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Assessment of Some Nutrient Contents and Heavy Metal Accumulation in Some Wild Edible Mushrooms in Türkiye

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Abstract: In this study, it was aimed to identify mushrooms gathered from two different regions and localities of Türkiye and to determine their heavy metal and nutrient contents. Four of the mushrooms (*Coprinus comatus* (O.F. Müll.) Pers, *Cantharellus cibarius* Fr., *Pleurotus ostreatus* (Jacq.) P. Kumm. and *Lactarius glyciosmus* (Fr.) Fr.) from nearby settlements, while the others (*Hydnum repandum* L., *Pleurotus eryngii* (DC.) Quél and *Lactarius delicious* (L.) Gray)) were collected from rural areas. All species have known and consume by local peoples. All identified species were given along with their trophic status, habitats, locations, Turkish names and edibility. Concentrations of elements were determined based on dry weight. The analysis of samples indicated that different result obtained from mushrooms. As (nd, 1.5-17.43), Ba (1.48-10.81), Cd (nd, 1.4-43.46), Co (nd, 12.0- 42.79), Cr (nd, 5.0-14.92), Cu (12.95-143.45), K (nd, 30085- 52680), Mg (nd, 5056-5955.9), Mn (52.45- 187.25), Mo (nd, 1.22-57.53), Ni (43.46-565), Pb (318.9-1483.5), Sb (nd, 0.14-4.12), Si (nd, 3.18-87.83), Ti (20.32-302.2), V (67.66-102.3), Zn (1026.8-2422.0), Ca (411.5 -2077), Na (752.5-2105.5) and Fe (470.5-1093.5) were determined and the elements studied were given in mg/kg. As a result, it was determined that *C. comatus*, *H. repandum*, *C. cibarius* and *P. eryngii* had the lowest content of heavy metals and *P. ostreus* had the highest value in terms of calcium and magnesium contents. Therefore, it has been determined that these mushroom species may have important beneficial effects to human health. It is thought that it can be used as a source in future studies.

Keywords: Atomic absorption, Food analysis, Heavy metals, Minerals, Mushrooms

Türkiye'de Yenilen Bazı Yabani Mantarlarda Bazı Besin İçerikleri ve Ağır Metal Birikiminin Değerlendirilmesi

Öz: Bu çalışmada, Türkiye'de iki farklı bölge ve lokalitelerinden toplanan yenilebilir yabani bazı mantar örneklerinin teşhis edilmesi ve ardından ağır metal ve besin içeriklerinin belirlenmesi amaçlanmıştır. Bu mantarların dördü (*Coprinus comatus* (O.F. Müll.) Pers*, Cantharellus cibarius*

Fr*, Pleurotus ostreatus* (Jacq.) P. Kumm. ve *Lactarius glyciosmus* (Fr.) Fr.) yakın yerleşim yerlerinden, diğerleri ise (*Hydnum repandum* L.*, Pleurotus eryngii* (DC.) Quél *ve Lactarius deliciosus* (L.) Gray) kırsal alanlardan toplanmıştır. Tüm türler yerel halk tarafından tanınmakta ve besin amaçlı tüketilmektedir. Teşhis edilen tüm türlerin, trofik durumları, habitatları Türkçe adları ve yenilebilirlikleri ile birlikte verilmiştir. Element konsantrasyonları kuru ağırlığa göre belirlenmiştir. Analiz edilen mantar türlerinden elde edilen sonuçların farklılık gösterdiği belirlenmiştir. Sonuçlara göre; As (nd, 1,5-17,43), Ba (1,48-10,81), Cd (nd, 1.4-43.46), Co (Nd, 12.0- 42.79), Cr (nd, 5.0-14.92), Cu (12.95-143.45), K (nd, 30085- 52680), Mg (nd, 5056-5955.9), Mn (52.45- 187.25), Mo (nd, 1.22-57.53), Ni (43.46-565), Pb (318.9-1483.5), Sb (nd, 0.14-4.12), Si (nd, 3.18-87.83), Ti (20.32-302.2), V (67.66-102.3), Zn (1026.8-2422.0), Ca (411.5 -2077), Na (752.5-2105.5) ve Fe (470.5-1093.5) belirlenmiş ve incelenen elementler mg/kg olarak verilmiştir. Sonuç olarak, ağır metaller bakımından en düşük değere sahip mantarlar: *C. comatus*, *H. repandum*, *C. cibarius* ve *P. eryngii,* kalsiyum ve magnezyum içeriği bakımından ise en yüksek değere ise *P. ostreus*'un sahip olduğu belirlenmiştir. Dolayısıyla bu mantar türlerinin insan sağlığı açısından önemli potansiyele sahip olduğu görülmektedir. Daha sonra yapılacak ilgili çalışmalarda kaynak olarak kullanılabileceği düşünülmektedir.

Anahtar Kelimeler: Atomic absorption, Besin İçeriği, Ağır Metaller, Mineraller, Mantarlar

Introduction

Fresh or dried macrofungi cooked in various ways are consumed as a nutrient. Mushrooms give flavor to the food thanks to their unique flavors and tissues. Although natural fungi are thought to have lower nutritional properties than vegetables, they have a high nutritional value in many foods. Even some species that are able to breed, such as meat, eggs, and milk show comparable significant nutritional properties (Boa, 2004). Natural mushrooms are very rich in terms of protein, amino acids, vitamins, minerals, and carbohydrates content. Button mushrooms are healthy food sources because they are a good source of bioactive compounds such as protein, vitamins, polyphenolics and minerals (Cavusoglu et al., 2021; Şaran et al., 2022).They also have low-calorie values due to containing almost no fat (Agahar-Murugkar, Subbulakshmi, 2005). *P. eryngii* may contain chemicals that strengthen into the connective tissue (Nozaki et al., 2008) *P*. *eryngii* can work as a cholesterol-lowering agent of the intake of nutrients in the diet (Jumpup Alam et al., 2011). It has been shown in a preliminary study that consumption of *P. ostreatus* (oyster mushroom) reduces cholesterol levels by an effect associated with beta-glucan content (Rop et al., 2009). *P*. *ostreatus* and *P*. *eryngii* are sold in local markets in Van province. *P*. *eryngii* is known as a heliz or mantis mushroom in Van. *P*. *ostreatus* is known as poplar mushroom or oyster mushroom in this region. *H. repandum* is a mycorrhizal fungi (Jumpupto et al., 2002) whose fructifications are grown alone or forming groups under coniferous trees or non-evergreen (Arora, 1986; Sterry and Hughes, 2009). It is known as a anchusa mushroom in Ordu territory.

The nutrient and chemical composition of *H. repandum* as a common edible species has been the subject of various scientific studies. *H. repandum* fructifications include 10.7% moisture and 9.2% cinders. The organic acid composition (54%) (100 grams of mushroom, 0.31 grams per dry weight) contains citric acid and malic acid (Ayaz et al., 2011). In another study, percentages of essential amino acids were evaluated as follows: valine, 3.9 %; leucine, 14.5%; carbohydrate, 3.2 %; threonin, 4.4 %; lysine, 4.2 %; trytophane, 1.4 %. The content of lipid (expressed as percentage of dry matter) was found 4.7 %. As big fatty acids, oleat was (20.3 %); lineoleate (47.5 %); linolenate (23.9 %); three dimensional (0.9 %), stearate (4 %). Mycosterol content is 628 grams of ergosterol and was recorded as 85 mg of fungisterol per 100 grams of dry substance. It has been reported that Chanterellus species contain antioxidants, amino acids, beta carotene, and canthaxanthin, and also contain significant amounts of vitamin D (Pilz et al., 2003). It is known as chicken tirmiti mushroom in Ordu area.

L. deliciosus in Türkiye is very popular mushroom. Pine forests in the Eastern Black Sea region constitute a suitable habitat for these species. It is known as the name of Kanlıca or Çıntar throughout the Black Sea region and in the Ordu area. *L. glyciosmus* is known as hazelnut tirmitii. *H. repandum*, chanterelle, *Lactarius delicious*, and *L. glycosomes* are sold in local markets in the Ordu province of Türkiye. *P. ostreatus* and *P. eryngii* are sold in local markets in Van province of Türkiye. *C. comatus* is known as ink mushroom or horse tail mushroom. Not only do mushrooms all over the world gain merely nutritious properties and taste but also have a medical value in terms of their chemical structure and functional functions (Kalač, 2009).

Mushrooms produce secondary metabolites with a variety of interesting biological activities, and are seen as an important potential for the discovery of new drugs. Many types of macrofungi are used as therapeutic agents

in diseases such as gastric cancer, cardiovascular diseases, tuberculosis, liver, heart diseases, inflammation, back pain, gonorrhea, bleeding, abdominal pain, and diabetes (Chang and Miles, 1989). These therapeutic biological activities are mediated by polysaccharides found in fungi such as especially beta glucans. There are many publications in the literature about the isolation and biological activity of polysaccharides produced by medicinal fungi. It is well known that the pharmacological effects and therapeutic potentials of these compounds are important for human health (Barros et al., 2007). Certain macrofungi are found to harbour copper, cadmium, mercury, lead, arsenic, cobalt, iron and nickel in high concentrations (Tyler, 1982; Kalač and Svoboda, 2000). Lalotra P. and his colleagues found that *Amanita augusta* and *Boletus subvelutipes* mushrooms carried heavy metal in extreme quantities. Many researchers have been carried out on metal contents of mushrooms especially for edible fungi (Demirbas, 2000; Lepsova and Majestrı'k, 1988). The heavy metal concentration in the fungi is a reflection of the pH and organic matter content of the soil (Gast et al., 1988).

It is thought that present study has supported previous studies and will contribute to future studies because the studies investigating the heavy metal and nutrient contents of the mushrooms are important and some species in the present study have different results each other.

Material and Metod

Macrofungi samples (*H. repandum*, *C. comatus*, *L. delicious*, *C. cibarius*, and *L. glycosomes*, *P. ostreatus* and *P. eryngii*) were collected in Türkiye's Ordu and Van provinces between 2015 and 2016 years. Diagnosis of fungal specimens was made using (Phillips, 1981; Moser, 1983; Breitenbach and Karnzlın, 1984-2000; Buczacki, 1989; Bresinsky and Besl, 1990; Jordan, 1995; Kibby, 1997) reference sources for macroscopic and microscopic data obtained using mycology techniques. The types of fungi used in this study, trophic status, habitats, locations, Turkish names and their edibility are given in Table 1.

Experimental

Samples of dried mushrooms were crushed in porcelain mortar. Grinded samples were sifted out on a 75 mesh sieve. After weighing to 1 gram (2 repeats), they were taken into the proselen crucibles. 2 ml ethanol/H_2SO_4 (95,5% by volume) were added on each of them. Muffule furnace heated to 550 °C was burned until burning to ashes (3 hours). 4 mL of 3 N HCl were added to the samples removed from the oven. Pure distilled water was added until the final volume of the supernatant was 25 mL. The blue band was filtered on the filter paper. The blue band was filtered through the filter paper. The prepared solution was read by AAS (Atomic Absorption spectrophotometer). Heavy metal and nutrient concentrations of mushroom samples were determined.

Tablo 1. Code, Family and Species, Trophic status, location, habitat, Turkish name and edibility of mushroom species (Sesli ve ark.,2020) i

Code	Family and species	Tropic Status	Location	Habitat	Turkish Name	Edibility
1	Cantharellaceae J.Schröt. ***Cantharellus cibarius*** Fr.	Mycorrhizal	Ordu, Kabadüz	Under *Corylus maxima*	Sarıkız Mantarı	Edible
2	Russulaceae Lotsy ***Lactarius deliciosus*** (L.) Gray	Mycorrhizal	Ordu, Kabadüz	In pine forest	Kanlıca Mantarı	Edible
3	***Lactarius glyciosmus*** (Fr.) Fr.	Mycorrhizal	Ordu, Kabadüz	Under *Corylus maxima*	Tatlı Sütlüce Mantarı	Edible
4	Hydrangea Chevall. ***Hydnum repandum*** L.	Mycorrhizal	Ordu, Kabadüz, Çambaşı	Deciduous and coniferous wood	Sığır Dili Mantarı	Edible
5	Pleurotaceae Kühner. ***Pleurotus eryngii*** (DC.) Quél.	Saprotrophic	Van, Gürpınar	It grows in association with the roots, *Ferula* sp.	Çakşır Mantarı	Edible
6	***Pleurotus ostreus*** (Jacq.) P. Kumm.	Saprotrophic	Van, Edremit	On stumps of *Populus* sp.	İstiridye Mantarı	Edible
7	Agaricaceae Chevall. ***Coprinus comatus*** (O.F. Müll) Pers.	Saprotrophic	Van, Merkez	In meadows	Söbelen Mantarı	Edible

Results and Discussions

All metal concentrations were determined as dry weight. Arsenic value was the highest in *P. ostreatus* (17.43±0.002 mg/kg) and the lowest value of as was found in *H. repandum* (1.5±0.002 mg/kg). Nothing was found in *C. cibarius*. Cd value was the highest in *P. ostreatus* (17.43±0.002 mg/kg) and the lowest for *P. eryngii* (1.4±0.0001 mg/kg). Cd value was not found in *L. glyciosmus*. Co value was the highest in *P. ostreatus* (42.79±0.0004 mg/kg) and the lowest for *C. cibarius* (12±0.0002 mg/kg). It was not found in *H. repandum*. *C. cibarius* (143.45±0.003 mg/kg) collected from the settlement areas was found the highest concentration of

Cu, and also *P. eryngii* (12.95±0.0027 mg/kg) collected from rural area had the lowest concentration. The highest of Fe concentration was found to be 1093.5 ± 0.0027 mg/kg in *P. ostreatus* collected from settlement area and was found to be 258.5 ± 0.0027 in *H. repandum* collected from the most rural area. Mn concentration of *L. glyciosus* collected from settlement area was found to be 187.25 ± 0.002 mg/kg and the lowest concentration of *C. cibarius* was found to be 52.45 ± 0.00035 mg/kg. The highest concentration of Ni was found in the settlement areas of *L. glycosomes* (565.8±0.0008 mg/kg) and the *H. repandum* (43.46±0.0002 mg/kg) collected from the rural areas was the lowest. The highest Pb concentration was found in the *L. glycosomes* (1483.5±0.005 mg/kg) collected from the settlement areas and the *P. eryngii* (318.9±0.0015 mg/kg) collected from rural areas was found the lowest value. The highest concentration of Zn was found in *C. cibarius* collected from the settlement areas and the *H. repandum* collected from the rural areas was the lowest concentration.

In this study, the accumulation of 16 heavy metals (As, Ba, Cd, Co, Cu, Cr, Fe, Mn, Mo, Ni, Pb, Sb, Si, Ti, V and Zn) and nutrients (Ca, K, Mg and Na) contents were investigated in 7 wild edible mushrooms (*C. cibarius*, *L. glyciosmes*, *H. repandum*, *C. comatus*, *P. eryngii*, *P. ostreatus* and *L. delicious*). The average heavy metal concentration and nutrients in the sporocarp of the wild-grown edible mushrooms is given in Table 2.

In addition to their nutritional values, mushrooms change their element content depending on the substrate content they use, as they play a role in organic matter breakdown in nature (Sevindik et al., 2015; Sevindik et al, 2018). For this reason, heavy metal concentrations of mushrooms are much higher than agricultural crops, fruits and vegetables (Liu et al., 2015). Although heavy metals such as iron (Fe), cobalt (Co), copper (Cu), manganese (Mn), chromium (Cr) and zinc (Zn) are required for living things, arsenic (As), cadmium (Cd) and Heavy metals such as lead (Pb) are considered harmful (Liu et al., 2015).

Arsenic has a carcinogenic effect when taken in excessive amounts to the human body, while dermatitis problems and allergic effects may occur if nickel is taken too much (Okut, 2019). The amount of arsenic was found in the range of 1.5 - 17.43 mg/kg (Koch et al., 2000). When Ni content was examined, it varied between 43.46 - 408 mg/kg. It was found to be relatively higher than the results of 44.6-127 (Demirbaş, 2001).

Barium is an element that is directly effective in human nutrition and Ba and Sb amounts in our study support the results of Koyyalamudi et al. (2013), which is a similar study.

High levels of Cd can lead to cancer, diarrhea, stomach problems, and death-affecting effects on the central nervous system. The amount of Cd was similar to the study of Tüzen et al. (2007) in *P. eryngii* cultivar and it was observed that the value in *Hydnum repandum*, *C. comatus*, *C. cibarius*, *L. delicious*, and *P. ostreatus* varieties were higher.

Co is one of the essential elements for the human body in small amounts and skin problems are encountered especially in its deficiency. Co element was found to be between 12 and 42.79 mg/kg in our study and it was found to be higher than the values determined in similar studies (Sarıkürkçü et al., 2011; Sevindik et al., 2015; ilker et al., 2019).

Because of its ability to increase glucose tolerance in type-2 diabetes mellitus patients (Anderson, 2000), chromium is considered essential to man. The recommended dietary intake for chromium is 0.035 mg / day for male and 0.025 mg/day for the female (Anonymous, 2001). Mushrooms could be thought as a potential source of this element. When the intervals determined in terms of the concentration of Cr ions are compared with previous studies, it was found to be similar. (Sarıkürkçü et al., 2011; Sevindik et al., 2015; ilker et al., 2019).

Copper plays a role with iron in the activity of the cytochrome oxidase enzyme. This activity is transformed into Cu + and Cu ++ and transports electrons to oxygen. It is present in the active group of the lysyl oxidase enzyme. This enzyme assists in cross-linking between collagen, elastin, and polypeptides. Besides catalase, phenyloxidase, and ascorbic acid oxidase, it is also necessary for iron to be used regularly in the body. Iron does not bind hemoglobin without copper (Çavuşoğlu, 2018). The difference concentration value of copper was seen as a significant result both in rural areas and in rural areas and in residential areas. It has been reported that the copper concentration in fungus does not constitute a risk for human health incase of 100-300 mg/kg in dry material (Kalač and Svoboda, 2000). The difference concentration value of copper was seen as a significant result both in rural areas and in residential areas. It has been reported that the copper concentration in fungus does not constitute a risk for human health incase of 100-300 mg/kg in dry material (Kalač and Svoboda, 2000). The amount of Cu varied between 12.95 - 143.45 mg/kg in our study and the results found in similar studies were 10-70 mg/kg (Kalač, 2009), 18.9-64.8 mg/kg (Tüzen et al., 2009), 10.3-145 mg/kg (Sesli and Tüzen, 1999; Işıloğlu et al., 2001), 10.60- 144.20 mg/kg (Yamaç et al., 2007), 11.6-41.9 mg/kg (Demirbaş, 2001), 3.80-32.6 mg/kg (Ouzouni et al., 2007) and 8.2-19.3 mg/kg (Colak et al., 2007).

Potassium is the main component of fluids in the cells. It provides acid-base balance, regulates blood pressure, acts in the transmission of nerve stimuli, and is effective in muscle contraction. When the K value is examined, *H. repandum*, *C. comatus*, *C.* can not be detected in the varieties, as a matter of fact, similar studies conducted by the researchers support this (Akın et al., 2019; Mendil et al., 2005; Sesli, 2007; Sesli and Dalman, 2006; Tuzen et al., 2007; Turkmen and Budur, 2018). Values determined in *L. delicious*, *L. glycosomes*, *P. ostreatus* and *P. eryngii* varieties are in the range of 30085-52680 mg/kg and are similar to the studies of other researchers (Demirbaş, 2001; Sesli, 2006; Sesli and

Tuzen, 2006; Pekşen et al., 2007; Pekşen et al., 2008; Ayaz et al., 2011a; Ayaz et al., 2011b; Turfan et al., 2018).

Magnesium regulates energy metabolism in the body and the working of muscle and nervous systems, and helps in the forming of bones and teeth and in the regulation of blood pressure (Samur, 2008). In the *C. comatus*, *P. ostreatus* mushroom species, the Mg value is found to be 5056 - 5955 mg/kg, respectively (Pekşen et al., 2007; Ayaz et al., 2011a; Akın et al., 2019), showing the results of the researchers. In *H. repandum*, *C. cibarius*, *P. eryngii*, *L. delicious*, *L. glycosome*s mushroom species, Mg value is both in our study and in similar studies conducted by researchers (Mendil et al., 2005; Sesli and Dalman, 2006; Sesli, 2007; Tuzen et al., 2007; Turkmen and Budur, 2018)

Manganese has an important role in growth and reproductive functions, carbohydrate and lipid metabolism, protein synthesis, mucopolysaccharide production, phosphorylation, and bone formation. Mn ion concentrations were 12.9-93.3 mg/kg (Kalac and Svaboda, 2000), 5.5-135 mg/kg (Gençcelep et al., 2009), 18.1-103 mg/kg (Mendil et al., 2005) and it supports our results.

Molybdenum is generally an essential element for nitrogen fixation in enzyme activations and legumes for plants. It is found in the structure of nitrogenase and nitrate reductase enzymes. It is necessary for biological nitrogen binding and the formation of amines by reducing nitrate in plants (Kacar and Katkat, 2010). Plants also need to make protein to molybdenum (Plaster, 1992).

When the amount of Mo is examined, the results in general were similar to the results in the study conducted by (Kiremedijian-Schumacher et al., 1994; Ekiz et al., 1995; Shankar and Prasad, 1998; Koyyalamudi et al., 2013). However, this ratio was higher in *C. comatus* species.

With lead accumulating in the body, acute and chronic poisoning occurs, leading to negative effects on the kidneys and causing death (Heyes, 1997). Pb amount value (Kalač, 2009; Yamaç et al., 2007; Ouzouni et al., 2007) was determined at a higher rate compared to similar studies. Silicon is among the 25 elements necessary for the normal development and nutrition of the human body and is the third most abundant element (Sripanyakorn et al., 2005). When the Si and V values were examined together, the results we found were found to be relatively higher than those of Koyyalamudi et al. (2013). However, the amount of Si was similar to the results of Koyyalamudi et al. (2013) in *C. comatus* species.

Titanium is an element that does not cause toxic effects and does not harm the human body. The amount of Ti was determined in the range of 20.32 - 302.2 mg/kg (Vetter, 1994; Györfi et al., 2010), and it was found to be higher than the results they found in their studies.

Zinc is involved in the structure of enzymes that have metabolic functions in the body. In our study, the amount of Zn was found in the range of 1026 - 2422 mg/kg. It was found higher compared to previous studies (Mendil et al., 2005; Dalman, 2006; Sesli and Tuzen, 2006; Sesli, 2007; Akın et al., 2019).

Calcium is an essential element for the construction of bones and teeth, for muscle contraction, for the work of nerves, for the supply of normal blood pressure, for blood clotting, and for keeping cells together (Samur, 2008).When the Ca concentration is examined, the results we find are in line with the values found in similar studies (Sesli, 2006; Sesli and Tuzen, 2006; Ayaz et al., 2011b; Akın et al., 2019; Bulam et al., 2019).

Sodium is very important for the continuation of nerve and muscle functions. Its main task is to provide liquid pumping and to allow food to pass through cell membranes. Excessive amounts of sodium contribute to high blood pressure. The values determined in terms of Na were found in the range of 752.5 - 2105.5 mg/kg (Ayaz et al., 2011), which is higher than the results.

Adequate iron level in a diet was reported to be very important in order to decrease the incidence of anemia (Uzun et al., 2011).It has been reported that there is no reported toxic effect of Fe element, especially in children, Fe element, which is taken too much, has a toxic effect and 60 mg/kg Fe intake may have a fatal effect (Kulhari et al., 2013). In studies with mushroom Fe concentration, 4.15-51.42 mg/kg (Sarıkürkçü et al., 2011), 211 - 628 mg/kg (Mendil et al., 2005), 319.2 - 379.1 mg/kg (Sevindik et al., 2015), 102 - 1580 mg/kg (Soylak et al., 2005), 173.1 - 5044 mg/kg (İlker et al., 2019) have been reported to vary with our findings.

Conclusion

Naturally grown mushroom species have different characteristics and nutritional content. Additionally, they have great importance for researchers, producers and consumers. The differences among the macrofungi species found in nature from the point of both visually and nutritional value have been proved their proportion in biodiversity. As a result, in this study, macro and micronutrient contents of seven natural fungal species were vary from each other. Additionally, *C. comatus*, *H repandum*, *C cibarius*, *P. eryngii* and *P. ostreus* species come to the fore in terms of heavy metals and nutrient content among the mushroom species included in the study. In conclusion, in this study, it was attempted to determine the changes of mineral content in seven wild mushroom species Ordu and Van/Türkiye. Therefore, in the light of the data obtained from this study, it was answered which fungus species are more valuable for human health It was concluded that *P. ostreatus* mushroom species was the richest in terms of nutrient content and *H. repandum* and *P. ostreatus* in terms of heavy metals. It is thought that it can be used as a resource in future studies.

Tablo 2 Heavy metal and mineral concentration

Heavy metal and mineral concentration (Avg. mean + std) mg/kg Dry weight							
	Cantharellus cibarius	***Lactarius glycosomes***	***Coprinus comatus***	***Hydnum repandum***	***Pleurotus eryngii***	***Lactarius delicious***	***Pleurotus ostreatus***
As	Nd	10.38±0.0015	4.86±0.003	1.5±0.002	10.21±0.0005	11.47±0.0025	17.43±0.002
Ba	2.97±0.0030	7.6±0.00031	3.76±0.00025	2.78±0.00015	3.98±0.0002	1.48±0.0004	10.81±0.0002
Cd	16.35±0.00013	Nd	4.52±0.00015	3.87±0.00005	1.4±0.0001	6.03±0.003	43.46±0.0003
Co	12±0.0002	32.25±0.0003	13.24±0.0002	Nd	19.11±0.0002	18.64±0.0002	42.79±0.0004
Cr	Nd	14.92±0.003	Nd	Nd	Nd	Nd	5±0.0003
Cu	143.45±0.003	104.65±0.00015	46.89±0.0025	49.49±0.0035	12.95±0.0027	26.4±0.0025	29.25±0.004
K	Nd	52680±0.85	Nd	Nd	30085±0.35	41665±0.3	46840±1.15
Mg	Nd	Nd	5056±0.045	Nd	Nd	Nd	5955.5±0.085
Mn	52.45±0.00035	187.25±0.002	57.53±0.00055	58.95±0.0007	88.15±0.002	104.05±0.001	177.9±0.004
Mo	1.22±0.00025	1.34±0.0003	57.53±0.00018	Nd	Nd	Nd	2.89±0.00015
Ni	119.67±0.0006	565.8±0.0008	131.45±0.00085	43.46±0.0002	62.93±0.0003	312.9±0.001	408.6±0.0015
Pb	1018.3±0.0135	1483.5±0.005	470.9±0.0015	334.4±0.003	318.9±0.0015	347.45±0.0035	488.05±0.0015
Sb	0.14±0.002	Nd	Nd	4.12±0.0015	1.2±0.001	1.56±0.001	Nd
Si	87.83±0.0165	55±0.01	3.18±0.015	Nd	Nd	Nd	36.98±0.01
Ti	37.15±0.00125	52.42±0.002	29.51±0.0001	20.32±0.0014	302.2±0.00085	30.2±0.001	183.35±0.0015
V	98.72±0.0045	80.58±0.003	101.58±0.0065	102.3±0.0045	86.02±0.002	100.54±0.005	67.66±0.0055
Zn	2422±0.008	1370.5±0.004	1451±0.003	1026.8±0.0025	1334±0.003	1679.5±0.0075	1382.5±0.003
Ca	580.5±0.0075	916.5±0.0395	1552.5±0.0215	411.5±0.0155	519.5±0.0025	851±0.0.0190	2077±0.0320
Na	1137.5±0.0215	1324±0.0230	2105.5±0.0105	1038±0.0530	906±0.0230	752.5±0.0625	1479.5±0.0105
Fe	470.5±0.0355	1009±0.0040	559±0.0030	258.5±0.0095	960±0.0140	478±0.0050	1093.5±0.0075

Author Contributions
All authors have equal contribution.

Conflicts of interest
The authors declare no competing interests.

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