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Therapeutic Evaluation and Mineral/Heavy Metal Content of *Pleurotus ostreatus*, an Edible Mushroom from Southeast Nigeria

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ABSTRACT

The therapeutic potential of *Pleurotus ostreatus* for use as an antibacterial agent and the mineral and heavy metal content were evaluated using the Agar diffusion method and X-ray Fluorescence Spectrometry using Skyray Energy Dispersive (EDXRF) EDX3600B (China) respectively. The extracts of the mushroom did not show any antibacterial effect against the tested organisms as no zone of inhibition was recorded in the agar plates. However, the mineral content showed that K had the highest concentration with a value of 15.9732 mg/kg dry weight and thus was the most abundant element in the sample while V had the least concentration of 0.0090 mg/kg. Others such as Mg, Al, Si, Ca, Fe, Ni, Cu, Zn, W, Rb, Nb, Mo had concentration range from 0.0216 to 0.9150 mg/kg. While, P, S, Sn and Sb concentrations ranged from 1.0404 to 3.1725 mg/kg. Heavy metals such as Ti, Cr, Mn, Co, As, Pb, Au, Ag, Cd were not detected. Therefore, the mushroom didn't possess any therapeutic value but a good nutritional value as it contained high amount of essential mineral elements and no potentially toxic heavy metals.

INTRODUCTION

Pleurotus ostreatus commonly called "Oyster mushroom" or Ero among the Igbo people of southeastern Nigeria is a species of mushroom widely found growing and cultivated in the tropical and subtropical regions of Nigeria, Asia and other parts of the world. They form part of the diet mostly prepared and consumed as soup because of their taste, flavor, nutritional values and medicinal properties [1].

In traditional medicine practice, the medicinal properties of mushrooms have been exploited particularly in Asia and is gaining acceptance in other countries of the world. Research findings have shown that the fruiting bodies and mycelium of *P. ostreatus* and other mushrooms contains a number of bioactive metabolites such as alkaloids, terpenoids, phenol etc with antibacterial activity [2, 3]. The oil from *P. ostreatus* has been reported to possess antimicrobial activity both Gram positive and Gram negative bacteria [4, 5].

In terms of its nutritional value, *P. ostreatus* is considered to be rich in protein (lectins, lignocellulolytic enzymes, proteases inhibitor and hydrophobins), fiber, carbohydrates, low fat, vitamins and minerals [6,7]. Their fruiting bodies contains high level of mineral constituents like copper, iron, potassium, magnesium, phosphorous, zinc and sodium [8, 9]. However, it has been shown that mushrooms have the ability to accumulate and concentrate high levels of heavy metals, toxic metallic elements, metalloids and radio nuclids in their mycelium, although the mechanism by which they adsorb these metals is still not known [10,11,12]. Thus, the content of metallic elements in many mushroom species is considerably higher than those found in fruits and vegetables [13]. While some of these metals such as Iron, Copper, Zinc and Manganese are essential elements in the lives of living organisms including humans, others such as lead, cadmium and aluminum particularly in high amounts are toxic and causes serious health damage to humans in the long term accumulation in their tissues [14]. Thus, the aim of this study was to evaluate and determine the antibacterial activity against common bacterial pathogens and heavy metal content of *P. ostreatus* obtained in Owerri, Imo state southeast Nigeria.

MATERIALS AND METHODS

Sample collection

The fungal sample *P. ostreatus* fruiting bodies were bought from Grocery shops in Owerri city, Imo State, southeast Nigeria in May 2019. The sample was air dried for 7 days and grinded into fine powder using an electric blender. The grinded mushroom sample was then stored in sample bottles for further analysis.

Antibacterial activity

The ground mushroom sample was weighed and 100g were soxhlet extracted using 500mL of ethanol, methanol and acetone solvents respectively and the extracts were concentrated in a rotary evaporator. The antibacterial activity of the extracts were tested against *Escherichia coli, Staphylococcus aureus, Klebsiella sp, Pseudomonas aeruginosa* and *Enterococcus sp* using the agar diffusion method. Mueller Hinton agar plates were seeded with 0.2 ml of the standardized inoculums ($1x10^7$ CFU/mL) of the organism in tryptone soy broth. This was uniformly spread with the aid of a sterile glass spreader. The seeded plates were allowed to dry in the incubator at 37°C for 20 minutes. A standard cork borer of the 7mm diameter was used to make wells on the surface of the agar into which was added 0.5 ml dilution of each extract. Tetracycline was used as control. The plates were incubated at 37^{o}C for 24h after which, diameters of zones of inhibition were measured. Results were average of triplicate experiments.

Heavy Metal Analysis

Metal analysis of the mushroom sample was determined by X-ray Fluorescence Spectrometry using Skyray Energy Dispersive (EDXRF) EDX3600B [15].

Data Analysis

Data analysis was done using the t-test. Each experiment was conducted in triplicate and repeated individually at least three times. The results are presented as mean and Standard Deviation. SPSS software was used for data analysis. A significance level of a = 0.05 was adopted for statistical hypothesis testing.

RESULTS

Antibacterial activity

The antibacterial effect of the mushroom extracts was evaluated and was shown not to have any antibacterial effect against all test organisms. There was no recorded zone of inhibition in the agar diffusion test and no growth inhibition was recorded in the broth dilution test. This shows that the *P. ostreatus* extracts had no antibacterial activity.

Mineral and heavy metal analysis

The results of the mineral and heavy metal content of the mushroom is presented in Table 1. From the results, K had the highest concentration with a value of 15.9732 and thus was the most abundant element in the sample while V had the least concentration of 0.0090. Others such as Mg, Al, Si, Ca, Fe, Ni, Cu, Zn, W, Rb, Nb, Mo had concentration ranges of 0.0216 to 0.9150. While, P, S, Sn and Sb concentrations ranged from 1.0404 to 3.172. Ti, Cr, Mn, Co, As, Pb, Au, Ag, Cd were not detected as they recorded 0.00 values. The energy dispersive x-ray spectra of the sample showing the intensity peaks of the various mineral/heavy metals is shown in Fig 1.

Table No. 1: Mineral and heavy metal concentration (mg kg^{-1} d.w.) of *P. ostreatus*

Elements	Intensity	Content
Mg	0.0004	0.4743
P	0.0343	1.6406
S	0.0322	3.1725
K	0.1959	15.9732
Ca	0.0074	0.1261
Mn	0.0001	0.0000
Fe	0.0015	0.2187
Cu	0.0023	0.0609
Zn	0.0065	0.2245
Mo	0.0023	0.2265
AI	0.0029	0.9150
Ti	0.0000	0.0000
V	0.0002	0.0090
Cr	0.0001	0.0000
Co	0.0001	0.0000
Ni	0.0011	0.0659
As	0.0000	0.0000
Pb	0.0000	0.0000
W	0.0010	0.3601
Au	0.0000	0.0000
Ag	0.0000	0.0000
Rb	0.0084	0.0875
Nb	0.0022	0.0216
Cd	0.0000	0.0000
Si	0.0052	0.4293
Sn	0.0064	1.1920
Sb	0.0083	1.0404

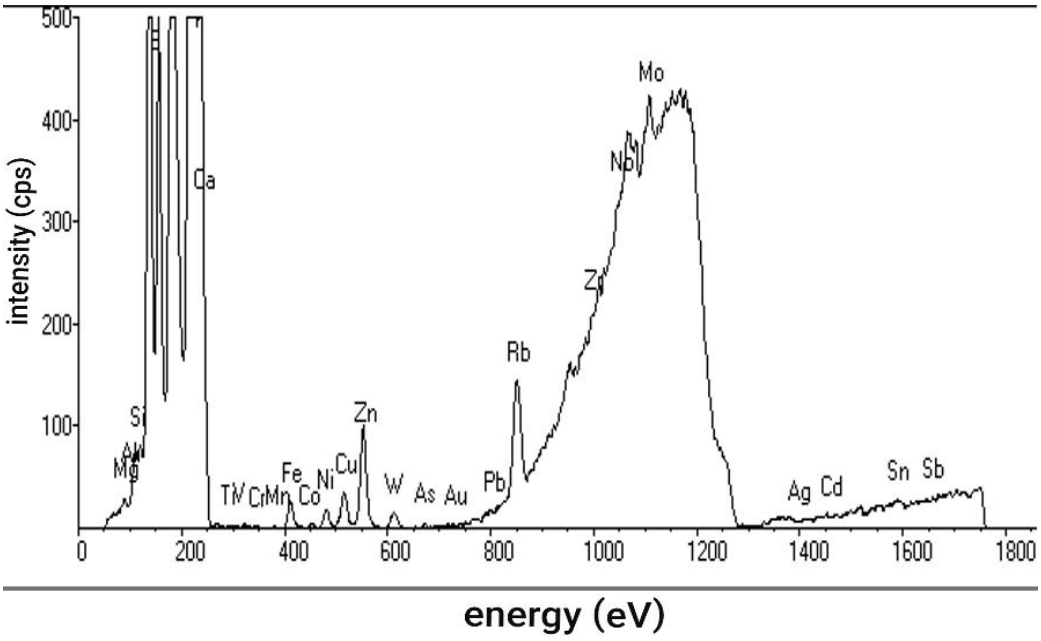

Figure 1: Energy dispersive X-ray fluorescence spectra of *P. ostreatus*

DISCUSSION

The antibacterial activity, mineral and metal content of *P ostreatus*, commonly called Ero, a mushroom from southeast Nigeria was studied. In the antibacterial studies, the mushroom sample didn't demonstrate any antibacterial activity against any of the tested organisms. This finding differed from some other previous reports of *P. ostreatus* possessing broad spectrum antibacterial activity [4,16]. However, this result may be attributed to and maybe dependent on the type of organisms tested, or the mushroom species may not possess the requisite antimicrobial substances such as phenols and tannin etc contained in other active ones [17]. It could also be as a result of the concentration of the mushroom used. Whatever the reason, the mushroom sample tested in this study did not possess antibacterial activity. This is understandable as not every species of mushroom is therapeutic and so maybe grown or used solely for dietary and nutritional purpose.

The mineral content of the test mushroom shows that they had more macro elements of K, S, P, Mg and Ca with K being the most abundant followed by other trace or microelements of Fe, Cu, Zn, Mo. This is in agreement with literature which states that potassium alone forms 45% of the total ash of mushroom while other macro elements make up about 70% [16]. The concentrations recorded in our study were far lower than those reported by previous researchers, but are within the WHO standard for mineral elements daily intake [18].

Mushroom has been reported to have the ability to accumulate heavy metals such as Pb, Cr, Cd, Ni, As etc. These metals have been known to be poisonous and toxic to human tissues. However, metals such as Cr, Co, As, Pb, Au, Ag, Cd and Ti regarded as toxic metals were not detected in the mushroom. This may be as a result of the substrate used in the cultivation and on the fact that these mushrooms may have be cultivated by the farmers rather than being harvested from the wild [19]. Other metals such as Al, Ni, Rb, Sn etc evaluated had values within the acceptable WHO limits for daily intake of between 0.06 to 0.214 mg.

CONCLUSION

In conclusion, the mushroom *P. ostreatus* gotten from grocery shop doesn't possess any antibacterial activity but contains a good amount or quantity of essential mineral elements with no detected levels of heavy metals toxic and poisonous to humans and animals. Therefore, the mushroom wouldn't serve a therapeutic purpose but a good food product.

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DECLARATION OF COMPETING INTEREST

The author declare that there is no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

[1] Akpaja EO, Nwogu NA, Odibo EA. Effect of some heavy metals on the growth and development of Pleurotus tuber-regium. Mycosphere. 2012; 3: 57-60

[2] Lindequist U, Niedermeyer THJ, Julich WD. The pharmacological potentials of mushrooms. Evid Based Complement Alternat Med. 2005; 2:285-299

[3] Prasad S, Rathore H, Sharma S, Yadav AS. Medicinal Mushrooms as a Source of Novel Functional Food. Int J Food Sci Nutr Diet. 2015; 4: 221-225.

[4] Iwalokun BA, Usen UA, Otunba AA, Olukoya DK. Comparative phytochemical evaluation, antimicrobial and antioxidant properties of *Pleurotus ostreatus*. Arf J Biotechnol. 2007; 6 (15): 1732-1739

[5] Karaman M, Jovin E, Malbasa R, Matavuly M, Popovie M. Medicinal and edible lignicolous fungi as natural source of antioxidative and antibacterial agents. Phytother Res. 2010; 24: 1473-1481.

[6] Herndndez D, Sanchez JE, Yamasaki K. A simple procedure for preparing substrate for *P. ostreatus* cultivation. Bioresour Technolo. 2003; 90:145-150

[7] Kalmis E, Nuri A, Hasan Y, Fatin K. Feasibility of using olive mill effluent (OME) as a wetting agent during the cultivation of oyster mushroom, *Pleurotus ostreatus* on wheat straw. Bioresour Technolo. 2008; 99:164-169

[8] Vetter J. Mineral elements in the important cultivated mushroom *Agaricus bisporous* and *Pleurotus ostreatus*. Food Chem. 1994; 50(3): 277-279

[9] Watanable T, Tsuchinasi N, Takai Y, Tanaka K, Suzuki A. Effect of ozone exposure during cultivation of oyster mushroom *Pleurotus ostreatus* on chemical components of the fruit bodies. J Jpn Soc Food Sci Technol. 1994; 41(10): 705-708

[10] Kalač P. Areview of edible mushroom radioactivity. Food Chem. 2001; 75: 29–35.

[11] Vetter J. 2004: Arsenic content of some edible mushroom species. Eur Food Res Technol. 2004; 219: 71–74.

[12] Campos JA, Tejera NA. (2009): Substrate role in the accumulation of heavy metals in sporocarps of wild fungi. Biometals. 2009; 22: 835–841.

[13] Turkdogan KM, Kilicel F, Kara K, Tuncer I, Uygan I. Heavy metals in soil, vegetables and fruits in the endemic upper gastrointestinal cancer region of Turkey. Environ Toxicol Phar. 2003; 13: 175–179.

[14] Gebrelibanos M, Megersa N, Taddesse AM. Levels of essential and non-essential metals in edible mushrooms cultivated in Haramaya, Ethiopia. Int. J.Food Contam. 2016; 3:2.

[15] Duru CE, Enedoh MC, Duru IA. (2019). Physicochemical Assessment of Borehole water in a Reclaimed Section of Nekede Mechanic Village, Imo State, Nigeria. Chemistry Africa. 2019; (https//doiorg/10.1007/s42250-019-00077-8).

[16] Deepalakshmi K, Mirunalini S. *Pleurotus ostreatus*: an oyster mushroom with nutritional and medicinal properties. J. Biochem. Tech. 2014; 5(2):718-726

[17] Kosanić M, Ranković B, Aleksandar RA, Stanojković T. Evaluation of metal contents and bioactivity of two edible mushrooms *Agaricus campestris* and *Boletus edulis.* Emirates Journal of Food and Agriculture. 2017; 29(2): 98-103.

[18] FAO/WHO standards. Expert Committee on Food Additives, Summary and Conclusions. In: 53rd Meeting 1999; Rome.

[19] Širić I, Kasap A, Kos I, Markota T, Tomić D, Poljak M. (2016). Heavy Metal Contents and Bioaccumulation Potential of Some Wild Edible Mushrooms. Šumarski list. 2016; 1–2: 29–37.