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LEVELS OF SOME HEAVY METAL RESIDUES IN MEAT OF DIFFERENT SPECIES IN THE WEST OF ALEXANDRIA

(With 2 Tables)

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مستويات بعض العناصر الثقيلة فى اللحوم المختلفة فى غرب الاسكندرية

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تم قياس مستوى تركيز كل من العناصر الثقيلة التالية: الحديد والنحاس والمنجنيز والرصاص والنيكل فى لحوم الابقار والاغنام والماعز فى ثلاث مناطق غرب مدينة الاسكندرية هى العامرية وبرج العرب وكنج مريوط وذ لك خلال شهر اغسطس ٢٠٠٨ و قد اسفرت الدراسة عن وجود اختلاف معنوى فى تركيزات كل من الحديد والنحاس والمنجنيز فى اللحوم المختلفة وذلك من منطقة الى اخرى بالاضافة الى الاختلاف الذى يعزى الى نوع الحيوان. اما عنصرى النيكل والرصاص فلم يوجد اى فروق معنوية فى تركيزاتهم فى اللحوم فى المناطق الثلاث وان كانت توجد فروق معنوية ترجع لنوع الحيوان فى حالة عنصر الرصاص وذلك فى منطقة العامرية وبرج العرب. وبشكل عام جميع تركيزات العناصر تم مناقشتها ومراجعتها لما هو مسموح به فى غذاء الانسان.

SUMMARY

Manganese, copper, iron, nickel and lead concentration levels have been determined in muscle meat of cattle, sheep and goat from three different sites in the western part of Alexandria city during August 2008 (El Amiriya, Burg Alarab and King Marriott). The mean values obtained related to wet weight for beef, mutton and chevon. The results showed that the concentration level of Fe > Cu > Mn > Pb > Ni in all samples. Substantial differences have been found in the mean copper, manganese and iron among the sites of collection. On the other hand, species difference was significantly clear in case of iron concentration in all sites and lead concentration in two sites (El Amiriya and Burg Alarab). The mean and maximum concentrations of lead found in meat of animals in the present study were low. The results obtained were compared with the literature data on the concentrations of the metals examined in meat.

Key words: *Heavy metal, residues in meat, Alexandria, environmental pollution*

INTRODUCTION

The contamination of pastures with potentially-toxic metals (PTM) and their accumulation in grazing animals can occur on soils that are naturally rich in metals following accidental or anthropogenic events and also, following the prolonged use of sewage sludge as a fertilizer (Martin and Coughtrey, 1982; Howard and Beresford, 1994; Wilkinson *et al.*, 2001).

Nieboer and Richardson (1980) classified 'heavy metal' chemically as elements with a density > 5 g/l and grouped them into three classes: A; B; and borderline. Class A elements (e.g. Cs, Mn, and Sr) have a preference for ligands containing oxygen. Class B elements (.e.g. Cd, Cu, Hg, Ag) show a preference to form ligands with nitrogen or sulpher. Borderline elements (e.g. Zn, Pb, Fe, Cr, Co, Ni, As, Sn, V) are of intermediate nature between classes A and B. This classification is important biologically. The characteristic of Class B elements to form ligands with N and/or S includes metallothioneins, phytochelatin and caeruloplasmin (Cousins, 1985; Lee *et al.*, 1994; Marschner, 1995; Underwood and Suttle, 1999) and excretion in bile e.g. Cd; (Kiyozumi and Kojima, 1978). In grazing mammals the elements Cd and Pb tend to accumulate in the liver and kidneys, and in some cases (e.g. Pb) also in bone (Lee *et al.*, 1999). Many elements interfere with essential enzyme reactions and/or organ function; hence their potential toxicity to the grazing animal and man.

Copper (Cu) is an essential trace element for animals; it is required for normal biological activity of many enzymes, haemoglobin formation and hair keratin (Underwood, 1977; Prohaska and Gybina, 2004). High concentration of copper oxide may result from welding operations. The corrosion of copper containing alloys in pipe fitting may add measurable amount of copper into the water. Copper toxicity is manifested by nausea, vomiting, diarrhea and intestinal pain. While, copper deficiency results in anemia. On the other hands, the congenital inability to excrete copper and its accumulation in the body known as Wilson, S disease (Greenwood and Earnshaw, 1986).

Iron (Fe) has a number of fundamental roles in cellular biochemistry and metabolism. These include oxygen binding to heme proteins and the formation of active centers in enzymes involved in the mitochondrial electron transport chain. Iron can also vary its redox state and can be rapidly oxidised from Fe^{2+} to Fe^{3+} (ferrous to ferric iron) in the presence of oxygen. This reaction generates the superoxide anion, which through a series of redox reactions leads to the generation of toxic hydroxyl radicals. Thus iron can be both toxic and beneficial to organisms, and its status in the body must be carefully regulated to provide sufficient iron for biological functions, whilst avoiding excess Fe^{2+} which can lead to oxidative stress (De Silva *et al.*, 1996; Aisen *et al.*, 2001).

Manganese (Mn) and its compounds exist naturally in the soil, rivers, lakes, underground water and in the air. In addition manganese can be introduced by human activity. Manganese can be released into the air by industry and by the burning of fossil fuels. Manganese from these human-made sources can enter surface water, groundwater, and sewage waters. Small manganese particles can also be picked up by water flowing through landfills and soil. The chemical state of manganese and the type of soil determine how fast it moves through the soil and how much is retained in the soil. Maneb and mancozeb, two pesticides that contain manganese, may also add to the amount of manganese in the environment when they are applied to crops or released to the environment from packaging factories. There is information on the amount of maneb and mancozeb released into the environment from facilities that make or use these pesticides. However, the amount of manganese in the environment because of the release and use of these pesticides is not known.

Nickel (Ni) is a natural element of the earth's crust; therefore, small amounts are found in food, water, soil, and air. Nickel is an essential nutrient for some mammalian species, and has been suggested to be essential for human nutrition. By extrapolation from animal data, it is estimated that a 70-kg person would have a daily requirement of 50 µg per kg diet of nickel (ATSDR, 1997). Food is the major source of nickel exposure, with an average intake for adults estimated to be approximately 100 to 300 micrograms per day (µg/d) (EPA, 1986 and ATSDR, 1997). There is some evidence that a few people may develop a skin sensitivity reaction to nickel. For these people, acid food cooked in stainless steel utensils and canned food may need to be avoided.

Lead (Pb) may enter the atmosphere during mining, smelting, refining, also automobile gasoline contains tetra-ethyl lead as knock inhibitor that is burned enters the atmosphere and manufacturing processes and by the use of lead containing products. Lead intake occurs from the consumption of fruit juices, food stored in lead lined containers, cosmetics, cigarettes (Benneth, 1981). Lead is able to cross the placenta as early as the 12th-14th week of gestation. Cord blood concentrations of lead are generally equivalent to that of the mother, or just a bit lower. Lead is not easily excreted, so it will continue to accumulate in fetal tissues throughout gestation, mostly accumulating in fetal brain (Schardein, 1998). Excess lead can cause serious damage to the brain, kidneys, nervous system and red blood cells. Young children, infants and fetuses are particularly vulnerable to lead poisoning. US environmental protection agency (EPA) says that lead may be implicated in causing leukemia (Anonymous, 2002).

The aim of the present study was determination of Fe, Cu, Pb, Mn and Ni concentrations in beef, mutton and goat meat from three different sites in west of Alexandria

MATERIALS and METHODS

Sample Collection and Preparation: Ten different samples of meat (beef, mutton and goat) were collected from three sites in the west of Alexandria (El Amiriya, Burg Alarab, and King Marriott) during August 2008. All samples were taken to the lab in plastic bags. For metal analysis wet digestion of metal samples was done using the method of Holak (1980). The atomic absorption spectrophotometer (Thermoelimental, type. Solaar 54/2001. NC. 9423-400-30042, Ser. No. GE 710728) was employed in analysis of samples. Air /acetylene were used as fuel. Three such determinations were taken as the observed value. The absorption signals of the samples were evaluated after subtracting the mean value of the blank. Certified AAS stock standards of Fe, Cu, Pb, Mn and Ni containing 1000 mg/dm^3 were obtained from Merck Company, for calibration curve. The standers were prepared by proper dilution of stock stander solution in 6n HCL.

Blank Solution: Blank solutions were prepared and treated exactly in the same way as the samples except the metal ion concentration. The absorption signals of sample solution were evaluated by subtracting the mean value of blank from the signals of the sample.

Statistical Analysis: Comparisons of metal concentrations between sites for each species and between different species in each site were done with Analysis of Variance (ANOVA) and Fisher's Least Significant Difference (LSD), using the Statistical Analysis System (SPSS 7.5, Michigan Avenue, Chicago).

Table 1: Metal concentration level (mg/kg wet weight) in beef, mutton and chevon from different areas in western of Alexandria.

		BEEF			MUTTON			CHEVON		
		El Amiriya	Burg Alarab	King Marriott	El Amiriya	Burg Alarab	King Marriott	El Amiriya	Burg Alarab	King Marriott
Fe	Min- Max	21.5- 23.17	23-24.7	23-24.2	20.52-22	22.1-24	23-22	20-21.1	22-22.7	21-22.1
	F (p)	47.9 (0.0001)			43.8 (0.0001)			47.9 (0.0001)		
	$\bar{X}$ ± SE	22.5±0.17	21.34±0.15	20.43±0.12	24.06±0.17	22.99±0.18	22.14±0.08	23.63±0.17	22.5±0.14	21.53±0.14
	El Amiriya		1.16 [a]	2.07 [a]		1.07 [b]	1.92 [b]		1.13 [c]	2.1 [c]
	Burg Alarab			0.9 [a]			0.85 [b]			0.97 [c]
Cu	Min- Max	1.59-9	1.19-8.6	1.8-9.2	3.9-8.72	5.91-8.32	6.5-8.7	4.79-10.9	4.39-9.5	5-7.5
	F (p)	7.5 (0.0025)			5.7 (0.009)			11.0 (0.0003)		
	$\bar{X}$ ± SE	5.47±0.77	7.27±0.47	8.87±0.58	4.96±0.81	7.43±0.33	7.82±0.87	5.05±0.78	7.79±0.29	8.78±0.57
	El Amiriya		1.8 [d]	3.4 [d]		2.74 [e]	3.13 [e]		2.74 [f]	3.73 [f]
	Burg Alarab			1.6			0.39			0.99
Mn	Min- Max	0.2-3	1-3.2	1.5-4.05	0.2-2.3	1.1-3	1.8-3	0.1-2.2	2.89-1.6	0.9-4.21
	F (p)	6.2 (0.006)			7.8 (0.0021)			6.3 (0.0055)		
	$\bar{X}$ ± SE	1.38±0.3	2.11±0.18	2.6±0.25	1.33±0.22	2.1±0.17	2.28±0.14	1.36±0.19	2.25±0.14	2.37±0.3
	El Amiriya		0.73 [g]	1.22 [g]		0.77 [h]	0.95 [h]		0.89 [i]	1.01 [i]
	Burg Alarab			0.49			0.18			0.12 [i]
Pb	Min- Max	0.01-0.5	0.01-0.6	0.02-0.7	0.01-0.2	0.01-0.2	0.01-0.2	0.01-0.09	0.01-0.3	0.01-0.5
	F (p)	0.7 (0.5)			0.2 (0.85)			1.0 (0.37)		
	$\bar{X}$ ± SE	0.2±0.06	0.22±0.06	0.13±0.04	0.06±0.02	0.07±0.02	0.05±0.02	0.06±0.01	0.08±0.03	0.12±0.05
	El Amiriya		0.02	0.07		0.01	0.01		0.02	0.06
	Burg Alarab			0.09			0.02			0.04
Ni	Min- Max	0.01-0.53	0.02-0.5	0.01-0.08	0.02-0.2	0.01-0.09	0.02-0.5	0.01-0.7	0.01-0.1	0.01-0.08
	F (p)	1.4 (0.26)			1.7 (0.19)			0.8 (0.46)		
	$\bar{X}$ ± SE	0.12±0.05	0.12±0.05	0.04±0.01	0.06±0.02	0.04±0.01	0.11±0.04	0.08±0.04	0.06±0.01	0.03±0.01
	El Amiriya		0.0	0.08		0.02	0.05		0.02	0.05
	Burg Alarab			0.08			0.07			0.03

Fisher's LSD $_{(0.05)}$: a=0.4304, b=0.421, c=0.4401, d= 1.8013, e=2.072, f= 1.6921, g= 0.7167, h= 0.5191, and i=0.6291

Table 2: Metal concentration level (mg/kg wet weight) in beef, mutton and chevon from different areas in western of Alexandria.

		El Amiriya			Burg Alarab			King Marriott		
		Beef	Mutton	Chevon	Beef	Mutton	Chevon	Beef	Mutton	Chevon
Fe	Min- Max	21.5-23.17	23-24.7	23-24.2	20.52-22	22.1-24	22-23	20-21.1	22-22.7	21-22.1
	F (p)	23.1 (0.0001)			29.4 (0.0001)			54.2 (0.0001)		
	X̄ ± SE	22.5±0.17	24.06±0.17	23.63±0.17	21.34±0.15	22.99±0.18	22.5±0.14	20.43±0.12	22.14±0.08	21.53±0.14
	Beef		1.56 [a]	1.13 [a]		1.65 [b]	1.16 [b]		1.71 [c]	1.1 [c]
	Mutton			0.43			0.49			0.61 [c]
Cu	Min- Max	1.59-9	1.19-8.6	1.8-9.2	3.9-8.72	5.92-8.8	6.5-9	4.79-10.9	5.91-8.8	5-11
	F (p)	0.2 (0.78)			0.5 (0.6)			0.7 (0.49)		
	X̄ ± SE	5.47±0.77	4.69±0.81	5.05±0.78	7.27±0.47	7.43±0.33	7.79±0.29	8.87±0.58	7.82±0.87	8.78±0.57
	Beef		0.78	0.42		0.16	0.52		1.05	0.09
	Mutton			0.36			0.36			0.96
Mn	Min- Max	0.2-3	0.2-2.3	0.1-2.2	1-3.2	1.1-3	1.6-2.89	1.5-4.05	1.8-3	0.9-4.21
	F (p)	0.1 (0.99)			0.3 (0.78)			0.5 (0.61)		
	X̄ ± SE	1.38±0.3	1.33±0.22	1.36±0.19	2.11±0.18	2.1±0.17	2.25±0.14	2.60±0.25	2.28±0.87	2.37±0.3
	Beef		0.05	0.02		0.15	0.14		0.32	0.23
	Mutton			0.03			0.15			0.09
Pb	Min- Max	0.01-0.5	0.01-0.2	0.01-0.09	0.01-0.6	0.01-0.2	0.01-0.3	0.02-0.4	0.01-0.2	0.01-0.5
	F (p)	4.7 (0.018)			4.0 (0.031)			1.4 (0.27)		
	X̄ ± SE	0.2±0.06	0.06±0.02	0.06±0.01	0.22±0.06	0.07±0.02	0.08±0.03	0.13±0.04	0.05±0.02	0.12±0.05
	Beef		0.14 [d]	0.14 [d]		0.15 [e]	0.14 [e]		0.08	0.01
	Mutton			0.0			0.01			0.07
Ni	Min- Max	0.01-0.54	0.02-0.2	0.01-0.4	0.02-0.5	0.01-0.09	0.01-0.1	0.01-0.08	0.02-0.5	0.01-0.08
	F (p)	0.7 (0.49)			1.7 (0.21)			2.8 (0.079)		
	X̄ ± SE	0.12±0.05	0.06±0.02	0.08±0.04	0.12±0.05	0.04±0.01	0.06±0.01	0.04±0.01	0.11±0.04	0.03±0.01
	Beef		0.06	0.04		0.08	0.06		0.07	0.01
	Mutton			0.02			0.02			0.08

Fisher's LSD $_{(0.05)}$: a=0.4856, b=0.4588, c=0.3434, d=0.0918, e=0.1298

DISCUSSION

Environmental pollution is one of the most serious problems in our planet which require our urgent practical attention due to adverse effects on the behavior and life of mankind and considerably damaging the animal and plant life. Garbage's, trash, raw sewage, chemical effluents of the industries and emission of irritant and harmful gases from various sources are considered as the primary sources of pollutants. These pollutants emerge from rapid population growth, massive urbanization and extensive industrialization through the world. West of Alexandria city shows a big load of newly settled population in the last few decades due to forming several industrial cities, however, facing the load of transportation especially the cars and vehicles.

In the present study, metals measured in beef, mutton and chevon samples can be arranged in descending order according to their concentrations as Fe > Cu > Mn > Pb >Ni. Iron concentrations levels in beef, mutton and chevon were significantly different from an area to another. Hence, the areas can be arranged according to Fe concentrations in the meat samples collected from it as El Amiriya>Burg Alarab>King Marriott (Table1). Fe concentrations of mutton and chevon were significantly higher than beef in all areas. While, no significant differences between mutton and chevon except within King Marriott, mutton samples were significantly higher than chevon in Fe concentration. Generally, El Amiriya had the highest Fe concentration in all meat samples particularly in mutton. Previous study (Hoppe *et al.* 1955) pointed to that acute toxicity of Fe ingested from normal dietary source has not been reported in human. However, acute toxicity may result from ingestion of large doses of medicinal Fe, especially in children. So, in present study Fe concentration level of meat may not contribute a hazard effect on human health.

Cu is an essential element present normally in sufficient amounts in forage and feed stuffs. Ruminants have a high capacity for hepatic copper storage and are also most susceptible to copper toxicosis. This is particularly in sheep. Concentrations of Cu in tissue are dependent on concurrent dietary levels of iron, zinc, cadmium, molybdenum, selenium and inorganic sulphur (Davis and Mertz, 1986).

In the present study, statistical significant differences were found among Cu concentration levels in beef samples collected from El Amiriya, Burg Alarab and King Marriott. Similar results were obtained with mutton and chevon samples (Table 1). On other hand, no significant differences found among meat samples can be related to species differences (Table 2). In general copper concentration levels in beef, mutton and chevon meat samples not exceeded the permissible limits (15mg Cu/kg wet weight) proposed by ES (1993). El Amiriya and Burg Alarab showed lower concentration levels of Cu in mutton and chevon than beef on contrast to Burg Alarab. This result may explained in the light of Walter study in 1986 as that the distribution of the total body Cu among the tissues of animals varies with the species, age and Cu status.

Mn is an essential trace element and is necessary for good health. The human body typically contains small quantities of Mn and under normal circumstances; the body controls these amounts so that neither too little nor too much is present (ATSDR 2000). Significant differences in Mn concentration levels were found among beef samples collected from El Amiriya, Burg Alarab or King Marriott. Similar results obtained with mutton and chevon samples collected from the same areas (Table 1). But no significant differences in Mn concentration levels could be attributed to the species differences although; Mn concentration levels in mutton and chevon were higher than beef in all areas (Table 2). With regard to the effect of dietary Mn on human health, the NRC (1989) has recommended safe and adequate daily intake levels for Mn that ranged from 0.3 to 1mg/day for children up to 1year, 1-2mg/day for children up to age 10, and 2-5 mg/day children 10 and older. Additionally, the upper tolerable intake level of Mn for children (1-3years old) and male/females (19-20 years old) is 2 and 11mg/day, respectively.

The potential effects of Ni on human health is discussed previously (ATSDR, 1997), very small amounts of Ni in people's diets may promote good health. However, some people exposed to small amounts of Ni for a long time develop an allergic reaction to it. The most common reaction is itching when Ni contacts their skin. In less common, severe cases, people experience vomiting and diarrhea when they swallow Ni or asthma attacks when they breathe it. In present study, the mean concentration levels of Ni in beef, mutton and chevon were not significantly different from area to anther and from species to anther species of animal (Table1 and 2). The mean daily intake of Ni assumed for an adult from food sources is therefore approximately 152 μg Ni per day (ATSDR, 1997). So, toxicity is considered unlikely to be a problem in humans with the current levels in meat samples.

The effects of Pb are similar across inhalation and oral routes of exposure. Pb has been shown to affect virtually every organ and system in the body in both humans and animals. The most sensitive effects of Pb appear to be neurological (particularly in children), hematological, and cardiovascular (ATSDR 1999). Pb concentration level in beef, mutton and chevon samples were not significantly differing from area to another within the same species (Table 1). However, the percentage of beef samples exceeded the permissible limits (0.1mg Pb/kg) proposed by ES (1993) which was 50% for El Amiriya, 60% for Burg Alarab and 30% for King Marriott. Also, for mutton samples were 20% for El Amiriya, 10% for Burg Alarab and 10% for King Marriott. As for Chevon samples it were 10% for El Amiriya, 20% for Burg Alarab, and 20% for King Marriott. Pb concentration levels of mutton and chevon samples were significantly lower than that of beef in El Amiriya as well as Burg Alarab. While, King Marriott did not show any differences among samples of different species (Table 2).

In conclusion the results of the present study indicated that beef, mutton and chevon may differ in metal concentrations from area to another in the western part of Alexandria. The environment may be contributed with an important part in this problem. So, This require more intensification of hygienic control that's being applied upon such feeding stuffs, in addition, effective ecological measures should be taken that would have a beneficial effect on reducing metals in the animal feeds, water and air. Awareness of public about toxic metals, which may accumulate in beef, mutton and chevon meat and causing health problems.

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