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# THE PRESENCE OF SOME HEAVY METALS IN EDIBLE MUSHROOMS PACKAGED FOR COMMERCIALIZATION

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***Abstract***

*Edible mushrooms are foods with a great nutritional value of which chemical composition differs from one species to another depending on the nutritive substrate, the development stage and microclimate conditions. The accumulation of heavy metals can take place in different phases of the technological process of growing, harvesting, conditioning, packaging as it becamed necessary to determine the acumulation of heavy metals from edible mushrooms.*
*The researches were done by using samples with commercial mushrooms (Agaricus and Pleurotus) packaged in bottle recipes, tin cans and on fresh samples, purchased from public sales units.*
*Determinations were done by using optical emission spectrometry with inductively coupled plasma ICP – OES, after the disaggregation with a microwave oven for digestion Berghof.*
*In the case of fresh mushrooms, the higher concentrations of zinc (4,16 mg/kg) and copper (3,15 mg/kg) can be explained by introducing them as zinc sulphide and copper sulphide in the nutritive substrate.*
*The mushrooms packaged in glass jars presented higher quantities of lead (0,44 mg/kg), this fact can be explained by the intense traffic in the vicinity of the mushroom farms or by soil composition where were grazing animals from which was obtained the fertilizer used in the substrat of culture.*
*The samples of mushrooms packaged in cans presented a higher quantity of tin (0,39 respectively 0,40 mg/kg) released probably from cans walls as a result of their deterioration. All the heavy metals existing in the samples were under the maximum admissible limits established by the legislation in force. In all the mushroom farms were identified residues of copper, zinc and lead. Tin was present just in the mushrooms packaged in cans.*

***Key words:*** *mushrooms, heavy metals, packages, commercialization.*

## INTRODUCTION

Edible mushrooms are considered as foods with high nutritional value, their chemical composition differs from one species to another depending on many factors of which the nutritive subtrate, the development stage and microclimate conditions represents the most important factors. Mushrooms can be consumed both fresh (raw food or after cooking) and preserved.
Regarding the food value, mushrooms are very suitable to be associated with different foods or ingredients, taking part in this way in improving the food quality. Regarding the content of organic substances, edible mushrooms contain proteins (3-5%), glucides (1-3%), lipids (0,5-1%), non nitrate substances (1,5-7%), vitamins A, B1, B2 and D. It contains also malic, tartric and citric acid as well as tanning substances, ethereal oils and enzymes. Therefore, mushrooms represents a hybrid between vegetable and animal protein, and are very rich in Amino Acids (especially glutamic acid) wich gives them a similar taste to meat (Mecinicopschi, 2013). In the Table 1 can be observed the content in essential Amino Acids of the mushroom compared to other basic foods.

Table 1. The essential Amino Acids present in some basic foods reported to fresh substance (by INS)

| Foods / Amino Acids | Milk | White bread | Rice | Cabbage | Lettuce | Potatoes | Mushrooms |
|---|---|---|---|---|---|---|---|
| Isoleucine | 200 | 300 | 350 | 40 | - | 90 | 200 |
| Leucine | 350 | 600 | 600 | 60 | - | 100 | 200 |
| Lysine | 300 | 170 | 300 | 70 | 70 | 100 | 200 |
| Methionine | 90 | 120 | 130 | 13 | 4 | 20 | 50 - 200 |
| Phenylalanine | 170 | 400 | 400 | 30 | - | 90 | 30 |
| Tryptophan | 60 | 70 | 80 | 10 | 12 | 30 | 10 |
| Valine | 200 | 300 | 60 | 40 | - | 100 | 50 - 200 |
| % proteins | 10 | 10 | 7.5 | 1.4 | 1.2 | 2 | 2.5 – 3.5 |

Because of their chemical composition, mushrooms combat the tiredness, prevent the cardiovascular diseases and even cancer. In addition, it has a special taste and flavour, and can be used both for healthy and diabetic people (because it does not contain starch).

From an economic perspective the mushroom culture creates the opportunity to obtain substantially incomes by producers, using cheap raw materials (e.g. horse dung, cereal straw). Recovery mushroom culture is ensured throughout the year, because of the fact that the market is not saturated and the sale price is convenient for producer, the offer being smaller compared to the demand. Also mushrooms can be raw materials for canning factory (Mateescu, 1982).

In our country can be prepared the mycelium (material for inoculation) for ten species of mushrooms including two species of *Agaricus* (Champignon) and six species of *Pleurotus*. There are some species of mushrooms that are cultivated strictly for their medicinal properties, for obtaining drugs (penicillin, favicina, streptomycin) or are used as raw materials for the extractraction of some colorants (*Coprinus, Rusulla*).

The acumulation of heavy metals can take place in different phases of the technological process of growing, harvesting, conditioning, packaging as it becamed necessary to determine the acumulation of heavy metals from edibles mushrooms in order to establish the conformity of their content in heavy metals reported to the maximum limit legally allowed (Petcu, 2014). Also, it becamed notorious the ability of mushrooms to absorb heavy metals from the environment (known as biosorption) and the possibility of decontamination of the environment (of the soil) using this method, by cultivating on a large scale the macroscopic mushrooms (Das, Vimala, Karthika, 2008).

## MATERIALS AND METHODS

The study was performed on sixteen samples of mushrooms from four types of packing such as: four samples of fresh mushrooms, four samples of cutted mushrooms packed in metal tins, four samples of whole mushrooms in cans belonging to the genus *Agaricus* and four samples of mushrooms in glass jars of the genus *Pleurotus*. For all of sixteen samples determinations were made in order to find lead, mercury, cadmium, zinc, tin, arsenic and copper. There have been used four samples (belonging to the lot) from each type of mushrooms that were taken from public sales units.

The samples were analyzed using optical emisson spectrometry with inductively coupled plasma (ICP – OES), which allows the determination of the concentration or of the total quantity of an element from the sample.

The determinations were done after a previously preparation of the samples, as the disaggregation with a microwave oven for digestion Berghof, according to the method described in the article „*Evaluation of Various*

*Sample Preparation Procedures for the Determination of Chromium, Cobalt and Nickel in Vegetable*" published in the Journal of Analytical Atomic Spectrometry in 1997 (Carlosena, Gallego, Valcarcel).

There was weigh from each type of mushrooms four samples having the weight mentioned in the Table 2, then were subjected to the digestion. After that the samples were let to cool for two hours and were made dilutions with bidistilled water then the samples were analyzed with a spectrometer.

Table 2. The weight of the 16 samples of mushrooms obtained after dissagregation and weigh

| Type / Sample | Type 1 | Type 2 | Type 3 | Type 4 |
|---|---|---|---|---|
| $S_1$ | $m_1 = 0,2993$ | $m_1 = 0,3010$ | $m_1 = 0,3017$ | $m_1 = 0,2993$ |
| $S_2$ | $m_2 = 0,2878$ | $m_2 = 0,3005$ | $m_2 = 0,3015$ | $m_2 = 0,2995$ |
| $S_3$ | $m_3 = 0,2990$ | $m_3 = 0,3010$ | $m_3 = 0,3010$ | $m_3 = 0,2995$ |
| $S_4$ | $m_4 = 0,2995$ | $m_4 = 0,3008$ | $m_4 = 0,3015$ | $m_4 = 0,2994$ |

The prepared standard samples were in concentration of 0,001 ppm, 0,1 ppm and 50 ppm for each element. Based on this standards was drawn the calibration curve of the device. In the preparation of the standards was used ultrapure water. The standard solutions of the used chemical element are inserted into the device, in this way being measured the intensity of the characteristic emission for each element. When is measured the intensity of the emission, it is compared with the specific calibration curve for measure the concentration corresponding to the intensity (Figure 1).

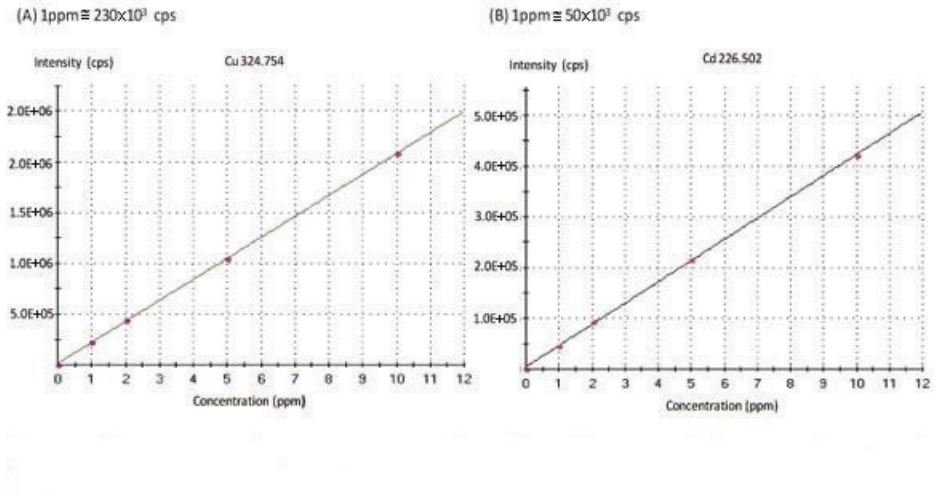


Figure 1. Standard curves for copper and cadmium used to convert between counts per second (cps) and concentration (ppm) (by Tonon, Oliveira, Soriano & Colepicolo, 2011)

## RESULTS AND DISCUSSIONS

The determinations performed according to the methodology presented above, highlighted the following results for lead, mercury, cadmium, zinc, tin, arsen and copper as follows:

Table 3. Results obtained by analyzing the *Champignon* fresh mushroom samples

| Mushrooms / Metals | $S_1$ mg/kg | $S_2$ mg/kg | $S_3$ mg/kg | $S_4$ mg/kg | Average mg/kg | LMA mg/kg |
|---|---|---|---|---|---|---|
| Pb | 0.1222 | 0.2411 | 0.1833 | 0.1774 | 0.1810 | 0.5 |
| Hg | 0.0023 | 0.0025 | 0.0011 | 0.0016 | 0.0018 | 0.05 |
| Cd | 0.0511 | 0.0311 | 0.0500 | 0.0420 | 0.0435 | 0.1 |
| Zn | 4.5111 | 3.4911 | 4.5011 | 4.1663 | 4.1677 | 15 |
| Sn | - | - | - | - | - | - |
| As | 0.2122 | 0.2333 | 0.1997 | 0.2210 | 0.2150 | 0.5 |
| Cu | 3.1665 | 3.3000 | 2.9999 | 3.1496 | 3.1540 | 5.0 |

Regarding the Champignon fresh mushrooms can be observed the fact that all the determined values are situated below the maximum limit allowed by the regulations in force and that, compared to other analyzed metals, were detected higher levels of zinc and copper (Table 3). This fact can be explained by the presence of zinc sulphide and copper sulphide added in order to achieve the culture substrate necessary for mushroom growth.

Table 4. Results obtained by analyzing the *Pleurotus* mushroom samples packaged in glass containers

| Mushrooms / Metals | $S_1$ mg/kg | $S_2$ mg/kg | $S_3$ mg/kg | $S_4$ mg/kg | Average mg/kg | LMA mg/kg |
|---|---|---|---|---|---|---|
| Pb | 0.440 | 0.440 | 0.440 | 0.441 | 0.440 | 0.5 |
| Hg | - | - | - | - | - | - |
| Cd | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.1 |
| Zn | 2.616 | 2.620 | 2.616 | 2.618 | 2.617 | 15 |
| Sn | - | - | - | - | - | 150 |
| As | - | - | - | - | - | 0.5 |
| Cu | 1.453 | 1.455 | 1.455 | 1.454 | 1.454 | 50 |

Regarding the *Pleurotus* mushroom samples packaged in glass jars, can be observed higher levels of zinc, copper and lead but that are also situated below the maximum allowed limits, as it can be seen in Table 4. A possible explanation for the lead can be given by the presence of some polluting sources near the place were are cultivated the mushrooms or for it presence in the culture substrate and in the manure coming from animals that were grazing on lands polluted with lead.

Table 5. Results obtained by anlyzing the integer *Champignon* mushroom samples packaged in metallic boxes

| Mushrooms / Metals | $S_1$ mg/kg | $S_2$ mg/kg | $S_3$ mg/kg | $S_4$ mg/kg | Average mg/kg | LMA mg/kg |
|---|---|---|---|---|---|---|
| Pb | 0.397 | 0.398 | 0.398 | 0.396 | 0.397 | 0.5 |
| Hg | - | - | - | - | - | - |
| Cd | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.1 |
| Zn | 5.502 | 5.505 | 5.514 | 5.509 | 5.507 | 15 |
| Sn | 28.43 | 28.44 | 28.48 | 28.46 | 28.45 | 150 |
| As | - | - | - | - | - | 0.5 |
| Cu | 1.972 | 1.973 | 1.976 | 1.975 | 1.974 | 5.0 |

Regarding the mushroom samples packaged in metallic boxes, both in case of the integer and the sliced mushrooms can be observed higher quantities of tin even if it is below the maximum allowed limits (Table 5 and 6). An explanations of it presence can be given by the

release of tin from box lining as a result of the deterioration of the can. It appears when the inner layer is not perfectly adherent to the metal surface so that can take place the migration of the metal in the food that preserves. If the inner wall of can has a dark colour, gray to black, it means that tin or another element from the box compositon was released and was combined with the food.

Table 6. Results obtained by analyzing sliced *Champignon* mushroom samples, packaged in metallic boxes

| Mushrooms / Metals | $S_1$ mg/kg | $S_2$ mg/kg | $S_3$ mg/kg | $S_4$ mg/kg | Average mg/kg | LMA mg/kg |
|---|---|---|---|---|---|---|
| Pb | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.5 |
| Hg | - | - | - | - | - | - |
| Cd | 0.025 | 0.025 | 0.041 | 0.039 | 0.032 | 0.1 |
| Zn | 6.047 | 6.118 | 6.072 | 6.063 | 6.075 | 15 |
| Sn | 33.351 | 34.000 | 33.335 | 33.349 | 33.508 | 150 |
| As | - | - | - | - | - | 0.5 |
| Cu | 1.829 | 1.828 | 1.912 | 1.907 | 1.869 | 5.0 |

In all samples obtained from all the mushroom types were observed significant lead concentrations but that were framed in the maximum allowed limits. The higher concentration was observed at the mushrooms packaged in glass containers and the lowest at fresh mushrooms.

The presence of heavy metals in the mushroom samples can be explained and by its bioabsorption ability, by its ability to retreive the heavy metals from the environment, the presence of cadmium, arsen and mercury in case of fresh mushrooms it can be attributed to this phenomenon.

## CONCLUSIONS

All the heavy metals existing in the samples were below the maximum allowed limits established by the legislation in force.

In all the mushroom farms were identified residues of copper, zinc and lead, coming from the mushrooms culture substrate.

Tin was present just in the mushrooms packaged in metallic boxes, resulted from the crossing of the metal from the mushroom wall cans.

Mercury, cadmium and the arsen were present in the samples in lowest quantities in some cases below the detectable limits of the device.

## REFERENCES


Carlosena A., Gallego M. & Valcarcel M., 1997. Evaluation of Various Sample Preparation Procedures for the Determination of Chromium, Cobalt and Nickel in Vegetable. Journal of Analytical Atomic Spectrometry, 12: 479-486.

Das N., Vimala R. & Karthika P., 2008. Biosorption of heavy metals - an overview. Indian Journal of Biotechnology, 7: 159-169

Lee, M. Susan, Metals in foods. A literature survey, No. 12, The British Food Manufacturing Industries Research Association, Surrey, UK, 1990.

Mateescu N., 1982. Producerea ciupercilor. Editura Ceres Bucuresti

Mecinicopschi, Gh., 2013. Cipercile- carnea sănătoasă a pământului. www.doctormenci.ro/sanatate/page/2

Petcu, C.D., 2014. Ambalaje utilizate în industria alimentară. Editura Granada Bucuresti.

Tonon A., Oliveira M., Soriano E. & Colepicolo P., 2011. Absorption of metals and chemical elements present in three species of Gracilaria (Gracilariaceae) Greville: a genus of economical importance. Revista Brasileira de Farmacognosia, 21(2).