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Impact of substrate on the nutrient profile of *Hypsizygus ulmarius* (Bull.) Redhead, Elm Oyster fungus from Nigeria

[1]Jonathan, S.G.*; [2]Nwaokolo, V.M.; [1]Omojola J.D.; [3]Omeonu F.C.; [4]Olaoye F.A. and [1]Ayeniyi, T.B.

[1]Mycology/Pathology & Applied Microbiology Group, Department of Botany, University of Ibadan, Nigeria
[2]Federal College of Forestry, Jericho, Ibadan, Oyo State. Nigeria.
[3]Department of Microbiology, Chrisland University, Abeokuta, Ogun State, Nigeria
[4]Department of Science Laboratory Technology, DS Adegbenro Polytechnic, Itori-Ewekoro, Nigeria

*Corresponding author. E mail: gbolagadejonathan@gmail.com; sgjonathan@mail.ui.ng.edu

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This study described the impact of different agricultural substrates on the nutrient compositions of *Hypsizygus ulmarius* (Bull.) Redhead, an elm oyster fungus, from Nigeria. This mycoorganism was grown on different local organic wastes. *H. ulmarius* carpophores were harvested on substrates such as rice bran (A), banana leaves (B), oil palm fibre (C), corn husks (D), sawdust + rice bran (E), oil palm fibre + rice bran (F) and saw dust (G). The experimental set up was completely randomized block design in three replicates. The data obtained were subjected to analysis of variance and the test of significance was subjected to Duncan's multiple range test at 5% level of probability. Results showed that the substrates used had a significant impact on the nutrient contents of this macrofungus (P ≤ 0.05). The samples grown on rice bran (RB) had the highest calorie content (291.10), while those grown on banana leaves (BL) had the lowest (273.37) calories. The mineral content of the *H. ulmarius* was also influenced by the local substrate used. The highest levels of selenium (1.96 mg/100 g) and phosphorus (91.67 mg/100 g) were found in sporophores that were grown on banana leaves while the lowest values were found in fruit bodies grown on oil palm fibre (OPF), with 0.88 mg/100g of selenium and 80.94 mg/100 g of phosphorus. The highest vitamin D content was recorded in BL substrates (20.69 mg/100 g) followed closely by SDRB substrates (20.61 mg/100g) while the lowest was recorded on OPF substrates (14.51 mg/100 g). The implications of these observations on *H. ulmarius* on the nutrient values were discussed.

Keywords: Substrates, nutrition, mineral-composition, fungus

INTRODUCTION

Edible fungi including morels, stinkhorns, puffballs and mushrooms such as *Agaricus* spp, *Pleurotus* spp and *Hypsizygus ulmarius* have been recognized as sources of food and medicines (Jonathan and Fasidi, 2003; Aina *et al*., 2012 Jonathan *et. al*, 2013a; Asemoloye *et. al*., 2020). Mushrooms have also been long known for their excellent flavor, texture and source of food condiments (Aina *et al*., 2012; Jonathan *et al*., 2013b; Oyebanji *et al*., 2018). Macrofungi are important sources of biologically active compounds (Oluranti *et al*., 2010; Chikwem *et al*., 2020; Asemoloye *et al*., 2022; Jonathan et. al, 2025). Various researchers have established that edible macro fungi contained digestible fibers, soluble starch, essential amino acids and important vitamins which are considered desirable for good human health (Gbolagade *et al*., 2006; Adeoye-Isijola *et al*., 2021; Mustafa *et al*., 2022). Mushrooms have been reported to possess higher mineral elements when compared to many other common food sources, such as meat, fish, eggs, cheese and leafy vegetables (Gbolagade *et al*., 2006; Valverde *et al*., 2015;

Jonathan *et al*., 2024a).

Mushrooms can be cooked alone or served along with other green vegetables, where they usually form combinations of delicious soup to Nigerian local people (Okoro and Isreal, 2012, Oluranti *et al.,* 2019). Edible fungi are known to be highly nutritious and diversely useful food options that can be incorporated into various recipes to offer unique complimentary food combinations of low calories, high fiber, and abundant nutrients, including copper, iron, magnesium and potassium (Okoro and Isreal, 2012; Jahan *et al*., 2021; Jonathan *et al*., 2024b).

Hypsizygus ulmarius is a brown rot fungus that usually grow on trees such as elm, beech, teak etc. Just like their Pleurotus counterpart, it has ability to grow on varieties of agro-industrial substrates. They could be found in temperate and tropical rain forests of America, Asia, Europe and Africa. They are less common in Nigeria when compared with *Pleurotus*, Termitomyces and *Agaricus species* (Jonathan, 2019).

Hypsizygus ulmarius could act as saprophyte, parasite or facultative saprophyte. This fungus is a causative agent of brown rot on of hardwood. The fungus has cellulase and laccase enzymes, no wonder they are cellulose and lignin degraders. The ability of this fungus to produce brown rot also acts as a guide any mycologist to distinguish between *H. ulmarius* and *Pleurotus* species which usually cause white rot (Jonathan, 2019).

Edible fungi including *H. ulmarius* are low-calorie foods that provide the body with several nutrients, such as copper, potassium, iron, and a couple of B vitamins (Asemoloye *et al*., 2022; Jonathan, 2019). Therefore, the objectives of this present study were to determine nutrient compositions of *Hypsizygus ulmarius* grown on different organic waste.

MATERIALS AND METHODS

The young fruitbodies of *Hypsizygus ulmarius* were cultivated on selected organic waste substrates (rice bran, banana leaves, oil palm fibre, corn husks, and sawdust) and after, they were harvested musing standard methods (Jonathan *et al*., 2024a).

Proximate Analysis

Determination of ash content

These were carried out using the methods of Kumar *et al*., (2017).

Determination of crude fibre

This was determined according to the procedures outlined by Ferreira *et al.,* (2018).

Crude protein

This was carried out using the method of Loveday, 2019.

Determination of crude fat

The crude fat was determined according to the method of Lee *et al*. (2015).

Determination of carbohydrate (CHO)

A modified method of Zhou *et al.,* (2012) was adopted for the determination of carbohydrate

Determination of Dry Matter

This was carried out in accordance with the method described by van Loon *et al.,* (2000).

Determination of Vitamin D

Vitamin D content was determined by mixing freshly prepared Carr price reagent (20 % antimony trichloride in chloroform with 40% pure acetyl chloride) that is free from alcohol. 9 ml of the Carr price reagent was added to 1 ml of the sample extracted with chloroform and the extraction was measured at 500 nm against the blank reagent (Higashi *et al.,* 2010).

Mineral determination

Mineral contents of samples were determined by atomic absorption spectrophotometer (AAS) according to the methods of AOAC (2020).

Determination of Selenium (Se) and Phosphorus (P)

These were determined using Shimadzu Atomic Absorption Spectrophotometer model AA-6800 according to the method of AOAC, (2020).

ANALYSIS OF DATA

The data generated from these studies were subjected to analysis of variance (ANOVA) and test of significance was determined using Duncan's multiple range test (DMRT) at 5% level of probability ($P \leq 0.05$).

RESULTS

There was significant difference ($P \leq 0.05$) in the proximate compositions of different samples as shown on Figure 1. Crude protein content ranged from 16.28 to 27.7 mg/100 g, with sample B showing the highest nutrients but the least value was obtained in sample G. The compositions of crude fat, crude ash and crude fibre were significantly lower in all the samples ($P \leq 0.05$), while crude fat had the least value (0.86 to 1.00 mg/100 g). This was followed by crude ash, with sample C having the least and sample B having the highest values.

There were significant differences ($P \leq 0.05$) in the mineral's elements and vitamin D contents of different

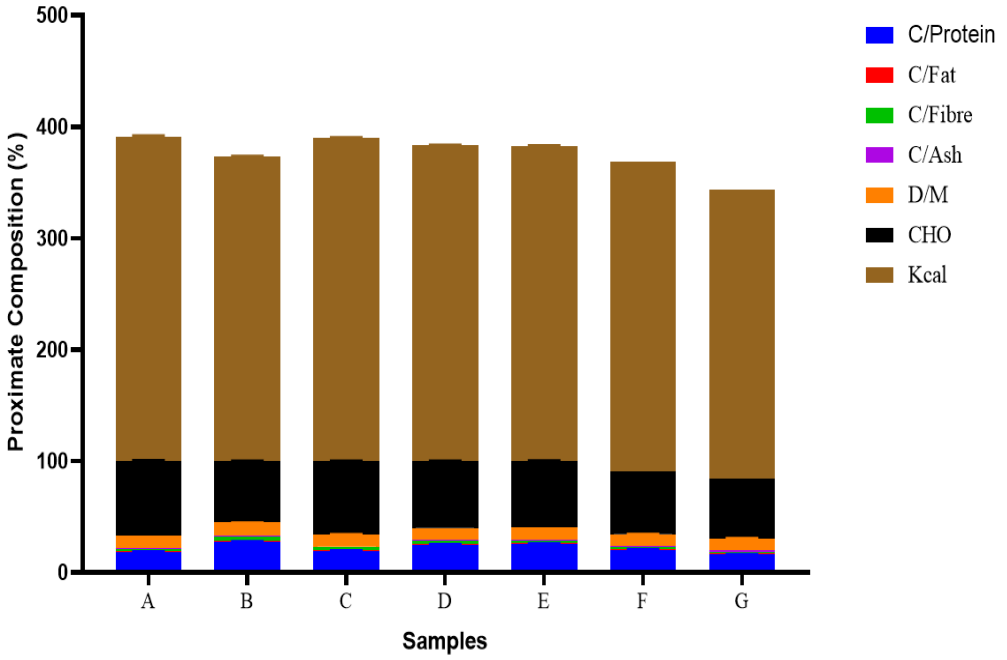

Figure 1. Proximate analysis of Different Mushroom Samples. A = Rice Bran, B = Banana Leaves, C = Oil Palm Fibre, D = Corn Husks, E = Sawdust + Rice Bran, F = Oil Palm Fibre + Rice Bran, and G = Saw Dust. Each value is a mean of 3 replicates ± standard error.

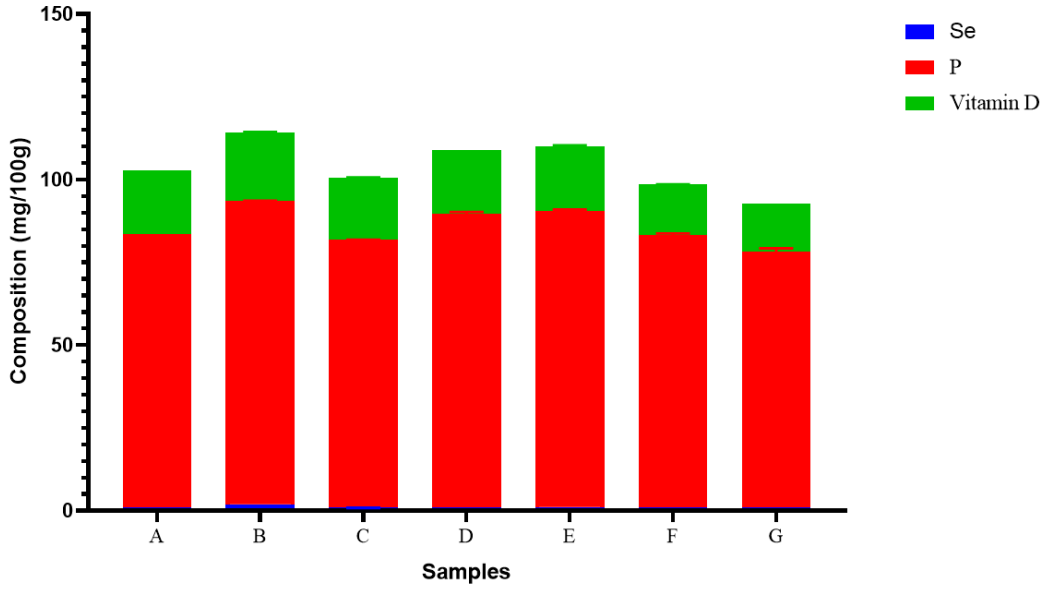

Figure 2. Effect of different organic wastes on mineral and vitamin D content of *Hypsizygus ulmarius.* Minerals and Vitamin D Contents of *Hypsizygus ulmarius*. A = Rice Bran, B = Banana Leaves, C = Oil Palm Fibre, D = Corn Husks, E = Sawdust + Rice Bran, F = Oil Palm Fibre + Rice Bran, and G = Saw Dust. Each value is a mean of 3 replicates ± standard error.

fungal samples (Figure 2). Phosphorus had the largest mineral content in all the samples with its least value (77.25 mg/100 g) in sample G. This was followed by vitamin D with the least value of 14.51 mg/100 g at sample G and highest at both samples D and E with a value of 20.6 mg/100 g. Selenium (Se) was generally observed to have the least content in all the samples with least value (0.88 mg/100 g) at sample C and highest value at sample

B (1.96 mg/100 g).

Across all samples, phosphorus was observed to be present in larger quantities compared to selenium. Vitamin D was observed available at almost equal quantities across the samples (Figure 2).

DISCUSSION

This study explored the effect of various organic waste substrates on the nutrient profile of *Hypsizygus ulmarius* from Nigeria. The results showed significant variations in the proximate composition, mineral content, and vitamin D composition of the test mushrooms cultivated on different organic waste. The nutrient values of the harvested mushrooms were determined by assessing their chemical composition.

Results showed that there was significant difference among the seven treatments. The highest protein content occurred in mushrooms grown on BL (27.71 mg/100 g), followed by OPF (25.54%) and SDRB at 25.38 mg/100 g. The least protein percentage were observed in those harvested from mahogany sawdust (16.28 mg/100 g) and corn husks (18.09 mg/100 g). The differences in protein content observed in mushrooms harvested from various organic wastes may be attributed to the varying nutrient compositions of the wastes (Nneka *et al.,* 2014). This observation agrees with the findings of Jonathan, et al. (2025) who reported that the protein content of mushroom is not only influenced by the protein content of the substrate but also the nature of protein in the substrate. The fungal mycelia are also known to secret extracellular enzymes which could play significant roles in the degradation of substrates (Rathore *et al.,* 2019). Additionally, the differential availability of usable nitrogen in the wastes after spawn run maybe a crucial factor in the observed differences (Charturvedi *et al*., 2021). Nitrogen has been reported to be an important nutrient required for fungal growth due to its involvement in protein, chitin and nucleic acid syntheses (Mustapha *et al*., 2022). The percentage protein content of cultivated fungus observed in this present study falls within the range reported by Vetter (2019) for *Lentinula edodes*. According to Valverde *et al.* (2015), the protein content of *L. squarrosulus* is significantly higher than that of Irish potatoes and oranges, with levels approximately twice as high as Irish potatoes and six times greater than oranges. The crude protein content of this mushroom could compare those reported for most legumes except groundnut and soybeans (Vrinda *et al.,* 2020). Using this protein content as approximate indices of nutritional quality, it would appear that *H. ulmarius* falls between most legumes and meat. However, while the protein content of the mushroom is still lower than that found in eggs, meat and fish, it is adequate to be used as a substitute in the diets of the populace in the developing countries.

The fat content obtained in this research were generally low (0.86 - 1.0 mg/100 g), thus agreeing with the report of Meghan and Katherine (2018) that mushroom are low sources of dietary fat. Among the different substrates tested, SDRB yielded mushrooms with the highest dietary fibre content (2.11%), followed closely by corn husks (2.02%) and banana leaves (2.01 mg/100g). In contrast, OPFRB substrate had the lowest dietary fibre content (1.33 mg/100 g), suggesting that the type of substrate used for cultivation plays a crucial role in determining the dietary fibre contents. The dietary fibre content of mushrooms grown on SDRB, CH, and BL substrates was likely influenced by the high cellulose content of rice bran and banana leaves, as well as the sawdust component. The production of enzymes during this mushroom's life cycle may have facilitated the breakdown of these compounds, allowing the mycelium to absorb and utilize them for fruit body production (Camassola, 2013).

Fungi that were grown on RB (67.07 mg/100 g) and CH (65.93 mg/100 g) substrates had the highest nutrients (67.07 mg/100 g), while that grown-on SD (53.21 mg/100 g) and BL (55.30 mg/100g) substrate had the lowest. This finding agrees with the report of Bhatia *et al*. (2022), who stated that elm oyster mushroom grown on banana leaves, usually have low carbohydrate content. For ash content, mushroom harvested from BL (1.26 mg/100 g) and SDRB (1.10 mg/100 g) substrates had the highest ash content, while those harvested from OPF substrate had the lowest ash content of 1.03 mg/100 g, followed closely by that from RB and CH with a value of 1.05% each. Mushroom grown on RB substrate recorded an high level of calories (291.10), whereas the least was recorded on BL (273.37) substrate confirming previous research reports by Onyeka *et al*. (2018) that oyster mushrooms grown on BL do contain lesser number of calories. The mineral content of the mushrooms was significantly influenced by the substrate used for their cultivation, suggesting that the choice of substrate has a substantial impact on the mineral composition of the harvested mushrooms. The highest selenium (1.96 mg/100 g) and phosphorus (91.67 mg/100 g) was recorded in *H. ulmarius* cultivated on banana leaves, whereas the least selenium (0.88 mg/100 g) and phosphorus (80.94 mg/100 g) were recorded in fungus that was cultivated on OPF. The differences in mineral content observed in elm oyster mushrooms in this study may be attributed to the varying biological and chemical compositions of the substrate media. As noted by Osemwegie *et al*. (2016), fungi usually obtain their nutrients from the substrates on which they grow, which could explain the variations in mineral composition among mushrooms grown on different substrates.

However, the findings of this research suggest that *H. ulmarius* can be a rich source of dietary fiber and vitamin D. The vitamin D content of this test fungus ranged from 14.51 mg/100 g to 20.61 mg/100 g, which is in agreement with the observations of Keegan *et al.* (2013). The highest vitamin D content was found in fruitbodies grown on BL substrates (20.69 mg/100 g), followed closely by those

grown on SDRB (sawdust + rice bran) substrates (20.61 mg/100 g), while the lowest content was observed in mushrooms grown on OPF substrates (14.51 mg/100 g). The variations in vitamin D content among elm oyster mushrooms are likely due to differences in substrate composition, as suggested by Zhao (2018).

Conclusion

The study showed that different organic waste substrates can significantly impact the nutrient contents of *Hypsizygus ulmarius*. The findings provided valuable insights for *H. ulmarius* producers to optimize their substrate selection and cultivation conditions in order to produce high-quality, nutrient-rich fungus.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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