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ORIGINAL ARTICLE

Environmental impact in a rural community due to a lead recycling plant in Zacatecas, Mexico

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Abstract A study was conducted to determine the concentrations of lead in soil and plants samples due to the exposure of emission from a metal-recycling plant in a rural community in Zacatecas, Mexico. The lead levels in the soils were determined as having cultivated crops, medicinal plants, and wild plants. Also, other potential sources of lead exposure, as firewood, a cooking glazed vessel, and soils from three houses were analyzed. Samples were analyzed with the energy dispersive X-ray technique. The average lead soil sample was 4940 μg/g, and the Pb average levels in firewood ashes was 207 ± 73 μg/g. The mean lead concentrations in edible parts of *Zea mays*, *Capsicum annuum*, and *Avena sativa* were 1551, 1474, and 1056 μg/g, respectively. Wild plants species showed very high lead concentration especially *Acacia schaffneri*, *Buddleja scordioides*, *Tillandsia recurvata*, *Opuntia streptacantha* and *Amaranthus hybridus*. The lead contamination path was through the emission of the metal-recycling plant.

Keywords Lead · Metal-recycling plant · Glazing pottery · Crops · Endemic plants · México

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Introduction

The toxic heavy metals entering the ecosystem may lead to geoaccumulation, bioaccumulation and biomagnification. In recent years the food chain contamination by heavy metals has become a serious issue because of their potential accumulation in biosystems through contaminated soil, air and water (Lokeshwari and Chandrappa 2006).

The soil is the common source of biological trace elements that reach man through plants and animals (Nunes et al. 2009). Soil contamination is a potential problem when residential and agricultural areas are located around a contaminated area where elements can be spread due to erosion (Chon et al. 1995).

In areas with tradition in mining and smelting, the Pb has been accumulated over time in the surface soil at nearby farmlands (Colbourn and Thornton 1978). Although smelters and/or mines are the obvious contamination sources, other lead sources may be present (Gulson et al. 2004), such as lead-containing paint, soil/dust, leaded gasoline, plumbing leachate (water), occupational exposure, and hobbies using lead-containing materials like the lead glazed items (Szalóki et al. 2000). Ceramics, lead compounds for glazing pottery, and metallic lead for cooking items and piping have been associated with lead toxicity since ancient times (Hernberg 2000).

Studies carried out in Mexico have shown that the use of lead-glazed ceramics has been the most important source of Pb levels in rural communities (Rojas-López et al. 1994). Many countries, including Mexico, are facing a largely unrecognized epidemic of low levels of lead poisoning (Romieu et al. 1994).

Among the inhabitants of a rural community, known as San Ignacio, located in Zacatecas, Mexico, there were concerns for the activities of a company named "Metal-recycling plant Gildardo Gómez Alonso". This facility has a 35–40 m-height smelter stack and is located in the middle of agricultural áreas, and approximately 200 m from the community. The recycling plant was established in 1984 as a pilot plant for silver recovery with the use of materials rich in sulphur and arsenic. Since 2000, the plant started the desbismutation of the lead, processing 80 tons of lead–bismuth per week. In 2005 the processing capability reached 1400 tons per month. After the bismuth recovery, the lead-rich waste was stored inappropriately, causing several pollution problems affecting the population health. The recycling plant was registered for processing non-ferrous metals, meaning as non-contaminant; therefore, claims of the affected population were unattended by health and environmental authorities.

The objective of this study was to determine the levels of lead in agricultural soils, crops, and wild plants species to find the pathways of exposure around of the metal recycling plant.

Materials and methods

Study area and sampling

Sampling was conducted in the agricultural area located around the metal-recycling plant in San Ignacio, located at 102°, 59′ 10″ W and 23° 19′ 50″ N, north of Zacatecas city, in Mexico (Fig. 1).

This region is characterized by a semi-arid climate, with an annual average temperature of 24.5 °C, and average of 351 mm rainfall. Soils are poor in nutrients, showing a sandy texture with low moisture retention. Natural vegetation is mainly *Opuntia* and herbaceous plants species, shrubs and trees with xerophitic characteristics.

Soil and plant samples were randomly collected in the area around the metal recycling plant; the sampling sites are shown in Fig. 2. Sampling sites were chosen in terms of the distance to the recycling plant and the abundance of crop and wild plants. To determine a background Pb level, sample 10 was collected at 50-cm depth. Soil samples were collected in two periods, 6 months apart. In the first, beside the soil samples wild plants were collected; in the second, together with soil samples, crop samples were also collected.

Soil samples were collected from agricultural soils where it was cultivated corn (*Zea mays* L.), oat (*Avena sativa* L.), beans (*Phaseolus vulgaris* L.), pepper (*Capsicum annuum* L.), pumpkin (*Cucurbita pepo* L.), and sweet potato (*Hipomoea batata* L.). Also, medicinal plants were sampled as Mexican arnica (*Heterotheca inuloides* Cass.) and wormseed or fetid goosefoot [*Chenopodium graveolens* (Willd.) Weber]. In addition, the more representative wild plants species were collected: pigweed (*Amaranthus hybridus* L.), barnyard grass [*Echinochloa crusgalli* (L.) Beauv.], buffalo gourd (*Cucurbita foetidissima* Kunth), ball moss (*Tillandsia recurvata* L.), butterflybush (*Buddleja scordioides* Kunth), arborescent prickly pear (*Opuntia leucotricha* DC.), wheel cactus (*Opuntia*

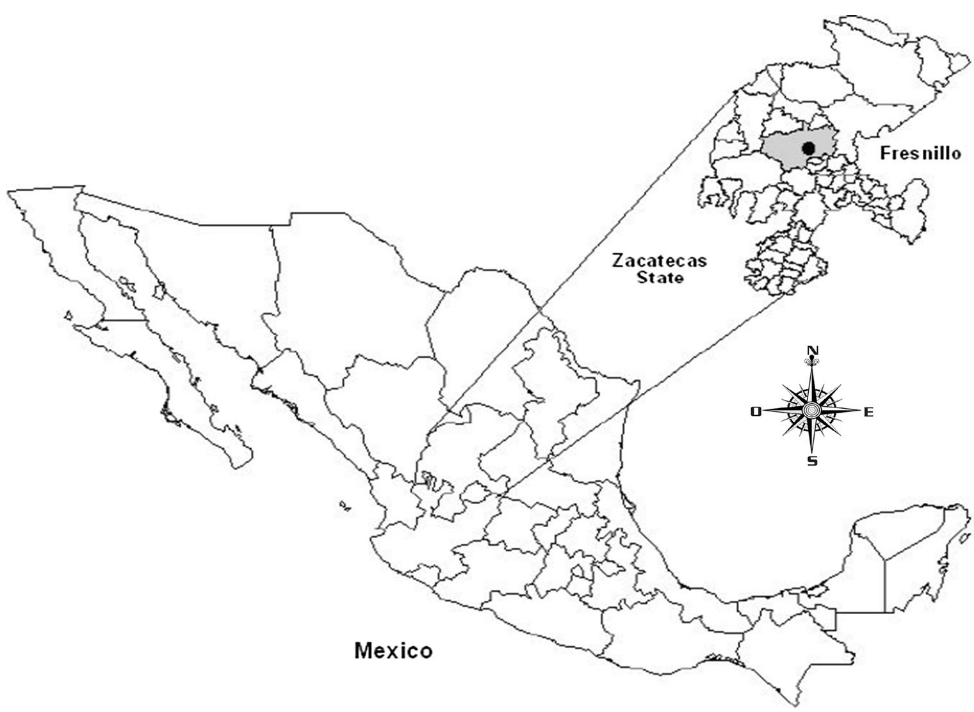

Fig. 1 Location of the study area in Fresnillo, Zacatecas, Mexico

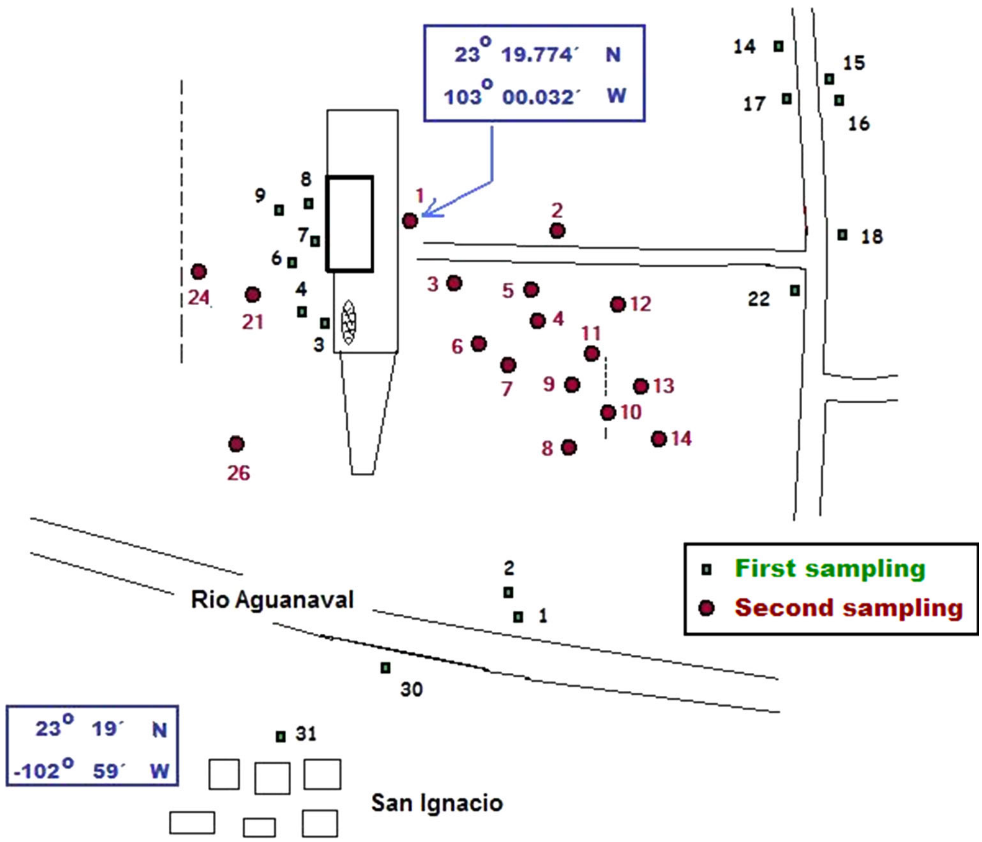

Fig. 2 Map of the study area with the soil sampling sites surrounding the metal recycling plant

robusta H.L. Wendl.), nopal pachón (*Opuntia heliabravoana* Scheinvar), schaffner's wattle [*Acacia schaffneri* (S. Watson) F.J. Herm.], and smooth mesquite [*Prosopis laevigata* (Humb. and Bonpl. ex Willd.) M.C. Johnst.].

Soil samples, including their corresponding ryzospheric soils, were taken from 0 to 25 cm-depth in five points within about 60 cm radius from the recollection sites. Every five subsamples were subsequently combined into a 2 kg single site-representative sample. Also, representative samples of collected crop and wild plant were taken mixing single samples of aerial parts of five plants. For soil samples the physicochemical properties like pH, texture, organic matter, and electric conductivity, were determined using standard procedures and in agreement to Mexican standard NOM-021-SEMARNAT-2000 (2002).

To determine other possible sources of lead contamination in the community, 17 soil samples from kitchens, with no concrete floor, and backyards from three family houses were taken in the community, thereafter designated as families 1, 2, and 3.

Families 2 and 3 used firewood from the area around the metal recycler plant for cooking. While, family 1 used it for the water heater. As a food supply family 2 did collect "nopalitos" of the varieties "duraznillo" (*O. leucotricha*) and beans (*P. vulgaris*) from areas next to the metal recycling plant. Inside the three houses ashes from the firewood were collected, as is shown in Fig. 3.

Family 3 is the only one using glazed pottery for cooking. Here, a pair of glazed clay pots ("the bean pot") 3 l-capacity were used at least for 10 years to cook beans consumed daily. These pots were purchased by the familiy in a different site, with no relation with the recycling plant. The pots were collected because these types of items have

Fig. 3 Ashes generated from combustion wood

been found as a source of Pb intake (Rojas-López et al. 1994; Romieu et al. 1994). Pots were recovered, and one was used to determine the amount of Pb. The raw and cooked beans were used to measure the amount of Pb released during beans cooking (Fig. 4).

In the laboratory one of the clay pots was fractionated and used to determine the concentration of lead in the inner and outside parts of the pot. From the same family were obtained dried bean samples used for food.

To determine the amount of lead that is released by the use of clay pot in which the beans were cooked, the raw and cooked beans were used to determine the lead concentration. Also, the mother of family 3 informed us that their children often played with a piece of metal found around the recycling plant. This piece was recovered for analysis (Fig. 5).

Fig. 5 Image of piece metal recycling plant recollected, source contamination recovered for analysis

Samples analysis

Soil samples were allowed to dry at room temperature, once dried, were mixed, homogenized and sieved through 350 mesh screens to a fine powder and weighed. To establish a basis for comparison, pepper crop from Bañuelos, Guadalupe, Zacatecas, México was used as a control. This site is approximately 80 km distance from the study area. After each crop and wild plant samples being cleared from major debris (soil particles, extraneous biological materials), were washed three times sequentially with a phosphate-free detergent, rinsed once with tap water, once with distilled water and finally twice with deionized water. Once dry at room temperature, the edible part crop and the wild plants shoot were selected. Drying processes were carried out at 60 °C for 75 h, then samples were crushed, milled and thoroughly homogenized. Likewise, raw and cooked beans in the glazed pottery pot, nopalitos, pepper, sweet potato, and the ashes of firewood were placed in an oven at 40 °C for 48 h to remove moisture.

Fig. 4 Glazed clay pots of the family 3 used for cook beans ("the bean pot")

Each sample was measured five times using Energy dispersive X-ray fluorescence (EDXRF), and the average value of lead concentration was calculated. The X-rays spectra were analyzed with the MiniPal II software. The X-ray tube was fed with 30 kV with a current of 13 mA. The X-ray was filtered with Mo to reduce the amount of small energy X-ray. The spectrometer was calibrated with 12 standards, four of them traceable to the National Institute of Standards and Technology USA (NIST): Montana soil 2710, and NBS 1570, 1573, 1575. The following eighth standards were prepared using soil with different concentrations of lead acetate ranging from 10 to 8×10^4 ppm. Standards have the same geometry and shape as the unknown soil samples. Seven of these standards were measured independently using the atomic absorption technique to verify the calibration curve obtained with EDXRF.

Lead was determined measuring the X-rays K_β lines arising from transitions from M and N shells, with energies of 85 and 87 keV and those of K_α arising from transitions from the L shells, with energies of 72 and 75 keV (Salas-Luevano et al. 2011). Each sample was measured five times and values were used to obtain an average value of lead concentration.

Results and discussion

Soil characteristics

Soils in the study area have sandy loam texture. Soils pH vary from 7.6 to 8.0 with a mean value of 7.8. While electrical conductivity of 0.39 dS m^{-1}.

Lead concentrations in agricultural soils

Figure 6 shows the mean values of Pb concentration in the soil samples taken around the metal recycler facility, and in the town. In the figure the limits for residential and agricultural uses of soil are also included. Lead concentration in soils decrease as the distance from the recycling plant increases. Probably the stack emissions and eolic erosion are deemed to be mainly responsible for the patterns of Pb in soils. As expected, the highest levels in the soil were found at areas near the metal recycling plant. In some of the soil samples the Pb concentration exceeded 84,238 µg/g. The sample with the highest concentration was collected directly from the lead–bismuth waste that was unconfined in the recycling plant. Sample 10, taken at 50 cm-depth, and sample 26 had the lowest lead concentration. Sample 26 was located at the same distance of another samples showing higher Pb concentration; however, this sample, as well as those taken from the urban areas are away from the mean wind stream that runs from south to north.

The average lead concentration in soil around the metal recycler facility was 4940 ± 14,950 µg/g, individual concentrations ranging from 73 to 84,238 µg/g. The mean value exceeds by far the maximum permissible Pb concentration in soils for agricultural purposes, being 375 µg/g (OECD 1993). It also exceeds 100 mg/kg (d.b.) defined as the limit for agricultural and grassland soils (Önorm 1990).

The average Pb concentration in soils agrees with similar findings reported around a smelter (Díaz-Barriga et al. 1993; Valdés and Cabrera 1999), and in similar studies carried out in soils around the processing metal industry (Kabata-Pendias and Pendias 2001).

Lead concentration in soils from the community streets is below the limit recommended for residential and agricultural use; therefore, the contamination from the recycling plant does not reach the community, because it is not on the dominant wind stream.

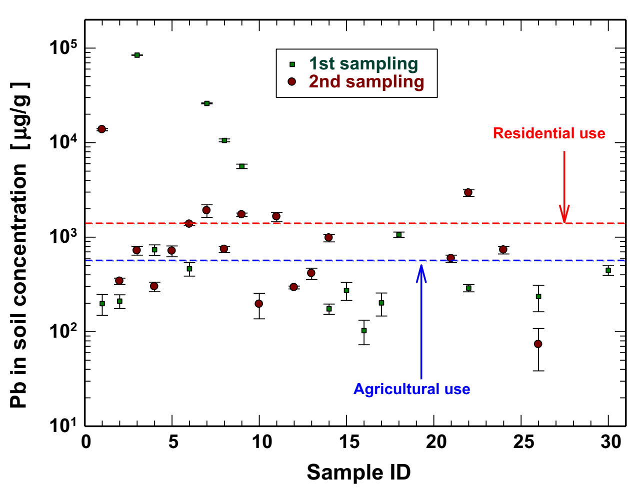

Fig. 6 Pb concentration in soils collected around the recycling plant and the community of San Ignacio, Fresnillo, Zacatecas, Mexico

Lead concentration in cultivated plants

Moreover, in this study 18 plant species and ten genera belonging to 12 botanical families, among them 6 cultivated species and 12 wild plants, were studied which showed different Pb levels. These plants are used in different forms as shown in Table 1. Lead concentration in the cultivated plants showed low content of Pb and wild plant species showed very high levels. In this set of samples the range of lead concentration in plants goes from 148 to 55,153 µg/g with an average of 16,220 ± 20,954 µg/g. In the group of plant samples taken from agricultural land there is a similar situation to areas close to the recycling plant. In these areas *Zea mays* sample, *Capsicum annuum*, and *Avena sativa* had concentrations, 1551, 1474 and 1056 µg/g, respectively.

Regarding edible plants, *Ipomoea batatas* had 422 µg/g of the metal, while beans and a sample from a pile of straw had lead concentrations of 57 and 159 µg/g, respectively. In general terms, Pb concentration levels exceeded international food standard guidelines the maximum level (ML) of 0.3 mg kg^{-1} fresh weight (FW) for brassicas, leafy vegetables and herbs, and 0.1 mg kg^{-1} FW for all remaining vegetables (CEC 2001; WHO 2004). Likewise, the lead concentration in the crop samples exceed the allowable levels established by ANZFA (2013), being ML 0.1, and 0.3 mg kg^{-1} FW for all vegetable types excluding brassicas.

Lead concentration in the fruits of pepper was 158 µg/g; this was compared with samples obtained from a control area whose concentration was 87 µg/g, being in agreement with studies carried out with vegetables grown in uncontaminated and contaminated soils (Guttormsen et al. 1995).

Therefore, it is concluded that the ingestion of the edible parts of agricultural plants are other means of incorporation of lead to humans and animals. Also, studies of vegetables grown in locations close to industries have reported elevated levels of heavy metals. The extent of Pb contamination in soils in sampled plants was greatest in regions located in the vicinity of smelters (Kachenko and Singh 2006). These results indicated significantly higher levels of metal accumulation in leafy vegetables. Thus, the crops grown surrounding in community studied, affected by recycling plant, have a health hazard for human and animals, as well as prolonged exposure to such high levels of Pb by residents of the study area may result in manifestation of adverse health effects associated with the metal.

Table 1 Lead concentration in cultivated and wild plants, located around the lead recycling plant and its uses in the community

Type of plant	Family	Plant species	Lead content (μg/g) shoot	Recorded uses[a]
Herbaceous	Amaranthaceae	*Amaranthus hybridus*	1301	Food, traditional medicine and fodder
	Asteraceae	*Heterotheca inuloides*	$(1.6 \pm 0.1) \times 10^4$	Traditional medicine and domestic
	Bromeliaceae	*Tillandsia recurvata*	11,087	Forage to livestock (goats) and wildlife, ornamental, ceremonial and commercial (Christmas)
	Chenopodiaceae	*Chenopodium graveolens*	530	Traditional medicine and domestic
	Convolvulaceae	*Ipomoea batatas*	422	Food (day of the dead festivities)
	Cucurbitaceae	*Cucurbita foetidissima*	72	Traditional medicine and obtain soap
		Cucurbita pepo	54	Food, traditional medicine
	Leguminosaceae	*Phaseolus vulgaris*	87	Food (dry grains)
		Phaseolus vulgaris	159	Fodder (straw)
	Poaceae	*Zea mays*	1551	Food, fodder
		Avena sativa	1056	Food, fodder
		Echinochloa crusgalli	1547	Fodder
	Solanaceae	*Capsicum annum*[a]	90	Plantations
		Capsicum annum[b]	212	Food, salsas
		Capsicum annum[c]	61	Food, salsas
Shrubs	Cactaceae	*Opuntia leucotricha*	440	Food, traditional medicine, fodder
		Opuntia robusta	368	Food, traditional medicine, fodder
		Opuntia streptacantha	1952	Food, traditional medicine and domestic, fodder
	Buddlejaceae	*Buddleja scordioides*	10,435	Food, traditional medicine and domestic, fodder
Trees	Fabaceae	*Acacia schaffneri*	39,926	Traditional medicine, fodder
		Prosopis laevigata	4186	Traditional medicine, fodder

a seedling, *b* var. Mulato, *c* var. Pasilla

[a] Source: UNAM (2009) and Vibrans (2014)

Lead concentration in medicinal plants

In this study, the lead levels for medicinal plants Mexican arnica (*H. inuloides*) and epazote (*C. graveolens*) were $(1.6 \pm 0.1) \times 10^4$ and 530 ± 30 μg/g, respectively. According to WHO (2005) the maximum permissible limits of lead in medicinal plants is 10 μg/g; therefore, our results far exceed this permissible concentration; particularly in the sample of *H. inuloides* the lead concentration exceeds the lead content in the soil rhizosphere, which may indicate a process of accumulation of this metal in the plant, because Pb is potentially more available for root uptake. The leaf of *H. inuloides* and *C. graveolens* is not large, but they have abundant foliage tending to foliar deposition and/or uptake of Pb from the atmosphere (Han et al. 2006; Zhuang et al. 2009). Moreover, the results showed that there was a clear accumulation of metals in soil and medicinal plants. Consequently, there is a potential risk of lead intake from drinking tea.

Lead accumulation in wild plants

Results of lead analysis of wild species are shown in Table 1. Lead concentration in *A. hybridus* was 1301 μg/g. Nevertheless, a previous study has reported lead concentrations twice higher in shoots of pigweed (2208 μg/g) from old terrace alluvial contaminated with mining tailings as a result of the failure of mine "El Bote" confirmed in 1956 in Zacatecas, Mexico. According to these results, both findings suggest that the *A. hybridus* is able to tolerate and accumulate Pb under semi-arid conditions (Salas-Luevano et al. 2009). Both results showed that the highest bioaccumulation of lead occurs in leafy vegetables growing in contaminated areas near to smelters, where plants absorb lead from the soil and air (Kabata-Pendias and Pendias 2001).

Lead concentrations in *A. schaffneri* and *P. laevigata* were 39,926 and 4186 μg/g, respectively. Due to the high concentration of lead in *A. schaffneri* samples, their sheaths were washed to remove the dust and to determine whether lead is incorporated into the plant or is due to dust deposited on the surface. The lead concentration in the *A. schaffneri* sheath unwashed is 55,456 ± 975 μg/g while, in the washed sample is 39,926 ± 538 μg/g. Approximately 39 % of the lead concentration is due to dust attached to that sample surface, while 61 % comes from the sheath.

In arid and semi-arid areas of Mexico it is common that *Acacia* and *Prosopis* species grow bearing substrates, on the top, on slopes and the surroundings of tailing piles, waste dumps, slag heaps and soils impacted by tailings and smelter slags can therefore be considered as an option for a remediation program to stabilize eroding tailings in contaminated areas and have been considered as an option for phytoremediation (Armienta et al. 2008).

Lead concentrations in samples of *Opuntia* were 368, 440, and 1952 µg/g in *O. robusta*, *O. leucotricha* and *O. streptacantha*, respectively. Therefore, it can be speculated that several *Opuntia* species, used as fodder, are another source of lead contamination affecting the grazing areas and possibly were responsible for acute lead toxicosis on livestock bovine registered in the community. However, the cactus species tolerate drought and grow in degraded areas; they are among the best plants for reforestation of arid and semi-arid areas (Nefzaoui and Salem 2002) and could be used to prevent and control soil erosion (Vigueras and Portillo 2001).

The amount of Pb in *B. scordioides* was 10,435 µg/g being ten times larger than the lead concentration reported in the same species shoots collected in another contaminated area (Salas-Luevano et al. 2009). Both results indicated that concentrations of Pb are >1000 µg/g. According to Baker and Whiting (2002) *B. scordioides* is able to tolerate and accumulate Pb. Therefore, it could be considered for use in treatment of mine tailings and applied to remediate soils contaminated by Pb, particularly in temperate and arid environments (Mendez and Maier 2008). Likewise, *E. crus-galli* registered a Pb concentration of 1547 µg/g; this result exceeds by far the Pb concentration reported in literature in the same type of grass (Liu et al. 2007). In addition, research on BCF of Pb confirms that the *E. crus-galli* can be used as a natural chelating agent to enhance phytoextraction (Kim et al. 2010). This Poaceae can play an important role for Pb removal, through absorption/adsorption and accumulation of Pb (Brix 1994).

The *T. recurvata* (L.) is an epiphytic plant that abundantly grows on *P. laevigata* in semi-arid areas of Mexico. These bryophytes are known to be heavy metal bioindicators in their environments (Schröder and Pesch 2004) and are often used in environmental monitoring (Giordano et al. 2004). Lead concentration found in *T. recurvata* is 11,087 µg/g, and can be considered an excellent biomonitor of Pb in rural environments to identify sources of natural and anthropogenic pollution.

Lead levels in the community items

The mean concentration of Pb in the firewood ashes of families 1, 2 and 3 was 311 ± 46, 152 ± 36, and 159 ± 53 µg/g, respectively. Lead concentrations found in the soils taken inside the houses were 205 ± 38, 174 ± 48, and 112 ± 23 µg/g, while in soils taken from the streets outside the three family houses were 74 ± 53, 80 ± 25, and 81 ± 27 µg/g, respectively.

Lead concentrations in the firewood ashes and the soils taken from inside the house of family 1 are larger than the amount of lead measured in soil taken outside the house, suggesting an enrichment process probably produced by bottom ash and the coarse fly ash. In this regard, to lead firewood ashes (Reimann et al. 2008) noted that wood has the ability to strongly enrich certain heavy metals. According to Dahl and Obernberger (2002) finer fly ash fractions contain high concentrations of the volatile Pb. Consequently, the ashes are spread inside houses and the lead concentration is larger than the levels on the streets. Thus the firewood used to prepare food is another source of contamination.

Lead content in glazed clay pot

Lead concentration was measured in raw and cooked beans in the 10-year-old pot. Lead concentration in the dry and raw beans was 87 µg/g, while in the cooked beans was 175 µg/g; the difference; 88 µg/g, agrees with the calculated lead-transfer rate from the pot to the beans during the cooking. Also a piece of this pot was used to determine the amount of Pb contained in the inner and outer parts of the pot; the average difference in the Pb concentration was 30,443 ± 1808 µg/g. The pot was used in the last 10 years on a daily basis; therefore, the lead in the inner part of the pot was transferred during cooking at a rate of 3044 µg/g-year, meaning a transfer rate of 8.3 µg/g-day. Our results agree with findings reported in literature (Romieu et al. 1994), where it is pointed out that in rural communities pottery that has been used for a long time is more likely to have altered glaze and to release more lead.

Conclusions

Lead levels in agricultural soils, crops, and wild plant species, collected around a metal recycling plant, were determined and exposure pathways were identified.

The average lead in soil samples was 4940 µg/g, a minimum and a maximum of 73–84,238 µg/g, respectively. The higher concentration value to of Pb was observed in the lead–bismuth waste that was outside the plant recycling. The amounts of lead in the soils exceed the limit values recommended by environmental health guidelines for several purposes from various countries.

The amount of lead in the ashes and the soils taken inside the houses are larger than the lead found on the soils outside the houses. In rural areas where firewood is used to prepare food, the ashes become a source of lead exposure.

Another source of lead exposure is the use of glazed clay pots used for food cooking, where the Pb is transferred at a rate 8.3 µg/g-day.

Variability of Pb levels in soils is also evident in the accumulation of metal in plants. The species cultivated showed low content of Pb whereas wild plant species showed very high levels Pb in the sites close to the recycling. However, there is high risk of Pb transfer to the nearby crop and toward the food chain. *Z. mays*, *C. annuum*, and *A. sativa* that are for human and animal consumption exceed various international food standard guidelines set. Also herbal medicines *H. inuloides* and *C. graveolens* far exceed the maximum WHO permissible levels. Therefore, the consumption edible portions of crops and the use as tea infusions of plants with medicinal purposes would pose risks to humans. However, it is suggested that further studies be carried out in relation to Pb uptake by these plants.

The wild plants were collected very near the metal recycling facility thus containing a higher concentration of lead, being Pb tolerant and accumulators under dry environment conditions. Among which highlight *A. schaffneri* (39,926 µg/g), *B. scordioides* (10,435 µg/g), *O. streptacantha* (1952 µg/g) and *A. hybridus* (1301 µg/g).

In addition, *T. recurvata* (11,087 µg/g) is reported for the first time as an appropriate bioindicator of atmospheric lead in rural areas in Zacatecas, México. These results illustrate lead translocation into leaves and also were the result of constant atmospheric deposition of lead dust directly onto the surface of plants.

The results indicated significant occurrence of lead in the study area and in specific products contaminated and harvested around the recycling plant. Also, when these foodstuffs, in combination with clay pot contains lead, are cooked, the lead is released and dissolves into the item ceramic and lead incorporation into the food increases significantly. In addition, dust in the patios, firewood ashes frequent used and metallic piece collected around recycling plant account for varying levels of lead in homes.

The allocation of a recycling metal plant in the middle of a farmland is, in principle, irregular, producing contamination of the surroundings.

Compliance with ethical standards

Conflict of interest None.

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