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Lead Profile in Blood and Hair from Cattle, Environmentally Exposed to Lead Around Isfahan Oil Industry, Iran

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Abstract: This survey aimed at acquainting the amount of dairy farms lead pollution around the Isfahan oil industry. Dairy farms those were in distant less than 20 km were identified and divided into four groups. viz farms located in radial zone of 0.5-2.5, 2.5-5, 5-7.5 and 7.5-13.5 km, respectively considered as group A, B, C and D. Group E (control farms) was in nonpolluting places in the east of Isfahan. From 24 cows in each group, blood and hair samples were collected. The lead content of samples was measured by Atomic Absorption spectrometer. The cows which were located closer to oil industry had higher blood and hair Pb content. There is significant difference ($p<0.001$) in lead accumulation in blood of cattle among the groups except B and C. In this study, hair and blood Pollution Factor (PF) of lead, (3.03-5.31 and 2.47-4.35, respectively) may reflect the higher effect of environmental pollution and anthropogenic interference. The results showed that in the examined area, blood lead concentrations were normal (less than 0.075 ppm) but lead content of hair had shown a mild lead poisoning (more than 10 ppm). These concentrations showed that lead pollution around Isfahan oil industry could be a serious problem and must be considered.

Key words: Blood, cattle, hair, Isfahan, lead, oil industry, pollution factor

INTRODUCTION

Toxic metals are natural components of the environment, but human activities in industry and agriculture, have been responsible for the wider diffusion of these elements. The almost ubiquitous presence of some metal pollutants, especially Pb, facilitates their entry into the food chain and thus increases the possibility of them having toxic effects on humans and animals.

Toxic effects of metals have been described in animals under relatively low levels of metal exposure (Kostial, 1986). One of their earliest effects is the disruption of trace element metabolism (Goyer, 1997; Lopez-Alonso *et al*., 2002) and Sub-lethal exposure to lead can also result in a variety of physiological and biochemical processes (Bires *et al*., 1995).

The toxicity of lead is also attributed to the fact that it is interferes with the normal function of enzymes. Bipolar lead forms strong bonds with enzymes bearing sulfydryl groups thus inhibiting their action. Lead is toxic to the circulatory, nervous, urinary, gastric and genital systems. Furthermore, it is also implicated in causing carcinogenesis, mutagenesis and teratogenesis in experimental animals (Pitot and Dragan, 1996).

Cattle production is the most important form of agriculture in Isfahan. The cattle are predominantly reared on locally produced feed and are the primary livestock species exposed to metal contamination in this region. Chumbley and Unwin (1982) reported that there is little uptake of Pb by plants from the soil and therefore grazing cattle are most likely to be exposed to Pb if there is a regular source of airborne contamination. Thus, oil industry can be considered as a dominant source of pollution in this area.

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It has shown that normal hair and blood lead content of cattle are 0.5-5 and 0.01-0.12 ppm, respectively also reported that 3.5-9 ppm of blood lead and 10-100 ppm of hair lead content is considered as high and toxic level in cattle (Puls, 1988). In other animals, Puls (1994) announced that normal hair lead contents of dog, horse and sheep are respectively 0.0-88, 0.7-5.2 and 4-7 ppm.

Combs *et al*. (1982) stated that hair analyses may help to detect severe deficiencies of some required minerals or toxicities exposure to some heavy metals. Lead concentration determination of hair is shown to be useful in diagnosis of chronic toxicity (Puls, 1988). Sterner (1972) reported that in cattle that were exposed to industrial air born pollution, hair lead concentration can be an indicator of the body lead concentration.

Therefore, the aim of the present study was to evaluate the contribution of anthropogenic pollution to lead concentrations of hair and blood in Isfahan's cattle, with respect to the alteration of distant from oil industry.

MATERIALS AND METHODS

The area selected for investigation was located around the oil industry of Isfahan, Iran. This study examines stratified random samples of cattle hair and blood that were collected during July to September 2005 from all of farms in Isfahan. It was important to identify the distribution of metals in surrounding districts which may be subject to different levels of contamination.

Four districts were studied, none of which had other local industrial pollution sources: group A: farms located in radial zone of 0.5-2.5 km group B: farms located in radial zone of 2.5-5.0 km group C: farms located in radial zone of 5.0-7.5 km and group D: farms located in radial zone of 7.5-13.5 km. group E (control farms) were far from exam place in the east of Isfahan.

In order to sampling, each farm was visited at summer and 24 cattle of 3-5 years old selected. Approximately 10 mL of jugular vein blood and 2 g scapular skin hair was collected from each animal. All blood and hair samples were placed into labeled acid washed glass tube and plastic bags, respectively. Then samples were flown to the Laboratory.

Flame atomic absorption spectrometer Unicam model 969 by system of graphite flame 90 (GF 90), with deuterium ground correction, employed in the determination of the lead. Standards prepared as standard enhancement with introducers of clinical (III) for measurement of blood trace element. Measurements were controlled by clinchek blood sample. During steps of standard preparation and measurement of samples, specific polyethylene sampler and tube of atomic absorption system have been used. ammonium dihydrogen phosphate was used as matrix modifier. All the operational conditions in the instrumentation manual were followed as in Table 1.

The effect of pollution on hair and blood lead concentration in examined cattle was compared by Pollution Factor (PF).

Overall, 120 samples were evaluated and results were analyzed by SPSS software with ANOVA on Ranks test for comparison of hair and blood lead burden of different groups.

Table 1: Furnace conditions for Pb measurement

Steps	Temp. (°C)	Ramp time	Hold time	Internal flow	Gas type
1	110	15	50	250	Normal
2	130	25	50	250	Normal
3	560	20	20	250	Alternate
4	560	20	20	250	Normal
5	850	10	20	250	Normal
6	1600	0	5	0	Normal
7	2450	0	3	250	Normal

RESULTS AND DISCUSSION

In all groups of animals lead concentrations in the hair were significantly higher than blood ($p \leq 0.001$) (Table 2). The effect of pollution on hair and blood lead concentration in examined cattle was compared by Pollution Factor (PF) are given in Table 3. Pollution factors, calculated as ratios of metal levels in the industrialized area to metal levels in the rural area (Miranda *et al*., 2005).

The cows which were located closer to potential contamination sources were found to have higher blood and hair Pb content (Table 2). The statistically significant differences existed between all groups ($p<0.001$) except for blood samples of groups A and B ($p<0.05$) and only no significant lead accumulation in blood of cattle was seen between group B and C. No significant differences between group B and C may be due to different concentration of lead in feed that arise from different sources, interference in lead absorption by iron sulfate, calcium, vitamin D, sulfide containing substances and unknown sources of lead contamination. The results showed that in the examined area, cow's blood lead was normal but lead content of hair had shown a mild lead poisoning.

It is obvious from the results of this study that environmental contamination has a significant effect on Pb concentration in cattle of Isfahan's farm. Similar results have been reported previously for cattle from other polluted environments, including areas in the vicinity of zinc refineries (Spierenburg *et al*., 1988), metalliferous areas (Koh and Judson, 1986; Antoniou *et al*., 1989; Zantopoulos *et al*., 1990; Antoniou *et al*., 1995; Farmer and Farmer, 2000) and areas in which pastures receive wastewaters (Sedki *et al*., 2003).

Only broad comparisons can be made between the results of the present study and data reported previously, basically because there is considerable variation among studies in the way in which average values are presented in limits of detection and in the value assigned to subdetectable concentrations. All three factors are very important when samples do not show a normal distribution and/or many samples have metal levels close to or below the limit of detection. The age of animals is also an important factor for bioaccumulative metals such as cadmium.

Hair lead concentrations in our cattle reared in 1 to 5 km of Isfahan oil industry area (9.21-10.40) were considerably higher than the mean values reported in other recent study of cattle from other polluted areas of Iran. Pourjafar *et al*. (2006), reported that cattle reared in 1 to 5 km of oil industry of Shiraz and petrochemical industry of Shiraz, had mean hair lead of 5.8-6.2 and 3.2-3.8 ppm, respectively in summer.

Studies on heavy metals in animals may be an indicator of pollution in human beings, thus the interpolation and comparison of data in animal studies with human could not be wrong. This is supported by study of Hayashi *et al*. (1981).

Table 2: Lead concentrations (ppm) in the hair and blood of cattle in examined groups

		Hair		Blood	
Groups	Sample size	Mean	SD	Mean	SD
A	24	10.416	1.346	0.074	0.008
B	24	9.217	0.760	0.065	0.006
C	24	7.900	0.910	0.062	0.006
D	24	5.937	0.872	0.042	0.009
E	24	1.967	1.123	0.017	0.012

Table 3: Pollution Factor (PF) in the hair and blood of cattle in examined groups

Group	A	B	C	D
PF				
Hair	5.31	4.70	4.03	3.03
Blood	4.35	3.82	3.65	2.47

There are many reports from human revealed equal to higher amount of hair lead concentration in comparison with present results, in school children (Chlopicka *et al*., 1998; Leukouch *et al*., 1999; Sanna *et al*., 1999) but almost equal amount in kindergarten children (Esteban *et al*., 1999).

Blood lead concentrations in our cattle were 10 to 30 fold lower than in the previous studies in human (children) (Chlopicka *et al*., 1998; Esteban *et al*., 1999; Leukouch *et al*., 1999; Sanna *et al*., 1999; Sanna *et al*., 2003) or in cattle (Zadnik *et al*., 2004). Blood lead concentration at present study were 1 to 5 fold lower when compared to some other studies of cattle (Dwivedi *et al*., 1995; Zadnik *et al*., 2004). In contrast, Miranda *et al*. (2005) showed that blood lead concentrations in calf raised in the industrialized central area of Asturian and a rural area are equal to 0.0054 ppm, i.e., 8 to 14 fold lower than our study results.

In recent years there has been a remarkable decline (more than 10-fold) in lead concentrations in animal tissues throughout the developed world (Tahvonen and Kumpulainen, 1994; Jorhem *et al*., 1996; Skalicka´ *et al*., 2002), which is attributed to the phasing-out of leaded petrol (Belle´s *et al*., 1995; Rodamilans *et al*., 1996).

Puls (1988) states that normal hair and blood lead content of cattle are 0.5-5 ppm and 0.01-0.12, respectively. He reported that 3.5-9 ppm of blood lead and 10-100 ppm of hair lead content is considered as high and toxic level.

According to Puls (1988), however, it is of particular interest to note the presence of Pb in blood samples studied in normal range but hair samples studied were near to dangerous concentrations.

The effects of pollution on toxic metal levels in Isfahan's cattle can be compared with data reported elsewhere on the basis of Pollution Factors (PFs). PF values have been widely used in monitoring studies (Fernandez *et al*., 2000; Sedki *et al*., 2003) that allow estimation of the proportion of tissue metal content that has anthropogenic origin. Taking into account PF values, the contribution of pollution to lead concentrations in our study was more pronounced than in previous studies, The most marked effect of pollution on lead concentrations was seen in the hair (PF of: 5.31, 4.70, 4.03 and 3.03, respectively in groups of A, B, C and E) and to lesser extent in the blood (Pollution factors of: 4.35, 3.82, 3.65 and 2.47, respectively in groups of A, B, C and E). This result is in accordance with report of Sanna *et al*. (2003) that revealed PF of hair lead concentration in boys and girls on 1999 (3.85 and 3.11, respectively) is higher than PF of blood lead (2.76 and 2.21, respectively).

In this study hair PF of lead (PF = 3.03-5.31) as compared to hair PF of Lead in school children living in a wastewater spreading field of Morocco (PF is 3.32) (Leukouch *et al*., 1999) and hair PF of lead in portoscuso, located about 2 km from one of the most important industrial complexes of the island, (PF is 3.11-3.85) (Sanna *et al*., 2003) and in cattle located 1-10 km around oil and petrochemical industries of Shiraz (PF is 4.03-4.77 and PF is 1.69-5.42, respectively) (Pourjafar *et al*., 2006) shows some higher effect of anthropogenic interference to environmental pollution in Isfahan.

Blood PF of lead in this study (PF is 2.47-4.35) as compared to blood PF of Lead in Portoscuso (PF is 1.48) and Iglesias, an important zinc-lead mining centre (PF is 1.21, Sanna *et al*., 1999) and in calf raised in the industrialized central area of Asturian (PF with 1) (Miranda *et al*., 2005) may reflect the higher effect of environmental pollution in blood lead concentration enhancement that might be because of recent increase of pollution.

This indicates that tissue lead concentrations in Isfahan's cattle were higher compared to other regions, hence pollution makes an important contribution to these concentrations. Although toxic metal levels in cattle from the industrialized area of Isfahan were almost low compared to other abroad polluted regions (Fig. 1), the cows which were located closer to potential contamination sources were found to have higher blood and hair Pb content.

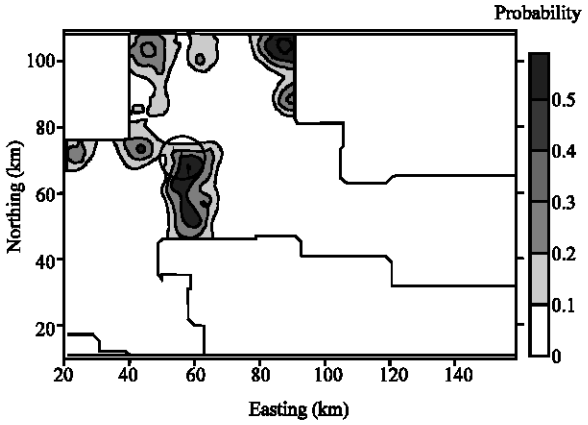

Fig. 1: Distribution of probability of lead in Isfahan province. Examined area is detected in a circle

According to Puls (1988), however, it is of particular interest to note the presence of Pb in all samples studied though not in dangerous concentrations, showing how this metal is evermore frequently found in hair and blood in Isfahan's cattle which is a region with great industrial activity.

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