MUSHROOMS, THE MIRACLE OF NATURE, A TREAT TO HUMAN HEALTH

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Abstract

The aim of this work was to determine the heavy metals levels in the fruiting bodies of three fresh mushrooms species white *Agaricus bisporus*, brown *Agaricus bisporus* and *Pleurotus Ostreatus* available on the Romanian market. The mushrooms where collected from four different supermarkets. Analysis of heavy metals (Fe, Mn, Zn, Cu, Cr Ni, Cd, Pb) was made using high-resolution continuum source spectrometer ContrAA-300, Analytik-Jena device. According to the data, the studied heavy metals concentrations seem to be similar to the values present in analyzed mushrooms originated from other countries and are under the recommended maximal limit (table 1), with one exception, nickel content. Nickel concentration is under the recommended levels for *Agaricus* species but is 2 to 4 times more than the recommended levels for all analyzed *Pleurotus* samples. This makes the consumption of *Pleurotus Ostreatus* dangerous in special for people with allergies, but recommends this mushroom as a fantastic bio-accumulator of nickel.

Key words: heavy metals, *Agaricus bisporus, Pleurotus ostreatus*, romanian market

Mushroom forming fungi are some of the most powerful nature's decomposers, capable to discharge strong extra cellular enzymes (lignin peroxidases, manganese peroxidase, laccase, etc) and characterized by aggressive growth and biomass production (Adenipekun C.O., Lawal R., 2012).

Agaricus bisporus and *Pleurotus ostreatus* amongst many other mushrooms have been reported in the decontamination of polluted sites (Adenipekun C.O., Lawal R., 2012).

One of the most fascinating uses of these mushrooms is their growing role in environment mycorestoration as well as in the world's food production. Mycorestoration is the process of using mushrooms to decrease pollution levels in a given area (Oyster mushrooms).

Pleurotus ostreatus (oyster mushroom) has the capacity to break down the organic bonds in wood into smaller molecules. The oyster mushroom is a saprotrophic, meaning it feeds on dead and decaying matter (mainly wood) (Mycoremediation). Due to the fact that the carbon-hydrogen bonds in wood are similar to those found in oil and pesticides, *Pleurotus* species are also efficient in breaking down the organic bonds in toxic chemicals and to help cleaning up the environment (Mycoremediation).

In addition to breaking down the organic bonds in oil, oyster mushrooms are also powerful absorbers of mercury. Their mycelium channels mercury from the ground up into the mushroom itself (*Oyster* mushrooms).

Agaricus is the major genus of the world's mushroom supply, contributing about 30% of the world's cultivated mushrooms (Siwulski M. *et al*, 2016) and *Pleurotus* species, after *Agaricus* spp. are the second most cultivated and consumed mushrooms in the world (27% of the world's output) (Royse J.D., 2014). The genus *Agaricus* has a worldwide distribution, *Agaricus* containing both edible and poisonous mushrooms species with up to 90 species recorded in Europe (Bas C., 1991 Calvo-Bado L. *et al*, 2000).

The genus includes the common ("button") mushroom (*Agaricus bisporus*) and the field mushroom (*Agaricus campestris*), the dominant cultivated mushrooms of the West (PRIMARY KNOWLEDGE ON AGARICUS BISPORUS, Royse JD., 2014). "Mushrooms from the genus *Pleurotus* (higher *Basidiomycetes*) are widely distributed around the globe with the exception of Antarctica" (Zervakis *et al*, 2001 cited by Siwulski M. *et al*, 2016).

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MATERIAL AND METHOD

Reagents and solutions

The stock standard solutions were analytical grade purchased from Riedel de Haen (Germany). The nitric acid 65% solutions used were of ultra-pure grade, purchased from Sigma. All reagents were of analytical-reagent grade and all solutions were prepared using deionized water.

Samples collection and preparation

Three fresh mushrooms species (white *Agaricus bisporus*, brown *Agaricus bisporus* and *Pleurotus Ostreatus*) available on the Romanian market where collected from four supermarkets (code No: 1-4).

The concentrations of heavy metals in the mushroom samples were assessed in the Environmental Research Test Laboratory (Banat's University of Agricultural Sciences and Veterinary Medicine "King Mihai I of Romania", from Timisoara, Romania). All the collected samples were washed with double distilled water to remove airborne and pollutants. After washing, the mushroom samples were oven dried at 105°C to constant weight. The dried samples were ground, passed through a 2 mm sieve and stored at room temperature before analysis (Nica DV. *et al*, 2013).

All samples were weighed before the chemical analyses on an analytical balance to the nearest 0.0001 mg. The heavy metals content in mushrooms was carried out in HNO_3 solution resulted by mushrooms ash digestion (LĂCĂTUŞU, 2008, Bordean *et al*, 2012). Each sample solution was prepared with dilute HNO3 (0.5N), as described in earlier papers (Lăcătuşu, R, Lăcătuşu, AR., 2008; Bordean D-M et al, 2012).

Analysis of heavy metals (Fe, Mn, Zn, Cu, Cr Ni, Cd, Pb) was made using high-resolution continuum source spectrometer ContrAA-300, Analytik-Jena device, by flame atomic absorption spectrometry (FASS) in air/acetylene flame. Under the optimum established parameters, standard calibration curves for metals were constructed by plotting absorbency against concentration.

This process was carried out in triplicate, using 5 g dried mushrooms per each triplicate sample.

Statistical analysis

Statistical analysis was performed using the statistical software program PAST version 2.17 and MVSP, version 3.22.

RESULTS AND DISCUSSIONS

The results of the performed analysis are presented in figure 1. According to the data, the studied heavy metals concentrations seem to be similar to the values present in analyzed mushrooms originated from other countries and are under the recommended maximal limit (*table 1*), with one exception, nickel content.

Nickel concentration (*figure 1*) is under the recommended levels for *Agaricus* species (0.27 - 0.76 $mgKg^{-1}$ DM), but is 2 to 4 times more than the maximum recommended levels for all the analyzed *Pleurotus* samples (11.26-21.22 $mgKg^{-1}$ DM).

According to Duda-Chodak, 2008, most of the food items contain Ni below 0.5 $mgKg^{-1}$ wet weight. At the same time nickel is considered responsible for allergies, being called in 2008 "Allergen of the Year" (Gillette B., 2008). "According to dermatologists the frequency of nickel allergies is still growing, and it cannot be explained only by fashionable piercing and nickel devices used in medicine (like coronary stents)" (Duda-Chodak A., Blaszczyk U., 2008). In the European Union, there are currently no maximum levels for nickel in food (EFSA).

Table 1

Range of reported literature values ($mgKg^{-1}$ DM) in mushroom

Mineral elements	The standard element contents ($mgKg^{-1}$ DM)	Reference
Iron	50-300	Kalac P., 2010
Manganese	10-60	Kalac P., 2010
Zinc	29.8–158	Işlolu M. et al, 2001
Copper	20-100	Kalac P., 2010
Chromium	0.5-5	Kalac P., 2010
Nickel	**1.18–5.14**	Tüzen M., 2003
Cadmium	1-5	Kalac P., 2010
Lead	≤ 3	Gucia M. et al, 2012

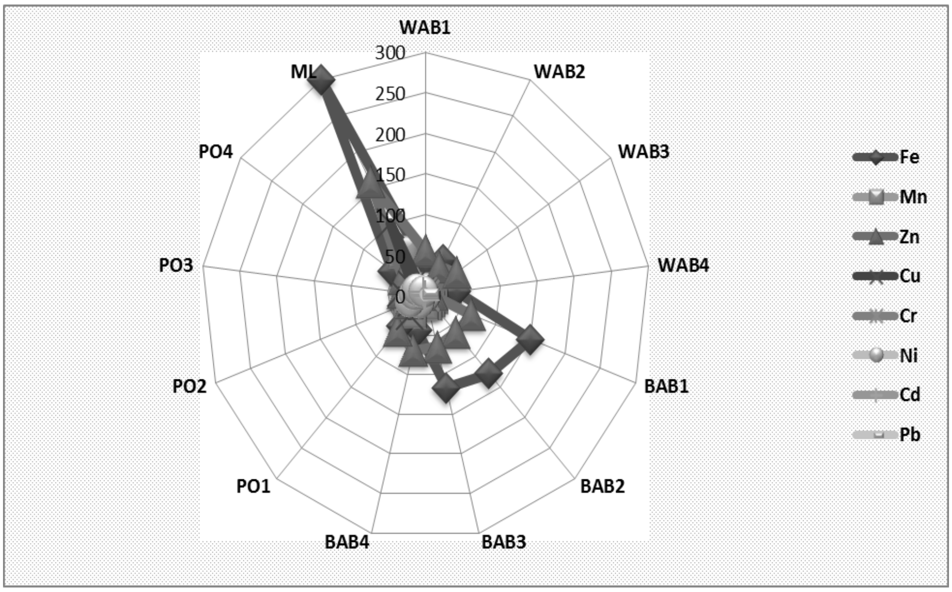

Figure 1 **Heavy metals concentration inedible mushrooms present on the Romanian market**

Legend: W = white, B = brown, AB = *Agaricus bisporus,* PO = *Pleurotus Ostreatus, 1-4* = code for the number of supermarket, WAB1= white *Agaricus bisporus* collected from supermarket 1, WAB2= white *Agaricus bisporus* collected from supermarket 2, WAB3= white *Agaricus bisporus* collected from supermarket 3, WAB4= white *Agaricus bisporus* collected from supermarket 4, PO1 = *Pleurotus Ostreatus* collected from supermarket 1, PO2 = *Pleurotus Ostreatus* collected from supermarket 2, PO3 = *Pleurotus Ostreatus* collected from supermarket 3, PO4 = *Pleurotus Ostreatus* collected from supermarket 4

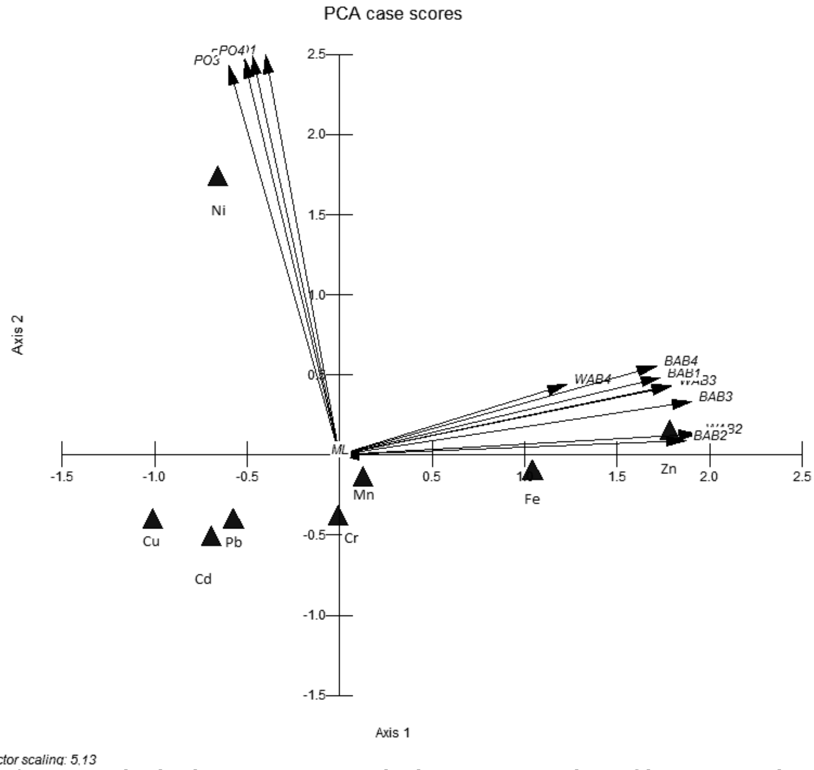

Figure 2 **Principal component analysis representation of heavy metals concentrations**

Legend: W = white, B = brown, AB = *Agaricus bisporus,* PO = *Pleurotus Ostreatus, 1-4* = code for the number of supermarket, WAB1= white *Agaricus bisporus* collected from supermarket 1, WAB2= white *Agaricus bisporus* collected from supermarket 2, WAB3= white *Agaricus bisporus* collected from supermarket 3, WAB4= white *Agaricus bisporus* collected from supermarket 4, PO1 = *Pleurotus Ostreatus* collected from supermarket 1, PO2 = *Pleurotus Ostreatus* collected from supermarket 2, PO3 = *Pleurotus Ostreatus* collected from supermarket 3, PO4 = *Pleurotus Ostreatus* collected from supermarket 4

The principal component analysis (PCA) suggests that together with nickel, the heavy metals: copper, cadmium and lead present also high contamination potential for the *Pleurotus* species available on the Romanian market (*figure 2*). PCA as a statistical technique was chosen to find the characteristic patterns of heavy metals data in the analyzed mushroom samples.

CONCLUSIONS

The presence of nickel in the *Pleurotus* mushrooms proves that the contamination of the substrate with heavy metals is not well controlled. Probably the producers did not pay attention to the possibility of contamination with heavy metals of these species not knowing that mushroom are great heavy metals bio accumulators and they are used to decrease pollution levels in different areas, exactly because of this incredible property.

At the same time as long as in Europe, there are no maximum levels for nickel in food, it's very important to intensify the studies in this field and to introduce regulations to verify in special the food items known for their high capacity of nickel accumulation.

Due to this fact, mushroom cultivators should pay higher attention to the substrate composition other way a healthy nutritional and valuable food might become a dangerous silent killer.

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