ANALYSIS OF HEAVY METALS IN RED MEAT IN DISTRICT PESHAWAR KHYBER PAKHTUNKHWA

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ABSTRACT

Objective: To determine toxic heavy metals in red meat samples at Peshawar.

Material and Methods: This study was conducted in Peshawar from January 2013 to December 2013. Hundred red meat samples were collected randomly from thirty different union councils of District Peshawar. Samples were transported to the laboratory by keeping in separate plastic bags and kept in refrigerator for processing. In order to detect these metals in various samples, methodology based on the principle of heavy metals that absorb different wavelengths of light is adopted and is termed as flame atomic absorption Spectrophotometer.

Results: Mean concentration of Cadmium and Lead in meat samples was 0.107 ug and 2.133 ug respectively. Average concentration of cadmium in buffalo and cow meat was 0.19 ug and 0.14 ug. Average concentration of lead in buffalo and cow meat was 2.52 ug and 1.95 ug. The distribution and concentration of metals varied in different organs of both species. Mean lead concentration in buffalo organ meat was higher than the permissible limits set internationally. Mean mercury concentration was higher in meat of both species. Mean of Cadmium (Cd) concentration in meat samples of both species were below the permissible limits.

Conclusion: There is difference in the concentrations of elements across different areas and meat samples from different parts and organs of cows and buffalos. This in turn can be related to the origin of organism or food preferences.

Key Words: Heavy Metals, Atomic, Absorption, Spectrophotometer, Meat.

INTRODUCTION

Heavy metals like lead, cadmium, mercury and arsenic are major toxic metals and showing continuously additive effect when they were consume by humans in various contaminated food stuffs of the food chain. Ingestion of these contaminants by animals causes deposition of residues in meat. Higher level of metals were found in mutton and beef because of grazing of cattle on contaminated soil. Food safety is the foremost global public alarm. There is natural attitude of human beings to avoid the harmful influences of manufacturing and farming production and tries to eliminate or keeps it to at minimum level. Pakistan is a developing country where the rate of urbanization and industrialization

is increasing day by day. These developments are likely to produce certain changes in the environment in the form of pollutions. The most hazardous among them is the contamination of food. It occurs because of unhygienic condition, industrial effluents, domestic wastes and use of pesticides in crops.[1] Heavy metals and various pathogenic bacteria among these pollutants generated by various industrial, domestic and commercial sewerage effluents are directly related to the health problems. Dangerous matter enters the food chain and become the main sources of pollution for humans. Heavy metals are the most dangerous pollutants.[2] A poisonous metal can be defined as the metal which is neither vital nor has beneficial consequence on human body and has a precise weight of more than 5 g/cm. They enter into the food material and from there they ultimately make their passage into the tissue whenever enters into the human body.[3] Recently heavy metals have come to the surface as dangerous chemical health hazards substances for men and animals. The presence of these substances

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in significant concentrations in meat is considered a potential health hazard to human and animal life.[4]

Meat is a food item and is composed of mainly protein, fat and some important essential elements. Meat consumed by public is sold in open markets and even on road sides and thus various heavy metals get way to meat and other food products and finally enters to human body, resulting in harmful diseases.[5] Meat is a very important human food; therefore, it may potentially accumulate toxic minerals and represents one of the sources of heavy metals for humans.[6]

Metals in general can be classified as toxic (cadmium, mercury) and essential (cobalt, copper, zinc, iron).[7] Heavy metals contamination of meat is a dangerous risk because it causes biomagnifications and bio-concentration in various levels of food chain and thus enters the human body and causes various adverse and toxic affects.[8] Among all heavy metals, arsenic, cadmium, mercury and lead are the most dangerous metals and having harmful impacts on the human body. The poison effects of of arsenic in its inorganic form has been recognized for periods under the following forms: sub chronic toxicity; acute toxicity, developmental toxicity, reproductive toxicity and genetic toxicity,[9] immune-toxicity, biochemical and cellular toxicity, and chronic toxicity.[10,11] Cadmium intake through food results in cardiovascular diseases, diabetes, digestive disturbances, growth impairment and headaches. Accumulation of lead results in abdominal pain, allergies, blindness, constipation, hypertension diseases and kidney disorders etc. Mercury also causes different harmful diseases in human beings like cadmium and lead such as brain damages, allergies, headaches, nervous and depression effects etc.[12] Objectives of the study are to analyze the concentration of heavy metals i.e. arsenic, lead, mercury and cadmium in collected meat samples of Peshawar which is one of the famous city and provincial capital of Khyber Pakhtunkhwa, Pakistan and having population of approximately 1.5 to 2 million and 77 km^2 area.

MATERIAL AND METHODS

This was a cross sectional descriptive study and conducted from January 2013 to December 2013 at District Peshawar. There are 93 union councils in district Peshawar comprising of both rural and urban areas. Sample size of this study calculated based on 95% confidence interval, 10% precision and 50% prevalence for obtaining maximum sample size. This comes to be 96 and after making it round number, sample size is 100. Hundred meat specimens were collected from randomly selected thirty Union Councils / areas of district Peshawar for more representation from each sites three to five different sample of meat were collected.

From different areas / markets of the respective union council and area, 3-5 samples were collected. Each sample collected from different areas/union councils weighted between the ranges of 150-250 grams. Samples were transported to the laboratory in airtight colorless separate plastic bags kept in cold box. The bags were properly labeled with ID, Union Council and date of collection. For assessing heavy metals Arsenic, Cadmium, Mercury and Lead in meat, the samples were kept in refrigerator for processing.

Concentrated nitric acid (70% high pure HNO3) 65% per chloric acid (HCLO4, 4:1 v/v) and distilled water. Pb, Cd, As & Hg Standards 1000 ppm (Merck) were the reagents used in this study. The dried meat samples obtained from the samples were initially decomposed by this method in order to assess the concentration of heavy metals in the collected meat samples. All the laboratory instruments like glass wares, crucibles were first washed with distill water and then ware made dry by means of heat. After that each crucible weight were made to be constant by placing them in electric furnace at a temperature of 700-800°C, then transfer it to the dedicator and then reweight it again to find the difference.

This method was used in order to avoid moisture in the collected samples of meat. This method is repeated again and again till we get same or equal weight of all the collected samples. After that approximately 2 gm of each of the selected samples was collected i.e. heart, kidney, liver, meat and pancreas and then was put in the crucible. The crucibles were again shifted to the electric furnace and heated to 200°C for 20 minutes; it took almost 3-4 days to digest the collected samples. After that we added 2.5 ml of HNO3 (6 molar) in order to dissolve the sample contents. Finally we filter and diluted the samples and made the volume up to 25 ml with distilled water.

In order to detect heavy metals in various samples, a procedure termed as flame atomic absorption Spectrophotometer is adopted. This method is the most simplest and accurate method and is performed on the principle of heavy metals which absorb different wavelengths of light. In this method the flame results in

conversion of heavy metal ions into their atomic states and then the requisite amount of wavelength light is absorbed against a standard measurement.

The representative meat samples were chopped and were weighed not less than 1g of each sample. These were treated with concentrated Nitric acid and Perchloric acid mixture of 1: 2. After treating samples with acid, samples were digested by heating the sample on electric hot plates to get analyst metal in solutions till 1 ml of clear transparent sample solution was remained. The temperature was increased after every 30 minutes during digestion of samples. Then the solutions were filtered and volume of filtrate was made up to the mark in volumetric flask using distilled water and samples

Table 1: Distribution of Lead & Cadmium levels by animal (Cow / Buffalo)

Type of animal	Cadmium		Lead	
	Minimum (ug/gm or ppm)	Maximum (ug/gm or ppm)	Minimum (ug/gm or ppm)	Maximum (ug/gm or ppm)
Cow	0.01	0.93	0.7	6.75
Buffalo	0.03	0.96	0.11	20.05

Table 2: Distribution of Cadmium & Lead levels by different organs of the animal

Organs/Area of animal	Cadmium		Lead	
	Minimum value (ug/gm or ppm)	Maximum value (ug/gm or ppm)	Minimum value (ug/gm or ppm)	Maximum value (ug/gm or ppm)
Neck	0.02	0.18	0.11	6.75
Chest	0	0.36	0.34	8.26
Leg	0	0.96	0.7	20.05

Table 3: Distribution of Cadmium & Lead levels in (μg/gm) among samples of Meat from Neck region of Cow / Buffalo by Union Council

Sample ID	Area / Lacation / Union Council	Cow		Buffalo	
		Cadmium (Cd) (ppm or ug/gm)	Lead (Pb) (ppm or ug/gm)	Cadmium (Cd) (ppm or ug/gm)	Lead (Pb) (ppm or ug/gm
6	Mera Kechora	0.02	2.13	0.03	2.00
13	Dalazaak	0.05	1.90	0.04	2.01
14	Zargarabad	0.04	1.07	0.04	1.03
21	Bhana Marri	0.05	2.01	0.02	2.01
26	Gul Bahar	0.05	2.20	0.06	3.16
32	Gulberg	0.05	2.45	0.08	2.95
36	Landi Arbab	0.09	1.82	0.07	1.1
37	Landi Arbab	0.09	1.4	0.03	0.09
38	Landi Arbab	0.09	1.13	0.03	1.10
39	Hassan Garhi	0.09	1.09	0.08	1.04
43	Nahaqi	0.1	0.99	0.09	1.00
47	Kababyan	0.12	1.48	0.11	1.29
54	Badaber	0.16	1.51	0.12	1.46
56	Badaber	0.18	1.45	0.16	1.33
62	Palosi	ND	2.35	ND	2.12
63	Palosi	ND	1.69	ND	1.45
64	Palosi	ND	1.68	ND	1.50
65	Hayatabad	ND	2.79	ND	2.67
66	Hayatabad	ND	2.19	ND	2.20
67	Hayatabad	ND	2.45	ND	2.36
68	Hayatabad	ND	2.22	ND	2.13
69	Hayatabad	ND	2.12	ND	2.11

were stored in plastic bottles. Filter paper 42 that gives maximum and minimum levels, was used for filtration of samples. The blank used for A.A spectroscopy was distilled water. Stock standard solution of 1000 ppm of respective elements (As, Cd, Hg and Pb) was used to prepare the working standard of 100 ppm. Then further dilution of 1, 2, 3, 4 and 5 ppm were prepared as working standard of test elements.

RESULTS

From purposively selected thirty different sites/ union councils of Peshawar, a total of 100 samples of meat were collected n order to determine the heavy metals concentration through Atomic Absorption Spectrophotometer (AAS) Z-2000 in these areas. Range of the weight of sample was from 1.36 gm to 3.35 gm. Table 1 shows animal wise distribution of heavy metals. Table 2 shows the organ/area wise distribution of heavy metals i.e. Cadmium and Lead.

Table 3 shows that 22 meat samples were taken from neck region of either Cow or Buffalo from above mentioned areas / location of District Peshawar. All the above mentioned samples either from cows or buffalos are imported from other places.

DISCUSSION

The heavy metals are generally not degradable and have the potential to be accumulated in different body organs of animals leading to both acute and chronic toxic effects.[13] In the current study Arsenic and Mercury were not determined or detected in the collected meat samples while Lead and Cadmium were detected in varying amounts. Pb and Cd are classified among the most toxic heavy metals which have no known biochemical benefits to animals and humans[14] Arsenic, Mercury, Cadmium and Lead were analyzed through Graphite Furnace in μg/kg, whereas Mercury was analyzed through Mercury Analyzer (AAS) in μg/kg. Among all 100 samples of meat, Arsenic and Mercury were not detected even in scant amount at all. The only heavy metals under study detected were either Cadmium or Lead while in some of the samples amount of Cadmium was also not detected.

Cadmium

The cadmium concentration in meat samples showed variations among different areas of Peshawar. Almost all samples contained cadmium concentration. The highest concentration was recorded in sample collected from Karimpura which is 0.96 (μg/gm) while some samples have 0.00 cadmium concentration. In some samples cadmium concentration was not even detected. Most of the metals get entrance into human body through taking diet. In surrounding environment the source of metals is the combustion of fuels, mining industry, disposal of waste, and sewage. Profession of forestry and farming also contribute to the increased metal content in the environment because of using fertilizers and pesticides.[15] Cadmium is virtually toxic to every system of the human body as at birth it is almost absent in the human body, however accumulates with the growing age.[3] Results of our study were consist with the results of a study in which the highest cadmium (Cd) concentration was observed as 0.124 μg/g while the lowest was 0.004 μg/g in meat samples. Cadmium accumulated in different organs has been reported[16] that cadmium interacts with a number of other minerals due to chemical similarities. It is also reported in a study that cadmium levels in the meat samples of cattle in Poland exceeded the permissible limits. Similarly it was observed in a study that higher levels of cadmium in the meat samples exceeded the standard tolerance levels. Looking at results of the present study, the concentration of cadmium in all the samples studied was found to be similar to the results obtained.[17] In another study regarding residual level of cadmium in meat samples analyzed that none of the examined muscle samples of some domestic animals exceeded the permissible limit (0.5 ppm) recommended by FAO/WHO while 100% of buffalo meat samples exceeded the permissible limits with mean value of 0.7±0.03 and 0.91±0.02ppm.[18] Nearly similar findings were detected by Khalafalla et al, Ambushe et al, Abd El-salam, and Badis et al.[19,20,21,22]

Lead

Lead is known to be a toxic metal with unknown valuable effects on human beings and its gradual accumulation in different organs of animals and human beings can cause grave ill effects.[23] Lead has been found in all samples in the current study. All the samples contained considerable amount of lead that ranges from 0.11 to 20.05μg/gm and highest concentration was found in sample collected from Bashir Abad, concentration of which is 20.05μg/gm. However majority of samples showed a similar range of concentration. These results are consistent with results of a study in which lead concentration observed in all the samples of different animals (Cow, Buffalo) and it was found that red meat samples of cow showed the highest concentration i.e. 11.838 mg/kg.[24] All the meat samples that

were analyzed contained lead in high doses (above the permissible limits) and this could be due to the use of the areas in which cattle were reared.[25] In another study it was observed that levels of Lead in meat samples were in highest concentration of 3.269 μg/g.[16] Similar results obtained in a study that showed lead concentration in meat samples and reported higher concentration of lead than the permissible limits.[26] The highest concentration of Pb refers to a serious contamination of sources of pollution that may be located near the breeding area, like industrial and chemical factories which will result in the contamination of feed, water, as well as the air inhaled by the animals. Other studies that showed high levels of Pb in meat samples addressed contamination from feed, water, air pollution.[17]

CONCLUSION

Lack of knowledge of hazards associated with contaminated food products is the key factor of many harmful diseases. It has been proved that heavy metals are considered to be toxic to both environmental and human health.

RECOMMENDATIONS

Keeping in view the results of present study it is recommended that;

1. Ongoing and continuous monitoring of heavy metals contamination especially Lead Cadmium as they can build up to toxic concentrations.

2. Cadmium and Lead contents should be decreased by applying limitations on the use of cement, fertilizers.

3. Ensure hygienic measures in the slaughter places and distribution of food.

4. Ensure that a consumer is aware of buying fresh and covered meat. As common man does not know about the harmful presence of heavy metals in meat. Building public private organization that should create awareness in public through print and electronic media and health education.

5. As meat is one of the important nutrients, which is frequently consumed by human, therefore it must be free from heavy metal contaminations. All the concerned departments must act accordingly to provide safe and high standard of meat at the consumer end.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

Nawaz R: Idea and concept.

Urehman S: Data analysis.

Nawaz S: Bibliography and statistics.

Iftikhar B: Supervision.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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