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EXPLORATORY ANALYSIS OF HEAVY METALS IN DIFFERENT ORGANS OF BUFFALO AND GOAT MEAT IN SWAT, KP, PAKISTAN

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Abstract

Animal tissues and organs are true indicators that reflect the potential toxicity of heavy metals due to animals' direct diet selection. The study was conducted to find out the high concentration of heavy metals such as lead, cadmium, copper and chromium in meat in different body organs of buffalo and goat meat in Swat, Pakistan. A total of 280 (n= 280) meat samples were collected from slaughtered animals and subjected to an Atomic Absorption Spectrophotometer. After analysis, the highest quantity of Cd in buffalo meat was recorded in kidneys and lower in heart muscles and a statistically significant difference of P<0.05 was recorded. Similarly, a higher concentration of Pb, Cr and Cu was recorded in kidneys, shoulder muscles and liver and a lower quantity of Pb and Cr was recorded in heart muscles and Cu in rump muscles and a statistically significant difference was observed. In goat meat higher quantity of Cd and Pb was observed in kidneys while Cr and Cu were recorded in rump muscles and liver and a statistically significant difference (P<0.000) was recorded in different organs while a lower quantity of Cd, Cr and Pb was a recorded in thigh muscles and Cu in shoulder muscles. As a result, it was concluded that the Liver and kidneys are the main source of the accumulation of different toxic heavy metals.

Keywords: *Buffalo, Goat, Heavy metals, Meat, Swat*

INTRODUCTION

Meat is an essential part of the human diet and it carries a large quantity of proteins in adding to some other highly important nutrient components such as fats etc. Fats play an important role in body growth as a storage form of energy and continuity of healthy life. Meat and other meat products are the major integral element of human diet in addition also a source of other important nutrients (1).

Meat is one of the basic nutritional diets which play an important role in human growth and maturity. All meat should be free from any infection, dirt and other hazardous agents such as heavy metals Chromium, mercury, cadmium, Copper and lead. Open markets are the major places where meat is available for sale and most of them are at road sides. In less developed countries, meat is often exposed to dirt and dust. As a result different types of metals and other infectious agents enter in meat and make meat harmful for human health resulting in production of different types of medical disorders in human health (2).

A large number of pollutants are produced by different industries, among the pollutants generate by a range of industrial marital and practical sewerage pollution which also play key role in spread of heavy metals. All the heavy metals and disease producing microorganisms are directly related to public health significance. Quality of the food can be easily measured by the health status of the community. There is a food cycle that circulates by hazardous substances associated to human life. Heavy metals circulate in food cycle and result in a big challenge to human life after consumption. Mostly heavy metals are toxic to human health (3).

In Pakistan there is different situation for grazing, feeding and watering of different animals. Mostly animals graze freely in industrial zones and other hilly areas. All the free grazing animals drink stagnant water, rivers, ponds and streams that are important source of contaminated water.

Often small and large ruminants graze on roads and other places infected by different poisonous materials. Butchers are important source of contamination the environment due to slaughtering of animals in open grounds. As a result, they spread the infected materials on the ground. Our butchers are mainly illiterate and slaughter the disease animals prior to antemortem examination. Animals are mainly suffered from pollution either drinking of contaminated water, close contact with toxic materials, fodders cultivated on heavy pesticides , use of fertilizers for fodders and waste materials of industries. Animal products are mainly contaminated by contaminated vehicles and slaughter house (4). Heavy metal contamination is also observed in the raw milk of cow (5). Keeping in view the above results the current study was considered necessary because limited information is available on concentrations of heavy metals in District Swat. The aim of the present study was to determine the presence of different level of heavy metals (Pb, Cr, Cd and Cu) in different selected parts of Buffalo and goat meat.

The present study was conducted to investigate the presence of heavy metals (Cd, Pb, Cr and Cu) in the selected body organs of buffalo and goat meat.

METHODOLOGY

STUDY AREA

This study was conducted in District Swat, an area with a heavy industrial presence. This area is free of tax so heavily populated with industries. Due to heavy industrialization, a large amount of wastes are produced. These wastes are mostly mix in drinking water and soil used for grazing. This water used for irrigation of fodder, vegetables, forages and other cereal crops. The fodders and other crops are used for feeding of small and large ruminants. As a result of feeding of contaminated fodder and water due to waste of industries, a large number of heavy metals enter in animal's body.

SAMPLES COLLECTION

During this study two hundred and eighty samples were collected from small and large ruminants. All the animals were slaughtered in local slaughter house of Swat (Mingora).Twenty samples were collected from each body part such as thigh, rump and shoulder region of goats and buffaloes. Similarly twenty samples were also collected from each soft/ visceral organs of the body such as lungs, heart, liver and kidney.

PREPARATION OF SAMPLES

All collected samples were maintained under hygienic conditions and were processed through acid digestion/ wet digestion. Heavy metals were determined by using a mixture of perchloric acid and nitric acid as reported by Javed *et al.,* 2009 (6). From each sample, one gram was taken and was placed in digestion flask (100 ml). Then added conc. nitric acid and both were heated for a period of twenty minutes. After heating, were placed at room temperature for cooling followed by adding of 5 ml of perchloric acid. Now heated the sample forcefully till the physical appearance was fully or partially disappeared and obtained white unambiguous solution of reduce quantity of 2-3 ml. All the contents of the digestion flask were subjected to filtration into volumetric flask (50 ml) and were filled up to the mark with water (4).

ANALYSIS OF THE SAMPLES FOR DETERMINATION OF ELEMENTS

All the samples were processed by using Atomic Absorption Spectroscopy at Department of Soil and Environmental Sciences, University of Agri. Peshawar. Similar study was also conducted by other researchers (7).

STATISTICAL ANALYSIS

All the collected data was entered in MS Excel and was analyzed by software SPSS 16.0. Duncan multiple range test (DMRT) was used for ranking of different means as reported by Steel and Torrie, 1980 (8).

EXPERIMENTAL LAYOUT

Species	Name of organs	Total number of samples examined
Buffaloes (Large Ruminants)	Shoulder muscles	20
	Rump muscles	20
	Thigh muscles	20
	Liver samples	20
	Kidneys	20
	Lungs	20
	Heart muscles	20
Goats (Small Ruminants)	Shoulder muscles	20
	Rump muscles	20
	Thigh muscles	20
	Liver samples	20
	Kidneys	20
	Lungs	20
	Heart muscles	20
Total number of collected samples		280

RESULTS

Currently, different levels of heavy metals such as chromium, lead, cadmium and copper were detected in buffaloes and goat meat. All the samples were collected from seven different organs of the buffalo and goat meat. Out of seven body parts, three were collected from skeletal muscles (shoulder, rump and thigh) whereas four samples were collected from visceral organs of the body such as heart, lung, liver and kidneys. Different mean concentrations of Cr, Pb, Cd and Cu (0.7530, 1.152, 0.032 and 0.029 mg/kg) have been shown in Table I.

Table I. Mean concentration of different heavy metals present in different body parts of buffalo meat

Sample Site	Mean Cd ± S.E	Mean Pb ± S.E	Mean Cr ± S.E	Mean Cu ± S.E
Shoulder muscles	0.032± 0.005	1.152 ± 0.172	0.753±0.098	0.029 ± 0.004
Thigh muscles	0.042 ± 0.005	0.809 ± 0.093	0.643±0.107	0.268± 0.086
Rump muscles	0.033 ± 0.005	1.251 ±0.183	0.566±0.086	0.021 ± 0.002
Heart	0.023 ± 0.003	0.562 ± 0.079	0.288±0.039	0.031 ± 0.002
Liver	0.028± 0.002	0.871± 0.097	0.351±0.025	0.626± 0.085
Lungs	0.029 ± 0.002	0.746 ± 0.064	0.477±0.039	0.091± 0.020
Kidneys	0.063 ± 0.014	1.261 ± 0.081	0.496±0.035	0.052± 0.005
P-values	0.001	0.0000	0.0000	0.0000

The buffalo heart muscles were examined for Pb, Cd, Cu, and Cr concentrations, detecting 0.562, 0.023, 0.031, and 0.288 mg/kg, respectively. The buffalo soft organ liver was also examined for presence of Pb, Cd, Cu and Cr where different concentrations such as 0.871, 0.028, 0.626 and 0.351 mg/kg were recorded respectively. The buffalo lungs were also found positive for different level of concentration of Pb, Cd, Cu and Cr such as 0.746, 0.029, 0.091 and 0.477 mg/ kg respectively whereas different level of concentrations of Pb, Cd, Cu and Cr (1.261, 0.063, 0.052 and 0.496 mg/kg) was also reported during analysis of kidneys respectively (Table I).

Similarly goat's meat was examined for presence of different level of concentration of heavy metals (Pb, Cd, Cu and Cr) and presented the data in Table II. The shoulder muscles of goat were examined for mean concentration of Pb, Cd, Cu and Cr where recorded different level of concentrations such as 1.173, 0.021, .0301 and 0.493 mg/kg respectively.

The thigh, rump and heart muscles were also examined for presence of Pb, Cd, Cu and Cr where recorded different level of concentrations in thigh muscles (1.104, 0.043, 0.049 and 1.051 mg/kg), Rump area

(1.246, 0.014, 0.044 and 1.193 mg/kg) and heart muscles (1.101, 0.044, 0.069 and 0.631 mg/kg) respectively. Similarly visceral organs such as liver, lungs and kidneys were also examined in goat for presence of different concentrations of Pb, Cd, Cu and Cr was recorded. The different soft organs of goat such as liver, lungs and kidneys were also examined for presence of Pb, Cd, Cu and Cr where observed different concentrations such as in liver (1.1276, 0.043, 0.254, 0.560 mg/ kg), lungs (0.611, 0.021, 0.039, 0.653 mg/kg) and kidneys (1.246, 0.046, 0.079 and 0.574 mg/kg) respectively (Table II).

Table II. Mean Heavy metals concentration (mg/kg) in different body parts of goat meat

Sample Site	Mean Cd ± S.E	Mean Pb ± S.E	Mean Cr ± S.E	Mean Cu ± S.E
Shoulder Muscles	0.021±0.004	1.173±0.118	0.493±0.052	0.0301±0.006
Thigh Muscles	0.043±0.004	1.104±0.082	1.051±0.086	0.049±0.006
Rump Muscles	0.014±0.002	1.246±0.150	1.193±0.159	0.044± 0.006
Heart Muscles	0.044±0.006	1.101±0.080	0.631±0.077	0.069±0.006
Liver	0.043±0.004	1.126±0.077	0.560±0.068	0.254±0.105
Lungs	0.021±0.002	0.611± 0.044	0.653±0.068	0.039±0.004
Kidneys	0.046±0.005	1.246±0.065	0.574±0.069	0.079±0.004
P-value	0.000	0.000	0.000	0.000

Similarly highest concentration of lead was also recorded in kidneys of goats (1.246 mg/kg) and buffalo (1.261 mg/kg) whereas the lowest quantity of Pb was recorded in the heart muscles (0.562 mg/kg) of beef meat. Furthermore the highest quantity of Cd was recorded in kidneys (1.246 mg/kg) while lowest quantity was found in lungs (0.021 mg/kg) in mutton.

The highest concentration of cadmium was recorded in kidneys of beef (0.063 mg/kg) while lower concentration was observed in heart muscles (0 .023 mg/kg) in beef meat. During analysis of mutton, the highest level of Cd was recorded in kidney (0.046 mg/kg) while lower concentration was recorded in rump region (0.014 mg/kg).During the analysis of the shoulder muscles (beef) the highest concentration of Cr was recorded(0.753mg/kg) whereas lowest concentration was found in heart muscle(0.288 mg/kg) in beef .

Similarly in rump region, the highest chromium concentration (1.193 mg/kg) was observed in mutton whereas lower concentration (0.493 mg/kg) was reported in the shoulder muscle. The highest concentration of Cu was recorded in liver (0.626 mg/kg) of large ruminants while lowest quantity was recorded in the rump muscles of beef (0.021 mg/kg). During mutton analysis, the soft organ liver showed the highest concentration of Cu (0.254 mg/kg) whereas lowest concentration was recorded in shoulder muscles (0.031 mg/kg).

The Table III presents the concentration of heavy metals cadmium (Cd), lead (Pb), chromium (Cr), and copper (Cu) in beef and mutton**,** along with their daily intake compared to the Maximum Allowable Intake (MAI) set by the Expert Group on Vitamins and Minerals (EVM) in 2003. The percent distribution indicates how much of the MAI each metal contributes based on daily intake

Table III. Heavy metals concentrations in meat (beef and mutton) (mg/kg) and quantification of the daily consumption in light of MAI by EVM 2003

Element	Mean	Std. Error	Daily intake	MAI	Percent distribution (%)
Cd (Beef)	0.035	0.002	0.001	0.083	2.380
Cd (Mutton)	0.025	0.001	0.001	0.083	1.190
Pb (Beef)	1.068	0.090	0.058	0.496	11.871
Pb (Mutton)	1.174	0.069	0.066	0.498	13.079
Cr (Beef)	0.653	0.055	0.035	0.770	4.675
Cr (Mutton)	0.912	0.072	0.050	0.770	6.493
Cu (Beef)	0.105	0.031	0.006	11.000	0.055
Cu (Mutton)	0.041	0.004	0.001	11.000	40.019

*MAI= Maximum Allowable Intake, EVM= Expert Group on Vitamins and Minerals

DISCUSSION

In the present study, the maximum concentration of Lead (1.261 ± 0.081) and Cadmium (0.063 ± 0.014) was reported in kidneys of buffalo meat. Similar report was also recorded in kidneys of goat where

highest value of cadmium and lead was (0.046 ± 0.006 and 1.246 ± 0.065 mg kg^{-1}) recorded respectively. Our findings are similar to Ayesha *et al.* 2014 (9) where the highest level of Cadmium was recorded in the Kidneys (0.14 µg/gram) followed by liver (0.08 µg/gram) while in heart non- detectable quantity was observed in heart of buffalo. Our reports are also in close with findings reported by Ayesha *et al*., 2014 where highest quantity of Lead concentration was recorded in kidneys of buffaloes. Our findings are also in line with the reports of (Chukwujindu, 2008) where highest quantity of Cadmium (0.20 ± 0.12 mg/kg) was recorded in kidneys. Our findings are also in close with the findings reported by Pompe & Crnic, 2002 (10, 11). Stoyke and his colleagues demonstrated the highest concentration of Cadmium in the kidneys because detoxification occurs in kidneys where as a result maximum metals are stored (12). Cadmium mainly detected in liver & kidneys due to availability of protein thiol group that react for fixation of different heavy metals. Heavy metals are mainly excreted through kidneys due to low molecular weight with –SH groups because all vertebrates cannot properly develop the mechanism during evolutionary period that was necessary for anthropogenic source of pollution (10). The higher renal level of cadmium was reported in herbivores (birds, mammals) while lower concentration was found in carnivores, although vegetables contain higher concentration of Cd due to either aerial deposition or absorption from soil (13). There are large number of sources help in ingestion of lead by ruminants and store in kidneys and liver. Different sources, such as airborne and industrial pollution, contribute to Pb contamination in grazing areas (14). The leaves parts of the plant are mainly responsible for the absorption of lead from atmospheric contamination while lesser quantity is absorbed by roots from the earth. Robert (1988) reported that the highest Cd levels were found in forages during winter," that highest quantity of Cd was found in forages during winter season. Different paints free of lead (Pb) are also containing up to 1%. There different sources of lead that contaminate the grazing areas such as lead batteries, waste oil of engine, roofing tiles, putty, industrial pollution, linoleum, automotive exhaust, golf balls, solder, caulking and grease etc. some thread compounds or pipe joint are also contain Pb powder up to 40%. Poor absorption of lead metal occurs in rumen (15).

The highest concentration of chromium (Cr) was recorded in shoulder muscles (0.753 mg/kilogram) after analysis of beef and mutton whereas lowest quantity was recorded in the heart muscles (0.288 mg/kg) in beef meat. Similarly in mutton, highest concentration of chromium was recorded in rump area (1.193 mg/kg) whereas lower quantity was recorded in shoulder muscles (0.493 mg/kg).When the outer part of the meat was observed for presence of Cr, higher quantity was recorded due to contamination from external environment. Our study is in line with study published by Korish and his colleagues in 2003 (16). It is possible that an extensive part of chromium is present in different foods due to pollution during the different steps necessary for production as well as processing. Chromium is a main constituent of stainless steel, which is used for manufacturing of knives, tanks, benches and machinery that contact with different food items during processing.

Chromium is also used in stainless steel apparatus/ utensils mainly used for cooking purpose in the household, particularly in food preparation of acidic foods. Meat is habitually reported as a good source of Chromium, but this is most likely due to pollution or other types of interactions during the examination. During analysis of beef for Copper concentration, the highest quantity was recorded in liver (0.626mg/kg) whereas the lowest quantity was recorded in rump area (0.021 mg/kilogram) in beef meat. Similarly the highest quantity of copper (Cu) was detected in liver (0.254 mg/kg) whereas lowest quantity was in shoulder muscles (0.0301 mg/kg).The current study has been supported by observations reported by Naseer *et al*., 2013. In goat, the highest concentration of copper (Cu) was detected in liver (82.83 mg/kg) followed by sheep liver (0.025 mg/kg). Our study is in line with results reported by Mukhacheva and others as referenced (17, 18). These researchers also observed the highest level of copper in livers when mutton and beef was examined. Copper is the major element mainly used as minerals supplementation in animals diets as a result it stores in the liver. Naseer *et al*, 2013 reported that Copper is the vital constituent of various enzymes and it plays an important role in the formation of bones (19). Copper also plays a vital role in skeletal mineralization's and maintain the integrity of the different connective tissues. Abdul Ghafar

Chukwujindu, (2008) analyzed 20 kg of meat per capita meat supply and concluded that daily intake of Pb, Cd, Cu and Cr through meat are (0.059 and 0.065), (0.002 and 0.001), (0.006 and 0.002) and (0.036 and 0.050) respectively (20).

CONCLUSION

As a result of final conclusion it was suggested that unhygienic conditions and grazing of animals in contaminated environment is responsible for deposition of heavy metals in meat. Kidneys are the key site for storage of Lead (Pb) and Cadmium (Cd).The shoulder muscles are the main site for maximum concentration of Chromium (Cr) while the lowest for copper (Cu)concentration. Similarly the liver is the common site for copper deposition in buffalo and goat meat while lower quantity of Lead (Pb) and Chromium (Cr) was recorded in the heart muscles of small and large ruminants.

Conflict of interest:

The authors have no conflict of interests concerning the publication of this research article

References:

1. Santhi D, Balakrishnan V, Kalaikannan A, Radhakrishnan KT. Presence of heavy metals in pork products in Chennai (India). Am J Food Technol. 2008;3(3):192-9.
2. Mehmood S. M.Sc thesis. Department of Environmental Planning and Management, University of Peshawar; 1995.
3. Ayesha. Water quality assessment of River Ravi around Lahore City Pakistan. Engineering Congress, 71st Annual Session Proceedings. 2007;637-48.
4. Akan JC, Abdulrahman FI, Sodipo OA, Chiroma YA. Distribution of heavy metals in the liver, kidney and meat of beef, mutton, caprine and chicken from Kasuwan Shanu market in Maiduguri Metropolis, Nigeria. Res J Appl Sci Eng Technol. 2010;2(8):743-8.
5. Anwar H, Iqbal S, Sajjad A, Ullah H, Farooqi A, Asif B. Health Risk Assessment of Heavy Metals in Raw and Packed Milk from the Areas of Rawalpindi and Islamabad: A comparative study. Pak-Euro Journal of Medical and Life Sciences. 2022;5(2):383-90.
6. Javed I, Jan IU, Muhammad F, Rahman ZU, Khan MZ, Aslam B, Sultan JI. Heavy metal residues in the milk of cattle and goat during winter season. Bull Environ Contam Toxicol. 2009;82:616-20.
7. Licata P, Trombetta D, Cristani M, Giofre F, Martino D, Calo M, Naccari F. Levels of toxic and essential metals in samples of bovine milk from various dairy farms in Calabria, Italy. Environ Int. 2004;30:1-6.
8. Steel RGD, Torrie JH. Principles and procedure of statistics: A biometrical approach. New York: McGraw-Hill. 1980.
9. Ayesha M, Sarfraz RA, Qudoos A, Akbar F. Appraisal of some heavy metals in organ meat from non-industrialized areas of Faisalabad, Pakistan. Glob Vet. 2014;12(1):98-103.
10. Pompe GJ, Crnic AP. Cadmium in tissue of roe deer (Capreolus capreolus) in Croatia. Vet Arhiv. 2002;72:303-10.
11. Gasparik J, Massanyi P, Slamecka J, Fabis M, Jurcik R. Concentration of selected metals in liver, kidney and muscle of the Red Deer (Cervus elaphus). J Environ Sci Health A. 2004;39:2105-11.
12. Stoyke MK, Doberschutz D, Lusky K. Heavy metal contents (cadmium, lead and mercury) in selected feedstuff, organs and tissue in cattle found at different sites of Brandenburg. Mengen Spureneler Arbeitstag. 1995;15:269-76.
13. Peterson PJ, Alloway BJ. Cadmium in soils and vegetation. In: Webb M, editor. The chemistry, biochemistry and biology of cadmium. Amsterdam, New York, Oxford: Elsevier, North Holland Biomedical Press. 1979:45-92.
14. Humphreys DJ. Effects of exposure to excessive quantities of lead on animals. Br Vet J. 1991;147:18-30.
15. Robert P. Mineral levels in animal health diagnostic data. Clearbrook, British Columbia: Sherpa International; 1988. ISBN 0-9693429-0-X.
16. Korish MA, Attia YA. Evaluation of Heavy Metal Content in Feed, Litter, Meat, Meat Products, Liver, and Table Eggs of Chickens. Animals. 2020;10(4):727
17. Mukhacheva SV, Bezel VS. Levels of toxic elements and functional structure in populations of small mammals under conditions of technogenic pollution (with reference to the bank vole). Ekologiya. 1995;3:237-40.

18. Jozef B, Pavol B, Miroslav H, Biresova M. Distribution of risk elements in the organism of sheep after industrial intoxication with zinc. Spectrosc Lett. 1997;30:1263-77.
19. Nasser M, Salam AE, Ahmad S, Basir A, Rais AK, Bibi A, Ullah R, Shad AA, Muhammad Z, Hussain I. Distribution of heavy metals in the liver, kidney, heart, pancreas and meat of cow, buffalo, goat, sheep and chicken from Kohat market Pakistan. Life Sci J. 2013;10(7):937-40.
20. Chukwujindu. Heavy metal composition of livers and kidneys of cattle from southern Nigeria. Vet Arhiv. 2008;78:401-10.