Assessment of geochemical forms of lead in lead-contaminated residential soils with varying physio-chemical characteristics

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INTRODUCTION

- Lead in yard soils has long been recognized as the principal source of elevated blood Pb levels, particularly in children[1].
- Weathering, chipping, and sandblasting of structures bearing Pb-based paint result in Pb becoming entrained in yard soils.
- Bioaccessibility of Pb primarily depends on its solubility and hence, the geochemical forms of Pb, which is a function of site-specific soil chemistry.
- While total Pb provides the maximum pool of Pb in the soil, physio-chemical properties of soil are important in determining how much of this total Pb will be bioaccessible[2].
- Thus, the hazard imposed by soil-Pb is dependent on soil properties such as pH, soil organic matter, clay and carbonate content which determines the geochemical forms of Pb in soils [3].

OBJECTIVE

- Assess the geochemical forms of Pb and hence its bioaccessibility in Pb-contaminated residential soils with varying physio-chemical properties.
- To the best of our knowledge, this is the first time to evaluate the difference in Pb distribution within Pb paint-contaminated soils of residential sites in San Antonio and Baltimore, USA, based on their different soil properties that probably affect the availability of Pb in the environment for potential absorption in the plant, animal, and human systems.

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MATRIALS and METHODS

- Representative soil samples were collected from the yards of 10 residential sites in San Antonio, TX, USA and 10 residential sites from Baltimore, MA, USA.
- The soils were characterized for texture, pH, salinity (EC), Cation Exchange Capacity (CEC), total and extractable lead, iron, aluminum, phosphorous, calcium and magnesium, Soil Organic Matter (SOM), and total carbon (TC).
- Soil samples were extracted for metals following USEPA method 3050B[4]. The digests were analyzed by ICP-OES.
- Geochemical forms of soil-Pb were identified by sequential extraction scheme established by Tessier *et al*. modified by Carbonell-Barrachina *et al* [5]

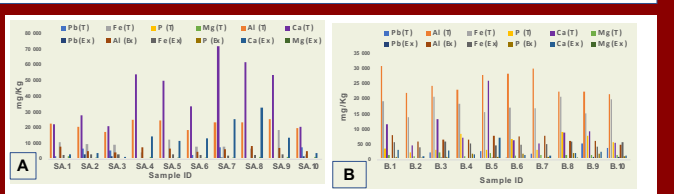

Fig (1): Total and extractable metals in **(A)** San Antonio samples, **(B)** Baltimore

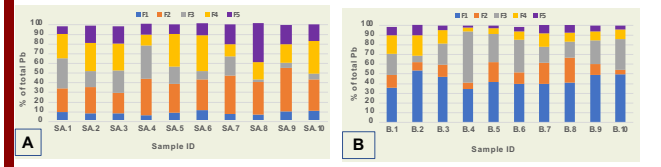

Fig (2): Profiles of geochemical fractions for Pb in **(A)**San Antonio soils and **(B)** Baltimore soils (F1: exchangeable, F2: carbonate-bound, F3: Fe-Mn oxide-bound, F4: organic-bound, and F5: silicate-bound)

RESULTS

Table (1): Physiochemical properties of San Antonio Soils

Sample Id	pH	EC (µS/cm)	CEC meq/100 g	Clay %	OM %	TC %
SA.1	7.71	1051	13.26	7.33	7.67	40.32
SA.2	7.77	766	12.17	14.4	9.93	36.15
SA.3	7.65	611	11.95	15.01	8.82	34.27
SA.4	7.51	341	12.17	8.13	5.23	36.23
SA.5	7.43	416	17.59	7.11	10.1	32.18
SA.6	7.46	330	22.5	8.71	12.8	40.89
SA.7	7.61	303	25.95	22.54	5.26	40.26
SA.8	7.87	234	41.67	65.22	6.84	42.84
SA.9	7.76	217	15.35	16.73	6.4	47.4
SA.10	7.54	323	14.85	14.64	11.0	37.03

Table (2): Physiochemical properties of Baltimore soils

Sample Id	pH	EC (µS/cm)	CEC meq/100g	Clay %	OM %	TC %
B.1	6.41	658	6.49	4.9	2.27	6.87
B.2	5.16	162.3	5.74	5.2	2.49	6.69
B.3	6.05	261.4	8.26	3.4	1.87	6.57
B.4	6.25	111.3	6.17	2.1	0.64	4.54
B.5	6.15	282	9.6	2.2	1.17	6.07
B.6	6.16	243	7.25	2.9	1.63	5.73
B.7	6.22	97.2	6.37	4.3	1.94	7.54
B.8	6.17	715	8.01	4.2	1.8	7.5
B.9	5.91	128.1	5.07	3.8	1.78	6.28
B.10	5.38	264	6.85	2.7	1.77	5.37

- Generally, San Antonio soils were alkaline, had relatively high salinity, high clay content, moderate to high SOM , whereas, Baltimore samples were acidic and characterized by low salinity, low clay content, and low SOM.

DISCUSSION

- In San Antonio soils, there was more Pb within the carbonate- and organic matter-bound fractions, which can be explained by the higher pH and the higher organic matter content in these soils.
- In contrast, in Baltimore, majority of the Pb was in soluble + exchangeable forms while very little Pb was in the silicate-bound fraction. This result could be attributed to the acidic nature of soil and low clay content.

CONCLUSIONS

- Results show that Pb resides in different chemical forms according to the physio-chemical characteristics of the soil.
- Therefore, physio-chemical properties of soils must be considered in bioavailability models to predict health risk from Pb-contaminated soils.

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