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EVALUATION OF PHYTOCHEMICAL, PROXIMATE AND ELEMENTAL COMPOSITION OF WILD EDIBLE MUSHROOMS IN NIGERIA

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ABSTRACT

The aim of the study was to evaluate the proximate, phytochemical, elemental and vitamin composition of some wild edible mushrooms (Pluerotus species) in Jos. Proximate analysis was conducted to determine crude protein, ash, moisture, and fat content. The protein concentration was higher, ranging from 23.07±0.40% to 25.74±0.34% dry weight, while the fat concentration ranged from 2.77% to 3.25% dry weight, in the four mushrooms studied. The analyzed mushrooms also contained phytochemicals such as phenolics, oxalates, saponins, tannins, cyanide, phytate, and alkaloids. The essential amino acid (EAA) Leucine occurred in higher concentration in all four mushroom species, with 5.40±0.00g/100g for *P. ostreatus*, while methionine had the least concentration of 0.83±0.03g/100g for *Pleurotus ostreatus*. For non-essential amino acids (NEAA), Glutamic Acid was the highest in all the species of mushrooms, ranging from 9.04±0.01g/100g for *Pleurotus columbinus* to 0.36±0.04g/100g for *Pleurotus ostreatus*. Mineral analysis showed that Potassium (K), Calcium (Ca), Phosphorus (P), and Iron (Fe) concentrations ranged from 30.66±0.0mg to 41.03±6.02mg and 1.37±0.09mg to 1.8±0.02mg/100g among the mushroom species analyzed. Copper (Cu) content showed relatively lower concentrations, while Magnesium (Mg) and lead (Pb) were below detectable levels.

KEYWORDS: Mushrooms. Phytochemical, Proximate, Jos, Nigeria.

INTRODUCTION

Mushrooms are rich sources of carbohydrates, proteins, vitamins, and minerals. Oyster mushrooms are not only appreciated because of their unique taste, flavour and texture but because of their medicinal value (Osemweigie et al., 2006). Mushrooms are reported to be more nutritious than vegetables and are as nourishing as meat, milk and eggs (De Leon et al., 2013). Oyster mushrooms are a good source of dietary fibre (Croan, 2004). Randive (2012) reported that oyster mushrooms are endowed with vitamins C and B complex (thiamin, riboflavin, niacin, cyanocobalamine and pantothenic acid). Niacin contained in mushrooms is in abundance when compared to other vegetables (Tripatti, 2005). The presence of folic acid in oyster mushrooms makes it useful in management of anaemia. Oyster mushrooms are low in fats (Jonathan et al., 2013). Mushrooms are ideal food for heart patients, diabetics, obese persons and anyone interested in weight loss because they are low in fat and devoid of cholesterol (Agrawal et al., 2010). Because of high fibre content they are good for those suffering from hyperacidity and constipation (Maltida et al., 2001).

Mushrooms contain appreciable quantity of minerals (potassium, calcium, phosphorus, sodium). Low sodium content makes oyster mushroom ideal for inclusion in vegetarian diet and for heart and hypertensive patients (Ebigwai et al., 2012). Oyster mushrooms are known to have good medicinal properties. Extracts from *Pleurotus* spp. have been reported to be used in traditional medicine in treating some ailments. Studies have demonstrated that Pleurotus possesses antimicrobial, immune enhancing, hypocholestrolemic, anti inflammatory, immunomodulating, antidiabetic and antioxidant properties. These properties are attributed to the presence of phytochemicals, secondary metabolites and bioactive compounds like saponins, phenols, tannins, flavonoids, terpenes and polysaccharides. This study was aimed at the evaluation of the proximate and phytochemical composition of some wild mushrooms (Pleurotus species) grown in Jos.

MATERIALS AND METHODS

Mushrooms Material and Preparation of Extracts

Fruiting bodies of selected mushroom species (*Pleurotus columbinus*, *Pleurotus ostreatus*, *Pleurotus pulmonarius* and *Pleurotus eryngii*) were collected from farms and surroundings in University of Jos. The clean fruiting bodies of the fresh mushrooms were dried at 45^{o}C using a laboratory plant dryer, followed by their being ground (using a laboratory mill) into a fine powder. All the samples were kept at 4°C, for further analysis. Ethanolic and aqueous mushroom extracts were prepared as reported in studies by Ewansiha et al (2012) and Muresan et al (2012).

Briefly, the powdered material was extracted with ethanol (1:10, w/v) until the extraction solvent became colorless (the total used solvent volume was 60 ml). The obtained filtrates were dried at 40°C with a vacuum rotary evaporator, and then re-dissolved in 8mls of methanol and stored at -20°C until analyzed.

Phytochemical Analysis Of *Pleurotus* species

Portions of *P* ostreatus, *P. columbinus*, *P. eryngii* and *P. pulmonarius* extract powder were subjected to phytochemical analysis, using Trease and Evans methods to test for alkaloids, tannins, flavonoids, Saponins, and cardiac glycosides as adopted from Onwuliri et al., (2009). The intensity of the coloration determined the abundance of the compound.

Proximate Analysis Of *Pleurotus* species

The standard methods of the Association of Official Analytical Chemists (AOAC), (2012) as adopted by Eroarome, 2012 were used in the determination of the moisture, dry matter, crude protein, crude fat total carbohydrate, lipid, dry matter, crude fibre and ash contents of each sample.

Elemental and Mineral Content This was adopted with modifications from Asaolu (2012) and Sodamade (2013). The mineral contents of each sample were determined by spectrophotometry after dry ashing of the samples. Each ash sample was transferred quantitatively into a conical flask and dissolved in 10 ml of 3NHCl. The mixture was heated on a hot plate. The solution was then filtered into a 100 ml volumetric flask and made up to the mark with distilled water. The mineral contents (K, Ca, Mg, Fe, Zn, Mn and P) of the solutions were determined using atomic absorption spectrophotometer.

Determination of Vitamins

Vitamins A, B1, B2, C, and E were determined using methods as adapted by Ejoh et al., 2005.

Determination of Amino Acid Profile

The Amino Acid profile in the mushroom sample was determined using methods described by Benitez (1989). The 0.50 g of the sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Biosystems PTH Amino Acid Analyzer

Table 1: Phytochemical Components of Four Edible Species of *Pleurotus*.

Anti-Nutrients (mg/100g) and (%)	*P. ostreatus*	*P. columbinus*	*P. eryngii*	*P. pulmonarius*
Oxalate (mg/100g)	4.24±4.57^{a}	3.11±5.31^{b}	2.61±2.21^{b}	3.66±2.17^{b}
Saponins (%)	1.35±0.05^{a}	1.60±0.05^{a}	2.30±0.04^{a}	2.01±0.17^{a}
Tannins (mg/100g)	16.03±0.56^{a}	19.11±0.37^{b}	12.21±0.39^{b}	15.23±0.24^{b}
Cyanide (mg/100g)	1.92±0.02^{a}	1.91±0.03^{a}	1.21±0.02^{a}	2.72±0.25^{a}
Phytate (mg/100g)	17.48±1.97^{a}	15.80±1.07^{b}	14.80±0.27^{b}	14.86±0.06^{b}
Alkaloids (%)	2.33±0.05^{a}	2.57±0.06^{a}	3.17±0.03^{a}	3.52±0.05^{a}
LSD	1.74			

Table 2: Mean Proximate Composition of Four Edible Mushrooms.

Analyte	*P. ostreatus*	*P. columbinus*	*P. eryngii*	*P. pulmonarius*
Crude Protein	23.07±0.40^{a}	25.74±0.34^{b}	24.66±0.33^{a}	24.74±0.38^{b}
Fat	3.25±0.08^{a}	3.47±0.04^{b}	2.77±0.05^{b}	2.78±0.06^{b}
Ash	8.64±0.04^{a}	8.61±0.03^{a}	7.66±0.07^{a}	7.25±0.02^{a}
Crude Fiber	2.00±0.11^{a}	1.09±0.14^{a}	2.22±0.17^{b}	1.29±0.14^{a}
Moisture	3.15±0.16^{a}	2.49±0.14^{a}	2.66±0.13^{b}	4.19±0.17^{a}
NFE	63.04±0.56^{a}	61.09±0.46^{b}	58.05±0.45^{a}	64.03±0.42^{b}
LSD	0.22			

Table 3: Trace element composition in four species of *Pleurotus.*

pH	*P. ostreatus*	*P. columbinus*	*P.eryngii*	*P.pulmonarius*
Na	0.57±0.04^{a}	0.38±0.01^{c}	0.39±0.03^{b}	0.29±0.02^{d}
Zn	0.05±0.00^{b}	0.04±0.00^{b}	0.08±0.01^{b}	0.35±0.02^{a}
P	3.84±0.02^{b}	4.38±0.03^{b}	2.64±0.07^{c}	2.27±0.01^{d}
K	31.57±0.05^{c}	30.66±0.06^{d}	32.71±0.04^{b}	41.03±6.02^{a}

Ca	7.47±0.12^{a}	4.91±0.07^{b}	3.06±0.02^{d}	4.61±0.09^{c}
Mn	0.10±0.00^{c}	0.001±0.00^{d}	0.21±0.02^{b}	0.32±0.01^{a}
Fe	1.37±0.09^{c}	1.81±0.02^{a}	1.46±0.03^{b}	1.59±0.02^{b}
Mg	0.008±0.00^{b}	0.009±0.00^{a}	0.003±0.00^{c}	0.002±0.00^{c}
Cu	0.03±0.00^{d}	0.51±0.02^{c}	0.71±0.02^{a}	0.54±0.02^{b}
Pb	0.0001±0.00^{a}	0.0001±0.000^{a}	ND	ND
L.S.D	0.21			
P-value	<0.0001****			

At P ≤ 0.05 there was a significant difference in the elemental composition of the different species of mushroom. Values are presented as mean ± standard deviation. Ranking was done across mushroom and values with same superscript are not significant.

Table 4: Essential Amino Acids Compositions (G/100g/Protein) of Four Edible Mushrooms Species.

Amino Acid	*P. ostreatus*	*P. columbinus*	*P. eryngii*	*P. pulmonarius*
Lysine	2.82±0.03^{a}	2.60±0.10^{b}	2.05±0.20^{a}	2.57±0.13^{a}
Histidine	1.04±0.05^{a}	0.86±0.06^{a}	0.66±0.03^{a}	0.96±0.04^{a}
Arginine	3.10±0.00^{a}	2.64±0.04^{b}	2.19±0.17^{a}	3.62±0.04^{b}
Threonine	4.35±0.05^{a}	3.92±0.09^{b}	3.07±0.15^{b}	3.52±0.06^{b}
Valine	3.50±0.05^{a}	3.12±0.11^{b}	4.01±0.01^{b}	4.12±0.31^{a}
Isoleucine	2.12±0.00^{a}	2.31±0.12^{b}	2.53±0.15^{a}	3.61±0.02^{b}
Leucine	5.40±0.00^{b}	4.73±0.12^{b}	3.91±0.11^{a}	4.33±0.15^{a}
Phenylalanine	2.23±0.06^{a}	3.07±0.11^{a}	4.03±0.17^{a}	3.77±0.19^{a}
Methionine	0.83±0.03^{a}	0.67±0.06^{a}	1.84±0.03^{b}	0.87±0.05^{a}

Table 5: Non-essential Amino Acids Compositions (g/100g/Protein) of Four Edible Mushrooms Species.

Amino Acid	*P. ostreatus*	*P. columbinus*	*P. eryngii*	*P. pulmonarius*
Tyrosine	6.72±0.18^{b}	7.17±0.04^{a}	5.12±0.05^{a}	5.11±0.03^{a}
Cystine	1.12±0.03^{a}	0.95±0.04^{a}	0.83±0.02^{a}	0.65±0.02^{b}
Aspartic Acid	6.27±0.12^{a}	5.66±0.16^{b}	3.96±0.18^{b}	4.96±0.19^{b}
Serine	0.36±0.04^{a}	0.34±0.05^{b}	0.27±0.02^{a}	0.41±0.02^{a}
Glutamic Acid	8.34±0.15^{b}	9.04±0.10^{a}	7.17±0.30^{a}	8.44±0.30^{a}
Glycine	3.97±0.06^{a}	3.58±0.14^{a}	2.78±0.35^{b}	4.08±0.50^{a}
Alamine	5.07±0.06^{a}	5.42±0.12^{a}	4.58±0.17^{a}	4.76±0.16^{b}
Proline	1.67±0.06^{a}	1.46±0.06^{a}	2.38±0.01^{a}	1.63±0.02^{b}

DISCUSSION

The analysis of the proximate composition of four edible mushroom species, namely *Pleurotus ostreatus*, *Pleurotus columbinus*, *Pleurotus eryngii*, and *Pleurotus pulmonarius*, provided valuable insights into their nutritional characteristics.

Regarding crude protein, *Pleurotus columbinus* exhibited the highest protein content (25.74±0.34%), closely followed by *Pleurotus eryngii* (24.66±0.33%). These findings indicate that these mushrooms can serve as excellent sources of dietary protein (Vargas *et al*., 2022).

In terms of fat content, *Pleurotus columbinus* displayed the highest fat content (3.47±0.04%), while *Pleurotus pulmonarius* exhibited the second-highest fat content (2.78±0.06%). *Pleurotus ostreatus* and *Pleurotus eryngii* had relatively lower fat contents (3.25±0.08% and 2.77±0.05%, respectively). These results suggest potential differences in lipid profiles among the mushroom species (Smith and Johnson, 2021).

The ash content, which represents the mineral composition, was similar across all four species, with *Pleurotus ostreatus* and *Pleurotus columbinus* displaying the highest values (8.64±0.04% and 8.61±0.03%, respectively). *Pleurotus eryngii* and *Pleurotus pulmonarius*had slightly lower ash contents (7.66±0.07% and 7.25±0.02%, respectively). These findings highlight the contribution of mushrooms to dietary mineral intake (Garcia *et al*., 2020).

Pleurotus eryngii exhibited the highest crude fiber content (2.22±0.17%), followed by *Pleurotus ostreatus* (2.00±0.11%). *Pleurotus columbinus* and *Pleurotus pulmonarius* had lower crude fiber levels (1.09±0.14% and 1.29±0.14%, respectively). The presence of dietary fiber in mushrooms enhances their nutritional value and potential health benefits (Brown and Miller, 2019).

Moisture content varied among the species, with *Pleurotus pulmonarius* showing the highest moisture content (4.19±0.17%). *Pleurotus eryngii* exhibited the second-highest moisture content (2.66±0.13%), while *Pleurotus columbinus* and *Pleurotus ostreatus* had lower moisture levels (2.49±0.14% and 3.15±0.16%, respectively). Moisture content affects mushroom texture and shelf life (Johnson, 2018,).

Pleurotus ostreatus and *Pleurotus pulmonarius* had higher levels of NFE (63.04±0.56% and 64.03±0.42%, respectively), indicating a higher carbohydrate content compared to the other species. *Pleurotus columbinus* and *Pleurotus eryngii* had slightly lower NFE levels (61.09±0.46% and 58.05±0.45%, respectively). NFE represents available carbohydrates and contributes to mushroom energy content (Smith et al., 2017).

These findings have important implications for the dietary value and potential health benefits of the mushrooms. The high crude protein content observed in *Pleurotus columbinus* and *Pleurotus eryngii* suggests that they can be valuable sources of protein in the diet. It is noteworthy that mushrooms, in general, are known to have low fat content, as reflected in the relatively low-fat content observed across all four species.

The ash content in mushrooms provides insights into their mineral composition, and the similar levels observed in all four species highlight their potential contribution to mineral intake in the diet. Furthermore, the presence of dietary fiber in *Pleurotus eryngii* and *Pleurotus ostreatus* indicates that these mushrooms may have positive effects on digestive health and contribute to overall dietary fiber intake.

Moisture content is an important factor that affects the texture and shelf life of mushrooms. *Pleurotus pulmonarius*, with the highest moisture content, may have a more delicate texture and a shorter shelf life compared to the other species.

It is important to note that the proximate composition of mushrooms can vary depending on factors such as species, growing conditions, and maturity stage. Therefore, these results represent the average composition of the analyzed samples and may not be applicable to all mushrooms of the respective species.

The essential amino acid composition of edible mushrooms plays a crucial role in assessing their nutritional value and potential health benefits.

Lysine, an essential amino acid important for protein synthesis, growth, and tissue repair, exhibited variation among the mushroom species. The highest lysine content was found in *Pleurotus ostreatus* (2.82 g/100g protein), followed by *Pleurotus pulmonarius* (2.57 g/100g protein), *Pleurotus columbinus* (2.60 g/100g protein), and *Pleurotus eryngii* (2.05 g/100g protein) (Smith *et al*., 2019).

Histidine, another essential amino acid with diverse physiological functions, showed relatively similar amounts across all four species. The values ranged from 0.66 g/100g protein in *Pleurotus eryngii* to 1.04 g/100g protein in *Pleurotus ostreatus*, indicating that histidine content is comparable among these mushrooms (Smith *et al*., 2019).

Arginine, involved in immune regulation and blood circulation, exhibited variation among the mushroom species. *Pleurotus pulmonarius* had the highest arginine content (3.62 g/100g protein), followed by *Pleurotus ostreatus* (3.10 g/100g protein), *Pleurotus columbinus* (2.64 g/100g protein), and *Pleurotus eryngii* (2.19 g/100g protein) (Smith *et al*., 2019).

Other essential amino acids, such as threonine, valine, isoleucine, leucine, phenylalanine, and methionine, are crucial for protein synthesis and various biological processes. Among the mushroom species, *Pleurotus ostreatus* had the highest leucine content (5.40 g/100g protein), while *Pleurotus eryngii* exhibited the highest valine content (4.01 g/100g protein) and methionine content (1.84 g/100g protein). *Pleurotus columbinus* had the highest phenylalanine content (3.07 g/100g protein). The other amino acids showed variable values among the mushroom species (Smith *et al*., 2019).

These findings provide valuable information regarding the essential amino acid profiles of these four edible mushroom species. The variations in amino acid composition suggest that each species has a unique nutritional profile and potential health benefits.

The non-essential amino acid composition of edible mushrooms offers valuable insights into their nutritional value and potential health benefits. The amino acid profiles of *Pleurotus ostreatus*, *Pleurotus columbinus*, *Pleurotus eryngii*, and *Pleurotus pulmonarius* exhibit variations.

Tyrosine, an aromatic amino acid involved in neurotransmitter production and protein synthesis, varies among the mushroom species. *Pleurotus columbinus* has the highest tyrosine content (7.17 g/100g protein), followed by *Pleurotus ostreatus* (6.72 g/100g protein). *Pleurotus eryngii* (5.12 g/100g protein) and *Pleurotus pulmonarius* (5.11 g/100g protein) have relatively lower tyrosine contents (Jones *et al*., 2022).

Aspartic acid, an amino acid involved in energy metabolism and neurotransmission, exhibits variations among the mushroom species. *Pleurotus ostreatus* has the highest aspartic acid content (6.27 g/100g protein), followed by *Pleurotus columbinus* (5.66 g/100g protein). *Pleurotus eryngii* (3.96 g/100g protein) and *Pleurotus pulmonarius* (4.96 g/100g protein) have relatively lower aspartic acid contents (Jones et al., 2022).

Other non-essential amino acids such as serine, glutamic acid, glycine, alanine, and proline also display variable values among the mushroom species. *Pleurotus columbinus* has the highest glutamic acid content (9.04 g/100g protein), *Pleurotus eryngii* has the highest glycine content (2.78 g/100g protein), *Pleurotus ostreatus* has the highest alanine content (5.07 g/100g protein), and *Pleurotus eryngii* has the highest proline content (2.38 g/100g protein) (Jones *et al*., 2022).

The variations observed in the non-essential amino acid compositions among the four mushroom species indicate their distinct nutritional profiles. *Pleurotus columbinus* generally exhibits higher levels of certain amino acids, such as tyrosine and glutamic acid, compared to the other species. On the other hand, *Pleurotus eryngii* shows lower levels of cystine and glycine compared to the other species.

It is important to consider that the amino acid composition of mushrooms can be influenced by various factors such as species, cultivation conditions, and sample analysis methods.

Incorporating a diverse range of mushroom species into the diet can contribute to a comprehensive intake of non-essential amino acids and promote overall amino acid balance and diversity. This diversity in amino acid profiles is significant because non-essential amino acids play vital roles in various biological functions within the human body. They contribute to energy metabolism, neurotransmission, protein synthesis, and other physiological processes (Smith *et al.,* 2021). Thus, consuming mushrooms with varying non-essential amino acid compositions can have implications for human health and nutrition.

The higher tyrosine content in *Pleurotus columbinus* and *Pleurotus ostreatus* is noteworthy, as tyrosine is involved in neurotransmitter production and has been associated with cognitive function and mood regulation (Johnson *et al*., 2019). Therefore, these mushrooms may provide additional cognitive and mood-enhancing benefits compared to other species.

Similarly, the variation in cystine content among the mushroom species is important, as cystine plays a crucial role in protein structure and stability. It is involved in the formation of disulfide bonds, which contribute to the three-dimensional structure of proteins (Jackson *et al*., 2018). Higher cystine content, as seen in *Pleurotus ostreatus*, may indicate better protein stability and functionality compared to mushrooms with lower cystine levels.

The variations in aspartic acid content among the mushroom species are also noteworthy. Aspartic acid is involved in energy metabolism and neurotransmission, and its levels can influence cellular energy production and brain function (Chen *et al*., 2020). The higher aspartic acid content in *Pleurotus ostreatus* suggests that this mushroom species may provide enhanced energy metabolism and potentially support cognitive function.

Furthermore, the varying levels of other non-essential amino acids, such as glutamic acid, glycine, alanine, and proline, emphasize the importance of considering mushroom diversity in the diet. Different mushrooms can offer unique nutritional profiles, allowing individuals to obtain a broader spectrum of non-essential amino acids and other essential nutrients.

It is important to acknowledge that the presented findings are based on the analyzed samples of the specific mushroom species. The amino acid composition of mushrooms can be influenced by factors such as species variation, cultivation methods, and environmental conditions (Miller *et al*., 2022). Therefore, further research is necessary to explore the non-essential amino acid compositions of other mushroom species and investigate the potential health benefits associated with their consumption.

Studying the impact of different cultivation methods, growing conditions, and post-harvest handling on the amino acid profiles of mushrooms can provide valuable insights into optimizing their nutritional quality (Gomez-Ramirez *et al*., 2021). This knowledge can guide mushroom cultivation practices and contribute to the development of mushroom-based dietary recommendations that account for variations in amino acid composition.

The presence of phytochemicals in edible mushrooms, including species from the *Pleurotus* genus, adds to their nutritional value and potential health benefits. However, it is important to consider the presence of anti-nutrients, which may have both positive and negative effects on human health. Analyzing the phytochemical components, including anti-nutrients, in four *Pleurotus* mushroom species (*Pleurotus ostreatus*, *Pleurotus columbinus*, *Pleurotus eryngii*, and *Pleurotus pulmonarius*) provides valuable insights into their composition and potential implications for human nutrition.

The variation in oxalate levels among the mushroom species is worth noting. *Pleurotus ostreatus* exhibited the highest concentration of oxalate, while *Pleurotus eryngii* had the lowest. Oxalate is known to contribute to kidney stone formation in susceptible individuals. Therefore, individuals with a history of kidney stone formation should consider the oxalate content of different mushroom species in their diet (Smith *et al*., 2021).

Saponins, bioactive compounds with potential health benefits, were found in varying amounts in the mushrooms. *Pleurotus eryngii* had the highest concentration of saponins, followed by *Pleurotus pulmonarius*. Saponins have been associated with antioxidant and anti-inflammatory properties, which can contribute to overall health and disease prevention (Fayek *et al.*, 2020).

Tannins, another class of phytochemicals, were also analyzed. *Pleurotus columbinus* had the highest tannin content, while *Pleurotus eryngii* had the lowest. Tannins possess antioxidant properties but can also inhibit the absorption of certain nutrients when consumed in excessive amounts. Thus, tannin levels in mushrooms should be considered in the context of overall dietary intake (Miller *et al*., 2022).

The levels of cyanide, a potentially toxic compound, were relatively low and similar among the four *Pleurotus* species. The concentration of cyanide in these mushrooms is unlikely to pose a significant health risk when consumed as part of a balanced diet (Jones *et al*., 2022).

Phytate, an anti-nutrient that can hinder the absorption of certain minerals, showed slight variation among the mushroom species. The overall contribution of phytate from mushrooms to the diet is relatively small compared to other dietary sources. Therefore, the impact of phytate in mushrooms on mineral bioavailability should be considered in the context of the entire diet (Johnson *et al*., 2019).

The analysis of alkaloids in the four *Pleurotus* species revealed similar levels among them. Alkaloids are a diverse group of compounds with potential antimicrobial and anticancer properties. Further research is necessary to identify the specific alkaloids present in these mushrooms and explore their potential health implications (Fayek *et al.*, 2020).

These findings contribute to our understanding of the phytochemical composition of *Pleurotus* mushrooms and their potential effects on human health. However, it is important to note that the presence and concentrations of phytochemicals can vary depending on factors such as species, growing conditions, and sample analysis methods. Therefore, caution should be exercised when extrapolating these findings to all mushrooms of the respective species.

The analysis of trace element composition in four species of *Pleurotus* mushrooms provides valuable insights into their nutritional profiles and potential implications for human health. Variations in mineral content among the mushroom species have been observed, highlighting their diverse mineral compositions.

Pleurotus ostreatus emerged as a richer source of sodium, calcium, and potentially phosphorus (Miller *et al.,* 2022). These findings indicate that *P. ostreatus* may contribute to dietary intake of these essential minerals. On the other hand, *P. pulmonarius* exhibited higher levels of zinc, potassium, and manganese (Miller *et al*., 2022). *P. columbinus* showed higher levels of phosphorus, iron, magnesium, and copper, making it a potential source of these minerals in the diet (Miller *et al.*, 2022). *P. eryngii* demonstrated relatively higher levels of phosphorus, manganese, iron, and copper (Miller *et al.*, 2022). These variations in trace element composition offer individuals the opportunity to select specific mushroom species that align with their dietary needs and mineral requirements.

It is important to note that the significant differences observed in the elemental composition among the mushroom species ($p < 0.0001$) suggest that different factors contribute to the variations. These factors include growth conditions, substrates, and genetic factors (Miller *et al*., 2022). Understanding these influences is crucial for optimizing the nutritional value of *Pleurotus* mushrooms and potentially developing cultivation strategies to enhance their trace element content.

The findings of this study contribute to the broader understanding of the nutritional benefits associated with *Pleurotus* mushrooms. By incorporating these mushrooms into the diet, individuals can potentially enhance their intake of essential trace elements, which play vital roles in various physiological processes.

Further research is warranted to investigate the bioavailability and potential health implications of these trace elements in *Pleurotus* mushrooms. Additionally, exploring the impact of cultivation practices on the trace element composition of these mushrooms can provide insights into strategies for maximizing their nutritional value.

It can be said that the analysis of trace element composition in four species of *Pleurotus* mushrooms reveals variations in their mineral content. Each species offers unique nutritional benefits, making them valuable dietary additions for individuals seeking to optimize their mineral intake. These findings have implications for the development of functional foods and dietary recommendations that incorporate *Pleurotus* mushrooms as a source of essential trace elements.

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