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Research Article

Association of Cadmium, Lead, Mercury and Zinc Occurrence in Bovine Meat with Artesian Water Pollution in Dakahlia Governorate Egypt with the Comparison to Imported Bovine Meat

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Abstract

Aim: Level of cadmium, mercury, lead, and zinc were analyzed in the fresh meat of cattle of local Dakahlia governorate, Egypt with the comparison to imported bovine meat.

Methods: Atomic absorption spectrophotometry was used to analysis different samples of 36 beef samples 18 local meat and 18 of imported meat and 18 samples of artesian water from different bovine farms in agriculture area which use artesian water instead of tap water for animals drinking. The order of the levels of the heavy metals of imported bovine meat obtained was zinc > mercury > lead > cadmium while the order of the levels of the heavy metals of local bovine meat was zinc > lead > mercury > cadmium.

Results: Notably, there was a correlation between heavy metal in artesian water of agriculture area with the level presented in local bovine meat. The fold change in selected heavy metal in local bovine meat divided by artisan water level was 63, 33, 56, 165 for cadmium, lead, mercury, and zinc respectively. Also, the fold change of selected heavy metal in local bovine meat divided by imported meat were 5, 1.4, 1.2 and 0.8 for cadmium, lead, mercury, and zinc respectively. Taken collectively, even level of heavy metal of artesian water of agriculture area is low but could be correlated with its level in meat as all heavy metals have a cumulative effect.

Keywords: *Cadmium; Lead; Mercury; Zinc; Bovine Meat; Artesian Water Pollution*

Introduction

Meat is the essential source of protein, mineral, and vitamin for the Human being. Safety of meat is important for human health and so monitoring and determining the source of toxic metal in meat should be in continuous rate and should be compared with the standard limit. Metals, in general, can be categorized as trace element (cobalt, copper, zinc, iron) of beneficial role in physiology of animal or human and heavy metals which are toxic and normally absent in human or animal tissue and fluids (cadmium, lead and mercury) [1].

Heavy metal residues enter to food chain through two contaminated sources feed or water and so immediate measurement have to be carried out for control, treatment and chelation of industrial and domestic discharge which are used for agricultural processing [2]. The contaminated sub-water with heavy metals could be through untreated factory effluents to the sewerage drains from many industries and its use for drinking by animals is hazardous [3-5].

Cadmium chronic toxicity is a serious environmental health problem that requires to be thoroughly analyzed from time to time due its already harmful effect and induce diseases in modern societies like diabetes, cancer and cardiovascular problems or will affect large proportions of the world's population [6].

Exposure to high level of lead metal affects renal, reproductive, hematopoietic and central nervous system of the human body. So, lead poising is a real hazard to the public health, especially in developing countries [7].

Mercury is highly toxic to the nervous system of younger age and organic mercury, in the form of methylmercury, is the main form of mercury to which humans and animals are exposed [8]. Although mercury exposure to both domestic and wild animals is not having significant adverse effects on a large number of animal species [9].

The mechanism of toxic effects of heavy metals depend on the forms and routes of exposure, interruptions of intracellular homeostasis include damage to proteins, lipids, enzymes, DNA [10] and gene expression [11] through the production of free radicals. The rational of this study to monitor heavy metals in local and imported meat and its correlation with artesian water.

Materials and Methods

The collected 36 fresh, local and imported bovine meat samples were washed with distilled water to avoid the presence of any contaminant particles. The samples were converted into a fine powder using a ceramic pestle and mortar and preserved in polyethylene bags till digestion stage by acid.

Liquid digestion: All meat samples were passed to acid digestion stage described by [12]. Nitric and Perchloric acids were used in the liquid digestion of samples (Sigma-Aldrich, Egypt). Combined acids (10 mL, 65% high purity HNO_3 and 3:1 v/v) was added to the beaker containing 2g fresh meat for liquid digestion of samples [13].

18 artesian water samples were collected from bovine farms in Dakahlia governorate Egypt, were measured directly without dilution by atomic absorption spectrophotometric method. Analytical procedures of heavy metals (Cd, Pb, Hg, and Zi) levels in meat were detected by atomic-absorption spectrophotometric [14] (AAS:Perkin Elmer, 2380, USA) which was adjusted at 228.8, 217 and 253.7 nm for Cd, Pb, Hg and Zn) in Faculty of Veterinary Medicine, Zagazig University, Egypt. N.B. all samples measured in triplet.

Statistical Analysis

Data collected were presented as mean and standard deviation and were carried out by t-test ($p < 0.05$) to measure whether heavy metals varied significantly between animals. All statistical calculations were performed with SPSS 13.0 for Windows.

Results

Monitoring of heavy metal is duty of researchers and authority to ensure safety of human food. Heavy metals are toxic for both livestock animals and human. We notice that many bovine farms owner replace tap water with artesian water for drinking of animals. The aim of study to explore the difference in heavy metals levels in local and imported beef meat and better understand that artesian water could be an entry for food chain.

The current study founded that mean of cadmium, lead, mercury and zinc in fresh meat of local bovine meat was 16.5, 168.12, 102, 2066 microgram respectively. While mean of cadmium, lead, mercury and zinc in fresh meat of imported bovine meat was 3.3, 117.9, 130.5 and 2584 microgram respectively. Additionally, mean of cadmium, lead, mercury and zinc in artesian water was 0.26, 5, 1.8, 12.5 respectively.

	Cadmium (Cd)	Lead (Pb)	Mercury (Hg)	Zinc (Zn)
Local bovine meat (ppb)	$16.5^{a} \pm 2$	$168.12^{a} \pm 17$	$102^{b} \pm 24$	$2066^{a} \pm 168$
Imported (ppb)	$3.3^{b} \pm 1.3$	$117.9^{b} \pm 28$	$130.5^{a} \pm 28$	$2548^{a} \pm 413$
Artesian water (µ/L)	0.26 ± 0.08	5 ± 1	1.8 ± 0.5	12.5 ± 3.4

Table 1: *Show level of means of cadmium, lead, mercury and zinc (microgram) in fresh local and imported meat and artesian water. A, b, c significant at $p \leq 0.05$.*

Interestingly, there was a correlation between heavy metals in artesian water of agriculture area with the level presented in local bovine meat. The fold change in selected heavy metals in local bovine meat divided by artisan water level was 63, 33, 56, 165 for cadmium, lead, mercury and zinc respectively. Taken collectively, even level of heavy metals of artesian water of agriculture area is low but could correlated with its level in meat as all heavy metal has cumulative effect. Notably, selected heavy metals didn't recorded in tap water which should be used as main source of animal drinking in beef farms (data not shown).

Also, the fold change of selected heavy metals in local bovine meat divided by imported meat were 5, 1.4, 0.78 and 0.8 for cadmium, lead, mercury and zinc respectively. This result explain that heavy metal residues are worldwide problem and need a strict control and treatment to avoid adverse effect on animal or human health.

Discussion

The authority, the Egyptian committee for veterinary service and researchers in faculties of veterinary medicine in all Egyptian governorates care to evaluate heavy metals in human or animal foods to keep individuals healthy. The entry of heavy metals to meat varies between food, water and environment. The aim of these study to investigate association of use of artesian water as a drinking water to animals on level of heavy metals on local bovine meat with comparison with its level on imported meat. In the current study, we found that heavy metals (Cadmium and Lead and mercury) in local bovine meat was significantly increased than its level in artesian water with 63, 33, 56-fold higher respectively. Also, these heavy metal present in imported meat but slight lower level than local meat.

Level of heavy metals in local bovine meat collected from Dakahlia governorate as well as Beni-suef, Egypt were low and did not exceed the permissible limits stated by different organizations [15-17]. Level of heavy metals in local bovine meat collected from Dakahlia governorate were lower than World Health Organization [18] maximum permissible limits of cadmium and lead (MPLs) (0.1 and 0.2 ppm for Cd and Pb respectively).

Increase level of heavy metals could be due to contaminated sub-water with heavy metals could be through escape of untreated factories discharge to the sewerage drainage in industry area and its use for drinking by animals is hazardous [3-5,19].

Even level of heavy metals in artesian water is very low but heavy metals had cumulative effect and along fattening period of animal that elongate from 6 month to one year could consider artesian water as source of heavy metals to animal and subsequent residues in meat. Heavy metals are resistant to environmental degradation and they tend to accumulate on plants, animal and human tissues [20].

Heavy metals levels in food like bovine meat is predisposing to health hazardous especially for younger children [21]. As tolerable weekly intake of Cd was 7 µg/kg bw. stated by WHO [22] and was confirmed in 2003 [23]. So, continuous detection of heavy metals in beef meat is importance to for production of safe food and maintain health of human individuals.

Conclusion

On conclusion, heavy metals residues are worldwide environmental problems and even level of heavy metal of artesian water of agriculture area is low but could be correlated with its level in meat as all heavy metals have a cumulative effect along fattening period of cattle. Finally, level of cadmium in local bovine meat is hazardous as its level above WHO tolerable weekly intake of Cadmium.

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