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Horse Hair as an Indicator of Pb Pollution Around Shiraz Oil Industry, Iran

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Abstract: The objective of the current study was to assess the potential for using the horse hair as a bio-indicator of environmental pollution. Horse hair samples from different radial distances from oil and petrochemical industries of Shiraz were analyzed to determine their Pb content. Viz farms located in radial zone of 1-1.5, 1.5-5, 5-7, 7-10 km, respectively considered as group A, B, C and D. Group E (control farms) were far from exam place and roads. In order to sampling, each farm was visited at every season and from 19 selected horses approximately 2 g cervical skin hair was collected. The lead content of samples was measured by Atomic Absorption spectrometer. The horses which were located closer to oil industry had higher hair Pb content. In all seasons except for winter significant differences existed between group A and all other groups ($p<0.05$). Also by respect of going from spring to winter we can see decline in lead burden in all groups. In this study, hair Pollution Factor (PF) of lead, 1-3.95 may reflect the higher effect of environmental pollution and anthropogenic interference. The results showed increases Pb concentration in the hairs of the horses according to decrease of distance to oil industry, therefore Pb as determined in the hair of the animals, showed a certain potential for using horses as bio-indicators of environmental pollution.

Key words: Environmental monitoring, hair, horse, lead, oil industry, pollution factor, Shiraz

INTRODUCTION

Pollution is a subject of worldwide concern and discussion and various areas of science are seeking to integrate their knowledge in an attempt to improve understanding of the harmful effects of modern human activities. 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.

Hair analysis as a material easily accessible for noninvasive sampling in individuals or population groups has been used to demonstrate exposure to toxic metals since many years in nutritional, forensic medicine, occupational and environmental health. Since the development of new analytical techniques such as neutron activation and Atomic Absorption Spectroscopy (AAS), human hair has been used to monitor exposure to toxic metals in occupational and environmental settings.

Inasmuch as lead (Pb) is ubiquitous toxic metal, exposure assessment of the metal with the use of hair as a biological media has been carried out in many epidemiological studies (Chlopicka *et al*., 1998; Wilhelm *et al*., 1989, 1994; Sanna *et al*., 2003; Barbosa *et al*., 2005; Patra *et al*., 2007; Stupar *et al*., 2007).

The horses in studied area are predominantly fed by locally produced feed and are from species exposed to metal contamination in this region. As stated by Chumbley and Unwin (1982), there is little

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uptake of Pb by plants from the soil and therefore horses 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.

Therefore, the aim of the present study was to evaluate the contribution of anthropogenic pollution to lead levels of horse hair in Shiraz, with respect to the alteration of distant from oil industry and evaluation of horse hair as a bio-indicator of environmental pollution.

MATERIALS AND METHODS

The area selected for investigation was located around the oil industry of Shiraz, Iran. This study examines stratified random, samples of horse hair which collected during 2001 from almost all of farms in Shiraz. 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, which none of them had other local industrial pollution sources: group A: farms located in radial zone of 1-1.5 km group B: farms located in radial zone of 1.5-5 km group C: farms located in radial zone of 5-7 km and group D: farms located in radial zone of 7-10 km. group E (control farms) were far from exam place and roads.

In order to sampling, each farm was visited at middle of every season and 19 horse selected. Approximately 2 g cervical skin hair was collected from each animal. All samples were placed into labeled plastic bags and 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. 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 lead concentration in examined horses was compared by Pollution Factor (PF).

RESULTS

The effect of pollution on hair lead concentration in examined horses was compared by Pollution Factor (PF). Pollution factors, calculated as ratios of metal levels in the industrialized area to metal levels in the rural area (Miranda *et al*., 2005), are given in Table 3.

Table 1: Furnace conditions for Pb measurement

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

*The step in which Pb measurement was done

Table 2: Lead concentrations (ppm) in the horse hair of examined and control groups around oil industry of Shiraz

	Mean±SD			
Group	Winter	Autumn	Summer	Spring
A	3.1 ± 1.0^{d}	3.9 ± 1.2^{bcde}	6.4 ± 2.1^{bcde}	7.5 ± 2.5^{bcde}
B	2.9 ± 0.6^{e}	3.1 ± 1.1^{d}	4.5 ± 1.9^{a}	5.1 ± 1.9^{acd}
C	2.4 ± 0.6^{e}	2.4 ± 0.8^{d}	2.4 ± 0.8^{ae}	3.1 ± 1.7^{ab}
D	2.1 ± 0.6^{a}	1.9 ± 0.7^{bc}	2.1 ± 0.8^{ae}	2.5 ± 1.1^{ab}
E	1.9 ± 0.4^{bc}	1.9 ± 0.5^{a}	1.8 ± 0.7^{acd}	1.9 ± 0.5^{a}

a, b, c, d and e: These characters show the statistical significant differences respectively with group A, B, C, D and E

Table 3: Pollution factor (PF) in the hair of horses in examined groups in order to compare with controls

Group	Spring	Summer	Autumn	Winter
A	3.95	3.55	2.05	1.63
B	2.69	2.50	1.63	1.53
C	1.63	1.33	1.26	1.26
D	1.31	1.17	1.00	1.10

The results showed that in the examined area, hair lead concentrations only in spring and summer in group A were abnormal (more than 5.2 ppm) and showed a mild lead poisoning in spring and summer. But its content in other seasons and other groups presented normal levels.

DISCUSSION

It is obvious from the results that environmental contamination has a significant effect on Pb concentration in horses of Shiraz'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).

Dorn *et al*. (1974) reported that reduction in lead exposure was reflected more rapidly in blood than in hair concentrations. They also emphasized these results demonstrate the value of using bovine hair samples in surveillance of environmental contamination, as well as other ecologic, epidemiologic and mineral metabolism research.

Huel *et al*. (1995) stated lead is concentrated in head hair (infants), which can be collected without injury and easily preserved and analysed. For measurement of past or current exposure, hair seems better than blood.

Patra *et al*. (2007) examined the use of tail hair from cows as a possible biomarker of environmental exposure to lead and cadmium around different industrial areas. They found significantly correlation lead between blood and hair lead ($p<0.01$).

Puls (1988) stated that normal hair lead content of horse is 0.7-5.2 ppm. According to Plus's statement, however, it is of particular interest to note the presence of Pb in studied hair samples were normal except for hair samples of A groups in spring and summer. Acidic diets may enhance absorption of lead by promoting dissolution of lead in spring and summer. There appears to be a direct correlation between high levels of vitamin D and enhanced lead absorption, which may explain the greater occurrence of the poisoning during the summer. However, according to presence of Pb in all studied samples, though not in dangerous concentrations, showing the low effect of anthropogenic interference to environmental pollution in Shiraz.

Studies on heavy metals in animals may be an indicator of pollution in human beings, thus the comparison of data in animal studies with human could not be wrong. This is supported by study of Hayashi (1981). There are many reports from human revealed equal to higher amount of hair lead concentration in comparison with our results, in school children (Chlopicka *et al*., 1998; Lekouch *et al*., 1999; Sanna *et al*., 1999) but almost equal amount in kindergarten children (Esteban *et al*., 1999).

It is obvious that 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 (Miranda *et al*., 2005).

The effects of pollution on toxic metal levels in Shiraz's horses 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 group A especially in spring and summer with PF_s of 3.95, 3.55, respectively.

PF of hair lead in group A (PF = 1.63-3.95) as compared to PF of hair Lead in school children living in a wastewater spreading field of Morocco (PF is 3.32) (Lekouch *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), shows almost the same results. This indicates that tissue lead concentrations in Shiraz's horse were almost equal when compared to other polluted regions; hence pollution makes an important contribution to these concentrations.

Horses which were located closer to potential contamination sources were found to have higher hair Pb content. The mean Pb concentration in group A in the spring samples was approximately 4 times higher than that of the control samples (maximum pollution) and this ration decreases from spring (3.95 times) to winter (1.63 times). The hair concentration of Pb was significantly affected by season and increase of distance from pollution source. There was a negative relationship between hair lead concentrations and distance from pollution source. Pearson's correlation coefficient between lead concentration of horse hair and distance from pollution source were -0.995, -0.989, -0.958 and -0.962, respectively in spring to winter. This result showed high intensity of correlation.

To sum up, Pb as determined in the hair of the horses, showed a certain potential for using horses hair as a bio-indicators of environmental pollution.

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REFERENCES

Antoniou, V., H. Tsoukali-Papadopoulou, P. Epivatianos and B. Nathanael, 1989. Cadmium concentrations in beef consumable tissues in relation to age of animals and area of their breeding. Bull. Environ. Contam. Toxicol., 43 (6): 915-919.

Antoniou, V., N. Zantopoulos and H. Tsoukali-Papadopoulou, 1995. Selected heavy metal concentrations in goat liver and kidney. Vet. Hum. Toxicol., 37 (1): 20-22.

Barbosa, F., Jr., J.E. Tanus-Santos, R.F. Gerlach and P.J. Parsons, 2005. A critical review of biomarkers used for monitoring human exposure to lead: Advantages. Limitations and Future Needs, 113 (12): 1669-1674.

Chlopicka, J., Z. Zachwieja, P. Zagrodzki, J. Frydrych, P. Slota and M. Krosniak, 1998. Lead and cadmium in the hair and blood of children from a highly industrial area in Poland. Biol. Trace. Elem. Res., 62 (3): 229-234.

Chumbley, C.G. and R.J. Unwin, 1982. Cadmium and Pb content of vegetable crops grown on land with a history of sewage sludge application. Environment, (Ser. B) 4: 231-237.

Dorn, C.R., P.E. Phillips, J.O. Pierce and G.R. Chase, 1974. Cadmium, copper, lead and zinc in bovine hair in the new lead belt of Missouri. Bull. Environ. Contam. Toxicol., 12 (5-9): 626-632.

Esteban, E., C.H. Rubin, R.L. Jones and G. Noonan, 1999. Hair and blood as substrates for screening children for lead poisoning. Arch. Environ. Health, 54 (6): 436-440.

Farmer, A.A. and A.M. Farmer, 2000. Concentrations of cadmium, lead and zinc in livestock feed and organs around a metal production centre in Eastern Kazakhstan. Sci. Total Environ., 257 (1): 53-60.

Fernandez, J.A., A. Rey and A. Carballeira, 2000. An extended study of heavy metal deposition in Galicia (NW Spain) based on moss analysis. Sci. Total Environ., 254 (1): 31-44.

Hayashi, H., 1981. Distribution of environmental pollutants in pet animals, VI heavy metals in hair of housedogs. Bull. Environ. Contam. Toxicol., 26 (1): 60-64.

Huel, G., D. Campagna, Th. Moreau and P. Tubert-Bitter, 1995. Hair lead studies were excluded. BMJ., 310 (6): 397-398.

Koh, T.S. and G.J. Judson, 1986. Trace elements in sheep grazing near a lead-zinc smelting complex at Port Pirie, South Australia. Bull. Environ. Contam. Toxicol., 37 (1): 87-95.

Lekouch, N., A. Sedki, S. Bouhouch, A. Nejmeddine, A. Pineau and J.C. Pihan, 1999. Trace elements in children's hair, as related exposure in wastewater spreading field of Marrakesh (Morocco). Sci. Total Environ., 15 (243-244): 323-328.

Miranda, M., M. Lopez-Alonso, C. Castillo, J. Hernandez and J.L. Benedito, 2005. Effects of moderate pollution on toxic and trace metal levels in calves from a polluted area of northern Spain. Environ. Int., 31 (44): 543-548.

Patra, R.C., D. Swarup, R. Naresh, P. Kumar, D. Nandi, P. Shekhar, S. Roy and S.L. Ali, 2007. Tail hair as an indicator of environmental exposure of cows to lead and cadmium in different industrial areas. Ecotoxicol. Environ. Safety, 66 (1): 127-131.

Puls, R., 1988. Mineral Levels in Animal Health. Sherpa International, British Columbia.

Sanna, E., G.G. Cosseddu, G. Florid, A. Liguori, M. Peretti and L. Carbini, 1999. Comparison of blood lead levels in three groups of Sardinian children. Anthropol. Anz., 57 (2): 111-121.

Sanna, E., A.L. Liguori, P.M.R. Soro and G. Floris, 2003. Blood and hair lead levels in boys and girls living in two Sardinian towns at different risks of lead pollution. Ecotoxicol. Environ. Safety, 55 (3): 293-299.

Sedki, A., N. Lekouch, S. Gamon and A. Pineau, 2003. Toxic and essential trace metals in muscle, liver and kidney of bovines from a polluted area of Morocco. Sci. Total Environ., 317 (1-3): 201-205.

Spierenburg, T.J., G.J. de Graaf, A.J. Baars, D.H.J. Brus, M.J.M. Tielen and B.J. Arts, 1988. Cadmium, zinc, lead and copper in livers and kidneys of cattle in the neighbourhood of zinc refineries. Environ. Monit. Assess., 11 (2): 107-114.

Stupar, J., F. Dolinšek and I. Eržen, 2007. Hair-Pb longitudinal profiles and blood-Pb in the population of young Slovenian males. Ecotoxicol. Environ. Safety, 68 (1): 134-143.

Wilhelm, M., I. Lombeck, D. Hafner and F.K. Ohnesorge, 1989. Hair lead levels in young children from the FRG. J. Trace Elem. Electrol. Hlth. Dis., 3 (3): 165-170.

Wilhelm, M., I. Lombeck and F.K. Ohnesorge, 1994. Cadmium, copper, lead and zinc concentrations in hair and toenails of young children and family members: A follow-up study. Svi. Total Environ., 141 (1): 275-280.

Zantopoulos, N., H. Tsoukali-Papadopoulou, P. Epivatianos, B. Nathanael and V. Mirtsou-Fidani, 1990. Lead concentrations in consumable beef tissues. J. Environ. Sci. Health, 25(5): 487-494.