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Minor and Toxic Element Content in Edible Mushrooms

Roushandy Asri Fardani[1*]

[1]Politeknik Medica Farma Husada Mataram, Teknologi Laboratorium Medis, Mataram, Nusa Tenggara Barat, Indonesia;

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*Corresponding Author:
Roushandy Asri Fardani,
Politeknik Medica Farma Husada Mataram, Teknologi Laboratorium Medis, Mataram, Nusa tenggara Barat, Indonesia;
Email: fardaniroushandy@gmail.com

Abstract: Minor and toxic elements in edible mushrooms are cultivated in residential areas of Mataram, West Nusa Tenggara. Minor elements are zinc (Zn), copper (Cu) and toxic elements such as lead (Pb), cadmium (Cd). Metals will be dangerous if they enter the body's metabolism in amounts that exceed the specified threshold.The purpose of this study was to determine the levels of minor elements and toxic elements in consumption mushrooms. This research was conducted to analyze minor and toxic metals using Atomic Absorption Spectrophotometer (AAS). The samples used in this study were mushrooms that are usually consumed by the public, namely, Pleurotus osteratus and Auricularia auricula-judae. The research method used is descriptive quantitative, namely to determine the levels of minor metal elements and toxic metal levels of consumption mushrooms. The results showed the highest minor levels of Zn in Pleurotus osteratus were 131.34 mg/kg and Auricularia auricula-judae mushrooms were 74.5 mg/kg. Toxic levels of Cd in Pleurotus osteratus are 0.547 mg/kg. While the levels of Cu and Pb in the analysis results are still within the maximum limit. The levels of Zn and Cd in each sample exceeded the maximum limit according to the Decree of the Directorate General of POM No. 03725/B/SK/VII/89 and the Indonesian National Standard SNI 7387:2009.

Keywords: Auricularia auricula-judae, minor element, pleurotus osteratus, toxic element.

Intoduction

Environmental pollution occurs due to the introduction of materials that can cause changes that damage the physical, chemical, biological or aesthetic characteristics of the environment. Changes can occur in water, air and soil, causing harm to human life. Human-generated domestic sewage pollution can be the most important impact of water, air and soil pollution. Heavy metal wastes are closely related to human health, the environment, agriculture and ecotoxicology. Heavy metal pollution can be grouped into 3 parts, namely, high toxic properties consisting of metal elements such as Cadmium (Cd), Lead (Pb), medium toxic properties consisting of metal elements such as Nickel (Ni), Cobalt (Co), Aluminum (Al) and low toxic properties consisting of elements such as Zinc (Zn), Copper (Cu), Manganese (Mn) and Iron (Fe). If heavy metals continue to pollute the soil, the soil will become unbalanced and then will be absorbed easily by plants through the roots and if the roots are weakened, it will be distributed to other roots.

Mushrooms that can be consumed by humans include *Pleurotus osteratus* and *Auricularia auricula-judae*, and various types that have been developed. The ecological role of fungi in forest ecosystems is as decomposers. As we know, mushrooms are foodstuffs that are widely consumed by the community, but the presence of metal elements in mushrooms is rarely known by the community. Based on the observation of the location of mushroom cultivation carried out in residential areas, from household, industrial and agricultural waste, where the place is one of the most influential pollution factors to the metal content of the mushroom cultivation. Environmental pollution often occurs with household waste disposal methods resulting in health hazards. The general public is not aware of the content in mushrooms.

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Materials and Methods

Material

The materials used include *Pleurotus osteratus* and *Auricularia auricula-judae* cultivated in residential areas, nitric acid (HNO_3). Zn, Cu, Pb and Cd metal standard solutions and aquadest.

Equipments

The equipments used include oven, porcelain cup, glass funnel, analytical balance, volume pipette, volumetric flask, measuring cup, hotplate, decicator, lumping stamp, whatman filter paper, hollow cathode lamp and atomic absorption spectrophotometry (AAS).

Sample Preparation and analysis

Mushrooms were cleaned with running tap water and drained at room temperature. weighed as a wet weight of 2 g. Then dried in an oven at a temperature of (50-100 ° C) for 3 hours. remove from the oven and cooled at room temperature (in a closed decicator). Weigh again as dry weight, grind the sample until smooth using a lumping stamper. Weigh the mushroom sample as much as 2 g, added 100 ml of aquadest and 5 ml of concentrated nitric acid as much as 5 ml. the sample is deconstructed using a hot plate until the solution is clear, filtered using Whatman filter paper, take the filtrate, add aquadest until the solution becomes 100 ml. Then the solution was read using atomic absorption spectrophotometry with different wavelengths and cathode lamps for Pb 217.0 nm, Cu 324.7 nm, Cd 228.8 nm, Zn 213.9 nm.

Results and Discussion

Minor Element in *Pleurotus osteratus*

One of the groups of the microelements occurring in relatively large amounts such as Zn and Cu. The concentration result of the minor elements determined in *Pleurotus osteratus* mushroom samples is summarized in Table 1. Based on the data in Table 1, the levels of minor and toxic elements in *Pleurotus osteratus* and *Auricularia auricula-judae* samples show that the metal content of Zn exceeds the maximum limit set in Dit Jen POM No. 03725/B/SK/VII/89 of 40 mg/kg. Heavy metal Cu, shows that the level of this metal is still below the maximum limit.

Table 1. Results of minor element content in *Pleurotus osteratus* mushrooms

Minor Element	Max Limit (mg/kg)	Minor element content in *Pleurotus osteratus*					
		Sampel 1 (µg/ml)	Sampel 2 (µg/ml)	Sampel 3 (µg/ml)	Average Content minor Element (µg/ml)	Content minor Element (mg/L)	Content minor Element (mg/kg)
Zn	40	2,65	2,66	2,63	2,64	2,64	131,34
Cu	36	0,093	0,093	0,091	0,092	0,092	4,57

Toxic Elements in *Pleurotus osteratus*

One of the groups of the toxic occurring in relatively large amounts such as Pb and Cd. The concentration result of the toxic elements determined in *Pleurotus osteratus* mushroom samples is summarized in Table 2. Based on the data in table 2, the results of the analysis of toxic elements in both of mushroom contain Pb metal found in < 0.500 mg/kg, the maximum allowable limit of Indonesian National Standard (SNI) 7387: 2009 is 0.5 mg/kg. Meanwhile, the Cd metal found in *Pleurotus asteratus* mushrooms is 0.547 mg/kg, the maximum allowable limit of the Indonesian National Standard (SNI) 7387: 2009 is 0.2 mg/kg.

Table 2. Results of toxic element analysis in *Pleurotus osteratus* mushrooms

Minor Element	Max Limit (mg/kg)	Minor element content in Pleurotus osteratus					
		Sampel 1 (µg/ml)	Sampel 2 (µg/ml)	Sampel 3 (µg/ml)	Average Content minor Element (µg/ml)	Content minor Element (mg/L)	Content minor Element (mg/kg)
Pb	0,5	0,015	0,001	0,000	< 0,01	<0,01	<0,500
Cd	0,2	0,011	0,011	0,010	0,011	0,011	0,547

Minor Elements in *Auricularia auricula-judae*

Minor minerals are of great biochemical interest and exhibit nutritional and clinical importance [38]. The concentrations of minor minerals in dry basis (Zn and Cu) in the edible mushroom species were shown in Table 3. Based on the research results contained in table 3, the Zn content in *Auricularia auricula-judae* is 74.5 mg / kg, which means that the Zn content is very high, the maximum limit of contamination allowed according to the Decree of the Directorate General of POM No. 03725 / B / SK / VII / 89 of 40 mg / kg. In ear mushrooms there is Cu metal with a level of 1.17 mg / kg, which is still allowed.

Table 3. Results of minor element analysis in *Auricularia auricula-judae* mushrooms

Minor Element	Max Limit (mg/kg)	Minor element content in *Auricularia auricula-judae*					
		Sampel 1 (µg/ml)	Sampel 2 (µg/ml)	Sampel 3 (µg/ml)	Average Content minor Element (µg/ml)	Content minor Element (mg/L)	Content minor Element (mg/ kg)
Zn	40	1,55	1,54	1,52	1,53	1,53	74,6
Cu	36	0,022	0,025	0,025	0,024	0,024	1,17

Minor Elements in *Auricularia auricula-judae*

Many wild edible mushroom species are known to accumulate high levels of heavy (toxic) metals and mainly cadmium (Cd) and Lead (Pb) (Kalac, 2000),perhaps related to the environment in which they are picked. The two toxic metals cadmium and Plumbum were evaluated here for *Auricularia auricula-judae* mushrooms. Table 4 states that the level of toxic elements in Pb metal in *Auricularia auricula-judae* mushrooms is <0.500 mg / kg, the maximum limit is 0.5 mg / kg according to Indonesian National Standard (SNI) 7387: 2009. While the analysis of toxic elements in Cd metal ear mushrooms is <0.150 mg / kg, the maximum limit allowed according to the Indonesian National Standard (SNI) 7387: 2009 is 0.2 mg / kg.

Table 4. Results of toxic element analysis in *Auricularia auricula-judae* mushrooms

Toxic Element	Max Limit (mg/kg)	Minor element content in *Auricularia auricula-judae*					
		Sampel 1 (µg/ml)	Sampel 2 (µg/ml)	Sampel 3 (µg/ml)	Average Content Toxic Element (µg/ml)	Content toxic Element (mg/L)	Content toxic Element (mg/ kg)
Pb	0,5	0,000	0,024	0,020	<0,01	<0,01	<0,500
Cd	0,2	0,003	0,003	0,002	<0,003	<0,003	<0,150

Discussion

Zink (Zn)

The results of the analysis of minor elements in *Pleurotus osteratus* mushroom show that Zn metal in both oyster mushroom and *Auricularia auricula-judae* is categorized as unsafe for consumption according to the Decree of the Ditjen POM No.03725/B/SK/VII/89 is 40 mg/kg. This happens because the environment where the research object is located is in a residential area, where there is household waste disposal which may contain a lot of Zn metal. In addition, it can be seen from the planting media which affects the high content of Zn metal which is quite high, Zn is not always toxic, because the body needs a certain amount of zinc. Consuming a lot of Zn can cause vomiting, diarrhea, fever, extreme fatigue, anemia, and reproductive disorders. Zn is inherently low, the body needs Zn for metabolic processes, but when Zn in natural foodstuffs is high, it can be toxic (Sunarjono, 2003).

Copper (Cu)

The content of Cu metal in *Pleurotus*

osteratus mushrooms and *Auricularia auricula-judae* mushrooms is still safe for consumption because it is below the threshold according to the Ditjen POM No.03725/B/SK/VII/89 is 36 mg/Kg. The Pb content in both *Pleurotus osteratus* mushroom and *Auricularia auricula-judae* mushroom samples in the safe category for consumption according to the Indonesian National Standard (SNI) 7387: 2009 is 0.5 mg / kg. Lead pollution is found not only in mushrooms and other foods but also in car fumes, which can release lead particles and pollute the air.Studies show that the levels of lead metal in mushrooms are far below the standard. It is also important to pay attention to the quality of mushrooms that can be consumed because Pb is an attractive metal and highly toxic when it enters the body.

Lead (Pb)

Pb contamination in mushrooms and other foods, as well as vehicle fumes can pollute the air by releasing lead particles. Pb is not needed in the body, so if Pb enters the body, it will cause toxic effects on organs such as damaging nerve tissue and organ functions such as the kidneys, heart, reproductive system and brain disorders in children.Reduction of heavy metal absorption by plants is related to a decrease in the levels of the active parts of heavy metals. In the growth medium, or higher selectivity of plants to the absorption of elements from the growth medium, a combination of both (Alloway, 2010). Higher concentration of Pb in both of mushroom.The uptake of heavy metal ions in mushrooms is higher than in plants. For this reason, the concentration variations of heavy metals could be attributed to mushroom species and their ecosystems. However, no mushroom species can be considered as an exact indicator of environmental pollution (Kalac, 2000).

Cadmium (Cd)

The Cd metal content of both samples, *Pleurotus osteratus* mushrooms are not safe for consumption because they exceed the maximum limit. Meanwhile, the *Pleurotus osteratus* mushrooms are safe for consumption according to the Indonesian National Standard (SNI) 7387: 2009) Cd levels in *Pleurotus osteratus* mushrooms exceed the threshold that can exist in mushroom plants, this is due to the absorption of plant Cd from the soil is influenced by the total intake of Cd in the soil, soil pH, zinc content, plant type and cultivar. Cd exists in mushroom plants because the absorption of cadmium by the soil is influenced by the total intake of cadmium, when the pH is low, the absorption of Cd is high, and when the pH is high, the absorption of Cd decreases. The content of oyster mushrooms is quite high. If Cd enters the food chain, it will eventually accumulate in high-end consumers, namely animals and humans.

Due to the acute toxicity of the element, cadmium is very harmful to health. If cadmium accumulates in the body for a long time, it will suppress the work of the lungs, slow growth and osteoporosis. Cadmium generally softens the bones caused by vitamin B deficiency and will cause disturbances in the balance of calcium and phosphate in the kidneys (Charlene, 2004). Cadmium is accumulated mainly in kidneys, spleen and liver and its level in blood serum increases considerably following mushroom consumption (Kalac, 2000). Thus, the consumption of contaminated mushrooms such as *Pleurotus osteratus*. Campestris may pose a health risk for consumers, especially during the rainy season when intake is high (Gargano, 2017).

Conclusion

Based on the research that has been done, it can be concluded that the minor element levels of Zn metal in *Pleurotus osteratus* mushrooms are 131.34 mg/kg and *Auricularia auricula-judae* mushrooms are 74.5 mg/kg. Minor elements in Cu metal levels in *Pleurotus osteratus* mushrooms 4.57 mg/kg and *Auricularia auricula-judae* mushrooms 1.17 mg/kg. Toxic element levels in *Pleurotus osteratus* mushrooms Pb metal levels <0.500 mg/kg and *Auricularia auricula-judae* mushrooms <0.500 mg/kg. Toxic elements in Cd metal levels in *Pleurotus osteratus* mushrooms 0.547 mg/kg and *Auricularia auricula-judae* mushrooms <0.150 mg/kg.

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