Phase II the analysis of heavy metals contamination in selected green leafy vegetable and the dietary intake of heavy metals from Sirukeerai was carried out.

Phase I: Assessment of Mean Daily Intake of Green Leafy Vegetables

A. Selection of sample- To assess the mean daily intake of green leafy vegetables a total of 75 women between the age group of 30-35years weighing between 50-55kgs comprising 25 women each who purchased sirukeerai exclusively from the identified three markets were selected through purposively sampling.

B. Selection of tools and collection of data- A well-structured interview schedule was constructed to collect background information like age, weight, economic status, occupational status, family size and type. Using the schedule the investigator also collected information on the consumption pattern of green leafy vegetables and the knowledge of heavy metals contamination.

C. Measurement of Weight- Since weight was considered as one of the criteria for selection of subject, thesame was taken for all the 75 respondents from the three selected regions. Weight was measured using an electronic weighing balance and the subjects were asked to stand erect on the weighing balance with minimum clothing and without shoes. Before taking the readings, the weighing machine was calibrated to the zero and the weight was recorded.

D. Consumption pattern of Green Leafy Vegetables- Using a well-structured interview scheduled, the investigator collected the information pertaining to the place of purchase of green leafy vegetables, the consumption pattern of commonly consumed green leafy vegetables, their frequency of consumption and also the various forms in which they were consumed. The investigator also collected information from all the 75 respondents on the knowledge of heavy metal contamination and home remedies if any that they follow to get rid of the heavy metal contamination.

E. Mean Daily Intake of Green Leafy Vegetables- Based on the data collected on the consumption pattern of Sirukeerai, the mean daily intake was calculated for all the three regions. The quantum of consumption of cooked volume of Sirukeeraiwas elicited in household measurements and was converted into raw equivalent.

Inclusion Criteria:

- Women 30-35years
- Weight ranging between 50-55kg
- Women who purchase green from Saibaba Colony, Ukkadam, Organic store market
- Women who are willing to participate in the study

Exclusion Criteria:

- Women under/ above 30-35 years
- Women weighing less /more than 55kgs
- Women who do not purchase green from Saibaba Colony, Ukkadam, Organic store market

An informed consent was obtained from all the respondents and it was approved by the Institutional Human Ethical Clearance AUW/IHEC/FSMD-16-17/XMT-07 dated 3rd. February 2017.

Phase II:Analysis of Heavy Metals Contamination in Selected Green Leafy Vegetables

A. Procurement of green leafy vegetables- Two bunches of Sirukeerai *(Amaranthuspolygonoides)*, was purchased from the three identified markets

B. Cleaning - The greens were washed with tap water followed by distilled water and were thoroughly rinsed to remove all the sand, dirt and impurities. The edible portion of the greens was then taken for further processing.

C. Drying and Dehydration- Edible portion of the Sirukeerai was cut into smaller pieces and were shade dried for two days to remove all moisture thoroughly. The dried greens samples was then kept in a hot air oven at 150ºC for 4hours and dehydrated till a constant moisture free sample was obtained.

D. Powdering- Using a clean blender, the dried samples were made into fine powder and was passed through a sieve of 1mm width to obtain a very fine powder.

E. Analysis of heavy metal- One gram of the Sirukeerai sample (1 g) was digested (Plate VII) by adding 15 ml of tri-acid mixture **(**Nitric acid (HNO3), Sulphuric acid (H2SO4), and Hydrochloric acid (HClO4) in the ratio of 5:1:1**)** at 80 °C until a mixture gives out white fumes and forms transparent solution. The digested sample was filtered using Whatman No. 42 filter paper after cooling and the filtrate was finally made up to 50 ml with distilled water. The sample wasanalysed by atomic absorption spectrophotometer using an air-acetylene flame for Cr, Pb and Zn. The instrument was fitted with specific lamp of particular metal. The instrument was calibrated using manually prepared standard solution of respective heavy metals as well as drift blanks using standard procedure**.**

The readings were noted at wavelength of 425.4nm for chromium 405.4nm for lead and 213.9nm for zinc with a slide width of 0.1nm

F. Calculation of Mean Intake of heavy metals- The mean intake of heavy metals by the subject representing the three selected regions was calculated using the formula:

$$\text{Mean Intake of Heavy metals} = \text{Heavy metals concentration in green leafy vegetables} \times \frac{\text{Daily intake of green leafy vegetables}}{\text{Average body weight}}$$

The mean intake of heavy metal was then compared with the recommended intake of heavy metal proposed by WHO/FAO (2001) standard.

III. RESULTS AND DISCUSSION

Mean intake of Sirukeerai

The mean age of the selected women was 33years and the mean weight was found to be 53kg a weight range meeting the standards of a reference woman**.** The families which earned more than Rs10000/ month purchased organic greens (23) compared to those who earned between Rs5000-10000 and less than Rs5000. None of the families with less than Rs5000 as family income purchased organic vegetables as they are expensive compared to the ones available in the market and from street vendors.

Out of 75 women, 43 of them were found to be employed. Also it is clear that more number of business women (8) and professional (6) had organic greens as their choice of purchase.Majority of the consumers from ukkadam (15) and Saibaba Colony (12) bought the green leafy vegetables from road side vendors and from street vendor. It was also evident that all the 25 member selected from Murugan Mills purchased greens only from organic stores.
The commonly purchased green were Arakeerai (19) which was the most commonly consumed greens followed by Mirukeerai (15) and mullaikeerai (14) respectively by the selected women surveyed from SaibabaColony.Sixty five out of 75 women were aware of the risk of contamination of heavy metals in green leafy vegetables and this is strongly felt as a reason as to why 25 women purchased organic green than the one sold in the markets.

Most respondents believed that organically farmed greens are safe for consumption when compared to the one available in the general market and 64 women opined that organic greens are free of heavy metal contamination and are safe to consume since they are grown without any additional pesticides and chemicals.

Out of 75 women, the practice of washing green leafy vegetables (32) followed by cooking (30), blanching (8) and few adopt usage of soaking in salty water (5) to get rid of heavy metals.The mean intake of Sirukeerai was found to be 70gm, 68gm and 80 gm per day fromSaibaba colony,Ukkadam and Murugan mills respectively.

- **Heavy Metals Contamination of Sirukeerai -** The contamination of heavy metals for chromium, lead and zinc in Sirukeerai (table I)

Table I
Contamination of Heavy Metals in Sirukeerai*(Amaranthuspolygonoides)*

	Heavy metals Contamination	Area			
		Saibaba Colony	Ukkadam	Organic store	
	Chromium(ppm)	183.4	103.7	75.55	
	Lead (ppm)	BDL	BDL	BDL	
	Zinc(ppm)	60	72.5	57.5	

From the table (I) it can be interpreted that the contamination of chromium is high in Sirukeerai procured from Saibaba colony market where as the zinc contamination was found to be highest in Sirukeerai procured from Ukkadam area (72.5ppm). It was also observed that the Sirukeerai purchased from organic store has the least contamination of chromium (75.5ppm)and Zinc(57.5ppm)compared to the other two samples.

A study conducted by LokeshwariChandrappain 2006 claims that amaranth is said to be an effective absorbent of heavy metals from the soil through roots. Also (Muhammad Farooq et al 2008) opines that Amaranth that is grown in the heavy metal contaminated soil accumulates high amount of heavy metals than those cultivated in uncontaminated soils. As amaranthabsorbs and accumulate heavy metal in edible and nonedible parts of the plant and heavy metal absorption depends on the nature of plants (Akan etal., 2009),the above observation can be attributed to agricultural practices, usage of fertilizers and level of pollutant in the soil . The presence of lead was to found Below Detectable Level for Sirukeerai.

Though a study conducted byH. L. Ramesh and V. N. Yogananda Murthy (2012), on the contamination of Amaranthus with Chromium (Cr) and Zinc in KGF showed accumulation of the metal,(BDL) at K.G.F (<0.24 ppm) followed by Bangarpet (<0.14 ppm), Bethamangala (<0.09 ppm) , the values were found to be within the FAO/WHO safe limit (20.0ppm) for chromium, whereasZn concentration exceeded the permissible limits at K.G.F (63.04 ppm) and was within the safe limit for Bethamangala (24.31 ppm), Bangarpet (42.16ppm) and control (21.66 ppm) .

From the above results it is evident that the Null Hypothesis I- There is no contamination of chromium, lead and zinc in Sirukeerai cultivated at different site of Coimbatore namely Saibaba Colony, Ukkadam and Murugan Mills was rejected.

Mean Daily Dietary Intake of Heavy Metals

Table II
Mean Daily Dietary Intake of Heavy Metals from Sirukeerai

Place of procurement	Cr (ppm)	Zn (ppm)	Permissible level intake of heavy metals	T-test
saibaba colony	246.88	80.76	Cr-0.46mg Zn-15.73m	Cr-.007 Zn-.014 %**
Ukkadam	96.93	73.77	Cr-0.46 mg Zn- 15.75 mg	Cr- .089 % Zn-.002 %
Organic stores	158.92	110.476	Cr-0.46 mg Zn- 15.73 mg	Cr-.011 %** Zn-.000 %**

From the table it is evident that the mean daily dietary intake of heavy metals was found to be maximum in women who consumed Sirukeerai grown in the agricultural field. It was surprising to note the mean daily intake of heavy metals from Sirukeerai procured from Ukkadam market grown on the banks of sludge's and sewages was less contaminated compared to the ones consumed from the organic stores. Further it was also observed that irrespective of the place of cultivation, the mean daily intake of chromium and zinc from Sirukeerai was found to be very high compared to the permissible level (chromium-0.4mg, zinc-15.7mg) recommended by WHO. The difference between the mean intake of heavy metals and permissible intake was found to be significant at 1% level of significance for both chromium and Zinc.

Jarup, L. (2003) proposes that , though,during the last century, lead emissions to ambient air have further polluted our environment, due to lead emissions originating from petrol, Over the last few decades, however, lead emissions in developed countries have decreased markedly due to the introduction of unleaded petrol. Thus the above observation of contamination of leadBelow Detectable Level (BDL) can be attributed to the declining lead emission in the environment.

Therefore the Null Hypothesis II, III and IV were rejected-

IV. CONCLUSION

In general,irrespective of the place of cultivation, Sirukeerai was highly contaminated with chromium and Zinc. Contamination of lead was below detectable in sirukeerai in all the three sites of cultivation. The mean daily intake of heavy metals was also found to be high than the recommended permissible level (chromium-0.4mg, zinc-15.7mg) proposed by WHO. Thus the above findings of the study throws a major challenge before the scientific fraternity to explore the user friendly remedial measures to reduce the level of heavy

metals contamination not only in greens but also for all fruits and vegetables in future.

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