RESEARCH ARTICLE (Open Access)

Evaluation of pollution in vegetables (potato and cabbage) in Kastriot, Kosovo

KALTRINA JUSUFI*[1], MAJLINDA VASJARI[2], BARDHA KORÇA[1]

[1]University of Prishtina "HasanPrishtina", Faculty of Natural Sciences and Mathematics, Department of Chemistry, str. "NënaTereze" nr.5, 10000 Prishtina, Kosovo.

[2]University of Tirana, Department of Chemistry, Faculty of Natural Sciences, Tirana, Albania

*Corresponding author; E-mail: kaltrina.jusufi@uni-pr.edu

Abstract

Life as we know it today would have been very different without electricity. However, in its present form it has proved to be challenging for the environment and more "expensive" once fossil fuels began to be used as sources for electricity production. Power plants that use coal for electricity generation can emit an enormous pollution whose consequences humans and other living organisms can suffer from.

According to the Food and Agriculture Organization of the United Nations, production of potatoes in 2013 was about 368 million tons, while for cabbage in 2011 was almost 69 million metric tons. The country of study of this paper, Kosovo, is known for cultivation of potatoes and cabbages for domestic and regional supply.

For our study we collected the potato and cabbage samples growing in farmland areas around Kosovo's power plants. Food samples were first dried at room temperature, milled and treated in the microwave system with nitric acid and hydrogen peroxide. Measurements of heavy metals were done using ICP-OES technique.

From the results obtained we conclude that we are dealing with an average contamination from the areas where the ashes and wastes of power plants of Kosova are deposited.

Keywords: heavy metals, potatoes, ICP/OES

1. Introduction

Heavy metals are elements defined as having a specific density of more than 5 g/cm^3 and atomic number greater than 20. [8, 12]. These metals can be harmful to the human and living organisms even in low concentrations as they can end up in the organism [14].

Vegetables play an important role in human nutrition and health, particularly as sources of different nourishing nutrients such as vitamins, thiamine, niacin, pyridoxine, folic acid, minerals, dietary fiber etc. [2,11, 7]. With the ever increasing population globally, the contamination from the industry becomes a more serious concern. Heavy metals are potential contaminants with the ability of penetrating to the human body and causing different complications.

In recent years, there have been attempts all over the world to raise awareness about the harms of high concentrations of heavy metals in vegetables. Metals such as lead, mercury, cadmium, and copper are cumulative poisons, which cause environmental hazards and are reported to be exceptionally toxic [6]. However the contamination of vegetables with heavy metals which are natural constituents of the Earth's crust and atmosphere are of major concern from the contamination and toxicity points of view [1,4, 5].

Therefore, monitoring the levels of heavy metals in food is a necessity due to the catastrophic consequences that high concentrations might have in humans and living organisms.

2. Sample collection and preparation

To study the factor accumulation of heavy metals in vegetables, we initially studied the area around Kosovo's power plants where we took soil samples [9]. Later on, vegetables were collected from surroundings locations. They were first cleaned and milled into particles, then digested in microwave digestion system (Berghof). The digested samples were leveled with

doubled distilled water to 50 ml, after which we measured the presence of 21 elements with inductively coupled plasma atomic emission spectroscopy (ICP / AES).

3. Results and Discussion

Our previous studies have shown that the concentration of the metals As, Cd, Cr, Cu, Ni, Pb, and Zn in soil samples from areas around the Kosovo Electrical Corporation (KEK in Albanian) exceeds the allowed concentration of heavy metals according to Dutch standards.

It should be mentioned that the mobility and toxicity of heavy metals is depended by different factors such as pH, organic matter and clay in soils, presence of other cations, type of vegetable etc. The pH values of our soil samples were measured in water and ranged between 7.52 –7.91, whereas in 1M KCl the values ranged from 6.91–7.07. The determined value for humus in our samples was from 2.79 – 5.05%, which shows that the soil is relatively rich in humus (organic matter).

In order to compare the scale of pollution, in the table below is presented the concentrations of heavy metals in potato and cabbage samples.

Table 1: Heavy metal concentration in potato and cabbage samples,

No.	**1**		**2**		**3**		**4**		**5**	
pH H_2O	7.85		7.83		7.72		7.91		7.52	
pH KCl	6.98		6.91		7.07		7.05		7.01	
%Humus	5.02		2.79		5.05		4.72		3.26	
	Potato	**Cabbage**	**Potato**	**Cabbage**	**Potato**	**Cabbage**	**Potato**	**Cabbage**	**Potato**	**Cabbage**
As	<0.1	<0.05	<0.1	<0.05	<0.1	<0.05	<0.1	<0.05	<0.1	<0.05
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Co	<0.01	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01	<0.1
Cr	0.53	0.05	0.41	0.08	1.37	0.05	3.13	0.14	3.29	0.02
Cu	1.75	4.25	7.02	7.98	6.97	2.26	7.02	2.56	4.91	2.52
Ni	1.38	<0.5	0.65	1.58	2.09	<0.5	2.60	0.69	4.89	<0.5
Pb	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	4.24	3.86	<0.1	<0.1
Zn	0.7	2.80	10.2	8.98	23.9	12.86	15.4	13.01	4.40	3.57

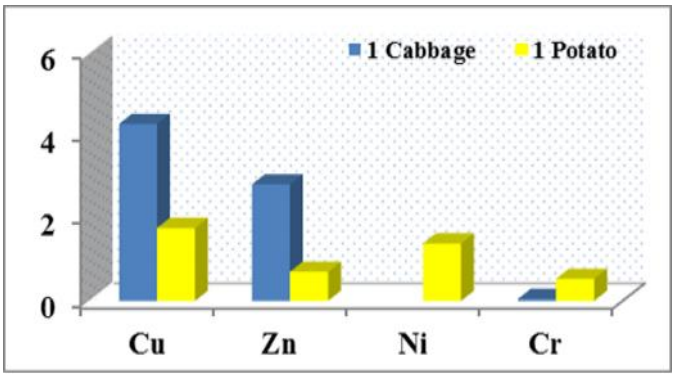

Figure 1. Heavy metals in cabbage and potato in sample 1

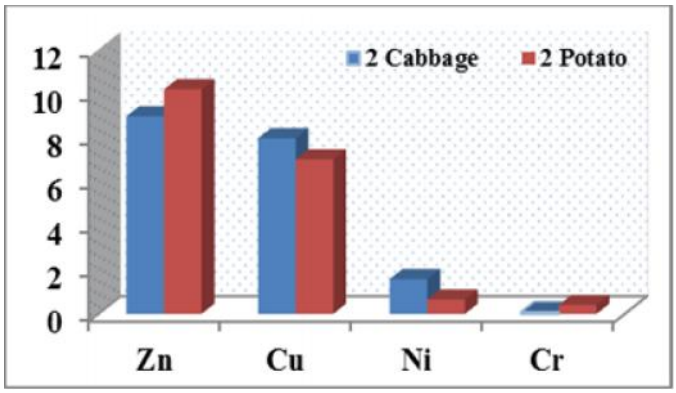

Figure 2. Heavy metals in cabbage and potato in sample 2

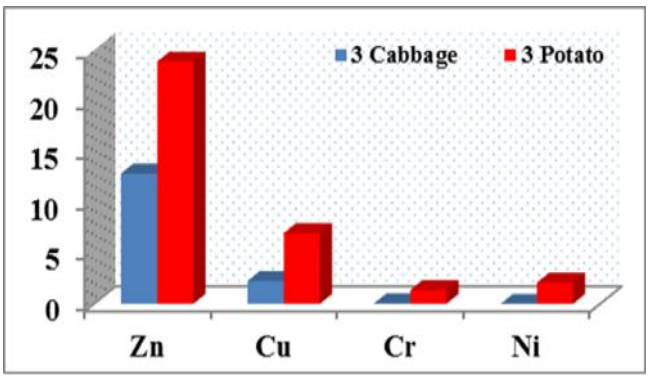

Figure 3. Heavy metals in cabbage and potato in sample 3

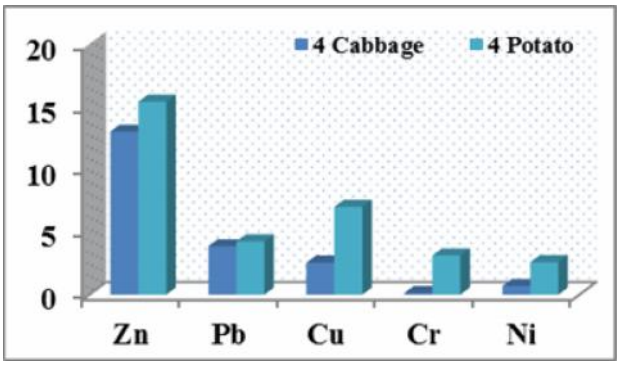

Figure 4. Heavy metals in cabbage and potato in sample

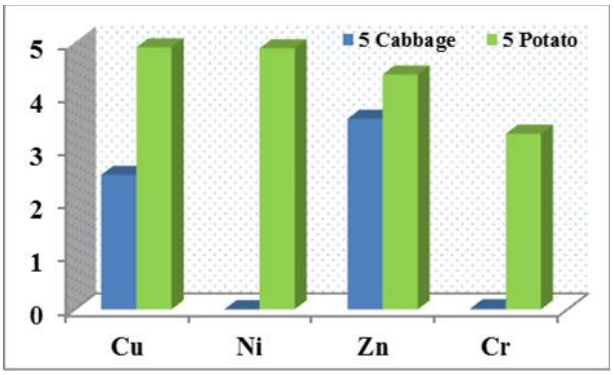

Figure 5. Heavy metals in cabbage and potato in sample 5

The maximum amount allowed for heavy metals in vegetables also depends on the type of vegetable and the state in which the determination is made (samples of fresh or dry matter). According to our experimental results, the values of cadmium, arsenic and cobalt are below the limit of detection.

The concentration of chromium ranges from 0.02-0.14 mg/kg in cabbages, whereas in potatoes it ranges from 0.41- 3.29 mg/kg. The concentration of copper ranges from 2.26-7.98 mg/kg in cabbages, whereas in potato from 1.75-7.02 mg/kg. The content of nickel in cabbages ranges from the minimum value of 0.69 to maximum value of 1.58 mg kg-1, while in potatoes 0.65-4.89 mg/kg. The concentration of lead in most of the samples is under the limit of detection and the maximum value recorded in cabbages is 3.86 mg/kg and 4.24 mg/kg in potato samples. The content of zinc in cabbage ranges from minimum of 2.8-13.01 mg/kg, while in potatoes from 0.7-15.4 mg/kg.

From the results obtained we see that the concentration of heavy metals is higher on potatoes than cabbage samples. Some of the samples compared in this study shows that these metals are accumulated more in potato which is grown under the ground, comparing to cabbage, which grows on the surface. Other studies were conducted with similar results [15, 16].

The following figure presents the summary of all sample points and the comparison of the results measured in potato and cabbage samples.

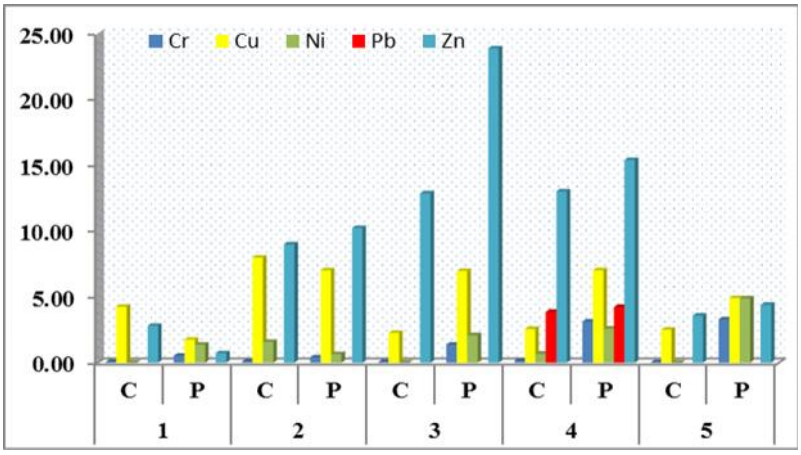

Figure 6. Concentration of heavy metals in cabbages (C) and potato (P) samples of all sampling points

The concentration of Ni in plants was found to be from 0.1-5 mg/kg of dry matter. In our samples this concentration is not exceeded in any of the results presented.

Zinc is an essential element for both plants and humans, but it is toxic in excess amounts [3]. In our measured samples zinc did not exceeded the maximum amount allowed in food (more than 50 mg/kg). Concentration of chromium expressed as dry matter is 0.1 to 1 mg / kg. Chromium critical values are above 1 mg/kg. In three potato samples this limit was exceeded from 1.37 to 3.29 mg / kg, while in cabbages, it is below 1 mg / kg. The concentration of Cu in plants is estimated to be 2-20 mg / kg. This concentration is not exceeded in any vegetable sample.

It should be noted that there are several different factors that could lead to the exposure and the path of heavy metals in food. The uptake of heavy metals in vegetables depends on climate, atmospheric depositions, the concentrations of heavy metals in soil, the nature of soil in which the vegetables are grown etc.[10,13].

4. Conclusions

Based on the results obtained of heavy metals in soils around Kosovo's power plants, it follows that this concentration is quite high for some metals, thus it is essential that all necessary prevention should be taken into consideration to decrease the contamination from power plants of Kosovo. From the measured results in vegetables, we can see that the concentration of heavy metals in potato and cabbage is not very high compared to the soil pollution.

A survey of literature shows that the affinity of potatoes and cabbages towards heavy metals is similar: they both have a medium affinity for the uptake of heavy metals from the soil.

Finally, we propose that further specific and detailed exposure estimates need to be performed in this area. In addition, the regular monitoring of heavy metals in air, water, fruits vegetables etc. is still necessary to ensure dietary safety.

5. References

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