Accumulation of Heavy Metals in Wild Mushrooms Found on Highways Around Ilaro, Ogun State, Nigeria.

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Abstract- ***The determination of heavy metals accumulation in mushrooms play important role in their dietary intake and therapeutic use. This study assessed the concentration of some heavy metals Zn, Fe, Ni, Pb, Hg, Cr, As, Cu, Mn, and Cd in different wild mushrooms collected from highways in Ilaro, Ogun State, Nigeria. Cortinarius cinnamomeus, Volvariella speciosa, Lepista nuda, Hypholoma fasciculare and Pleurotus florida were collected from highways around Ilaro and its environs. These mushroom species were air dried and digested using nitric acid/perchloric mixture (ratio 2:1). The result of the heavy metal concentrations in mg/kg ranged from 12.60±0.064 - 0.939±0.039 for Zn, 7.60±0.018 - 0.602±0.013 for Fe, 8.09±0.103 - 0.226±0.027 for Ni, 0.20±0.008 - 0.020±0.026 for Pb, 0.600±0.026 - 0.071±0.004 for Cr, 5.00±0.132 - 0.265±0.069 for Cu, 2.300±0.049 - 0.323±0.039 for Mn, 0.05±0.002 for Cd while Hg and As were not detected in all the mushroom samples. Zinc was the most predominant while lead was the least in all the samples. The metal concentrations in the samples were below WHO and FAO permissible limits. However, it is important to conduct frequent mushroom monitoring in order to safeguard the populace from ingesting heavy metal-laden mushrooms as food or medicine.***

Indexed Terms- ***Accumulation, Concentration, Food, Heavy Metal and Mushrooms.***

I. INTRODUCTION

Mushrooms are plant-like microorganisms that belong to a special group of fungi which are saprophytic in their life patterns. They lack chlorophyll and therefore cannot use sunlight in manufacturing their food. Their mode of nutrition is by producing large ranges of enzymes that can break down complex substances which absorb the soluble substances that is formed [1]. Mushrooms are consumed for many reasons such as their delicious tastes and medicinal values. They have become renowned as therapeutic foods due to their chemical composition, which have been used in the prevention of ailments such as hypertension, hypercholesterolemia, and cancer [2]. Some mushroom extracts have been investigated as prospective treatments for diseases such as cardiovascular disorders [3], while others exhibit antiviral, antibacterial, anti-parasitic, anti-inflammatory, and anti-diabetic properties [4]. Mushrooms include polysaccharides, glycoproteins, and proteoglycans, which have the ability to alter immune responses and suppress tumor growth [5]. *Pleurotus* species has been reported to have hypocholesterolemic, anti-atherogenic and anti-oxidant capabilities [6] [7]. In various studies *Pleurotus* species have been found to be effective in curing headache, stomach disorder, cold, fever, asthma and high blood pressure; other species are recommended to diabetes and anemic persons who have low carbohydrate and high folic acid content [8]. Millions of people in developing countries suffer from malnutrition and starvation [9]. Generally, mushrooms have been proven to be a highly source of sugar, protein, lipid vitamins, mineral and fibers which are used medicinally in the treatment of diarrhea, kwashiorkor, obesity, rheumatism and as a laxative [10] [11]. Before the invention of synthetic dyes, mushrooms were utilized as dyes, and they were also used to dye wool and other natural fabrics. Mushrooms, like green plants, are capable of bioaccumulating a variety of heavy metals in their fruity bodies, as some heavy metals are naturally present in the earth's crust. It has been studied that the mycelial structure in mushrooms can bioaccumulate many molecules [12]. When compared to plants, mushrooms can accumulate heavy metals such as

Cadmium, Mercury, Copper, and Lead, suggesting that mushrooms have a very effective mechanism for absorbing heavy metals from the soil [13].

Furthermore, mushrooms that grow in polluted environments near highways with heavy traffic, sewage sludge sites, and emission environments have been found to possess high amount of these heavy metals. Extremely high metal levels have been discovered in a metal smelting location or environment [14] [15]. The presence of heavy metals in water, air, soil, and living things is a major source of concern for public health, because they have a harmful effect on the environment and humans, and their removal is essential for environmental safety and health. The objectives of this study are to research on the assessments of local wild mushrooms in order to enlighten the local population about the safety of their consumption; to conduct a survey of different wild edible mushrooms around Ilaro Town in Southwest Nigeria; and to determine the concentration of heavy metals in wild mushrooms round Ilaro Town in Southwest Nigeria.

II. LITERATURE REVIEW

Mushrooms are collected or hunted in the wild for consumption and medicinal purposes. China has been the sources of many consumption of mushrooms, like *Auricularia auricula* (600 AD), *Flammulina velutipes* (800 AD), *Lentinula edodes* (1000AD) and *Tremella fuciformis* (18000AD). *Pleurotus ostreatus* (Jacq: Fr) Kumm was first grown in the United States of America in 1990, and *Agaricus bisporus* was first cultivated in France in 1960 [16]. While mushroom cultivation dates back to many centuries, it is only in the last 2-3 decades that there has been a significant expansion in research and knowledge that has led to the creation of major companies around the world [17].

Mushrooms are the fruiting bodies members of the Agaricales order, with the genus *Agaricus* and the species *Agaricus campestris*. Thus, according to contemporary molecular taxonomies, not every members of the order Agaricales can grow fruity bodies like mushrooms, and several other gilled fungi belong to the class Agaricomycetes. In Agaricales, the essential body of mushrooms are typical fungi like the common fairy-ring mushroom, enoki, shiitake, fly agarica, oyster mushrooms and other Amanitas. Lobster mushroom is a typical mushroom which is deformed, cooked-lobster-colored parasitized fruit body of a *Russula* or Lactarius, colored and deformed by the mycoparasitic Ascomycete *Hypomyces lactifluorum* [18]. Other non-gilled mushrooms are difficult to classify. Some have pores beneath them, which are known as boletes, while others, like the hedgehog mushroom and other tooth fungi, have spines. The term "mushroom" is more commonly used to refer to macroscopic fungal fruiting bodies than it is a taxonomic name. About 14,000 mushroom species have been identified [19].

High levels of heavy metals in any food substances or source can be extremely damaging to our health. Lead, Mercury, Arsenic and Cadmium are the worst kind of heavy metals to avoid if one needs to live a long and healthy life. For example, too much of Mercury in the body causes brain and kidney damage, as well as impair cognition. Lead has been linked to bone, heart and behavioural disorder. Arsenic is a known carcinogen that effectively disables the body's detoxification system and Cadmium has been linked to heart disease, skin and kidney disorders. In our modern environment, it can be difficult to avoid the toxic build-up of heavy metals; even organic food can be contaminated because there is no proper heavy metal regulation in place. Daniel-Umeri *et al.* investigated the heavy metal concentrations in five edible mushroom species: *Pleurotus ostreatus, Morchella deliciosa*, *Grifola Polypilus frondosa, Cantharellus cibarius* and *Agaricus bisporus*. The samples were examined for heavy metal concentrations such as Cd, Pb, Ni, Fe, and Zn. According to the authors, the variation in heavy metal concentrations could be due to differences in heavy metal composition, which was influenced by the ecosystem, as well as large differences in individual metal uptake by mushroom species. It was also discovered that the age of the fungi fruiting bodies, as well as their size, had little bearing on the accumulation of heavy metal by mushrooms. Fe and Zn had the largest concentration in all the samples under consideration ranging from 0.5781 - 134.013mg/kg. *Pleurotus ostreatus* had the highest Fe concentration of 134.013mg/kg, while *Morchella deliciosa* had the lowest Fe concentration of 0.5781mg/kg [20].

III. METHODOLOGY

The study area is Ilaro and its environs in Yewa South Local Government Area, Ogun State, Southwest, Nigeria. The samples were collected from the following location Papalato, Ilaro, Ibese, Oja Odan and Owode areas. Table 1 describes the wild mushroom species collected from Ilaro's highways while plates 1 – 5 show the images of the samples collected.

1. PREPARATION AND TREATMENT OF SAMPLES

The samples were washed with distilled water to remove the dust particles. They were dried in an open air for five days and were ground to powder by using industrial blender. The samples were then stored in polyethylene bags prior to acid digestion.

2. ACID DIGESTION AND METALS DETERMINATION

2.0g of the powered samples were introduced in the digestion vessel. 10 ml of nitric/perchloric acid; in ratio 2:1 was added to the sample and digested at 80^{o}C for 1hour until a transparent solution was observed. After cooling, the digested sample was filtered into a 100ml volumetric flask by using Whatman (No. 1) filter paper and the filtrate was diluted with distilled water in 100ml standard flask. The samples were analyzed for heavy metals using Atomic Absorption Spectrometer (Varian Spectra AA 200 Series).

Table 1: Wild Mushroom species collected from Ilaro's highways.

Location	Mushroom species	Class/ Subclass	Family	Edibility of Species
Ilaro – Owode road	*Cortinarius cinnamomeus*	Basidiomycetes / Agaricomycetes	Cortinariaceae	Unknown
Ilaro – Ibese road	*Volvariella speciosa*	Basidiomycetes / Agaricomycetes	Pluteaceae	Edible
Papalato road	*Lepista nuda*	Basidiomycetes / Agaricomycetes	Trichlomataceae	Choice
Old Sokoto (Oke-Ela) road	*Hypholoma fasciculare*	Basidiomycetes / Agaricomycetes	Strophariaceae	Poisonous
Itolu Village (Ilaro – Oja Odan road)	*Pleurotus florida*	Basidiomycetes / Agaricomycetes	Pleurotaceae	Edible

Source: Authors, (2020)

Plate 1: *Cortinarius cinnamomeus*, collected on the highway along Ilaro - Owode road.
Source: Authors, (2020)

Plate 2: *Volvariella speciosa*, collected on the highway along Ilaro - Ibese road.
Source: Authors, (2020)

Plate 3: *Lepista nuda,* collected on the highway along Papalato road.
Source: Authors, (2020)

Plate 4: *Hypholoma fasciculare,* collected on highway along Old Sokoto (Oke-Ela) road.
Source: Authors, (2020)

Plate 5: *Pleurotus florida,* collected on the highway in Itolu Village (Ilaro – Oja Odan road).
Source: Authors, (2020)

IV. RESULTS AND DISCUSSION

Accumulation of metals in wild mushrooms collected from highways in Ilaro was investigated. Zinc had the highest value of 12.600 mg/kg while zero levels of Mercury and Arsenic were recorded. Nickel and Iron also showed significantly high concentrations (Figure 1). *Hypholoma fasciculare* had the highest heavy metal concentration (12.600mg/kg) while *Lepista nuda* had the lowest concentration.

1. HEAVY METALS VALUES (MG/KG) OF THE MUSHROOM SAMPLES

The results of heavy metal accumulation in the various mushroom species are shown in Table 2. *Hypholoma fasciculare* had the highest accumulation of metals of 12.60 ± 0.064 mg/kg while the least accumulation of 0.020 ± 0.008 mg/kg was by *Lepista nuda*. Zinc highest accumulation of metal was observed to be 12.60 ± 0.006 mg/kg in *Hypholoma fasciculare* while the lowest was observed to be 0.939 ± 0.039 mg/kg in *Lepista nuda*. Iron highest accumulation of metal was observed to be 7.60 ± 0.018 mg/kg in *Hypholoma fasciculare* while the lowest was observed to be 0.602 ± 0.013 mg/kg in *Lepista nuda*. Nickel highest accumulation of metal was observed to be 8.90 ± 0.103 mg/kg in *Volvariella speciosa* while the lowest was observed to be 0.226 ± 0.027 mg/kg in *Cortinarius cinnamomeus.* Lead highest accumulation of metal was observed to be 0.20 ± 0.008 mg/kg in *Hypholoma fasciculare* while the lowest was observed to be 0.020 ± 0.026 mg/kg in *Lepista nuda* and lead was not detected in *Volvariella speciosa*. Chromium highest accumulation of metal was observed to be 0.60 ± 0.026 mg/kg in *Hypholoma fasciculare* while the lowest was observed to be 0.071 ± 0.004 mg/kg in *Lepista nuda*. Copper highest accumulation of metal was observed to be 5.0 ± 0.132 mg/kg in the control sample *Pleurotus florida* while the lowest was observed to be 0.265 ± 0.069 mg/kg in *Lepista nuda.* Manganese highest accumulation of metal was observed to be 2.30 ± 0.049 mg/kg in *Hypholoma fasciculare* while the lowest was observed to be 0.323 ± 0.039 mg/kg in *Cortinarius cinnamomeus.* Cadmium accumulation was not detected in any of the samples, with the exception of *Volvariella speciosa*, which had a concentration of 0.050 ± 0.002 mg/kg, whereas Mercury and Arsenic were not detected in the entire mushroom samples.

Table 2. Heavy metal concentrations in mushroom species from Ilaro Town Highway expressed in mg/kg.

Heavy Metals	*C. cinnamomeus*	*V. speciosa*	*L. nuda*	*H. fasciculare*	*P. florida*
Zinc (Zn)	2.0650	4.8000	0.9390	12.6000	1.5810
Iron (Fe)	0.9840	3.1000	0.6020	7.6000	0.7740
Nickel (Ni)	0.2260	8.9000	0.1630	1.2000	0.2740
Lead (Pb)	0.0650	0.0000	0.0200	0.2000	0.0970
Mercury (Hg)	0.0000	0.0000	0.0000	0.0000	0.0000
Chromium (Cr)	0.1450	0.1450	0.0710	0.6000	0.0970
Arsenic (As)	0.0000	0.0000	0.0000	0.0000	0.0000
Copper (Cu)	0.3550	1.8000	0.2650	3.9000	5.0000
Manganese (Mn)	0.3230	1.2000	0.1940	2.3000	0.3350
Cadmium (Cd)	0.0000	0.0050	0.0000	0.0000	0.0000

Source: Authors, (2020)

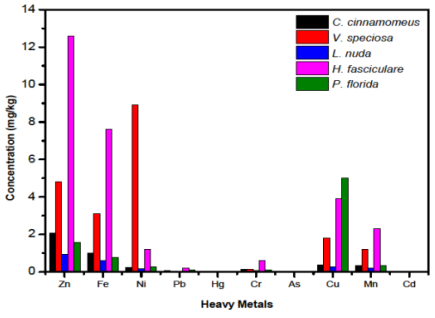

Figure 1: Heavy metals accumulation in wild mushroom along the Ilaro Town Highway.

CONCLUSION

This study revealed that the heavy metal accumulation by mushrooms is dependent on the mushroom species. It established the fact that different mushroom species have distinct biosorption efficiency for various heavy metals. These metals are generally essential for humans and may not cause health problems even if the mushrooms are consumed regularly because the quantities of heavy metals found in the samples were within the limits set by international organizations like the WHO/ FAO Expert Committee on Food Additives. These metals, on the other hand, are toxic to humans at higher concentrations; however, their concentrations were much below the permissible limits.

RECOMMENDATION

The present study reveals that mushrooms species from Ilaro, Yewa South Local Government of Ogun State, Nigeria are safe for human consumption and could be used as a good diet supplement in humans, due to low level of heavy metals. Macronutrient deficiency, as well as the consumption of inadequate staple foods, are the leading causes of death. Children, women, and the elderly are the ones that are most affected. As a result, mushrooms should be encouraged to be consumed in conjunction with other basic foods, particularly those found in a poor man's diet, as they have a high probability of alleviating malnutrition in the aforementioned vulnerable population.

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