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Lead Concentrations in Different Animals Muscles and Consumable Organs at Specific Localities in Cairo

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Abstract: Lead is among the heavy metals and it is one of the highly toxic metals. Lead polluted environment constitutes a serious problem for human. So, the present study aimed to throw light on the concentrations of lead in the muscles, livers, kidneys, spleen and hearts of different food animals (buffalo, cattle, sheep, goat and elk) from three different localities at Cairo governorate. A total of 450 samples were collected for this purpose and lead concentrations were assayed using atomic absorption spectrophotometer. Results showed that lead concentrations are dependent on the sampling locality, the organ and animal species. The highest concentrations of lead were detected in kidney of cattle beside heavy traffic area and from urban area as 0.198 and 0.490 mg/kg, respectively. Kidney of buffalo at industrial area contained the highest concentration of lead (0.790 mg/kg). The concentrations of lead in liver and kidney from industrial area were higher than the other areas, so, the consumption of both organs from industrial areas should be avoided.

Key words: Lead · Consumable organs · Animals · Ecosystems · Pollution · Metals · Contamination

INTRODUCTION

Lead is one of toxic metals; it is dangerous to most human body organs if exposure exceeds tolerable levels [1]. Lead can affect individuals of any age, but it has a disproportionate effect on children because their behavioral patterns place them at higher risk for exposure to lead, their bodies absorb a larger percentage of the lead that they ingest and they exhibit lead toxicity at lower levels for exposure than adults [2]. Accumulation of lead produces damaging effects in the hematopoetical, hematic, renal and gastrointestinal systems [3]. Lead has been associated with various forms of cancer, nephrotoxicity, central nervous system effects and cardiovascular diseases in human [4,5]. Toxicity of lead is closely related to age, sex, route of exposure, level of intake, solubility, metal oxidation state, retention percentage, duration of exposure, frequency of intake, absorption rate and mechanisms and efficiency of excretion [6]. The inhalation of lead can permanently lower intelligence quotient (IQ), damage emotional stability, cause hyperactivity, poor school performance and hearing loss [7].

The presence of lead in the environment is partially due to natural processes and anthropogenic sources [8, 9], but is mostly the result of industrial wastes [10,11]. Although atmospheric lead originates from a number of industrial sources, leaded gasoline appears to be a principal source of general environmental lead pollution. So, the heavy traffic flow of vehicles that burn gasoline with high lead content is the main cause of the high levels of lead in street dusts and in air born particles [12].

Foods may be contaminated by lead from different sources such as air, water and soil. Accurate determination of lead in food is important since intake of even low concentrations of lead can cause serious toxic effects.

The aim of the present study was to evaluate the concentrations of lead in animals (buffalo, cattle, sheep, goats and elk) meat and consumable organs (liver, kidney, spleen and heart), which are liable to be contaminated by lead. Also, the investigation provided information about the concentrations of lead in three main areas represents different ecosystems in Great Cairo, i.e., heavy traffic, urban (city center) and industrial areas.

MATERIALS AND METHODS

Materials

1. Sample Collection: A total of 450 samples which represent five organs (muscle, liver, kidney, spleen and heart) from five types of animals (buffalo, cattle,

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sheep, goat and elk) were collected from Great Cairo governorate which considered one of the highly polluted cities in the world due to the increase urbanization and industrialization processes in and around it [13]. Samples were collected from three main areas represent different ecosystems. 150 samples were collected from each area representing 30 samples of each organ. The first area (Faysal, Giza governorate), is a crowded area by population and heavy traffic. The second are industrial areas (Helwan and Shoubra El-Kheima) which contain industrial activities such as, textile, chemicals, ceramics, plastic, glasses, ferrous and non ferrous metallurgical work, bricks, fertilizers and smelting. The third was an urban area (city center of Cairo) which located between the two industrial areas. It is characterized by the presence of commercial activities besides heavy traffic and main railway station. All the samples were collected during the period of January to December 2006. The samples were collected randomly, packed separately and stored at -18°C until analysis.

2. Standard: Standard solution of lead (Pb) was provided by Merck (Darmstadt, Germany). The standard solution was prepared from the stock solution (1000 mg/l), in 0.1N HNO_3. Working standard was prepared from the previous stock solution.

Methods: Lead concentration was extracted from the samples (muscle, liver, kidney, spleen and heart) according to the method of [14]. Samples were homogenized separately and 5-10 g of the fresh homogenate were weighed into quartz dishes and evaporated to dryness in an oven at 100° C (~16 h). Dried samples were ashed in a muffle furnace at 450-500°C for 8-12 h. Ashed samples were cooled to room temperature and 1.0 ml of concentrated nitric acid was added and the volume was adjusted to 25 ml with deionized water. The metal was measured by atomic absorption spectrophotometer (Perkin Elmer 2380). Lead was measured at wavelength 217.0 nm with Hollow Cathode Lamp of lead. The limit of detection was 0.06 mg/kg for lead. The recovery of lead was studied by adding known amounts of standard solution to different samples under investigation. The added amounts of lead were selected so that they would be close to the amounts normally found in the different samples. Recoveries in muscle, liver, kidney, spleen and heart ranged from 94-98%. All the results obtained were corrected according to the percentage of recovery.

Statistical Analysis: Statistical differences between the different areas (heavy traffic, urban and industrial) were determined by one-way analysis of variance (ANOVA) according to [15]. A general linear model of [16] was performed for the analysis of variance.

RESULTS

Results presented in Tables (1-5) show the mean concentrations of lead in analyzed samples collected from heavy traffic, urban and industrial areas from the different investigated animal species. The highest concentrations of lead were detected in kidney followed by liver samples. The levels of lead varied according to the species of animal and the locality (Figs. 1 and 2).

Table 1: Lead concentration (mg/kg wet weight±SD) in buffalo organs collected from three areas represent different ecosystems in Great Cairo

	Mean concentrations (mg/kg±SD)		
Organs	Heavy traffic area	Urban area	Industrial area
1. Muscle	0.048±0.02	0.077±0.15	0.106±0.05
2. Liver	0.061±0.02	0.274±0.03	0.586±0.16
3. Kidney	0.122±0.06	0.456±0.02	0.790±0.03
4. Spleen	0.010±0.01	0.021±0.01	0.056±0.02
5. Heart	0.016±0.01	0.101±0.02	0.185±0.08

Table 2: Lead concentration (mg/kg wet weight±SD) in cattle organs collected from three areas represent different ecosystems in Great Cairo

	Mean concentrations (mg/kg±SD)		
Organs	Heavy traffic area	Urban area	Industrial area
1. Muscle	0.055±0.02	0.079±0.15	0.103±0.03
2. Liver	0.109±0.01	0.364±0.02	0.623±0.16
3. Kidney	0.198±0.05	0.490±0.02	0.788±0.04
4. Spleen	0.013±0.04	0.030±0. 18	0.046±0.03
5. Heart	0.022±0.03	0.125±0.05	0.232±0.03

Table 3: Lead concentration (mg/kg wet weight±SD) in sheep organs collected from three areas represent different ecosystems in Great Cairo

	Mean concentrations (mg/kg±SD)		
Organs	Heavy traffic area	Urban area	Industrial area
1.Muscle	0.006±0.01	0.052±0.02	0.090±0.02
2.Liver	0.072±0.02	0.278±0.10	0.510±0.10
3.Kidney	0.163±0.05	0.386±0.10	0.599±0.20
4.Spleen	0.110±0.05	0.055±0.01	0.098±0.02
5.Heart	0.016±0.01	0.058±0.01	0.100±0.03

Table 4: Lead concentration (mg/kg wet weight±SD) in goat organs collected from three areas represent different ecosystems in Great Cairo

	Mean concentrations (mg/kg±SD)		
Organs	Heavy traffic area	Urban area	Industrial area
1. Muscle	0.009±0.02	0.055±0.02	0.098±0.15
2. Liver	0.071±0.03	0.321±0.15	0.570±0.02
3. Kidney	0.094±0.15	0.462±0.02	0.780±0.12
4. Spleen	0.006±0.03	0.031±0.03	0.052±0.02
5. Heart	0.016±0.16	0.034±0.03	0.069±0.03

Table 5: Lead concentration (mg/kg wet weight±SD) in elk organs collected from three areas represent different ecosystems in Great Cairo

	Mean concentrations (mg/kg±SD)		
Organs	Heavy traffic area	Urban area	Industrial area
1. Muscle	0.031±0.02	0.104±0.03	0.177±0.15
2. Liver	0.074±0.03	0.295±0.15	0.509±0.03
3. Kidney	0.162±0.02	0.425±0.03	0.682±0.02
4. Spleen	0.010±0.01	0.036±0.02	0.048±0.03
5. Heart	0.036±0.03	0.064±0.02	0.089±0.02

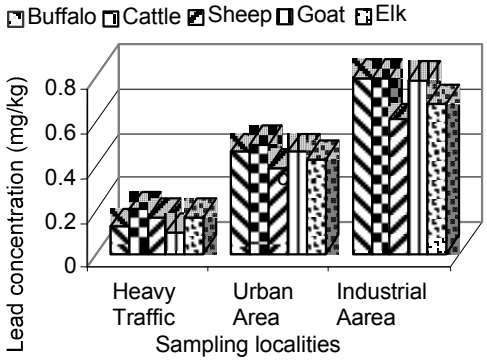

Fig. 1: Lead concentrations in livers of animals from different localities

In samples collected from heavy traffic areas, the minimum and maximum lead concentrations in the different organs collected from animals under investigation were (0.006-0.055),(0.061-0.109),(0.094-0.198),(0.006-0.013)and (0.016-0.036 mg/kg) for muscles, liver, kidney, spleen and heart samples, respectively.

Results in Tables (1-5) indicate that lead concentrations in the samples collected from urban area ranged from (0.052-0.104), (0.274-0.364), (0.386-0.490), (0.021-0.055) and (0.034-0.125 mg/kg) in muscle, liver, kidney, spleen and heart samples, respectively. The highest concentration of lead in liver samples was detected in cattle (0.364), followed by goat (0.321), elk (0.295), sheep (0.278) and buffalo (0.274 mg/kg). On the other hand, the highest level in kidney samples was found in cattle (0.490), goat (0.462), buffalo (0.456), elk (0.425) and sheep (0.386 mg/kg).

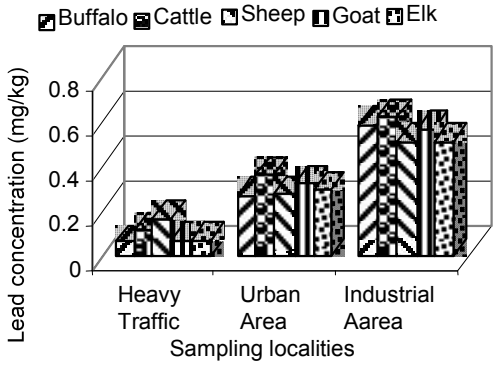

Fig. 2: Lead concentrations in kidneys of animals from different localities

In industrial areas, lead contents in muscle (0.090-0.177), liver (0.510-0.623), kidney (0.599-0.790), spleen (0.046-0.098) and heart (0.069-0.232 mg/kg) were higher as compared to the same organs from the other two areas (Tables 1-5).

DISCUSSION

Comparing the concentrations of lead in samples from the heavy traffic area with the values recommended by [17] for liver and kidney from cattle, as 0.50 mg/kg, it is clear that lead concentrations in this study is lower. Mostly the reduction of lead concentration is possibly due to the remarkable reduction in national as well as international lead emissions from automobiles [18]. The selling of the unleaded gasoline has been implemented in Cairo city fuel stations. In the period of 1980-1995, the Egyptian authorities gradually reduced the lead content in gasoline sold in Cairo [19]. During the period of 2001-2003, [13] determined the concentrations of lead in the air of residential area, Feisal (the same locality of collected meat samples in this study) and they reported that lead concentrations ranged between 0.30 to 0.99 $\mu g/m^3$. This level is below both the Egyptian Standards (1 $\mu g/m^3$, [20]) and the World Health Organization (0.5-1.0 $\mu g/m^3$, [21]) for air quality standards for lead. In the US, for example, a clear decrease in the lead content of food due to atmospheric origin has been demonstrated [22]. The current results show that the concentration of lead in cattle and buffalo kidneys as well as livers were lower than those detected in Austria [23], The Netherlands [24], Brazil [25] and Finland [26]. Also, the mean concentrations of lead in sheep liver and kidneys in the present study were lower than those detected in Greece [27-30].

With respect to the results of urban area and by comparing them with the values of [17], the levels of lead were below this proposed limit (0.5 mg/kg). Moreover the concentrations of lead in kidneys of buffalo (0.456), cattle (0.490) and goat (0.462 mg/kg) were near the maximum value of proposed limit (0.5 mg/kg). The concentrations of lead in urban area samples are higher than those detected in heavy traffic area samples. This may be due to the contamination by the atmospheric area which ranged between 0.35 to 6.02 μg/m^3 during the period of 2001 to 2003 [13]. The sources of lead in the air were, lead emission of vehicles from the provinces surrounds Cairo city that still use leaded gasoline and from the accumulated lead particles in the exhaust system of the vehicles that formerly used unleaded gasoline. The second source is the resuspension of street dust (lead-bearing dust) by the wind and anthropogenic activities. This was confirmed by the presence of high lead content in streets of Cairo [31]. This may due to high concentration of lead in the air of urban area (that we took our samples) which are located downwind of an industrial areas that has smelters, foundries and factories of paints and other sources of lead [13].

From the results of the present samples which were collected from industrial area in Cairo, the lead content in its organs samples was higher than organs samples colleted from the other two areas. The difference probably result from different animals diets, whereas the animals are exposed to the influence of air pollution for longer periods where accumulate lead [32]. Lead in the industrial area is emitted from different sources (smelters, batteries recycling, combustion of fuel for different industries, crystal manufacturing and paint industries). Also, the emission of lead from traffic and resuspension of dust from streets as well as a refuse burning other than automobiles [13]. During the period from 2001 to 2003, the concentrations of lead in atmospheric industrial area (the same area in this study) were ranged between 0.18 to 5.5 μg/m^3. Most of these samples are exceeded both the Egyptian standards (1 μg/m^3) and the World Health Organization (0.5-1.0 μg/m^3) air quality standards for lead [13]. These results show the relation between lead concentration in air and in meat samples contaminated from air. Levels of lead in the liver and kidney samples in this study were compared to the values of [17]. Results showed that the concentration of lead was exceeded the recommended value. Abou-Arab [32] reported that lead contents in meat samples in the same area (industrial) during the period of March, 1999 to January, 2000 were (0.081-0.161),(0.401-0.566),(0.541-0.721),(0.032-0.083)and (0.061-0.211 mg/kg) with muscle, liver, kidney, spleen and heart, respectively. The concentrations in the present study were slightly higher than that recorded by Abou-Arab [32].

Similar results obtained by Spierenburg *et al*. [33] who determined lead concentrations in liver and kidney of cattle within a 20 Km radius of zinc refineries and compared these with cattle in unpolluted control areas. Significantly higher amounts of lead in liver and kidneys were found in cattle sampled around the refineries than in the levels in cattle reared in the mining area were higher than those in cattle in the rural area.

Finally, it can be concluded that the highest concentrations of lead was detected in kidney followed by liver samples. The concentrations of lead in liver and kidney from industrial areas were higher than that from other areas, so, the consumption of both organs of animals from industrial areas should be avoided.

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