DETERMINATION OF LEAD ACCUMULATION BY LEAVES OF DIFFERENT VEGETATION, GROW IN SOIL POLLUTION

Mirela Alushllari, Dr.
Nikolla Civici, Prof. Dr.
Institute of Applied Nuclear Physics, University of Tirana, Albania

Abstract

Both natural and anthropogenic contributions are the sources of lead emissions to the environment. Lead is easily accumulated in the edible parts of leafy vegetables, as compared to grain or fruit crops. The accumulation of lead in agricultural soils is potentially hazardous to human, livestock and plants species. The purpose of this study is: determination of lead in soil and different spontaneous plant species grown it, as well as calculation of determinate bioaccumulation factors (BAF) soil to plant. We have selected 21 sampling point at a distance 80-600 m around Former Factory Production of Batteries to Berat, Albania. We have collected a total of 42 samples where 21 are soil samples and 21 are vegetation samples. All the representative samples for this study were analyzed using Atomic Absorption Spectrometry for their lead content, at the Institute of Applied Nuclear Physics, University of Tirana, Albania. From results obtained, the concentrations of lead in representative soil samples were found in the levels: 126 mg/kg-24207 mg/kg while in the biological samples, the levels of lead were: 0.238-4.572 mg/kg. The concentration ranges of lead in soil samples collected at different points are compared with the Maximum Contaminant Levels (MCL) recommenced by European Union according the Directive 86/278/EEC. Also, we have calculated Hazardous Quoted (HQ) for each sampling point of soil. The concentration ranges of lead in biological samples collected are compared with the Maximum Contaminant Levels (MCL) specified by the Directive No. 1881/2006, Brussels. Concentrations of lead were measured also in surface soil, near the root of plant species, in one of the most polluted areas in Albania, Uznove, Berat. Also we have calculated bio accumulation factor (BAF) soil to plant.

Keywords: Lead, soil and vegetation samples, BFA, atomic absorption spectrometry

Introduction

Lead is known as one of the most toxic heavy metals in the environment. Just as the other heavy metals, it is a solid and a continuous pollutant in the environment due to the fact that it is not degraded or destroyed (Ernst 1996). Lead is inclined and tends to be accumulated in the environment (Zayed et al., 1998). The high level of lead has a negative impact on the natural environment and the human health. The exposure to lead in the environment results in a wide range of negative effects, depending from the level of lead and time of extended. The high levels of exposure to Pb result in biochemical and toxic effects on the people, causing problems acute or chronic damage and physical and psychological in capabilities on people (Aigbedion, 2005). In general, areas close to Factory of Battery Production are presented with environmental problems, due to increased production and consumption of lead from vegetation and livestock. As a result, the contamination of soils has influence on the increase of the level of lead in vegetation (Zakrzewski, 2002). The environmental protection should be and remain the main goal and task of the society. Subject area: The area of the former Battery Production Factory in the city of Berat, Albania was selected the scope of this study because its activity has been in about 20 years. The complex of Factory for the production of batteries in Berat, Albania has begun its activity in 1970. It was designed to produce batteries for passengers' cars and technical equipment. The Battery Factory conducted its activity as a state-run factory for about 20 years. During its activity except primary production, this factory has produced solid, liquid and gaseous waste, into the surrounding environment.

The purpose of this study was analyses of surface soil samples to define concentration of lead, define of lead concentration in different spontaneous plant species grown around the former Battery Production Factory as well as calculation of determinate bioaccumulation factors (BAF) soil to plant. In this paper we present determination of lead in soil and vegetation samples using Atomic Absorption Spectroscopy technique. The level of Pb in soil samples was compared to the values recommended by the European Community according to Directive 86/278 EEC while for biological samples level of lead was compared by Directive No. 1881/2006, Brussels. In the finally were calculated the BFA soil to plant.

Material and Methods:

Both representative soil and vegetation were collected around the former Battery Production Factory, Berat. This Factory is located in the northeastern city of Berat, with respective coordinate: 400 42' 24.82" N and 190 58' 59.42'' E. During the sampling we have chosen 21 stations and have collected a total 42 soil and vegetation samples in this area, where 21 samples were surface soils samples and 21 were vegetation samples. Soil samples are collected at the surface soil while vegetation samples were random vegetation in this area. Sampling stations and their coordinate are presented respectively in table 1 and in figure 1.

Map of sampling stations of soil.

Represented soil samples analysed using Atomic Absorption Spectrometer, Aanalyst 800 Perkin Elmer with Flame Atomic Absorption Spectrometry method. Hollow cathode lamp (HCL) used as radiation source for the determination of lead according recommended conditions. Acids used for the digestion of samples, stock solutions of lead have high grade purity. Glass and Teflon vessels used were treated with solution 10% v/v nitric acid, for 24 hours and then washed with water bidistilled. Both soil and vegetation samples are digested according Analytic Method Atomic Absorption Spectrometry.

Digestion soil samples are prepared using a procedure recommended by Environmental Protection Agency (EPA, Method 3050B) was used as the conventional acid extraction method. Biological samples are prepared using nitric and perchlorhic acid, according method AOAC, 1990. Instrumental conditions for lead are based on Analytical Methods of Atomic Absorption Spectrometry, from Perkin Elmer (Perkin-Elmer Corp. 1991-1999). Three applications were carried out for the measurement of calibration standards and measurement of samples. For each element calibration curve equation is linear and passing through point zero. A quality control material IAEA-Soil_7 was analyzed in parallel with the soil samples and IAEA_336 Lichen was analyzed in parallel with the biological samples. To check the instrumental drift, an aqueous standard solution was analyzed after every three samples.

Results and Discussions:

We have collected a total 42 samples during the sampling; 21 surface soil samples and 21 biological samples. In the table 1 are presented the mean concentration of lead as well as Relative Standard Deviation percentage (% RSD), Standard Deviation (SD) and calculated Hazardous Quoted (US EPA 2006) in representative soil samples.

Table 1: Sampling points and concentration of lead in surface soil and calculated of HQ (US EPA 2006).

Nr.	Sampling points	Code	Nord	East	Pb (mg/kg)	SD	RSD %
1	S_1	P1_T1	40^{0}42"27.26'	19^{0}58"59.67'	24207	11	18
2	S_2	P2_T1	40^{0}42"33.45'	19^{0}58"57.86'	350	3	5.6
3	S_3	P3_T1	40^{0}42"34.04'	19^{0}58"53.05'	342	12	9.3
4	S_4	P4_T1	40^{0}42"35.44'	19^{0}58"56.36'	244	0.2	0.8
5	S_5	P5_T1	40^{0}42"31.29'	19^{0}58"58.87'	951	28	1.1
6	S_6	P6_T1	40^{0}42"31.81'	19^{0}58"9.00'	1203	22	1.83
7	S_7	P7_T1	40^{0}42"31.33'	19^{0}58"58.80'	236	9.7	2.2
8	S_8	P8_T1	40^{0}42"31.03'	19^{0}58"59.08'	228	12	5.26
9	S_9	P9_T1	40^{0}42"39.38'	19^{0}59"05.72'	243	9.4	12.7
10	S_10	P10_T1	40^{0}42"28.41'	19^{0}59"02.91'	126	1	0.6
11	S_11	P11_T1	40^{0}42"23.70'	19^{0}59"02.70'	460	0.3	0.1
12	S_12	P12_T1	40^{0}42"24.25'	19^{0}59"00.87'	742	22	0.2
13	S_13	P13_T1	40^{0}42"22.67'	19^{0}58"59.83'	384	0.4	4.9
14	S_14	P14_T1	40^{0}42"24.45'	19^{0}59"00.96'	78	0.2	0.1
15	S_15	S15_T1	40^{0}42"04.97'	19^{0}58"42.21'	341	1.11	0.33
16	S_16	S16_T1	40^{0}42"06.07'	19^{0}58"43.86'	185	2.7	1.46
17	S_17	S17_T1	40^{0}42"08.00'	19^{0}58"52.31'	1503	3.21	0.21
18	S_18	S18_T1	40^{0}42"08.13"	19^{0}58"53.46'	149	0.78	0.52
19	S_19	S19_T1	40^{0}42"08.20"	19^{0}58"53.33'	163	0.94	0.58
20	S_20	S20_T1	40^{0}42"07.25"	15^{0}58"52.39'	662	0.13	0.02
21	S_21	S21_T1	40^{0}42"05.09"	15^{0}58"59.73'	187	16.3	8.72
			Directive	**86/278/EEC**	**300**		

Graph in figure 2 is presented concentration of lead in soil samples and Hazardous Quoted, HQ. The mean concentration of lead in surface samples was found in the order 126 mg/kg-24207 mg/kg. The concentration of lead in four representative sampling points S_1, S_5, S_14 and S_17 were found same times higher than normal value. In these area were mixed soil with waste from factory. The mean concentrations level of lead in soil samples are compared with the Maximum Contaminant Levels (MCL) specified by the Directive 86/278/EEC. In addition, from results obtained we have calculated Hazardous Quoted (US EPA 2006). The factor of calculated Hazardous Quoted, HQ in representative soil samples was found in the order 0.4-80.7.

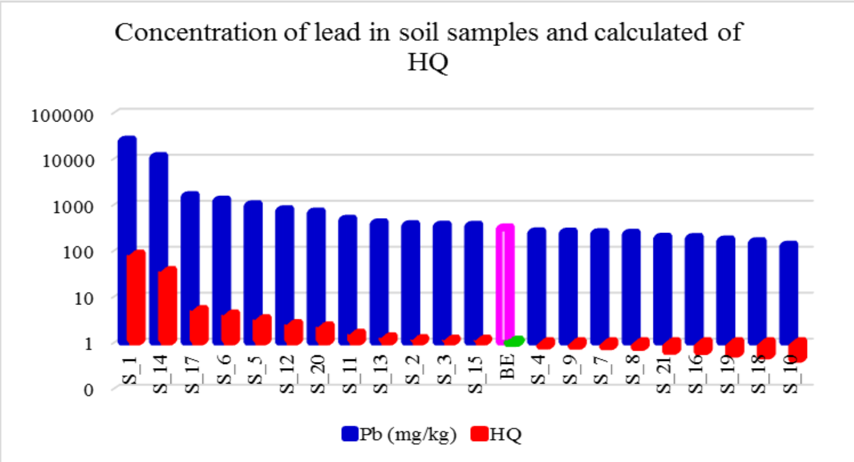

Figure 2: Concentration of lead in soil and HQ.

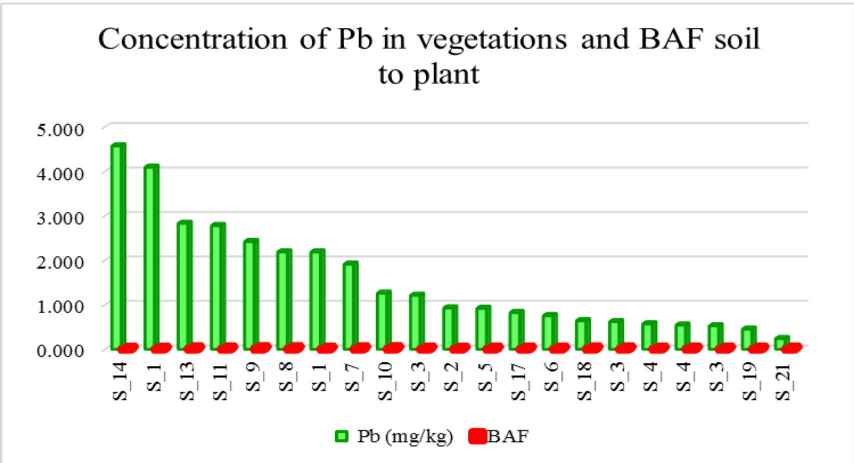

Figure 3: Level of lead in vegetation and BAF.

Graph in figure 3 is presented variation of lead concentration in respective vegetation samples and calculated of BAF soil to vegetation.

In the table 2 is presented, sampling points, mean concentration of lead in vegetation, Relative Standard Deviation percentage (% RSD), Standard Deviation (SD) and calculated BAF soil to plant in representative vegetation samples.

Table 2: Concentration of lead in vegetation, calculated of BAF soil to plant.

Nr.	Station points	Code	Material	Pb (mg/kg)	SD	RSD %	BAF
1	S_1	P1_C	*Cynadon dactiyon*	2.186	0.2	8.2	0.0001
2	S_1	P1_V	*Verbascum (sp)*	4.093	0.05	1.3	0.0002
3	S_2	P2_C	*Cynadon dactiyon*	0.927	0.02	1.7	0.0002
4	S_3	P3_V	*Verbascum (sp)*	1.212	0	0.4	0.0026
5	S_3	P3_P	*Pinus pinea*	0.619	0.01	2.1	0.0035
6	S_3	P3_M	*Myrtus communis*	0.525	0.02	3	0.0015
7	S_4	P4_P	*Pinus pinea*	0.569	0.03	6	0.0023
8	S_4	P4_M	*Myrtus communis*	0.543	0	0.8	0.0022
9	S_5	P5_T	*Triticum aestivum*	0.918	0	0.2	0.001
10	S_6	P6_T	*Triticum aestivum*	0.754	0.02	2.9	0.0006
11	S_7	P7_C	*Cynadon dactiyon*	1.913	0.1	6.3	0.0081
12	S_8	P8_C	*Cynadon dactiyon*	2.187	0.2	7.8	0.0096
13	S_9	P9_C	*Cynadon dactiyon*	2.422	0.1	4.1	0.011
14	S_10	P10_M	*Medicago sativa*	1.259	0.04	3.5	0.012
15	S_11	P11_P	*Platanus orientalis*	2.78	0.2	8.7	0.0037
16	S_13	P13_S	*Setaria (sp)*	2.83	0.03	0.9	0.0074
17	S_14	P14_V	*Verbascum (sp)*	4.572	0.02	0.4	0.0004
18	S_17	P17_T	*Triticum aestivum*	0.824	0	1.9	0.0012
19	S_18	P18_P	*Pinus pinea*	0.642	0.05	7.3	0.0043
20	S_19	P19_P	*Pinus pinea*	0.451	0.01	3.2	0.0028
21	S_21	P21_T	*Triticum aestivum*	0.238	0.02	8.7	0.0013

The mean concentrations level of lead in vegetation samples was found in the order 0.238 mg/kg-4.572 mg/kg. Level of lead in vegetation samples are compared with the (MCL) specified by the Directive No. 1881/2006, Brussels. Graph 4 is presented the relationship between lead concentration in surface soil samples and lead concentration in the vegetation samples. While graph in figure 5 is presented average bioaccumulation factor soil to plant. It is observed highest ability of accumulated lead had Setaria (sp), Cynadon dactiyon and Myrtus communis.

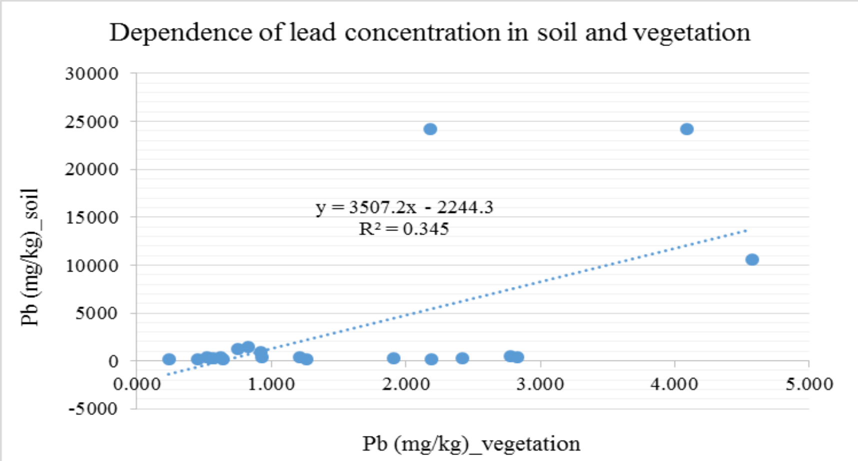

Figure 4: Variation of Pb in soil and vegetation

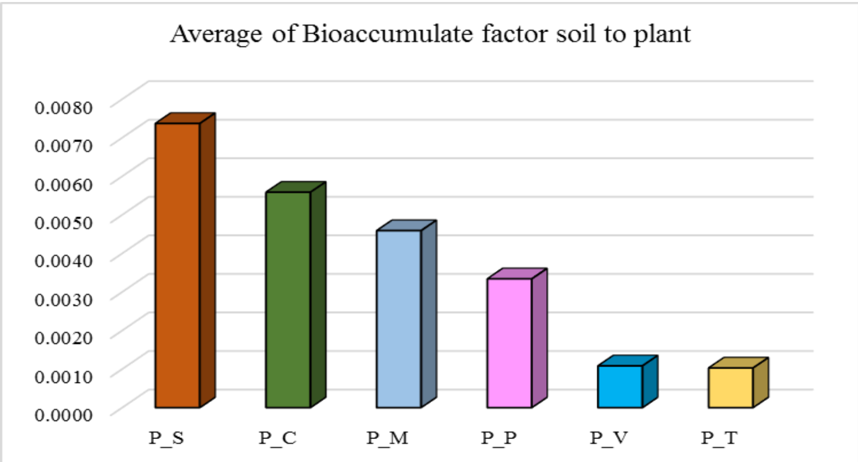

Figure 5: Average of BAF Soil to vegetation

Conclusion

During this investigation the fraction of lead was found to be present in all of the representative soil and vegetation samples that analyzed, but there is not unique distribution. From the results obtained 12 soil samples contained lead concentration above the MCL, recommended by Directive 86/278/EEC for concentration of lead in soil. Calculated Hazardous Quoted for surface soil samples is higher than 1, so the territory of factory was contaminated with lead and this pollution is associated with the high negative ecological and human effects.

Lead concentration in vegetation samples was found above the MCL concentration recommended by Directive No. 1881/2006, Brussels. From calculated of BAF soil to vegetation samples was low, because the mean concentration of lead in soil and in vegetation was not in the same order. Environment pollution and BFA depends from the concentration of lead in soil and vegetation as well as its duration of exposure. By calculating the average of BAF soil to plant it is observed lead accumulates in plants at different levels. The ability of lead accumulation by random vegetation in descending order was: Setaria (sp)> Cynadon dactiyon> Myrtus communis> Pinus pinea > Verbascum (sp)> Triticum aestivum. The area around of the former Battery Production Factory in the city of Berat, Albania which we are collected samples was contaminated with lead. The high concentration of lead affected in environment ecosystems and health of human. Lead contamination of this territory was caused by the activity of the factory. Often industrial pollution produced by the manufacturing process, have been uncontrolled.

References:

Aigbedion LN, Environmental Pollution in the Niger Delta, Nigeria. Inter Disciplinary J. Enugu Niger, 2005.

http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/3050b.pdf. EPA, Method 3050B.

AOAC Official Method of Analysis. Association of Official Analytical Chemists, Arlington, USA 1990.

EEC, Economic European Communities. Setting maximum levels for certain contaminants in foodstuffs. Official Journal European Communities, L 364/5-L 364/24, Directive No. 1881/2006, Brussels.

EEC, Economic European Communities. The Council Directive 86/278/EEC on protection of the environment.

Ernst WHO, Bioavailability of Heavy Metals and Decontamination of Soils by Plants, Applied Geochemistry 1996.

Perkin-Elmer Corp.: 1964-2000, Analytical Methods for Atomic Absorption Spectrophotometry and Recommended conditions for THGA furnaces 1991.

U.S. EPA (Environmental Protection Agency). Provisional Peer Reviewed Toxicity Values for Aluminum (CASRN 7429-90-5). U.S. Environmental Protection Agency, National Center for Environmental Assessment, Superfund Technical Support Center, Cincinnati, OH. 2006.

U.S. EPA. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final. EPA/540/R/99/005. Office of Solid Waste and Emergency Response, Washington, DC. PB99-963312, 2006.

Zakrzewski SF. Environmental Toxicology. 3Rd Edition. Oxford University Press. USA, 2005.