Exposure assessment of potentially oxic trace elements via consumption f fruits and vegetables grown under the impact of Alaverdi's mining complex

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## Abstract

- This study is aimed to investigate the transfer of potentially toxic trace elements from soils to plants grown
- Some trace elements (Pb, Zn, Cd) exceeded the maximum allowable levels
- Detailed investigations need to be done for the overall assessment of health risks, taking into consideration not only adverse health effects posed by more than one toxic trace element but also through other exposure pathways.



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### Introduction

The activity in mining complexes is carried out without treatment facilities, dumping the superficial waterways of miner waters, abandonment of tailings dams, and many other violations have a negative impact on the environment

Various international studies have been undertaken to assess the transfer of trace metals from soil to plants and possible health risks caused by their consumption

Fruits and vegetables which are considered to be an essential part of human diet can accumulate trace elements from soil in their edible and nonedible parts

Pollution levels were classified from moderate to strongly polluted, with high concentrations of arsenic and lead

## Methods and materials

## Statistical analysis

- The significance of difference between food consumption of males and females were analyzed by using Student's t-test
- All the statistical tests were performed using Excel and SPSS software (SPSS Inc., version 11)
- All the data are presented in terms of mean (M) and standard deviation (SD) of triplicates







## Sample collection and treatment



Soil sampling points

Figure 2. Soil sampling points

• This study covered Neghoc and Qarkop rural communities located near the town of Alaverdi (N 41 50 4200, E 44 390 2100)

- Sampling procedures were done between July and September 2014
- Topsoil (0–15 cm) sampling was done according to Standard Operation Procedures (SOPs) developed in the Center for Ecological-Noosphere Studies of NAS, RA
- A stainless steel hand auger was used
- A total of 15 plant species, including nine species of fruits, two species of seeds, one species of fruiting vegetable, one species of root vegetable, and two species of leafy vegetable were sampled
- Seven samples of soil and 45 samples of fruits and vegetables were collected and then placed in special clean polyethylene bags and transported to the laboratory

Edible part of sample	Common name	Botanical name		
Fruit	Apple	Malus		
Fruit	Peach	Prunus persica		
Fruit	Pear	Pyrus		
Fruit	Plum	Prunus domestica L.		
Fruit	Cornel	Comus mas		
Fruit	Fig	Ficus carica		
Fruit	Cherry	Prunus avium		
Fruit	Raspberry	Rubus idaeus		
Fruit	Grape	Vitis vinifera L		
Seed	Maize	Zea mays L.		
Fruit	Cucumber	Cucumis sativus L.		
Root	Potato	Solanum tuberosum L.		
Seed	Bean	Phaseolus vulgaris L.		
Leaf	Onion leaves	Allium cepa L		
Leaf	Greens			

#### Table 1. Plant samples collected from the studied sites.

## **Digestion of samples**

For destruction of organic matter, wet digestion was used

- Acids that have been used in these procedures include nitric acid (HNO3), sulfuric (H2SO4), and perchloric (HClO4) acids
- All samples (1 g) were digested after addition of 15 mL of triacid mixtures (HNO3, H2S04, and HClO4 in 5:1:1 ratio) at 80C until transparent solution was obtained



Figure 3. Wet digestion of organic matter

## Analysis of trace elements

For the trace element analysis, only the edible parts of vegetables and fruits were used.

Concentrations of trace elements (Cu, Ni, Pb, Zn, Hg, As, and Cd) in soil and plant samples were estimated by using X-ray fluorescence spectrometry

A PerkinElmer Analyst 800 AAS was used to quantify the total metal concentrations in plant samples

Standard stock solution of 1000 ppm for all the metals was obtained from SchelTec, authorized distributor of PerkinElmer



Figure 4. PerkinElmer Analyst 800 AAS

## **Results and discussion**

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Plant species	Mean/SD*	Contents (mg/kg fresh matter)						
		Cu	Ni	Pb	Zn	Hg	As	Cd
Fruits, vegetables, a	and seeds							
Apple	M	0.725	1.46	0.082	6.4	0.0015	0.003	0.001
	SD	0.246	0.615	0.041	2.015	0.001	0.001	0.001
Peach	M	0.802	1.573	0.003	6.03	0.001	0.002	0.01
	SD	0.21	0.23	0.001	0.13	0	0.001	0.003
Pear	M	0.64	0.117	0.001	2.02	0.002	0.0017	0.003
	SD	0.13	0.03	0	0.67	0.001	0.0008	0.001
Plum	M	0.635	0.156	0.005	2.25	0.0015	0.0005	0.001
	SD	0.096	0.012	0.002	0.88	0.001	0.0001	0.001
Cornel	M	0.29	0.08	0.013	1.14	0.0013	0.0027	n/d
	SD	0.05	0.01	0.002	0.23	0.001	0.001	
Fig	PAG .	7.8	2.01	0.18	15.19	0.094	0.0017	n/d
	SD	1.47	0.35	0.00	2.27	0.013	0.001	
Cherry	N0	1.2	1.87	0.005	2.32	n/d	n/d	0.012
	SD	0.35	0.33	0.001	0.55			0.004
Raspberry	M	13.48	3.55	n/d	34.51	n/d	0.005	n/d
	SD	5.13	0.89		11.06		0.004	
Grape	M	7.77	0.52	0.1	7.41	0.0017	0.002	0.001
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	SD	1.75	0.09	0.09	2.98	0.001	0.001	0.001
Maize	M	1.58	0.68	0.05	21.32	0.07	0.027	0.114
	SD	0.6	0.19	0.01	6.44	0.02	0.01	0.05
Cucumber	0.0	0.47	0.33	0.0015	19.48	0.0015	0.004	0.001
and the second second second	SD	0.05	0.07	0	2.07	0.001	0.002	0.000
Bean	M	10.7	1.7	0.129	20.85	0.0015	0.004	0.001
	SD	3.97	0.48	0.09	2.51	0.001	0.001	0.001
Root vegetable								
Potato	0.0	12,43	0.68	0.12	12.41	0.0012	0.005	0.001
	SD	4.56	0.21	0.04	3.55	0.0005	0.002	0
Leafy vegetables								
Onion leaves	0.0	9.34	0.263	0.022	22.51	0.0012	0.012	0.141
	SD	1.01	0.036	0.016	1.97	0.001	0.009	0.024
Greens	M	20.78	1.43	0.068	51	0.003	0.1	n/d
	SD	3.09	0.3	0.028	15.1	0.001	0.012	_

#### able 2. The contents of trace elements in fruits and vegetables from investigated areas.

*lote:* Data are means of n = 3 replicates. \*SD: Standard deviation. n/d: not detected.

Soil samples	Contents (mg/kg)								
	Cu	Ni	Pb	Zn	Hg	As	Cd		
				MAC (mg/kg)					
	132	80	65	220	2.1	2	2		
As-1	808	65.64	47.3	1127	< 0.05	6.01	< 0.07		
As-2	1223	74.94	116	801	< 0.05	3.07	< 0.07		
As-3	811	82.77	(123.8)	642	0.09	3.75	(7.66)		
As-4	470	37.8	50.9	831	0.176	3.8	0.22		
As-5	390	35.8	43	619	< 0.05	6.7	0.26		
As-6	733	22.8	40.1	816	< 0.05	8.7	0.33		
As-7	1847	28.4	(117.9)	877.8	< 0.05	7.4	< 0.07		
Average	897.43	49.74	91.29	816.26	0.13	5.63	2.12		

#### Table 3. The contents of trace elements in soil samples from investigated areas.

Note: MAC - maximum allowable concentrations, exceeded contents are highlighted.



# Thank you for your attention