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Soil Pollution Factors Affecting the Quality of Crops (*Solanum Tuberosum* L.)

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ABSTRACT
The circulation of heavy metals in nature is characterized by high toxicity. However, the effects depend on the amount of toxic, the form of exposure to toxicity, the types of species exposed, age, sex, genetics and nutritional status, and on the consequences in ecosystems. With the onset of the COVID-19 pandemic, the environmental situation in some regions has deteriorated even more due to poor monitoring by state institutions. The challenges that await us in the future are complex and hence we risk not knowing how to meet the future challenges. The situation with toxicity and pollution is complicated by the COVID-19 pandemic, which for the first time in this century has turned into a global pandemic. Although we were not prepared to cope with this pandemic, still we succeeded to manage it better than the previous pandemics. High concentrations of heavy metals such as arsenic, cadmium, lead, and nickel are among the metals that are dangerous for the public health of citizens. Metallic elements are characterized by toxic effects, especially with the consumption of food products. High concentrations cause great damage to human and animal organs but sometimes even small concentrations of it can have harmful effects. The increase in toxic concentration has affected industrial development, poor waste management, the release of toxic gases from industrial activities, as well as use of pesticides and herbicides in agriculture. High toxicity causes health damage, e.g. resulting from human exposure to metal toxicity and the use of contaminated foods. The heavy metals present in the environment such as Cu, Fe, Mg, Mn, Ni, Se, Zn, Co, Cr, are essential nutrients required for various biochemical and physiological functions.

Keywords: metals, food, health effects, the environment.

INTRODUCTION

Heavy metals in the environment are classified as carcinogenic to humans, based on the analysis of their concentration in the environment (transport in the food chain) (Abakpa et al. 2013). No reported cases of COVID-19 have anything to do with food contamination (Adams and Moss 2000). There is currently little scientific information on the survival of COVID-19 (coronavirus) on the surface of food (Alam et al. 2006). The main danger of transmission is from the close contact with infected people. However, the advice for food businesses and consumers is to maintain good hygiene practices, although full cooking will kill the virus (Bytyçi et al. 2018). Some of the common global challenges are global warming, human impact on the environment, pandemics, as well as financial and technological crises which have a major impact on all the regions of the world (Amoah et al. 2007).

We must be seriously concerned that even though social and economic development has increased from the industrial revolution to globalization by reducing poverty and improving living conditions, now it can be slowed down. In 2020, over 150 million citizens have been impoverished and feel a decline in quality of life as rising commodity prices and overall rising inflation threaten to lead us to the social revolution and lack confidence in the environment (Anon 2007). The report on Kosovo of the International Monetary Fund, which was published in early September 2020, says that the COVID-19 pandemic has also affected the agricultural sector and it concludes that the COVID-19 pandemic has hit the economy of Kosovo hard. Kosovo's economy has shrunk by 5%. After the outbreak of the pandemic, there has been a decrease of 20% in the tourism sector, a decrease of 19% in exports, as a consequence of a decrease of 10% in remittances (Beqiraj et al. 2008). According to the latest data from the agricultural census, Kosovo is estimated to have the area of 413,635 hectares, of which over 5,000 hectares are planted with potatoes in the areas with suitable climatic conditions. Kosovo is a major exporter of potatoes in the Western Balkans. Potato cultivation is done mainly near the rivers of Kosovo or the areas where groundwater is used for irrigation of agricultural products.

According to the WB, Kosovo's economy, for 2021, is expected to shrink by 8.8%, as a result of the crisis caused by the COVID-19 pandemic. Our country has exported a total of 61,448 tons of potatoes during the year 2018/19, potato production increased by 7.3%, compared to 2018. Domestic potato production in Kosovo during the period 2015–2021, has managed to not only meet 100% of domestic requirements but to be exported to the western Balkans, as well.

The production of potatoes per hectare, depending on the position of the land, is on average 20 tons per hectare. One kg of potatoes contains 3.55 food units or 1/3 of the value of bread (Dreshaj 2013). The impact of restrictive measures against the spread of the COVID-19 pandemic in the private sector, according to research is as follows: 95% of surveyed enterprises assess the crisis caused by COVID-19 as negative, 60% of enterprises respondents believe that the COVID-19 pandemic endangers their survival, while 30% of surveyed enterprises stated that they have reduced the number of employees by over 40% in the agricultural sector (Ntanos et al. 2019). The rapid development of the chemical industry (pesticides, herbicides) has become a major concern to the public health of citizens. Their impact has harmful ecological effects because of the environmental pollution with heavy metals which has negative health effects on humans (Jusik and Staniszewski 2019). The human exposure to heavy metals in environments (food intake) has increased significantly with the development of the chemical industry as a result of the use of pesticides and herbicides in industry and agriculture (Charoenteeraboon et al. 2019).

Dukagjini Plain Areas in the Republic of Kosovo is an area of great interest for studies on the behavior of heavy elements in polluted soils. Other industrial activities led to heavy pollution of surface soils by heavy metals (Cowan 1999).

These processes are carried out without any special attention to the environment and the health of the population. This pollution is caused by the transmission and discharge of particles, in the form of dust. In this sense, heavy metals like Pb, Zn, Cd, Cu, etc., are being transmitted with air currents (wind) and sediment in the soil (Lateef 2004). The accumulation of metals in the soil enables their introduction into the food chain (plants and animals), from where the man also receives his share, including highly toxic Cd and Pb (Krishnasree et al. 2018).

METHODOLOGY

The determination of chemical elements was performed by using the method (ICP-OES), (the induction paired plasma — mass spectroscopy), (the induction paired plasma — optical emission spectroscopy). Apparatus (Plasma Induction Copulation-Mass Spectroscopy), and ICP-OES (Plasma Induction Plasma Induction-Optical Emission Spectroscopy), are one of the most important methods of elementary analysis, due to the advantages in detection. The samples were taken in the Drini I Bardh river (basin), which were divided into four sampling sites and 8 samples in each subgroup, a total of 32 samples were sent to the laboratory for testing. Samples A1–A8 are the samples of potatoes taken and irrigated by atmospheric precipitation. Sampling sites B1–B8 comprise the samples of potatoes irrigated by the river Drin I Bardh. Samples C1–C8 are the samples of potatoes from greenhouses and samples D1–D8 are the samples of potatoes from irrigated groundwater (Wells) (Figure 1).

RESULTS AND DISCUSSIONS

The sampling sites with potential environmental pollution activity have been selected. The disposal of waste containing pesticides used in agriculture near rivers involves their rinsing up to river flows. The sampling was done in the places where river water was used to irrigate the sweet potato crop. Groundwater sources of drinking water are essential for human life. According to statistical reports, they are almost depleted, out of the 37 largest water basins in the world, 21 of

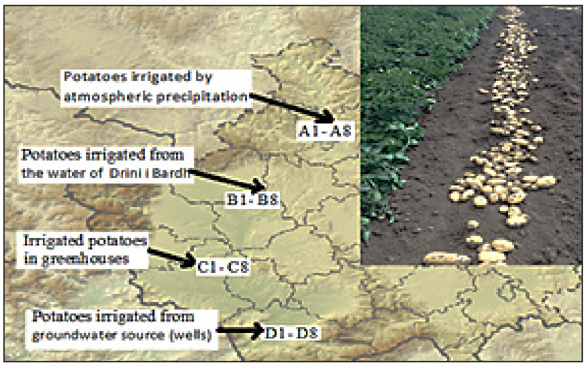

Figure 1. Potato cultivation (*Solanum tuberosum*)

them have passed the critical point, with more water extracted than the groundwater basins are filled with. On the basis of scientific research, 13 other basins in the world are not in good condition. The amount of water utilization by human activities is 35% in the underground basins.

The main objective of this study was the analysis of the concentration of metal pollutant deposition in the Dukagjini region. The result of this work is the determination of heavy metals as well as micro- and macroelements in the Drini I Bardh Basin (Table 1). The obtained results will be part of the study covering all water and potato sampling sites.

Among the most common pollutants, there are organic substances such as food waste and feces, inorganic substances such as chemicals, plastics, and heavy metals. Likewise, pollution can occur with the introduction of exotic species of pathogenic microorganisms into the river.

Among the main consequences of the river, pollution is the loss of water quality, making it unfit for drinking. In the same way, it affects the biodiversity that is threatened by toxic substances or eutrophication processes. River pollution also affects such economic activities as tourism and agriculture. Agriculture is negatively affected due to poor water quality for irrigation.

On the other hand, agricultural and livestock activities produce the wastes that are carried by the groundwater or a surface runoff into rivers. These substances include fertilizers and pesticides. Likewise, mining activity and oil exploitation are a source of river pollution, causing heavy metal and hydrocarbon spills.

The analyzed results are based on the concentration of heavy elements in the water of the Drin I Bardh River, at all sampling points, starting from A1 to A8 (Table 2, Figure 2).The analytical result in the samples of some elements varies with high concentrations. The concentration of varies Mg, reaching a concentration of 1681 ppm at sample site A1, while at sample site A8, it equals to 4890 ppm (with changes in concentration 3208 ppm). The concentration of As at sample site A1, reaches

Table 1. The concentration of heavy elements in the water of the Drin I Bardh river

Elements ppm	Sampling points that showed							
Nr	A1	A2	A3	A4	A5	A6	A7	A8
Mg	1681	1687	1968	3770	3830	3970	4130	4890
Al	15	17	69	41	44	59	49	30
Si	9010	1200	1355	1899	1877	1800	2111	2212
Cr	4.3	6.5	2	<0.5	<0.5	<0.5	4.4	1.9
Mn	1.8	2.4	7	12.8	12.9	18.7	12.1	13.5
Fe	53	23	34	45	36	51	43	70
Co	0.032	0.034	0.077	0..	0.099	0.18	0.15	0.109
Ni	1	1	0.7	1.4	0.9	1	1.6	1.2
Cu	22.1	3.6	9.0	4.9	6.0	3	9.9	11.0
Zn	14.4	7.7	55.8	29	24.4	4.6	21.8	12.0
As	0.07	0.1	0.29	0.38	0.3	0.30	0.37	0.33
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cd	2.43	1.99	2.7	0.27	0.18	0.2	2.3	0.96
Au	0.002	0.002	0.002	0.03	0.002	000.	0.03	<0.2
Hg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pb	28.1	35.1	14.6	5.37	2.99	4.12	24.4	9.55
U	0.040	0.058	0.080	0.15	0.199	0.18	0.167	0.176

007 ppm, while at sample site A4, concentration it amounts to 0.38 ppm (concentration changes – 0.31 ppm). The concentration of Cd, at test site A5 equals to 0.18 ppm, while at site A1, it amounts to 2.43 ppm (concentration change – 2.25 ppm). The Pb concentration at position A2 amounts to 35.1 ppm, while at site A5 it equals to 2.99 ppm (concentration change – 32.11 ppm). In terms of the concentration of heavy metals in the sweet potato irrigated under atmospheric conditions (Table 3, Figure 3), the concentration of Cd at sample site A3 reaches 0034 ppm, while at sample site A8 it amounts to 0.049 ppm, (concentration change – 0.015 ppm). The concentration of As at sample A1 equals 0.016 ppm, while at sampling site A4 it amounts to 0.086 ppm (concentration change – 0.07 ppm). The concentration of Pb at the A8 site equals 0.017 ppm, while at the A6 site it reaches 0.1786 ppm with a concentration change of 0.1616 ppm. The concentration of Ni in the A8 sample site equals 0.81 ppm, while in the A5 sample site it amounts to 2.80 ppm, (concentration change – 1.99 ppm). As far as the concentration of heavy metals in the sweet potato, irrigated by the white Drin River water (Table 4, Figure 4) is concerned, the concentration of Cd at sample site B3 amounts to 0.044 ppm, while at sampling site B8 it equals to 0.091 ppm, (concentration change – 0.047 ppm). The concentration of As in sample B6 equals 0.141 ppm, while at sample site B7 it reaches 0.182 ppm, (concentration change – 0.041 ppm).

The concentration of Pb at site B3 equals 0.411 ppm, while at sample B7 it amounts to 0.879 ppm (concentration change – 0.468 ppm). The concentration of Ni in sample B7equals 2.19 ppm, while in sample B6 it amounts to 2.91 ppm, (concentration difference – 0.72 ppm). The concentrations of heavy metals in the sweet potato, irrigated with drinking water system (Table 5, Figure 5) are as follows: the concentration of Cd at sampling site C2 amounts to 0.013 ppm, while at sample site C8 it equals 0.041 ppm, (concentration change – 0.028 ppm). The concentration of As at sample site C3 amounts to 0.015 ppm, while at sampling site C1 it reaches 0.027 ppm,

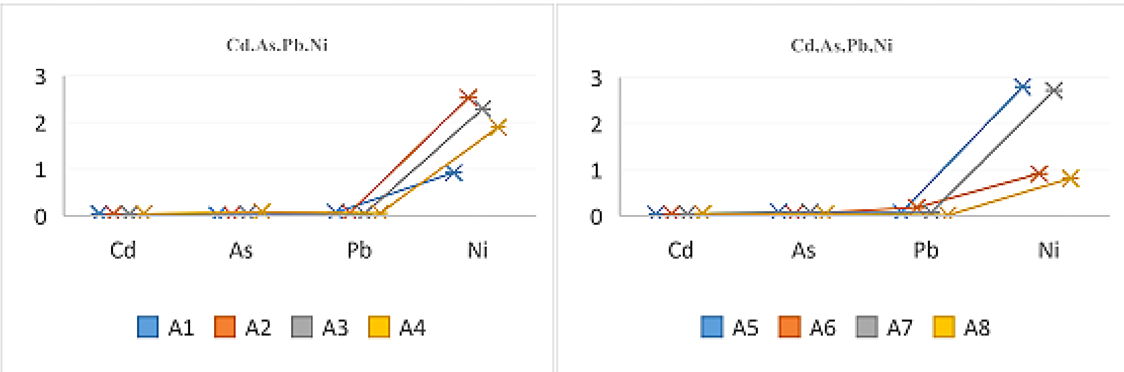

Figure 2. Graphic representation of the concentration of heavy metals in the sweet potatoes irrigated by atmospheric conditions

Table 2. The concentration of heavy metals (Cd, As, Pb, Ni, ppm), in the sweet potatoes irrigated by atmospheric conditions

Sampling points	Cd	As	Pb	Ni
A1	0.041±0.004	0.016±0.159	0.0731±0.260	0.92 ±0.160
A2	0.043±0.005	0.019±0.090	0.0657±0.341	2.53 ±0.440
A3	0.034±0.010	0.041±0.012	0.0426±0.041	2.29±0.290
A4	0.043±0.003	0.086±0.210	0.0605±0.092	1.89±0.190
A5	0.037±0.002	0.078±0.028	0.0674±0.066	2.80±0.250
A6	0.045±0.012	0.033±0.019	0.1786±0.049	0.91±0.560
A7	0.039±0.002	0.079±0.022	0.0698±0.056	2.72±0.450
A8	0.049±0.012	0.039±0.029	0.0171±0.059	0.81±0.270

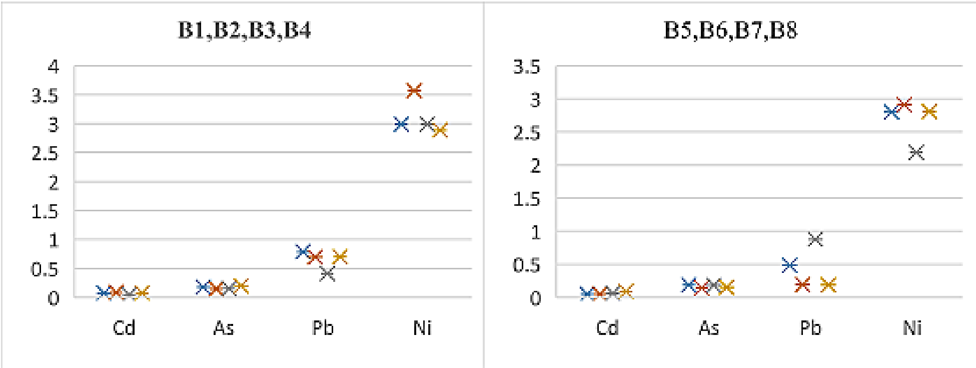

Figure 3. Graphic representation of the concentration of heavy metals in the sweet potato irrigated by the Drini i Bardh river

Table 3. The concentration of heavy metals (Cd, As, Pb, Ni, ppm), in sweet potatoes, irrigated with water of Drini I Bardh river

Sampling points	Cd	As	Pb	Ni
B1	0.077±0.004	0.179±0.165	0.790±0.280	2.99 ±0.590
B2	0.089±0.005	0.149±0.099	0.697±0.357	3.57 ±0.370
B3	0.044±0.010	0.155±0.032	0.411±0.053	2.99±0.440
B4	0.076±0.003	0.196±0.290	0.701±0.098	2.89±0.370
B5	0.051±0.002	0.185±0.038	0.487±0.069	2.80±0.290
B6	0.049±0.012	0.141±0.029	0.191±0.059	2.91±0.120
B7	0.063±0.002	0.182±0.031	0.879±0.066	2.19±0.690
B8	0.091±0.012	0.151±0.036	0.187±0.069	2.81±0.240

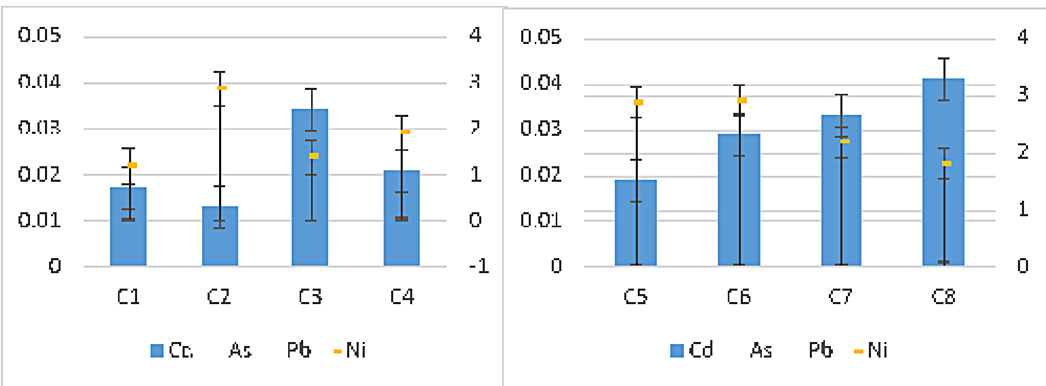

Figure 4. Graphic representation of the concentration of heavy metals in the sweet potato irrigated by a drinking water system in (Greenhouses)

(concentration change – 0.012 ppm). The concentration of Pb at the C2 site equals 0.012 ppm, while at the C8 site it amounts to 0.097 ppm (concentration difference – 0.085 ppm). The concentration of Ni in the C3 sampling site amounts to 1.39 ppm while in the C6 sampling site it equals 2.91 ppm, (concentration change – 1.52 ppm). Regarding the concentration of heavy metals in the sweet potato irrigated with a well water system (tab 6.), the concentration of Cd at sampling site D6 amounts to varies 0.029 ppm, while at sample site D8 it equals 0.077 ppm, (concentration change – 0.048 ppm). The concentration As in sample site D5, reaches 0.121 ppm, while in sampling site D8 it equals 0.621 ppm (concentration change – 0.50 ppm). The concentration of Pb at the D2 site amounts to 0.110 ppm, while at the D7 site it varies equals 0.670 ppm (concentration

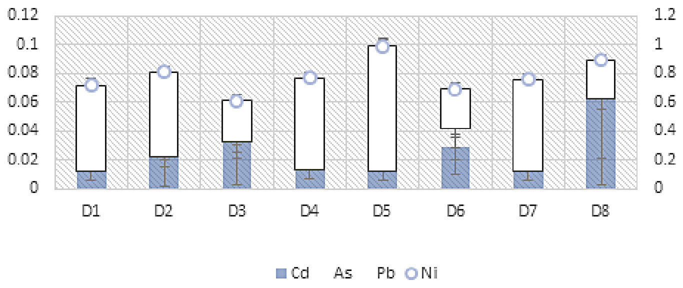

Figure 5. Graphical representation of the concentration of heavy metals in the sweet potato irrigated by a well water system

Table 5. The concentration of heavy metals (Cd, As, Pb, Ni, ppm) in the sweet potatoes irrigated by well water

Sampling points	Cd	As	Pb	Ni
D1	0.037±0.003	0.123±0.139	0.630±0.210	0.72±0.110
D2	0.036±0.010	0.221±0.013	0.110±0.390	0.81±0.550
D3	0.039±0.010	0.322±0.021	0.121±0.029	0.61±0.340
D4	0.047±0.003	0.134±0.139	0.630±0.290	0.77±0.220
D5	0.096±0.010	0.121±0.013	0.150±0.330	0.99±0.230
D6	0.029±0.010	0.422±0.021	0.191±0.039	0.69±0.270
D7	0.038±0.003	0.123±0.139	0.670±0.250	0.76±0.470
D8	0.077±0.010	0.621±0.013	0.120±0.310	0.89±0.310

difference – 0.56 ppm). The concentration of Ni, in the D3 sampling site reaches 0.61 ppm, while in the C5 sampling site it varies amounts to 0.99 ppm, (concentration change – 0.38 ppm).

CONCLUSIONS

The analytical results show that there is a change in the concentration of heavy metals and in some cases, they even exceed the normal parameters according to the WHO. Whenever there is an increase in the irrigation of sweet potatoes, there is an increase in the absorption of heavy metals by plants. The reduction of water flow increases the concentration and pollution of the river by the industrial factor and 48 days after the fall of the water level, the water becomes much more polluted. The results of identifying heavy metals in food products it can be concluded that the Government of Kosovo is making efforts to take the necessary measures to prevent, reduce and control environmental pollution from industrial activities. However, the government oftentimes tends to adapt and rely on the legal acts which envisage fictitious rights and obligations (on paper), which in turn violates the natural rights to protect the environment from industrial pollution. Internationally, positive diplomacy is needed on an extensive scale to enhance international cooperation in environmental protection and active engagement in the prevention of environmental pollution. In the legislative aspect, national legislation must be harmonized with the international one to enable the protection and advancement of the environment and its real and exact implementation in practice. In addition, there should be more efforts to enhance local cooperation between neighboring countries, regional and international in the management of the environmental sector.

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