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
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 Dreni 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

![Figure 1. Potato cultivation (Solanum tuberosum)](image)

| Elements ppm | Sampling points that showed |
|--------------|----------------------------|
|              | Nr | A1   | A2   | A3   | A4   | A5   | A6   | A7   | A8   |
| Mg           |    |      |      |      |      |      |      |      |      |
| Al           |    |      |      |      |      |      |      |      |      |
| Si           |    |      |      |      |      |      |      |      |      |
| Cr           |    |      |      |      |      |      |      |      |      |
| Mn           |    |      |      |      |      |      |      |      |      |
| Fe           |    |      |      |      |      |      |      |      |      |
| Co           |    |      |      |      |      |      |      |      |      |
| Ni           |    |      |      |      |      |      |      |      |      |
| Cu           |    |      |      |      |      |      |      |      |      |
| Zn           |    |      |      |      |      |      |      |      |      |
| As           |    |      |      |      |      |      |      |      |      |
| Ag           |    |      |      |      |      |      |      |      |      |
| Cd           |    |      |      |      |      |      |      |      |      |
| Au           |    |      |      |      |      |      |      |      |      |
| Hg           |    |      |      |      |      |      |      |      |      |
| Pb           |    |      |      |      |      |      |      |      |      |
| U            |    |      |      |      |      |      |      |      |      |

Table 1. The concentration of heavy elements in the water of the Drin I Bardh river
0.07 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 0.034 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 0.1786 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 B7 equals 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, 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](image)

**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 | 0.073±0.260 | 0.92±0.160 |
| A2              | 0.043±0.005 | 0.019±0.090 | 0.065±0.341 | 2.53±0.440 |
| A3              | 0.034±0.010 | 0.041±0.012 | 0.042±0.041 | 2.29±0.290 |
| A4              | 0.043±0.003 | 0.086±0.210 | 0.060±0.092 | 1.89±0.190 |
| A5              | 0.037±0.002 | 0.078±0.028 | 0.067±0.066 | 2.80±0.250 |
| A6              | 0.045±0.012 | 0.033±0.019 | 0.176±0.049 | 0.91±0.560 |
| A7              | 0.039±0.002 | 0.079±0.022 | 0.069±0.056 | 2.72±0.450 |
| A8              | 0.049±0.012 | 0.039±0.029 | 0.017±0.059 | 0.81±0.270 |
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 change – 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.

**REFERENCES**

1. Abakpa G.O., Umo V.J., Ameh J.B., Yakubu S.E. 2013. Microbial quality of irrigation water and irrigated vegetables in Kano State, Nigeria. International Food Research Journal, 20(5), 2933.

2. Adams M.R., Moss M.O. 2000. Food Microbiology. 2nd Ed. Royal Society of Chemistry, Cambridge, UK, 479.

3. Alam M., Ahsan S., Pazhani G.P., Tamura K., Ramamurthy T., Gomes D.J., Nair G.B. 2006. Phenotypic and molecular characteristics of Escherichia coli isolated from the aquatic environment of Bangladesh.
1. Microbiology and immunology, 50(5), 359–370. https://doi.org/10.1111/j.1348-0421.2006.tb03802.x

4. Amoah P., Drechsel P., Henseler M., Abaidoo R.C. 2007. Irrigated urban vegetable production in Ghana: microbiological contamination in farms and markets and associated consumer risk groups. Journal of Water and Health, 5(3), 455–466. https://doi.org/10.2166/wh.2007.041.

5. Anon. 2007. Consumer Attitudes to Food Standards Report, Wave 7. London, UK: Food Standards Agency. http://www.food.gov.uk/multimedia/pdfs/cas07uk.pdf

6. Barth M., Hankinson T.R., Zhuang H., Breidt F. 2009. Microbiological Spoilage of Fruits and Vegetables. In: Sperber, W.H., Doyle, M.P. (Ed.), Compendium of the Microbiological Spoilage of Foods and Beverages. Newyork, Epublising Inc., 135–183.

7. Beqiraj S., Liçaj P., Luotonen H., Adhami E., Hellsten S., Pritzl G. 2008. The situation of benthic macroinvertebrates in Vjosa River, Albania, and their relationships with water quality and environmental state. In: Conference Proceedings “Balwois”, 416–428.

8. Bytyçi P., Fetoshi O., Durmishi B., Cadraku H., Ismaili M., Shala-Abazi A. 2018. Status assessment of heavy metals in water of the Lepenci River Basin, Kosovo. Journal of Ecological Engineering, 19(5), 19–32. https://doi.org/10.12911/22998993/91273

9. Charoenteeraboon J., Ngamkitidechakul C., Soonthornchareonnon N., Jaijoy K., Sireratarawong S. 2010. Antioxidant activities of the standardized water extract from the fruit of Phyllanthus emblica Linn. Songklanakarin Journal of Science and Technology, 32(6), 599–604.

10. Cowan M.M. 1999. Plant products as Antimicrobial agents. American Society for Microbiology, 12(4), 564–582. https://doi.org/10.1128/CMR.12.4.564

11. Dreshaj A. 2013. Study chemical-environmental watershed White Drin and Ibar in Kosovo University (Doctorate), Tirana.

12. Friberg L.M., Piscaor G.F., Nordberg T. 1974. Cadmium in the Environmental, 2nd ed., CRC Press, Cleveland, OH. https://doi.org/10.1007/978-3-0348-7238-6.

13. Guler G.O., Kiztanir B., Aktumse A., C, Ozparlak H. 2008. Determination of the seasonal changes on total fatty acid composition and ω3/ω6 ratios of carp (Cyprinus carpio L.) muscle lipids in Beyschir Lake. Food Chemistry, 108, 689–694. https://doi.org/10.1016/j.foodchem.2007.10.080

14. Jusik S., Staniszewski R. 2019. Shading of river channels is an important factor reducing macrophyte biodiversity. Pol J Environ Stud., 28(3), 1215–1222. https://doi.org/10.15244/pjoes/81559.

15. Krishnasree V., Nethra P.V., Dheeksha J., Madumitha M.S., Vidyasvarar W., Lakshya P. 2018. A pilot study on assessing the sustainability of food safety and hygienic practices in street food handling system. Asian Journal of Dairy and Food Research, 37(3), 321–325. https://doi.org/10.18805/ajdfr.DR-1381

16. Lateef A. 2004. The microbiology of a pharmaceutical effluent and its public health implications. World Journal of Microbiology and Biotechnology, 20(2), 167–171. https://doi.org/10.1023/B:WIBI.0000021752.29468.4e

17. Ntanos S., Kyriakopoulos G., Skordoulis M., Chatkias M., Arabatzis G. 2019. An application of the New Environmental Paradigm (NEP) scale in a Greek context. Energies, 12(2), 239. https://doi.org/10.3390/en12020239

18. Raghu H.S., Ravindra P. 2010. Antimicrobial activity and phytochemical study of Phyllanthus emblica Linn International, Journal of Pharmaceutical Studies and Research, 1, 30–33.