DISTRIBUTION OF LEAD IN SELECTED ANIMAL ORGANS AND TISSUES IN PROBISTIP AND ITS SURROUNDINGS

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Abstract: *Lead belongs to the group of heavy metals and is one highly toxic. Lead polluted environments constitute a serious problem for human beings. This paper is aimed at throwing light on the concentrations of lead in the muscles, liver, kidneys, spleen and hearts of different animals (swine, sheep, and goat) from three different localities around Probistip. A total of 98 samples were collected for this purpose and lead concentrations were analyzed 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 swine taken at the mine waste landfill near the central town area of Probistip (1.025 and 2.454mg/kg respectively). Chicken kidney taken in the Strmosh area contained the highest concentration of lead (1.125 mg/kg). The concentrations of lead in liver and kidney taken from the industrial area were higher compared to other localities from which samples of tissue were taken for analysis.*

Key words: *Lead, organs, animals, ecosystems, pollution, metals, contamination.*

1. INTRODUCTION

Heavy metals are chemical elements with specific gravity that is at least five times the specific gravity of water [31], [18]. Examples of heavy metals commonly found in the environment include lead, cadmium, mercury, zinc, arsenic, bismuth etc. These metals are particularly dangerous because they tend to bio-accumulate in the body tissues and organs [26], [5].

Lead is a ubiquitous and versatile metal which has been used by mankind for many years. It ranks as one of the most serious environmental poisons amongst the toxic heavy metals all over the world. Mankind has used it for many years because of its wide variety of applications. Human exposure to lead is from numerous sources and a myriad of pathways including air, food, dust, soil and water [14], [19]. In the recent past, lead toxicity has emerged as an important global problem with public health consequences, particularly in children, due to its serious impact on brain functions. A higher incidence of acute intoxication among children than adults has been reported and children are exposed to higher levels of lead than are adults because of behavioral patterns (for example, characteristic mouthing of objects, pica). Also, exposures to lead from sources such as air, food and water are higher as per kilogram of body weight basis for children than for adults [4], [22].

Lead is one of toxic metals; it is dangerous to most human body organs if exposure exceeds tolerable levels [4]. 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 [1]. Accumulation of lead produces damaging effects in the hematopoetical, hematic, renal and gastrointestinal systems [8]. Lead has been associated with various forms of cancer, nephrotoxicity, central nervous system effects and cardiovascular diseases in human. Toxicity of lead is closely related to age, sex, route of exposure, level of intake, solubility, metal oxidation state, retention percentage, and duration of exposure, frequency of intake, absorption rate and mechanisms and efficiency of excretion [27]. The inhalation of lead can permanently lower intelligence quotient (IQ), damage emotional stability, cause hyperactivity, poor school performance and hearing loss [16].

Lead is absorbed by ingestion and inhalation. Absorption varies from individuals to individuals and depends on the chemical form of lead and type of exposure. The alimentary and respiratory tracts are the main portals of entry for lead into the body. Approximately 90% of absorbed lead is reported to be stored in the bone with a half life of 600 - 3000 days. The remaining 10% is stored in soft tissues like kidney, liver and brain. The half life of lead in these tissues ranges from 40 - 50 days [13]. Lead passes through the placenta easily and fetal blood has almost the same lead concentration as maternal blood [24]. 90% of the ingested led is excreted in the stool and urine whereas the inhaled lead is excreted through the renal pathway [30].

Lead is also eliminated through sweat and mother's milk [21]. Lead has very high affinity for red blood cells, it has been shown that lead inhibits the enzymes-aminolevulinic acid dehydratase (ALAD) and ferrochelatase of the hem synthetic pathway thus preventing conversion of ALA to porphobilinogen and inhibits incorporation of iron into the protoporphyrin ring respectively. This results in reduced hem synthesis and elevated levels of the precursor-aminolevulinic acid (ALA), which is a weak gamma-amino butyric acid (GABA) agonist that decreases GABA release by presynaptic inhibition [37], [32],[28].

The presence of lead in the environment is partially due to natural processes and anthropogenic sources [2], [9], but is mostly the result of industrial wastes [11], [23]. 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 [32].

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 localities around Probistip, i.e., industrial Zone in the town of Probistip, village Strmosh and control point

2. MATERIALS AND METHODS

Lead concentration was extracted from the samples (muscle, liver, kidney, spleen and heart) according to the method of [33]. 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 ached 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 5000). 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.

The material for analysis (fresh tissue from muscle, liver, kidney, spleen and heart of three domestic animals – swine, sheep and goat) were taken from three localities in the vicinity of the town Probistip.

1. The first measuring point was the industrial zone in the town of Probistip – flotation of the lead-zinc ore.
2. The second measuring point was the locality in the vicinity of the waste landfill near the village of Strmos.
3. The third measuring point was the control measuring point, located at 10 km from the town of Probistip where there are no sources of pollution with heavy metals.

3. STATISTICAL ANALYSIS

Statistical differences between the different areas (heavy traffic, urban and industrial) were determined by one-way analysis of variance (ANOVA) according to [38]. A general linear model of Baht, et all., was performed for the analysis of variance [4].

4. RESULTS AND DISCUSSION

Results presented in Tables (1-3) 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 (Fig. 1 and 2).

Tab. 1: Lead concentrations (mg/kg wet average weight) in chicken organs collected from three areas represent different ecosystems in Probistip,

Organs	Industrial Zone in the town of Probistip	Village Strmosh	Control point
Muscle	0.089	0.215	0.035
Liver	0.354	0.984	0.056
Kidney	0.568	1.125	0.120
Spleen	0.154	0.985	0.007
Heart	0.253	0.546	0.010

If we compare the results obtained for lead content in different organs and domestic animals in the three measuring points around Probistip it will be noticed that different values are obtained in terms of the tested sites, as well as of animal organs.

The highest values are measured in kidney and liver and the lowest values in spleen.

In terms of measurement sites, the lowest values are measured at the control measuring point. These results show the relation between concentration of lead on the spot where the tested animals are kept and in tissue samples contaminated from water and soil.

Table 1 shows the results of the examination of the contents of lead in muscle, liver, kidney, spleen and muscle of chicken, where people keep them for food. In terms of the tested organs, the highest values are measured in kidney (0.120-1.125 mg/kg fresh weight), and the lowest in heart tissue (0.010 - 0.546 mg/kg fresh weight). As for the measurement sites the lowest values were obtained in the control measurement point in whose vicinity there are no sources of contamination with heavy metals, and the values were highest near the village Strmosh in whose immediate vicinity are located the old and new waste landfills where waste water from the flotation of lead-zinc ore from the lead and zinc mines "Zletovo" is accumulated. Strmosh village is located only 6 km from the town of Probistip. The concentrations of lead in liver and kidney in the industrial zone were highest in relation to other sites, so that consumption and using of organs from these sites for food should be avoided.

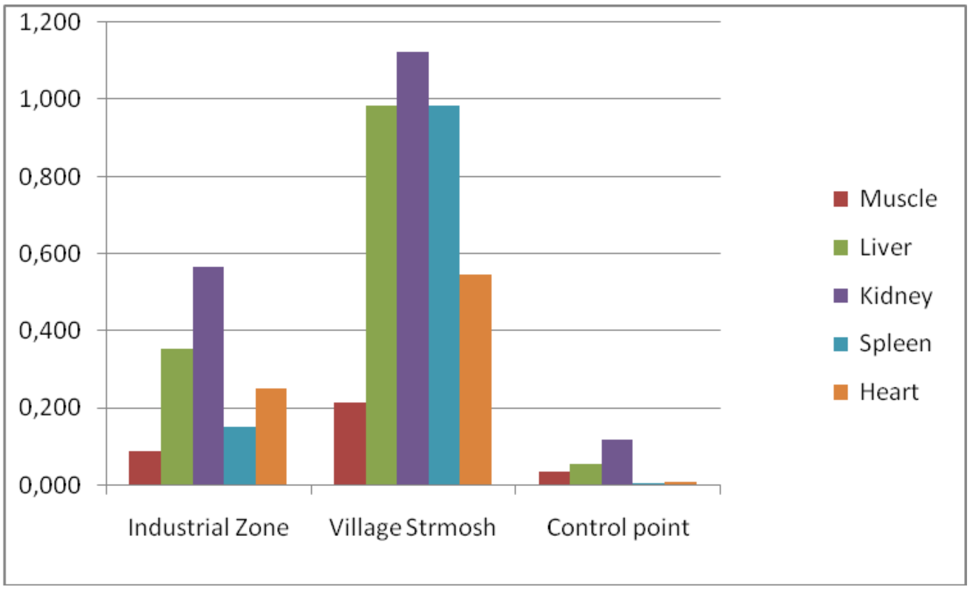

Fig. 1: Lead concentrations (mg/kg wet average weight) in chicken organs

Where should we look for the reason for keeping domestic animals at such sites that are heavily contaminated with heavy metals?

- In the fact that the population is uninformed about the consequences of eating meat with high content of lead which is inserted into the human organism and indirectly causes serious diseases.

- In the low-standard of the population that seeks way to survive during the state of crisis.

Heavy metals represent a serious problem of global pollution of the planet Earth, as well as the consequences arising from that pollution. Because of this they are the subject of much research in many countries worldwide.

Lead impairs learning, memory and audio-visual functions in children (Cohn et al., 1993). Toxic effects of lead also include Nephrotoxicity [29], Hepatotoxicity [12], cardiovascular damage. The carcinogenic effect of lead has been receiving increasing attention [20]. Research has shown that lead causes oxidative stress in the body by inducing the generation of free radicals thereby reducing the antioxidant defense system of the cells [17].

Effect of lead on reproductive systems is also well documented. Lead causes sterility in males by damaging the germinal epithelium and also spermatocytes [15]. In females, menstrual irregularities, preterm deliveries and still births have been reported (WHO, 1986).

The Netherlands [36], Brazil [3] and Finland [35]. Also, the mean concentrations of lead in sheep liver and kidneys in the present study were lower than those detected in Greece [10]. With respect to the results of urban area and by comparing them with the values of [7] 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).

Tab. 2: Lead concentration (mg/kg wet weight) in swine organs collected from three areas represents different ecosystems in Probistip.

Organs	Industrial Zone in the town of Probistip	Village Strmosh	Control point
Muscle	0.126	0.356	0.035
Liver	0.954	1.280	0.092
Kidney	1.025	2.457	0.123
Spleen	0.098	0.185	0.012
Heart	0.355	0.894	0.015

The results obtained from our research are in close correlation with the content of lead in the areas where these animals are kept and with lead content in the examined organs.

Table 2 shows the results for lead content in the examined tissues in swine. The results obtained show the distribution of lead in tissues and at measuring points, whereupon here also the highest values were measured in kidneys and they vary from 0.123 at the control measurement point to 2.457at the locality Strmosh.

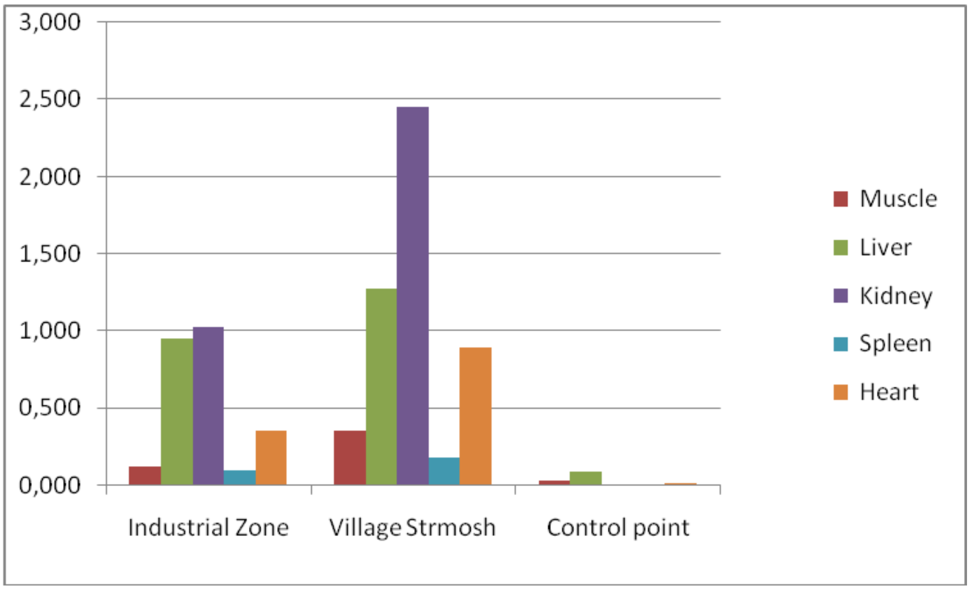

Fig. 2: Lead concentration (mg/kg wet weight) in swine organs

Table 3 gives the results for lead content in the examined tissues in goat. In respect of the measuring sites, all tissues - muscle, liver, kidney, spleen and heart were measured in the area around the village Strmosh and they vary from 0.122 in heart to 1.359 in kidney, and the lowest values were obtained at the control measuring point near which there are no sources of heavy metals pollution. They vary from 0.012in muscle to 0.984 mg/kg fresh weight in kidney. Kidneys accumulate the highest amounts of lead, and they are not less in the analyzed spleen too.

Table 3: Lead concentration (mg/kg wet in goat organs collected from three areas represent different ecosystems in Probistip

Organs	Industrial Zone in the town of Probistip	Village Strmosh	Control point
Muscle	0.089	1.874	0.012
Liver	0.641	1.127	0.058
Kidney	0.851	1.359	0.984
Spleen	0.221	0.356	0.042
Heart	0.032	0.122	0.091

The concentration of lead at the locality Strmosh is significantly higher than those obtained at the site on which there is no nearby source of pollution with heavy metals

All this is a consequence of the position of the waste landfill in the vicinity of the village Strmosh where waste waters from the flotation of lead-zinc ore from the mine “Zletovo” are accumulated. Another source of atmospheric pollution is the re-suspension of lead dust from the old waste landfill which is also located in the vicinity of this site and which is dispersed by the wind. From the results obtained at the Strmosh site, the content of lead is much higher compared to the lead content in tissue samples collected at other measurement points.

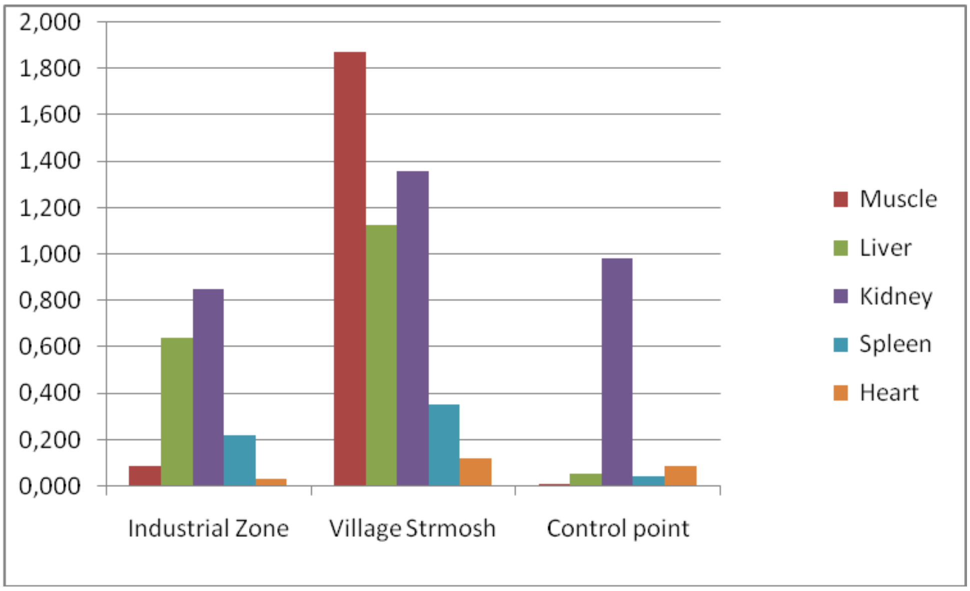

Fig. 3: Lead concentration (mg/kg wet weight) in goat organs

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. Lead in the industrial area is emitted from different sources (smelters, batteries recycling, combustion of fuel for different industries.

These results show the relation between lead concentration in soil and in meat samples contaminated from water and soil. Levels of lead in the liver and kidney samples in this study were compared to the values of.

5. CONCLUSION

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 swine taken at the mine waste landfill near the central town area of Probistip (1.025 and 2.454mg/kg respectively). Chicken kidney taken in the Strmosh area contained the highest concentration of lead (1.125 mg/kg). The concentrations of lead in liver and kidney taken from the industrial area were higher compared to other localities from which samples of tissue were taken for analysis.

At the control point of measuring the lead content in all examined tissues from the organs of chickens is significantly low compared to the industrial zone of Probishtip and the vicinity of the village Strmosh.

All the above mentioned facts require greater commitment to remediate the harmful effects of heavy metals on the environment and man.

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