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HEAVY METALS TOXICITY:

ESTIMATION OF HEAVY METALS IN BRANDED AND LOCAL SNACKS AVAILABLE IN THE MARKETS OF PESHAWAR, PAKISTAN.

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ABSTRACT… Objectives: To estimate the concentration of heavy metals (Lead, cadmium, Chromium and copper) in branded and non-branded (local) snacks in the markets of Peshawar, Khyber Pakhtunkhwa, Pakistan. **Study Design:** Cross-sectional analytical study. **Setting:** District Peshawar, Khyber Pakhtunkhwa, Pakistan. **Period:** 6 months; from December 2016 to April 2017. **Materials and Methods:** A total of 96 different samples of potato and corn snacks were selected from four towns of district Peshawar by convenient sampling technique. All samples were subjected to wet digestion using acid digestion technique and Lead, Cadmium, Chromium and copper were quantitatively detected, using Atomic Absorption spectrometer in the Public Health laboratory Khyber Medical College Peshawar. **Results:** Mean concentration of Lead, cadmium, chromium and copper in potato based branded snacks were in the range of 0.085-0.423mg/kg, 0.003-0.046 mg/kg, 2.186-2.328 mg/kg and 0.008-0.108 mg/kg and concentration of heavy metals in corn based branded snacks were in range of 0.240-0.351 mg/kg, 0.007-0.012mg/kg, 2.254-2.179 mg/kg, 0.030-0.082 mg/kg respectively. While mean concentration of Lead, cadmium, chromium and copper in non-branded (local) snacks were 0.057-0.324 mg/kg, 0.005-0.012 mg/kg, 2.137-2.247 mg/kg and 0.018-0.06 mg/kg respectively. **Conclusion:** Lead and chromium were exceeding in majority samples of branded and local snacks. Particular concern was of chromium, which was exceeding far beyond the allowed limits in all samples.

Key words: Heavy Metals, Snacks, Branded, Local.

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INTRODUCTION

Heavy metals in food is emerging public health problem. They can be defined as elements that are having high atomic weight as compared to water and a minimum density of 5 times greater than that of water. They are of concern because of their adverse effects on individual health. Heavy metals are widespread in the environment because they are used in agriculture, industries, domestic, medical and many other areas. Toxic potential of heavy metals depends on various factors which includes; quantity, site of exposure and type of metal involved and also age, gender, nutritional and hereditary status of persons that are exposed to them.[1]

Soil is the main source of heavy metals accumulation. Heavy metals in soil are dangerous because they effect health of human beings through different absorption mechanisms particularly food. Crops absorbs heavy metals both from soil as well as polluted environment.[2] The most common mechanism by which soil is contaminated with heavy metals is irrigation of fields with waste water. Heavy metals in waste water is absorbed by soil and subsequently in vegetables grown in such soil accumulate leading to serious threat to human health.[3]

Snacks are processed food mostly composed of potatoes and other vegetables. Nowadays potato and corn based snacks are very popular all over the world especially among young children, because of its mouthwatering taste and easy availability in the markets. According to previous studies from different countries; potato and corn snacks are contaminated with different heavy metals which are very dangerous for health. As

discussed above snacks can be contaminated with heavy metals from raw vegetables grown on soil containing dissolved heavy metals and secondly during processing in industry particularly from the containers in which they are stored. Chips are fried in oil which can also be a source of heavy metal.[4] finally different kind of spices used in snacks are also a source of heavy metals contamination.[5]

Heavy have profound effects on health of individual. Symptoms of acute lead poisoning includes appetite loss, easy fatigability, raised blood pressure, sleep abnormalities, malfunction of kidneys, joint pain and vertigo. While chronic poisoning causes decrease weight, kidney and brain damage and ultimately death. Antenatal exposure to lead leads to abortions and birth defects in new borne including mental development and intelligence.[6,7]

Cadmium toxicity effects various vital organs. Principal organ that is effected is kidney. Cadmium toxicity may also causes Itai-Itai, disease characterized by bone pain and bone fracture due to osteoporosis. There is also some evidence that cadmium causes cancer particularly prostate and kidney but exact association is yet to be further explored.[8]

Copper causes changes in the structure of low density lipoproteins leading to atherosclerotic plagues formation. Formation of reactive oxygen species Interferes with antioxidants in the body, mutation in protein and DNA. This leads to cancer, cardiac diseases, neuronal disorders and many other manifestations.[9]

METHODOLOGY

A cross-sectional study was done to determine the concentration of Lead, Cadmium and Copper levels in most common branded and non -branded potato and corn based snacks from December 2016 to April 2017. A total of 96 samples were taken through convenient sampling technique from different shops located in different towns of Peshawar using following formula.

$$N = \frac{(1.96)^2 \times (s)^2}{(d)^2}$$

N = Sample size

S = Maximum standard deviation which was taken as 0.25 from previous study

d = Margin of error which was taken 5% in this study

All the samples were analyzed in the Public health laboratory Khyber Medical College Peshawar using Atomic Absorption Spectrometer

Laboratory Procedure

Sample was prepared by "Acid digestion technique. A sample of 2 gm weight was taken in a volumetric glass containing Per-Chloric acid ($HClO_4$) and Nitric acid (HNO_3) in a ratio 1:3 i.e. 5ml of Per-Chloric acid ($HClO_4$) and 15ml Nitric acid (HNO_3) in flask. It was kept over a hot plate for about 2 hours till white fumes appeared and the volume reduced to half i.e. 10ml. This procedure was repeated so as to ensure complete digestion. The flask was then filled with de-ionized water for dilution till the mark of 100ml. It was then filtered through watman filter paper No. 40 and sample was ready for the estimation of concentration of the elements on atomic Absorption Spectrometer.

RESULTS

Mean Concentration of Heavy Metals in Branded snacks

Potato Based Branded snacks

Table-I summarizes concentration of Pb, Cd, Cr and Cu in mg/kg in different potato based branded snacks. Comparing the values with WHO and FAO standards for heavy metals in food; concentration of lead was high in all brands of potato snacks except kurleez, while concentration of cadmium and copper are within normal range. Dangerous level of chromium is noted in all potato based branded snacks beyond maximum permissible levels.

Corn based branded snacks

Table-II summarizes concentration of Pb, Cd, Cr and Cu in mg/kg in different corn based branded snacks. Concentration of lead was high in all brands of corn snacks while concentration of cadmium was below permissible levels. Copper is within normal range except in catty chins. Dangerous level of chromium is also noted in all corn based branded snacks exceeding maximum

permissible levels.

Concentration of Heavy Metals in Local (Non Branded) snacks

A total of 67 non branded snacks were analyzed for heavy metals. As shown in Table-III mean concentration of Pb exceeds beyond permissible levels in samples from haji camp (Town 1), Pir Bala Chauk (Town 2) and Hazarkhwani (Town 4). Cd and Cu are within normal levels. While similar to branded snacks dangerous level of Cr is detected in all samples that significantly exceeded maximum allowed limits set by FAO.

Potato based branded snacks		Pb mg/kg	Cd mg/kg	Cu mg/kg	Cr mg/kg
slanty	Mean	.28433	.00900	.05250	2.19800
	Std. Deviation	.157376	.006693	.074840	.101757
Lays	Mean	.26475	.00875	.10750	2.19825
	Std. Deviation	.132553	.008808	.047339	.094827
knockout	Mean	.42300	.01000	.07000	2.21500
	Std. Deviation	.014142	.004243	.029698	.108894
super crisp	Mean	.38300	.02300	.00800	2.20100
	Std. Deviation	.	.	.	.
kurlees	Mean	.08500	.00300	.05300	2.26100
	Std. Deviation	.	.	.	.
Oye Hoye	Mean	.37000	.01900	.06600	2.32800
	Std. Deviation	.	.	.	.
Wawy	Mean	.31400	.01700	.04100	2.18600
	Std. Deviation	.	.	.	.
Pringles	Mean	.32200	.04600	.05300	2.22900
	Std. Deviation	.	.	.	.
kolson	Mean	.38800	.01000	.03000	2.32200
	Std. Deviation	.	.	.	.
Total	Mean	.30406	.01261	.06311	2.21878
	Std. Deviation	.128244	.010869	.053741	.084287

Table-I. Concentration of heavy metals in branded potato snacks

Corn based Branded snacks		Pb mg/kg	Cd mg/kg	Cu mg/kg	Cr mg/kg
Khurkuree	Mean	.34414	.00729	.02971	2.17929
	Std. Deviation	.108776	.003302	.014716	.054500
Cheetos	Mean	.35100	.00833	.03767	2.25400
	Std. Deviation	.035341	.002517	.035810	.118528
Catty chins	Mean	.24000	.01200	.08200	2.18900
	Std. Deviation	.	.	.	.
Total	Mean	.33655	.00800	.03664	2.20055
	Std. Deviation	.091566	.003130	.025021	.076019

Table-II. Concentration of heavy metals in branded corn snacks

Local (Non branded snacks)		Pb mg/kg	Cd mg/kg	Cu mg/kg	Cr mg/kg
Sikander and Bilal town (Town 1)	Mean	.05883	.00533	.05225	2.15767
	Std. Deviation	.035442	.005051	.042192	.107139
Haji camp (Town 1)	Mean	.41533	.00967	.04433	2.10367
	Std. Deviation	.044770	.001528	.028024	.126729
Pir bala chauk (Town 2)	Mean	.21586	.00757	.02114	2.23657
	Std. Deviation	.162188	.008304	.016517	.051114
Mathra Bazar (Town 2)	Mean	.06391	.00864	.05991	2.13109
	Std. Deviation	.037756	.006120	.027769	.060561
Raufabad (Town 3)	Mean	.08900	.00667	.04713	2.14393
	Std. Deviation	.120022	.006161	.023519	.066171
Hazarkhwani (Town 4)	Mean	.30509	.00864	.04000	2.13691
	Std. Deviation	.122717	.004478	.015588	.084579
Pando chauk (Town 4)	Mean	.05722	.01133	.05822	2.13733
	Std. Deviation	.036779	.007124	.014780	.076946
Total	Mean	.13782	.00791	.04762	2.15003
	Std. Deviation	.142662	.006037	.027572	.082712

Table-III. Concentration of heavy metals in different types of local snacks

DISCUSSIONS

This study was conducted to determine the concentration of Lead, cadmium, chromium and copper in branded and locally available snacks. 29 branded and 67 local snacks were selected from different markets of Peshawar. Mean concentration of Pb, Cd, Cr and Cu in branded snacks were 0.314 mg/kg, 0.011 mg/kg, 2.21 mg/kg and 0.0540 mg /kg respectively while mean concentration of Pb, Cd, Cr and Cu in local snacks were 0.149 mg/kg, 0.008 mg/kg, 2.149 mg/kg, 0.047 mg/kg respectively. Comparing potato snacks with corn; potato snacks were having slightly increased concentration of all tested heavy metals. Overall Pb and Cr were detected in highest concentration, exceeding maximum permissible levels in both branded and non branded snacks while levels of Cd and Cu were approximately normal.

Qasem M. Jaradat and Amer Tarawneh in their study on branded potato and corn based chips sold in Jordan market, showed that potato based snacks were having higher concentration of heavy metals as compared to corn based snacks. Beside other heavy metals, mean levels of Pb was 6.57 mg/kg, Cd 0.25 mg/kg and Cu 2.25 mg/kg in potato chips while mean levels of Pb was 6.79 mg/kg, Cd 0.21 mg/kg and Cu 0.54 mg /kg in corn based snacks. This study also compared different brands of heavy metals from other countries. Chips from Saudi Arabia were having more Cu, Chips of Kuwait showed high concentration of Pb while chips from Lebanan showed highest level of Cd[4]. Our study also showed high concentration of Pb, Cd, Cr and Cu in Potato chips as compared to corn based. Our study showed high concentration of Cr and Pb exceeding permissible levels but in low concentration than detected in samples of snacks manufactured in Jordan. While Cu levels in our study were less than samples from other countries.

Modhir et all in their study in potato and corn based snacks in Hilla city in Iraq documented that Potato based snacks were having high concentration of heavy metals. Dangerous levels Pb and Cd was detected in high concentration in potato and corn based snacks than other metal.[10] Our study also showed slightly increased heavy metals in potato than in corn based snacks but in contrast to this our study showed low levels of Cd and moderately increased quantities of Pb and high levels of chromium than detected in this study.

Ahmed etal in their study on potato and corn chips sold in the markets of Baghdad Iraq stated that corn based chips were having increased quantity of heavy metals as compared to potato snacks. Tested heavy metals in this study were Pb, Cd, Cu and Cobalt (Co). Their findings were within permissible levels as per Iraqi criteria of food hygiene.[11] Tested heavy metals in our study were same except Co and we also measured Cr levels. In contrast to their study, our results showed slightly increased heavy metals in potato based snacks as compared to corn. While levels of Pb and Cr were above permissible levels.

AL-rajhi in his study on 12 different heavy metals in Potato chips obtained from Riyadh city Saudi Arabia, stated that mean concentration of all tested heavy metals were within permissible levels and present in very low quantity. Beside other heavy metals all 4 heavy metals tested in our study were also tested which were also present in low quantities i.e Pb 0.0026 mg/kg, Cd 0.0001 mg/kg, Cr 0.0009 mg/kg and Cu 0.0001 mg/kg.[12] In contrast to this our study showed increased concentration of all heavy metals if compared to this study. Our study also showed dangerous levels of Cr i.e. > 2 mg /kg as well as Pb.

Mustafa eta al also determined concentration of heavy metals in potato and corn based snacks from different local stores in Turkey. Beside other heavy metals concentration of Pb, Cd, Cr and Cu were below permissible levels and also low when compared to our results. Their study also showed that levels of cu were high in potato snacks although within permissible limits.[13] Our study also showed that potato based snacks were heaving high Cu as compared to corn based but in contrast to their study our study documented high concentration of Cr and Pb and normal concentration of Cd and Cu except few samples.

Garcia et al in United states tested different heavy metals in corn as well as corn based snacks. Beside other heavy metals four included those that were measured in our study. Mean levels in their study were; Cu 1.19 mg/kg, Pb 0.347 mg/kg, Cr 0.185 mg/kg and Cd 0.072 mg/kg.[14] Comparing their results with our study shows similarity in results of the concentration of Pb and Cd while contrary to their results increase levels of Cr and low levels of Cu were detected in our study.

Lanre et al studied concentration of heavy metals in two of the most commonly consumed snacks in Nigeria. Tested heavy metals included Ni, Cu, Cd, Zn, As and Pb while Cr was not tested in this study. Cd were within permissible level while dangerous levels of Cu and Pb were detected in studied samples.[15] In our study dangerous levels of Cr were detected while levels of Pb were exceeding maximum permissible levels of FAO. Cu and Cd concentration were within permissible levels.

Idowu-Adebayo et al also tested different heavy metals in potato chips obtained from different areas of Nigeria. Four different heavy metals were tested in which two were same as in our study i.e. Cd and Pb. Their results showed normal levels of Cd and Pb while increase levels of Arsenic (Ar) were detected in their study.[16] In our study levels of Cd were also normal. In contrast to their study; our study showed increase concentration of Pb.

Meetu Gopalani et al demonstrated different heavy metals in potato chips bought from Nagpur city India. About 10 different heavy metals were analyzed in different samples of potato chips. Four of the heavy metals were same as measured in our study. Pb, Cd and Cr were not detected in their study while slightly increase quantity of Cu were detected in few samples.[17] In contrast to this our study all four heavy metals were present.

CONCLUSION

Heavy metals were present in both potato and corn based snacks and branded as well as non-branded. Potato based snacks were having slightly increased quantity of heavy metals when compared with corn based snacks. Levels of Pb and Cr were high in almost all samples of branded and non-branded snacks. Cr was detected in alarming concentration in all snacks. Concentration of heavy metals varies according to flavors of the same brand.

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