MacroFungi
Journal of Macrofungi
Journal homepage: www.macrofungi.org
IQMT IRAQI MUSHROOM AND TRUFFLE PLATFORM
Volume: 1 Issue: 1 (2025) Pages: 8-13

Mini-Review

The Oyster Mushroom *Pleurotus*: A Renewable Mycological Treasure

Maarib Ahmed AWAD [1,*]

[1] *Department of Plant Protection, College of Agriculture, University of Tikrit, Iraq*

* Corresponding author: maarib.a.awad@st.tu.edu.iq

Received: **02-08-2025** Revised: **20-08-2025** Accepted: **11-09-2025** Published: **13-09-2025**

ABSTRACT: The oyster mushroom (*Pleurotus* spp.) offers a viable solution for the world towards sustainable agriculture, owing to its nutritional, medicinal, and environmental benefits. Generally, due to the nutritional value of *Pleurotus* species and the presence of bioactive substances with high therapeutic activity, such as pleuran and pleurotin, *Pleurotus* has shown a significant role in public health by improving the state of modern diseases with the help of its immunomodulatory, antitumor, and antimicrobial properties. Environmentally, *Pleurotus* spp. depend on the biodegradation of agricultural residues to reduce pollution and improve resource utilization. Recent studies of its microbiology have also discovered that it is one of the microbial biopesticides that explains its role in reducing the farm's chemical demand and supporting ecological agricultural practices. Thus, with more people concerned about ethnicity, healthy and exotic food, the demand for products of oyster mushrooms shall be increasing rapidly. Yet all this potential is only accessible by overcoming technical and market barriers, and ensuring farmers receive the necessary training and support. This seemingly resource-rich opportunity needs a more cohesive research agenda to evaluate its productivity, health advantages and environmental consequences. Another will likely be to explore and utilize its bioactivity. Exploiting the potential available in *Pleurotus* spp. requires that technical change and innovation push the frontier upward and invest in it to improve food security and sustainability.

Keywords: Nutritional value, Oyster mushrooms, Pleurotus, Pleurotin.

Cite this article: Awad, M. A. (2025). The oyster mushroom *Pleurotus*: A renewable mycological treasure. *Journal of Macrofungi 1*(1), 8-13.

1. INTRODUCTION

Due to the nutritional, health, and economic benefits, interest in edible mushrooms is escalating, as the global concern grows to explore alternatives to traditional food sources, appreciate the significance of sustainable farming, and mitigate the impact of climate change. Among these, *Pleurotus* spp. are the most developed edible species, including commercial mushrooms such as oyster (*Pleurotus ostreatus*), which has been one of the most popular cultivated mushrooms over the past few decades. This explains their demand as a crop due to their nutritional value, simplicity of cultivation, and their wide application in medicine and industry (Jarial et al., 2024). Oyster mushrooms fall under the phylum Basidiomycota, whose body forms are shell-like, mimicking an oyster. The genus *Pleurotus* encompasses approximately 200 worldwide species and belongs to the family Pleurotaceae. Both in terms of production and consumption, *Pleurotus* is second only to the *Agaricus bisporus* (white button mushroom) cultivated mushroom in the world.

Apart from their nutritional value, oyster mushrooms are also crucial for local economies and food security. They are also receiving attention in both medical and industrial research due to their versatility. Emergent evidence of significant nutritional, environmental and economic benefits from the integration of this species into low-input farming systems has been reported. These fungi, in particular, can produce bioactive compounds with a high level of antimicrobial activity against various bacteria, fungi, and their related toxins. This opened new horizons to their application in natural antibiotics and biopesticide agents, especially in integrated pest management (IPM) strategies against plant pathogens like *Fusarium oxysporum*, *Rhizoctonia solani* and *Alternaria alternata* (Sitara et al., 2023; Awad & Hassan, 2023)

Recent studies have revealed *Pleurotus* species as an important organism contributing to food security and the local economy, with great potential to be exploited in reducing environmental pollution. This is mainly because they turn agricultural waste and utilize it as a nutrient-rich substrate for growth. Besides the existing ecological benefits, oyster mushrooms have recently attracted attention in the field of biomedicine due to their abundance of bioactive compounds, including polysaccharides, vitamins, and antioxidants. Notably, the used substrates were identified as potential sources of important enzymes, including MnP, laccase, and LiP, which could be utilized in various industries and environmental applications (El-Ramady et al., 2022).

2. MEDICAL AND NUTRITIONAL SIGNIFICANCE OF OYSTER MUSHROOMS

Oyster mushrooms (*Pleurotus* spp.), as shown in Fig. 1, which offer a full profile of nutrients, are among the best options for plant-based meat replacements, especially in vegetarian diets. They contain protein reaching 20–30% of dry weight, making them an excellent source of dietary fiber with also the B-complex vitamins 357, vitamins D and K, and sometimes vitamins C and A (Furlani & Godoy, 2008) Ideally, these mushrooms have with higher content of essential minerals i.e., calcium, phosphorus and potassium, while having lower sodium, which is good for high blood pressure people and heart patients (Hassan, 2005)

Apart from *Pleurotus* spp. carry numerous healing properties. They contain bioactive components such as Pleuran and Pleurotin, which are known to exhibit antioxidant, antimicrobial, anticancer, cholesterol-lowering, and immunomodulatory properties. And those substances help fight bacteria and fungi, lower oxidative stress, and improve immune function (Furlani & Godoy, 2008). The positive influence is further enhanced by the presence of chitin and a range of carbohydrates, which not only makes them more valuable due to their nutritional and medicinal properties but also boosts their functionality.

Figure 1. The fruiting bodies of cultivated *Pleurotus* sp. (Hassan and Awad, 2023)

Oyster mushrooms (*Pleurotus* spp.) have over 270 species characterized by their useful properties (Majesty et al., 2019), and are globally acknowledged for their therapeutic potential. This bioactive property also leads to the application of these foods as an important strategy for the prevention and control of diseases associated with lifestyles, such as diabetes, hypertension, and obesity They have high antitumor and antioxidant effects, reduce cholesterol values and show antimicrobial, antiviral and anti-inflammatory activities with significant properties Additionally, it has been shown that blood sugar regulation, cell-mediated immune activation, and immune system defense have also been activated (Kong et al., 2014; Toros et al., 2023). All these characteristics combined show the potential of the *Pleurotus* spp., both in terms of a functional food that serves to combine nutritional and therapeutic properties and in terms of being an adjunct to chronic disease prevention and management

3. BIOCHEMICAL COMPOSITION AND PHARMACOLOGICAL AND FUNCTIONAL ACTIVITIES OF *PLEUROTUS* SPP.

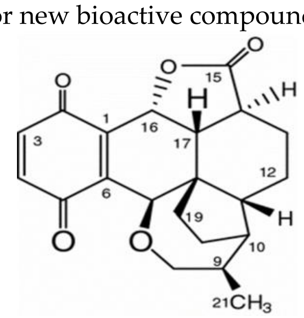
Pleurotus spp. are freely acknowledged for their ability to produce a wide variety of bioactive materials, which makes them more important in the field of science in medicine, pharmacy and biotechnology. Interestingly, antitumor, antimicrobial, and anthelmintic activities of species like *P. ostreatus, P. florida* and *P. sajor-caju* suggest that they could function as a natural biocontrol agent against significant phytopathogens (e.g., *Fusarium oxysporum* and *Rhizoctonia solani*) in agriculture (Sitara et al, 2023). Some of the major compounds extracted from *Pleurotus* spp. are Pleuran – a polysaccharide having an immunomodulatory effect that increases the response of immune cells to pathogen threats (Urbancikova et al., 2020). Pleurotin, which belongs to the naphthoquinone family, is another major metabolite known as a potent anticancer and antibacterial agent supported by many studies (Wolff et al., 2008; Al-Temimay et al., 2015).

Pleurotus mushrooms contain various bioactive constituents, in addition to their nutritional value, which enhance their therapeutic and functional applications and utility. These are mainly hydrolytic enzymes (chitinase, lipase), polysaccharide–peptides, glycoproteins, proteoglycans and lectins. In addition to this, they include several secondary metabolites - fatty acids, terpenoids, esters and polyphenols, making them even more potent in their medicinal applications (Refaie et al., 2009; Adebayo et al., 2012; Morris et al., 2011). Among these, the most relevant compounds extracted from *Pleurotus* spp. The latter includes β-glucans and mannans, complex polysaccharides with immunostimulatory and anticancer properties. These molecules have been extensively used commercially for the production of β-glucan (Smiderle et al., 2012) because they drive immune responses and inhibit cancer cell populations. There is increasing interest in using the mycelium of *Pleurotus* species as a biocontrol agent for agricultural biotechnology. It releases enzymatically active products that degrade nematodes through hydrolysis of their structural proteins and carbohydrates, providing a biodegradable alternative for crop management (Khan et al., 2011).

Pleurotus mushrooms attract considerable attention from a medical perspective, where they have shown potent anticancer effects. The β-glucan content from these strains appears to stimulate natural killer (NK) cells to provide a more robust immune response to focus on and eliminate malignant cells in whatever area of the body they are located (Shipley et al., 2006; Sweeney et al., 2016). In addition to being beneficial for lipid metabolism (they are able to lower LDL cholesterol and increase the levels of HDL [high density lipoprotein] also known as the “good cholesterol”), *Pleurotus* mushrooms also have a beneficial role on lipid metabolism. As is their broader therapeutic profile, this dual action promotes cardiovascular health. Additionally, *Pleurotus* spp. extracts have compelling clinical evidence for high efficacy against pathogenic bacteria and fungi, confirming an undeserved low profile as a natural reservoir of bioactive compounds (Torki, 2021) with antimicrobial activity.

4. PLEUROTIN: AN ANTIBIOTIC DERIVED FROM OYSTER MUSHROOM

Pleurotin is a biologically active naphthoquinone compound (Scheme 1), which is the main secondary metabolite from some oyster mushroom species, namely: Pleurotus griseus and family of the genus *Hohenbuehelia,* such as *H. geogenius* and *H. atrocaerulea*. Next, due to its unspecific antibiotic activity, this compound has attracted interest since it has been shown to be effective against a number of pathogens like yeast (e.g. Owing to its antimicrobial potential, Pleurotin has a potential role in the development of natural therapies, which has become crucial given the rise of antimicrobial resistance globally and the need for new bioactive compounds derived from fungi (Robbins et al,1947).



Scheme 1. Chemical structure of Pleurotin (Shipley et al., 2006).

In laboratory studies, Pleurotin has been shown to inhibit pathogenic fungi in humans, such as *Trichophyton mentagrophytes* and *Candida albicans*, as reported by Berdicevsky et al. (2009). The antifungal action of Pleurotin occurs via the disruption of cell membranes and the inhibition of critical metabolic pathways within the fungal cells. Several studies also reported high antifungal and antibacterial activity of Pleurotin. The toxicity was also tested on laboratory household mice, and it was found not to be toxic when administered in white mice by the intravenous route at a single dose of 24 mg/kg body weight. None of these studies evidenced any toxicity or adverse effects (Robbins, 1947). Fig. 2 showed the pure Pleurotin.

Figure 2. Pure Pleurotin compound (Al-Azzawi, 2023)

Because of the importance of this compound in medicine, much effort has been devoted to the chemical synthesis of this compound for industrial production. Nevertheless, this process is complicated and expensive; hence, a direct biosynthesis from mushrooms could be more cost-effective (Sandargo et al., 2018; Hoskin & Sørensen, 2022). In the study conducted by Al-Azzawi (2023), all concentrations of Pleurotin extracted from *Pleurotus* spp. showed the inhibition of growth of pathogen *Rhizoctonia solani* and *Alternaria alternata* in vitro. Also, the ability of the fungicides Othello Top, Swift and Sabithane to suppress the pathogenic fungi was more compatible with the drug Pleurotin

5. CONCLUSION

The oyster mushroom *Pleurotus* is at the crossroad of highly versatile, sustainable, ecological, nutritional, and medicinal resources. If rich bioactive compounds (Pleuran, Pleurotin etc.) that they produce try to have relatively potent immunomodulatory, antitumor, and antimicrobial activities, and thus warrant high application value as incomparably complex broad-spectrum regulators of diseases in humans and agroecosystems. *Pleurotus* spp. enhance the health of the soil, minimize chemistry in pesticide use, and augment immunity. be a model of sustainable ag, and provide functional food. Also, the physiological performance of *Pleurotus* spp. through its inherent ability to serve as a Biopesticide that may act as an eco-friendly alternative to chemical pesticides and thus, could be used to strengthen crop system resilience and ecological integrity. Nevertheless, the interest in the subject is accompanied by many challenges related to its cultivation, such as low awareness of the population and the farmer, in addition to a deficiency of knowledge about this important agricultural raw material to unlock its full potential. On one hand, there are several areas of research under the niche of plant-microbe associations which include optimization of production systems, extraction and application of bioactives, and mitigation of diseases and pests, where more multidisciplinary work would be beneficial for us to appreciate the contribution that plant-microbe associations can play in sustainable agricultural development. Such strategic initiatives are important steps to exploit the full potential of *Pleurotus* spp. improving food, nutrition and security, environmental sustainability and agricultural productivity.

Ethical Statement

Not Applicable.

Conflicts of Interest

The authors declare no competing interests.

Funding

No funding was received for this research.

REFERENCES

Adebayo, E.A., Oloke, J.K., Majolagbe, O.N., Ajani, R.A., & Bora, T.C. (2012). Antimicrobial and anti-inflammatory potential of polysaccharide from *Pleurotus pulmonarius* LAU 09. *African Journal of Microbiology Research* 6(13), 3315-3323.

Al-Azzawi, M. A. A. (2023). The efficacy of pleurotin extracted from Pleurotus spp. against *Rhizoctonia* root rot and *Alternaria* leaf spot in faba bean. PhD thesis, University of Tikrit, College of Agriculture, Department of Plant Protection, Iraq.

Al-Temimay, I. A., AL-Jibouri, M. H., Hassan, A. A., & Mohammad, F. I. (2015). Test the cytotoxicity of Pleurotin extracted from an edible mushroom *Pleurotus osteratus* against three human carcinoma cell line. *Iraqi Journal of Science 56*(4A), 2773-2781.

Awad, M., & Hassan, A. (2023). Evaluation of the Pleurotin Efficacy Extracted from *Pleurotus* spp. in Controlling Leaf Spot Disease caused by *Alternaria alternata* on Broad Bean. *Euphrates Journal of Agricultural Science* 15(2), 120-130.

Berdicevsky, I., Kaufman, G., Newman, D. J., & Horwitz, B. A. (2009). Preliminary study of activity of the thioredoxin inhibitor pleurotin against *Trichophyton mentagrophytes*: a novel anti-dermatophyte possibility. *Mycoses 52*(4), 313-317. https://doi.org/10.1111/j.1439-0507.2008.01620.x

El-Ramady, H., Abdalla, N., Fouad, Z., Badgar, K., Llanaj, X., Törős, G., Hajdú, P., Eid, Y., & Prokisch, J. (2022). Green Biotechnology of Oyster Mushroom (*Pleurotus ostreatus* L.): A Sustainable Strategy for Myco-Remediation and Bio-Fermentation. *Sustainability* 14(6),3667. https://doi.org/10.3390/su14063667

Furlani, R. P. Z., & Godoy, H. T. (2008). Vitamins B1 and B2 contents in cultivated mushrooms. *Food Chemistry* 106(2),816-819. https://doi.org/10.1016/j.foodchem.2007.06.007

Hassan, A.A. (2005). Production of fibrinolytic protease from *Pleurotus ostreatus* by solid state fermentation. Ph.D. Thesis. College of Science. University of Baghdad, Iraq.

Hassan, A. A., & Awad, M. A. (2023). Isolation, Phenotypic and Molecular Characterization of the Oyster Mushroom *Pleurotus* spp. and Evaluation of Its Efficacy in Producing the Antibiotic Pleurotin. *IOP Conference Series: Earth and Environmental Science* 1158(7),072023. IOP Publishing. https://doi.org/10.1088/1755-1315/1158/7/072023

Hoskin, J. F., & Sorensen, E. J. (2022). A Concise Synthesis of Pleurotin Enabled by a Nontraditional C–H Epimerization. *Journal of the American Chemical Society*, *144*(31), 14042-14046. https://doi.org/10.1021/jacs.2c06504

Jarial, R. S., Jarial, K., & Bhatia, J. N. (2025). Comprehensive review on oyster mushroom species (Agaricomycetes): Morphology, nutrition, cultivation and future aspects. *Heliyon* 10(5): e26539. https://doi.org/10.1016/j.heliyon.2024.e26539

Khan, M. A., Rahman M. M., Tania M., Uddin M. N., & Ahmed, S. (2011). *Pleurotus sajor-caju* and *Pleurotus florida* mushrooms improve some extent of the antioxidant systems in the liver of hypercholesterolemic rats. *Open Nutraceuticals Journal* 4, 20-24.

Kong, F., Li, F. E., He, Z., Jiang, Y., Hao, R., Sun, X., & Tong, H. (2014). Antitumor and macrophage activation induced by alkali-extracted polysaccharide from *Pleurotus ostreatus*. *International Journal of Biological Macromolecules 69*, 561-566. https://doi.org/10.1016/j.ijbiomac.2014.05.045

Majesty, D., Ijeoma, E., Winner, K., & Prince, O. (2019). Nutritional, anti-nutritional and biochemical studies on the oyster mushroom, *Pleurotus ostreatus. EC Nutrition 14*(1), 36-59.

Morris, H.J., Llauradó G., Gutiérrez A., Lebeque Y., Fontaine R., Beltrán Y., García N., Bermúdez R.C., & Gaime-Perraud I. (2011). Immunomodulating properties of *Pleurotus* sp. Fruiting bodies powder on cyclophosphamide treated mice. *Proceedings of the 7th International Conference on Mushroom Biology and Mushroom Products* pp. 324-333.

Refaie, F.M., Esmat A..Y, Daba A.S., & Taha S.M. (2009). Characterization of polysaccharopeptides from *Pleurotus ostreatus* mycelium: assessment of toxicity and immunomodulation in vivo. *Micologia Aplicada Internacional* 21(2),67-75.

Robbins, W.J., Kavanagh, F., & Hervey, A. (1947). Antibiotic substances from basidiomycetes I. *Pleurotus griseus*. *Proceedings of the National Academy of Sciences of the United States of America* 33(6),171-176. https://doi.org/10.1073/pnas.33.6.171

Sandargo, B., Thongbai, B., Stadler, M., & Surup, F. (2018). Cysteine-Derived Pleurotin Congeners from The Nematode-Trapping Basidiomycete *Hohenbuehelia grisea*. *Journal of Natural Products 81*(2), 286–291. https://doi.org/10.1021/acs.jnatprod.7b00713

Shipley, S. M., Barr, A. L., Graf, S. J., Collins, R. P., McCloud, T. G., & Newman, D. J. (2006). Development of a process for the production of the anticancer lead compound pleurotin by fermentation of *Hohenbuehelia atrocaerulea*. *Journal of Industrial Microbiology and Biotechnology 33*(6),463-468. https://doi.org/10.1007/s10295-006-0089-0

Sitara, U. Z. M. A., Baloch, P. A., Pathan, A. U. K., Bhutto, M. A., Ali, Q. M., Ali, A. B. I. D., & Iqbal, M. E. H. W. I. S. H. (2023). In vitro studies to determine antibacterial and antifungal properties of three *Pleurotus* species (oyster mushroom). *Pakistan Journal of Botany 55*(1), 387-392. https://doi.org/10.30848/PJB2023-1(14)

Smiderle, F. R., Olsen, L. M., Ruthes, A. C., Czelusniak, P. A., Santana-Filho, A. P., Sassaki, G. L., Gorin, P. A. J., & Iacomini, M. (2012). Exopolysaccharides, proteins and lipids in Pleurotus pulmonarius submerged culture using different carbon sources. *Carbohydrate Polymers* 87,368-376. https://doi.org/10.1016/j.carbpol.2011.07.063

Sweeney, M., Coyle, R., Kavanagh, P., Berezin, A. A., Re, D. L., Zissimou, G. A., ... & Aldabbagh, F. (2016). Discovery of anticancer activity for benzo [1, 2, 4] triazin-7-ones: Very strong correlation to pleurotin and thioredoxin reductase inhibition. *Bioorganic & Medicinal Chemistry 24*(16), 3565-3570. https://doi.org/10.1016/j.bmc.2016.05.066

Torki, H. A. (2021). Antimicrobial activity of crude, phenolic and terpenes extracts of Pleurotus ostreatus mushroom (Master's thesis, University of Baghdad, Iraq). University of Baghdad.

Toros, G., El-Ramady, H., Prokisch, J., Velasco, F., Llanaj, X., Nguyen, D. H., & Peles, F. (2023). Modulation of the Gut Microbiota with Prebiotics and Antimicrobial Agents from *Pleurotus ostreatus* Mushroom. *Foods 12*(10), 2010. https://doi.org/10.3390/foods12102010

Urbancikova, I., Hudackova, D., Majtan, J., Rennerova, Z., Banovcin, P., & Jesenak, M. (2020). Efficacy of pleuran (β-glucan from *Pleurotus ostreatus*) in the management of herpes simplex virus type 1 infection. *Evidence-Based Complementary and Alternative Medicine* 2020,8562309. https://doi.org/10.1155/2020/8562309

Wolff, E. R. S., Wisbeck, E., Silveira, M. L. L., Gern, R. M. M., Pinho, M. S. L., & Furlan, S. A. (2008). Antimicrobial and antineoplasic activity of *Pleurotus ostreatus*. *Applied Biochemistry and Biotechnology 151*(2-3), 402-412. https://doi.org/10.1007/s12010-008-8208-1