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LEVELS OF SOME HEAVY METALS IN MEAT AND ORGANS OF CATTLE AND THEIR HAZARD EFFECTS ON PUBLIC HEALTH IN ASSIUT GOVERNORATE

(With One Table)

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مستوى بعض المعادن الثقيلة في لحوم وأعضاء الأبقار وأثارها على الصحة العامة بمحافظة أسيوط.

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هدفت هذه الدراسة إلى قياس مستوى بعض العناصر الثقيلة مثل عنصر الكادميوم وعنصر الرصاص في كبد وكلى ولحوم الأبقار، ومقارنة هذه النتائج بالسابقة التي تم الحصول عليها في بحوث أخرى. إشتملت هذه الدراسة على عدد ٣٢ عجل بقري، تراوحت أعمارهم بين ٢- ٣ سنوات والتي تم ذبحهم في مجزر أسيوط فى الفترة من مارس إلى يونيو ٢٠٠٩. تم تجميع عينات من أنسجة كل من الكبد والكلى واللحوم وذلك بعد التأكد من خلو الحيوانات من أي إصابات مرضية. تم قياس تركيزات كل من الكادميوم والرصاص في هذه الأنسجة. أظهرت النتائج وجود زيادة في تركيزات كل من الكادميوم والرصاص في كبد وكلى ولحوم العجول وذلك عندما تم مقارنتها بالتركيزات القصوى المسموح بها في أنسجة هذه الحيوانات. تم في هذه الدراسة مناقشة التأثير السام لزيادة هذه العناصر الثقيلة على صحة الإنسان.

SUMMERY

Cadmium and lead concentrations in the liver, kidney and muscie from 32 male cattle (2-3 years old) slaughtered in Assiut slaughterhouse, from March to Jun 2009, were quantified. Analysis was performed by Atomic Absorption Spectrophotometry. The mean cadmium concentrations were 0.52 ± 0.03; 0.58 ± 0.03 and 0.40 ± 0.2 ppm in the liver, kidney and muscles respectively. The mean lead concentrations in the liver, kidney and muscles of the examined samples were 1.20 ± 0.17; 3.74 ± 0.27 and 1.01 ± 0.28 ppm respectively. Cadmium and lead concentrations in the estimated tissues of the examined cattle exceeded the acceptable maximum concentrations that have been adopted by many countries. The adverse health effect due to consumption of this meat, liver and kidneys were discussed.

Key words: *Cadmium, lead, muscle, liver, kidney*

INTRODUCTION

Heavy metals are invaluable and unavoidable components of our environment. They are in varying quantities throughout the geosphere and are being cycled continuously through different components of the ecosphere. The amounts of different heavy metals in ambient atmosphere have been increasing with advances of human civilization and are likely to increase further with increasing exploitation of geological resources, such as mining and fossil fuel development (Hammond and Aronson, 1964; Chow, 1970 and Fleischer *et al.,* 1974). Swarup *et al.* (1997) recorded that farm animals are often exposed to toxic heavy metals including cadmium and lead which are disseminated into environment from number of sources. Animal may gain excess cadmium and lead from water soil and vegetation contaminated from industrial and automobile emission.

Animal tissues like liver, kidney and muscle retention would represent the major source of cadmium and lead to the human diet (Johnson *et al.,* 1981). WHO (2007) also reported that, food is the main source of cadmium exposure in the general population, while ingestion of lead through food and water is the major exposure pathway for lead in adults. The continuous consumption of feed stuffs contaminated with heavy metals exceeding the safe permissible limits may result in a serious health problem through progressive irreversible accumulation in human body (Goyer, 1986).

Recent data indicate that adverse health effects of cadmium may occur at lower exposure levels than previously anticipated, primarily in the form of kidney damage but possibly also bone effects and fractures as well as carcinogenic effect (Lars, 2003). Lead is a well-known neurotoxin an. cause impairment of neurodevelopment in children (WHO, 2007). It is also potentially carcinogenic (Steenland and Boffetta, 2000).

The aim of this study was to determine the levels of cadmium and lead in cattle liver, kidney and meat in Assiut, Egypt and to compare them with concentrations in cattle elsewhere and to the maximum acceptable levels.

MATERIALS and METHODS

A total of 32 male cattle (2-3 years old) were subjected to study. These animals were slaughtered from March to Jun 2009 in Assuit slaughterhouse belongs to Assiut governorate. Samples of at least 5 g. were obtained from: the liver, kidney and skeletal muscle (psous major muscle). All samples were packed in clean, labeled plastic bags and then kept in deep freeze (-20 °C) for chemical analysis.

Analytical methods

Tissue specimens were digested according to Koirtyohann *et al.* (1982) using nitric acid. All chemicals used were of analytical-reagent grade and the highest purity available. Double distilled deionized water, HPLC-grade, were used throughout. Glass vessels were cleaned by soaking in acidified solutions of nitric acid and rinsed several times with high-purity deionized water. Nitric acid (approx. 65%, Merck) was used. Metal levels were calculated on the basis of similarly prepared Merck standards. Lead and cadmium concentrations were determined in digested samples using Atomic Absorption Spectrophotometry (Atomic absorption 906, GBC, Australia). The analysis was done at Dept. of Soil, Faculty of Agriculture, Assiut University.

Statistical analysis

All statistical analyses were performed using SPSS statistical software (SPSS for Windows, Version 14.0, CA, and USA). Data were subjected to descriptive analysis, and then tissue concentrations of cadmium and lead were compared using Least Significant Difference (LSD).

RESULTS

Estimation of cadmium in liver, kidney and muscle was presented in table 1. Levels of cadmium in the liver kidney and muscles of investigated cattle were 0.52 ± 0.03, 0.58 ± 0.03 and 0.40 ± 0.2 ppm respectively. No significant changes were recorded in cadmium concentration between liver and muscle and between liver and kidney. Cadmium concentration in kidney was higher than in muscle.

Estimation of lead level in liver, kidney and muscle was presented in table 1. The levels of lead in the liver, kidney and muscles of examined cattle were 1.20 ± 0.17, 3.74 ± 0.27 and 1.01 ± 0.28 ppm respectively. Lead concentration in kidney tissues was higher than in muscle and liver. No significant change in lead concentration between muscle and liver.

Table 1: Values of cadmium and lead concentrations (ppm) in tissues

	Liver (No.=32)	Kidney (No.=32)	Muscle (No.=32)
Cadmium (ppm)	0.52 ± 0.03^{a}	0.58 ± 0.03^{ab}	0.40 ± 0.02^{ac}
Lead (ppm)	1.20 ± 0.17^{b}	3.74 ± 0.27^{c}	1.01 ± 0.28^{b}

Data expressed as Mean ± SE
In each row means followed by the same letter are not significantly different ($p<0.05$)
In each row means followed by different letter are significantly different ($p<0.05$)

DISCUSSION

Estimated levls of cadmium in liver, kidney and muscle of examined cattle were 0.52 ± 0.03, 0.58 ± 0.03 and 0.40 ± 0.2 ppm respectively. Analytical findings of cadmium level in liver, kidney and muscles revealed a significant increase in cadmium concentration than acceptable limit 0.05 mg/kg recommended by David (1993) in muscles. This results were increased the health hazard effect of cadmium. There was an association between cadmium exposure and chronic renal failure [end stage renal disease (ESRD)]. Using a registry of patients, who had been treated for uraemia, the investigators found a double risk of ESRD in persons living close to (<2 km) industrial cadmium emitting plants as well as in occupationally exposed workers (Hellström *et al.*, 2001). Many literatures have emerged suggesting that also relatively low cadmium exposure may give rise to skeletal damage, evidenced by low bone mineral density (osteoporosis) and fractures (Staessen *et al.*, 1999; Alfven *et al.*, 2000 and Nordberg *et al.*, 2002). A Japanese study showed an excess risk of cardiovascular mortality in cadmium-exposed persons with signs of tubular kidney damage compared to individuals without kidney damage (Nishijo, 1995). The IARC (International Agency for Research on Cancer) has classified cadmium as a human carcinogen (group I) on the basis of sufficient evidence in both humans and experimental animals (IARC, 1993). Cadmium has been associated with prostate and kidney cancer (Kolonel, 1976 and Mandel *et al.*, 1995).

In our results, cadmium concentration in kidney is higher than in muscle. Cadmium is a cumulative toxicant in the continental ecological cycling; it accumulates mostly in the liver and kidney (Han *et al.*, 1994). Our obtained results of cadmium level in the liver are nearly similar to levels in the kidney, this result is in harmony with Takayuki and Leonard (1993), who stated that levels of cadmium in kidneys are roughly 10 times the levels in the liver in case of high doses while the levels of cadmium in these two organs become similar with continued low doses.

Cadmium concentration in liver and kidneys of cattle from contaminated areas averaged 0.28 and 1.29 mg/kg respectively while corresponding values in sheep were 0.29 and 0.547 mg/kg (Doyle *et al.*, 1993). Antoniou *et al.* (1995) estimated the cadmium concentration in kidney and liver of goats in contaminated area revealed 3.5 ± 0.40 and 0.53 ± 0.05 mg/kg respectively while cadmium values in the rural area are 1.3 ± 0.16 mg/kg for kidney and 0.19 ± 0.01 mg/kg for liver. Doha Ahmed, (2005) estimated the cadmium concentration in cattle liver, kidney and muscles in Assiut governorate and the results were 0.087 ± 0.038, 0.152 ± 0.031 and 0.008 ± 0.001 respectively. Abou-Arab (2001), reported a level of 0.112 ± 0.07 mg/kg in cattle liver and 0.320 ± 0.11 mg/kg in cattle kidney and 0.01 ± 0.01 mg/kg in muscle. Our obtained results of cadmium level in liver and kidney were less than the tolerance limits for cadmium which are 1 mg/kg in liver and 3 mg/kg in kidney (Spierenburg *et al.*, 1988).

Lead is considered one of the major environmental pollutants and has been incriminated as a cause of accidental poisoning in domestic animals more than any other substance, particularly in cattle, sheep and horses (Liu, 2003). The results of the present study revealed that lead levels in liver, kidney and muscle of examined cattle were 1.20 ± 0.17; 3.74 ± 0.27 and 1.01 ± 0.28 ppm respectively was higher than that reported by many authors in different countries. Previous studies reported mean lead levels of 0.440 ± .0.07 and 0.381± 0.03 in cattle liver and kidney respectively (Abdou *et al.*, 2004). Doha Ahmed, (2005) found that lead concentration in liver, kidney and muscles from male cattle in Assiut governorate were 0.21 ± 0.03, 0.22 ± 0.01 and 0.11 ±

0.01 mg/kg respectively. In addition, Kreuzer *et al.* (1982) determined lead concentrations in liver and kidney of cattle (mg/kg ww) as 0.21 and 0.1 respectively.

Tahvonen and Kumpulainen (1994) in Finland found that the average lead content of beef (tenderloin) was 10 µg/kg, ground beef 8 µg/kg, cow's liver 37 µg/kg. Also López *et al.* (2000) in Spain found that, the concentrations of lead in slaughtered cattle were, 0.057, 0.066, 0.017 mg/kg in liver, kidney and muscle respectively. In spite of that, this result was in harmony with our finding, which indicates that lead concentration in kidney tissues is higher than in muscle and liver.

In general, the levels of lead in our estimated samples exceeded the safe permissible limit of lead in meat and meat products which stipulated to be 1.0 mg/kg by FAO/WHO (1992); 0.5mg/kg by Egyptian standards (Egyptian Organization for Standardization and Quality control, 1993); and 1.0 mg/kg by Codex Alimentarius Commission (FAO/WHO, 2003).

Lead is a well-known neurotoxin. Impairment of neurodevelopment in children is the most critical effect. Exposure in utero, during breast feeding and in early childhood may all be responsible for the effects. Lead accumulates in the skeleton, and its mobilization from bones during pregnancy and lactation causes exposure to fetuses and breastfed infants (WHO, 2007). IARC classified lead as a 'possible human carcinogen' based on sufficient animal data and insufficient human data in 1987. Since then a few studies have been published, the overall evidence for lead as a carcinogen being only weak, the most likely candidates are lung cancer, stomach cancer and gliomas (Steenland and Boffetta, 2000).

Therefore, in view of these results, sufficient effort should be carried out to achieve further reductions in cadmium and lead emissions to the environment as well as roles and methods for food hygiene control measures must applied in order to minimize the risk of adverse health effects.

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