

Bioactive components and therapeutic potential of *Pleurotus florida*: a comprehensive analysis

Original Article

Abstract:

Pleurotus mushrooms, commonly known as oyster mushrooms, are celebrated for their edibility and emerging health benefits. This study investigates the bioactive components and functional groups in *Pleurotus florida* mushrooms, focusing on polysaccharides, peptides, fatty acids, and phenolic compounds. Comprehensive analysis identified functional groups and diverse range of 37 bioactive compounds, each exhibiting distinct biological activities. These include treatment for phobic disorders, antiseborrheic effects, sclerosant properties, cholesterol antagonism, antieczemetic effects, regulation of lipid metabolism, antihypercholesterolemic properties, antisecretoric activity, and cardiovascular analeptic effects. Additionally, the study highlights the potential synergistic effects of these compounds, which may contribute to their overall therapeutic efficacy. The findings underscore the promise of *Pleurotus florida* as a valuable source of functional compounds with diverse and significant therapeutic applications, warranting further research to fully explore their potential benefits in clinical settings.

Key words:

bioactive compounds, *Pleurotus florida*, FT-IR, GCMS, oyster mushroom

Apstrakt:

Bioaktivne komponente i terapijski potencijal *Pleurotus florida*: sveobuhvatna analiza

Pečurke roda *Pleurotus*, poznate kao bukovače, poznate su po svojoj jestivosti i sve većim zdravstvenim koristima. Ova studija istražuje bioaktivne komponente i funkcionalne grupe u pečurkama *Pleurotus florida*, sa fokusom na polisaharide, peptide, masne kiseline i fenolna jedinjenja. Detaljna analiza je identifikovala funkcionalne grupe i širok spektar od 37 bioaktivnih jedinjenja, od kojih svako ispoljava različite biološke aktivnosti. Ove aktivnosti uključuju lečenje fobičnih poremećaja, antiseboroične efekte, sklerozantna svojstva, antagonizam holesterola, antičekzemske efekte, regulaciju metabolizma lipida, antihiperholesterolemična svojstva, antisekretornu aktivnost i kardiovaskularne analeptičke efekte. Pored toga, studija ističe potencijalne sinergističke efekte ovih jedinjenja, koji mogu doprineti njihovoj ukupnoj terapijskoj efikasnosti. Rezultati naglašavaju obećavajući potencijal *Pleurotus florida* kao vrednog izvora funkcionalnih jedinjenja sa različitim i značajnim terapijskim primenama, što opravdava dalje istraživanje kako bi se u potpunosti istražile njihove moguće koristi u kliničkim uslovima.

Ključne reči:

bioaktivna jedinjenja, *Pleurotus florida*, FT-IR, GCMS, bukovača

Introduction

Mushrooms are the spore-bearing fruiting bodies of matured mycelium typically formed above the soil or on its substrate. Greeks and Romans have taken mushrooms as food since ancient times. Chinese considered mushroom as an elixir of life and Romans regarded it as food of God. Mushroom belongs to the class Basidiomycota of kingdom Fungi because

of unique fungal characteristics and development (Song, 2004). Mushrooms have drawn attention as a therapeutic food, as a source of drugs and nutritional supplements since they are hyped for their antioxidant, antitumor and antimicrobial properties. In addition to their pharmacological properties, mushrooms have become much more significant in our diet due to its high nutritional value, high protein content and low fat / energy content (Khatun

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et al., 2012). Mushrooms have predominantly been employed in conventional medicinal practices across China and various other Asian nations. These fungi exhibit a plethora of beneficial properties, including antineoplastic, antibacterial, antiviral, hypoglycaemic, hypocholesterolemic, anti-inflammatory, and antioxidant effects (Guillamón et al., 2010; Wasser, 2014).

The present study reveals the various types of bioactive compounds, potential health benefits, and the exciting possibilities they hold for future applications in medicine and functional foods.

Materials and Methods

FT-IR

Mushroom sample was lyophilized and mixed with KBr pellets and then subjected to FT-IR spectral analysis. The dried pellets were subjected to FT-IR spectroscopy measurement in the spectral range of 4000-400 cm with resolution of 4 cm. The results were compared with standard values and the functional groups were identified.

GC-MS analysis

GC-MS analysis of the mushroom sample was performed using a GC Clarus 500 Perkin-Elmer system comprising an AOC - 20i autosampler and gas chromatograph interfaced to a mass spectrometer (GC-MS) equipped with an Elite-1, fused silica capillary column (330 mm×0.25 mm ID×1µm df, composed of 100% dimethyl polysiloxane). For GC-MS detection, an electron ionization system

with ionizing energy of 70 eV was used. Helium gas (99.999%) was used as the carrier gas at constant flow rate of 1ml/minute and an injection volume of 0.5 µl was employed (split ratio of 10:1); Injector temperature 250 °C; Ion-source temperature 280 °C. The oven temperature was programmed from 110 °C (isothermal for 2 minutes), with an increase of 10 °C/minute, to 200 °C, then 5 °C/minute to 280 °C, ending with a 9 minutes isothermal at 280 °C. Mass spectra were taken at 70 eV; a scan interval of 0.5 seconds and fragments from 40 to 550 Da. Total GC running time was 36 minutes. The relative percentage of each component was calculated by comparing its average peak area to the total areas, software adopted to handle mass spectra and chromatograms was a Turbo mass. Interpretation on mass spectrum of GC-MS was conducted using the database of National Institute of Standard and Technology (NIST) having more than 62,000 patterns. The spectrum of the unknown components was compared with the spectrum of the known components stored in the NIST library. The name, molecular weight and structure of the components of the test materials were ascertained.

Results

FT-IR analysis

FT-IR analysis of the *Pleurotus florida* mushroom powder provides the information about the functional groups present in it (Fig. 1, Tab. 1). The peak at 3387.25 is associated with N-H stretching, which is characteristic of aliphatic primary amines, and it shows medium intensity. A weak peak at 2081.93

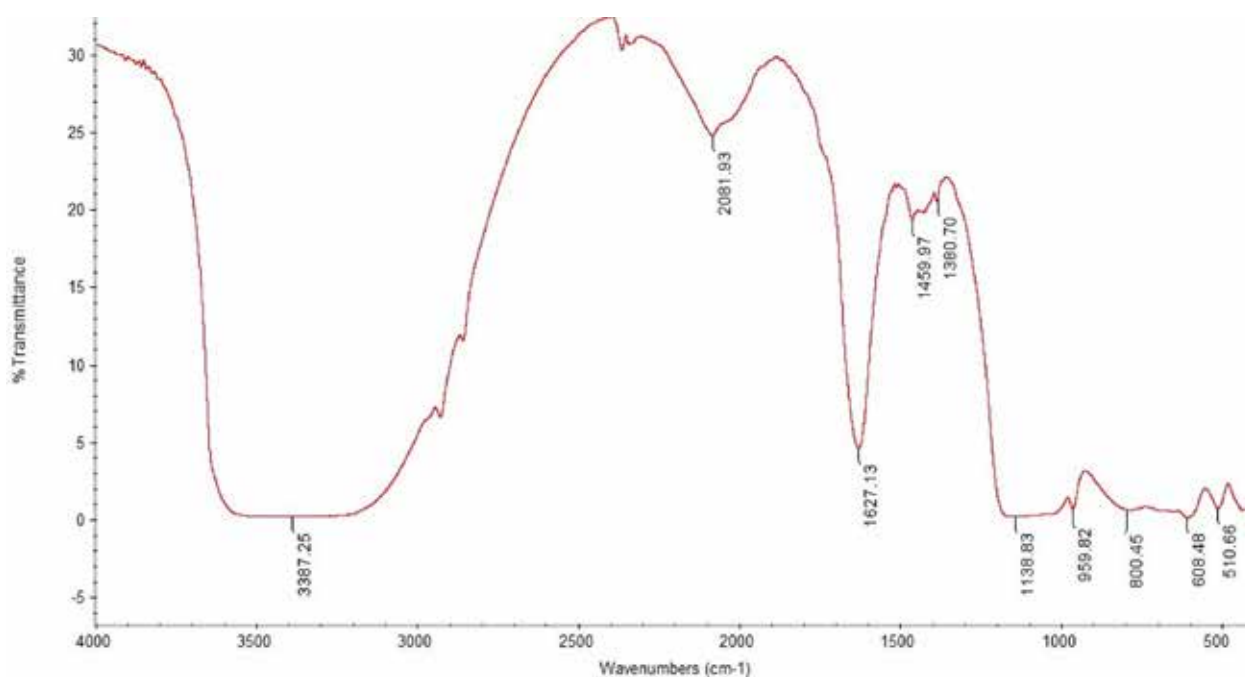


Fig. 1. FT-IR Spectrum of *Pleurotus florida*

Table 1. FT-IR Analysis of *Pleurotus florida*

S. No.	Peak value	Group	Class	Peak details
1	3387.3	N-H stretching	aliphatic primary amine	medium
2	2081.9	C≡C stretching	alkyne	weak
3	1627.1	C-H bending	aromatic compound	weak
4	1460	C-H bending	alkane	medium
5	1380.7	C-H bending	aldehyde	medium
6	1138.8	C-O stretching	aliphatic ether	strong
7	959.82	C=C bending	alkene	strong
8	800.45	C=C bending	alkene	medium
9	608.48	C-Br stretching	halo compound	strong
10	510.66	C-I stretching	halo compound	strong

corresponds to C≡C stretching, indicating the presence of an alkyne group. Aromatic compounds are represented by a weak C-H bending peak at 1627.13, while a medium-intensity C-H bending peak at 1459.97 suggests the presence of alkanes. The 1380.70 peak is associated with C-H bending in aldehydes and is of medium intensity. A strong peak at 1138.83 corresponds to C-O stretching in aliphatic ethers. Alkenes are identified by two peaks: a strong C=C bending peak at 959.82 and a medium-intensity C=C bending peak at 800.45. Halo compounds are

indicated by strong peaks at 608.48 and 510.66, corresponding to C-Br stretching and C-I stretching, respectively. These peaks help to elucidate the chemical structure and functional groups present in the sample.

GC-MS analysis

From the GC-MS analysis of the mushroom extract totally 37 compounds were identified (**Fig. 2**). With the help of the online tool PASS Online its biological activity was identified. **Tab. 2** presents a list of compounds along with their molecular weight, peak area, molecular structure, bioactivity, and probability of activity. The bioactive compounds are shown to have a wide range of therapeutic

properties, such as antineoplastic, anti-inflammatory, lipid metabolism regulation, cardiovascular benefits, etc. The probability of bioactivity for each compound highlights its potential efficacy in various medical treatments.

Antineoplastic treatments

Antineoplastic agents play a critical role in inhibiting the growth and spread of tumors. Several compounds are identified with antineoplastic properties in the

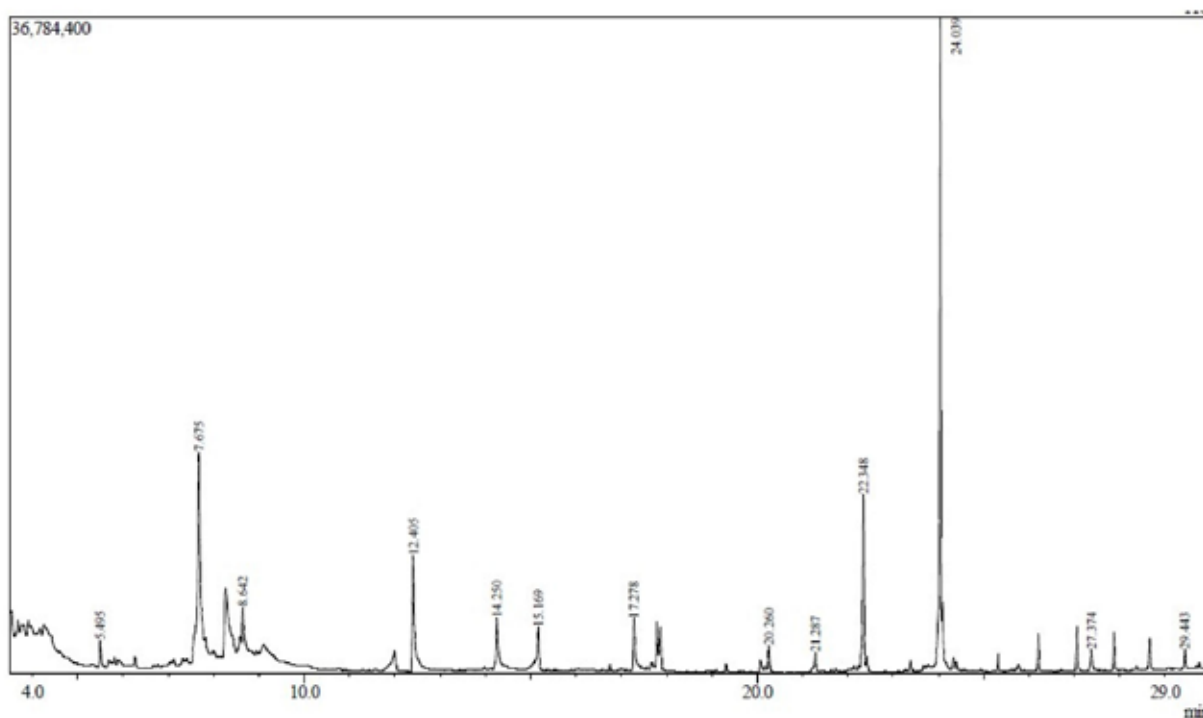


Fig. 2. GC-MS spectrum of *Pleurotus florida*

Table 2. Bioactive compounds identified by GC-MS analysis of *Pleurotus florida*

S. No.	R/T	Name of the Compound	Molecular Weight	Peak Area %	Molecular Structure	Bioactivity	Probability of activity
1	5.495	Triethylsilanol	132	1.41	<chem>CC[Si](CC)(CC)O</chem>	Antineoplastic	0.995
2	5.495	Formic acid	118	1.41	<chem>C(=O)O</chem>	-	-
3	5.495	Methoxyacetaldehyde diethyl acetal	148	1.41	<chem>CCOC(COC)(OC(C)C)C</chem>	Antiosteoporotic, Antibesity, Bone diseases treatment	0.954, 0.958, 0.928
4	7.675	Benzene, 1,2,3-trimethyl	120	23.96	<chem>CC1=C(C(=CC=C1)C)C</chem>	Antiseborrheic	0.85
5	7.675	Benzene, 1,2,4-trimethyl	120	23.96	<chem>CC1=CC(=C(C=C1)C)C</chem>	Antiseborrheic, Carminative	0.86, 0.828
6	8.64	1-Hexanol, 2-ethyl	130	2.06	<chem>CCCCCC(CO)CC</chem>	Sclerosant, Phobic disorders treatment	0.897, 0.896
7	8.64	2-Propyl-1-pentanol	130	2.06	<chem>CCCC(CCC)CO</chem>	Phobic disorders treatment, Sclerosant	0.900, 0.86
8	12.41	1,4:3,6-Dianhydro-alpha.-d-glucopyranose	144	10.21	<chem>C1[+F15C@@H]2[C@@H]3[C@H]1[C@H](O1)[C@H]([C@@H](O2)O3)O</chem>	Calcium regulator, Antineoplastic, Antiinflammatory, Restenosis treatment(non-Hodgkin's lymphoma)	0.925, 0.912, 0.878
9	12.41	4,5-Octanediol, 2,7-dimethyl-	174	10.21	<chem>CC(C)CC(C(C(C)C)C)O</chem>	Phobic disorders treatment, Sclerosant, Antiseborrheic	0.922, 0.854, 0.822
10	12.41	Methacrylic acid, ethyl ester	114	10.21	<chem>CCOC(=O)C(=C)C</chem>	Skin irritation, Antieczemetic, Phobic disorders treatment, Pediculicide, Cholesterol antagonist, Leukopotesis stimulant	0.957, 0.874, 0.826, 0.79, 0.727, 0.723
11	12.41	5-Decanone, 6-hydroxy-	172	10.21	<chem>CCCCCC(=O)CCCCO</chem>	Leukopotesis stimulant	0.777

12	12.41	4-Octanone, 5-hydroxy-2,7- dimethyl-	172	10.21	CC(C)CC(C(=O)CC(C)C)O	Phobic disorders treatment	0.872
13	14.25	Malic Acid	134	3.46	C(C(C(=O)O)O)C(=O)O	Antiseborrheic	0.793
14	14.25	Propanoic acid, 2-methyl-, propyl ester	130	3.46	CCCC(=O)C(C)C	Phobic disorders treatment, Antiseborrheic, Sclerosant, Antieczemetic	0.933, 0.881, 0.792, 0.756
15	14.25	Propanoic acid, 2-methyl-, 2-ethyl-3- hydroxyhexyl ester	216	3.46	CCCC(C(C)C)COC(=O)C(C)C)O	Sclerosant, Leukopoiesis stimulant	0.840, 0.725
16	14.25	3-Hydroxydecanoic acid	188	3.46	CCCCCCCC(C(=O)O)O	Lipid metabolism regulator	0.888
17	15.17	Tetradecane	198	2.59	CCCCCCCCCCCCCCCC	Antieczemetic, Antiseborrheic	0.895, 0.857
18	15.17	Hexadecane	226	2.59	CCCCCCCCCCCCCCCCCC	Antieczemetic, Antiseborrheic	0.895, 8.857
19	15.17	Pentadecane	212	2.59	CCCCCCCCCCCCCCCCC	Antieczemetic	0.895
20	17.28	Diethyl Phthalate	222	3.15	CCOC(=O)C1=CC=CC=C1C(=O)OCC	Cardiovascular analeptic	0.868
21	20.26	Nonadecane	268	1.32	CCCCCCCCCCCCCCCCCC	Cardiovascular analeptic	0.868
22	20.26	Octadecane	254	1.32	CCCCCCCCCCCCCCCCCC	Antieczemetic, Antiseborrheic, Cardiovascular analeptic	0.895, 0.857, 0.868
23	21.29	Pentadecanoic acid, ethyl ester	270	0.74	CCCCCCCCCCCCCCCC(=O)OCC	Mucositis treatment	0.815
24	21.29	Ethyl 13-methyl- tetradecanoate	270	0.74	CCOC(=O)CCCCCCCCCCCC(C)C	Sclerosant, Lipid metabolism regulator, Cholesterol antagonist	0.832, 0.807, 0.793
25	21.29	Hexadecanoic acid, ethyl ester	284	9.6	CCCCCCCCCCCCCCCCCC(=O)OCC	Fibrinolytic, Mucositis treatment	0.768, 0.771
26	22.35	Heptadecanoic acid, ethyl ester	298	9.6	CCCCCCCCCCCCCCCCCC(=O)OCC	Antieczemetic, Leukopoiesis stimulant	0.919, 0.850

and coronary artery disease.

Leukopoiesis stimulation

Leukopoiesis, the production of white blood cells, is essential for immune system function. Compounds such as heptadecanoic acid, ethyl ester, 5-decanone, 6-hydroxy-, heneicosane, methacrylic acid, ethyl ester, propanoic acid, 2-methyl-, 2-ethyl-3-hydroxyhexyl ester and hexadecanoic acid, ethyl ester have shown the ability to stimulate leukopoiesis. These compounds could help boost the immune system by increasing white blood cell counts, making them potentially useful in treating conditions like neutropenia and enhancing immune response.

Cardiovascular analeptic treatments

Cardiovascular analeptics are agents that stimulate heart function and improve circulatory health. Diethyl phthalate, nonadecane, ocatadecane, hexacosane, pentacosane, octacosane, tetratetracontane, and heneicosane have been found to exhibit cardiovascular analeptic properties. These compounds could help enhance heart function and overall cardiovascular health, making them potential candidates for managing heart conditions and improving circulation.

Discussion

The *Pleurotus* genus comprises approximately 40 distinct species, among which several hold considerable economic importance. The fruiting bodies of oyster mushrooms possess significant nutritional value and confer health-promoting benefits. Furthermore, numerous species within the *Pleurotus* genus have been recognized as sources of compounds with established medicinal attributes, including polysaccharides, peptides, and proteins, terpenoids, fatty acid esters, and polyphenols. The bioactive compounds present in *Pleurotus* species demonstrate a variety of beneficial properties, including immunostimulation, anti-neoplastic effects, anti-diabetic activity, anti-atherosclerotic effects, anti-inflammatory responses, antibacterial properties, and antioxidative capabilities. The multifaceted positive effects on the human body can be attributed to the synergistic interactions of these bioactive compounds (Golak-Siwulska et al., 2018). The fruiting bodies of various species of oyster mushrooms have yielded an extensive array of polysaccharides exhibiting several biological activities. Zhang et al. (2012) successfully isolated two distinct fractions of polysaccharides from *P. ostreatus*, demonstrating their significant antioxidative capabilities. Facchini et al. (2014) reported that polysaccharides derived from the

mycelium of *P. ostreatus* effectively inhibited the proliferation of neoplastic cells associated with Ehrlich tumor and sarcoma 180. Protein extract derived from *P. ostreatus* demonstrated a significant therapeutic impact on the colorectal cancer cell line SW 480 as well as on the monocytic leukaemia cell line THP-1 by promoting their apoptosis (Wu et al., 2011).

Furthermore, protein extracts from *P. eryngii* and *P. ostreatus* (eryngin and pleurostrin) exhibit notable antifungal and antibacterial activities (Erjavec et al., 2012). The species *P. cornucopiae* has yielded two oligopeptides that display antihypertensive effects (Jang et al., 2011). Additionally, the mycelium and fruiting bodies of *P. citrinopileatus* are characterized by high concentrations of ergothioneine, a water-soluble amino acid recognized for its exceptional antioxidant properties (Lin et al., 2016). Ribonuclease derived from *P. djamor* demonstrates an inhibitory effect on the proliferation of hepatic and breast cancer cells (Wu et al., 2010). Investigations have established that the polysaccharide-peptide complex obtained from *P. abalonus* significantly lowers blood glucose levels in murine models (Chen et al., 2015). Lectins isolated from *Pleurotus citrinopileatus* exhibit both antineoplastic and antiviral properties (Li et al., 2008). Terpenoids extracted from *P. cornucopiae* showed cytotoxic properties towards HeLa and HepG2 cancer cell lines (Wang et al., 2013). Menikpurage et al. (2009) and Alam et al. (2009) performed an investigation involving animal subjects, demonstrating that lovastatin present in the powdered fruiting bodies of *P. osteratus* and *P. sajor-caju* favorably influenced lipid profiles as well as hepatic and renal functions. The concentrations of total cholesterol and triglycerides in the bloodstream of the rats were found to be reduced.

The application of oyster mushrooms within the realms of cosmetology and dermatology represents another pertinent subject. Owing to their rich content of antioxidants, along with anti-aging, anti-wrinkle, whitening, and moisturizing agents, extracts from oyster mushrooms are suitable for the formulation of various cosmetics and cosmeceuticals. Certain countries offer soap featuring *P. ostreatus* extract, known for its skin regeneration properties. The utilization of a pleuran-based cream as an adjunctive therapy for patients suffering from atopic dermatitis has showed promising outcomes. Recent scientific literature substantiates the efficacy of various oyster mushroom species as viable raw materials for the cosmetics sector (Taofiq et al., 2016; Wu et al., 2016; Morris et al., 2017).

Cholesterol is a crucial lipophilic molecule essential for human survival, playing numerous roles in maintaining cellular function. It serves

as a precursor in the synthesis of vitamin D, steroid hormones and sex hormones. Additionally, cholesterol is a key component of bile salts, which aid in the digestion and absorption of fat-soluble vitamins A, D, E, and K (Ciaula et al., 2017). The impact of diet on cholesterol levels varies among individuals (Stone & Lloyd-Jones, 2015). Certain compounds in mushrooms help maintain healthy blood cholesterol levels and eliminate unwanted fats from the body. Psilocybin, a classic hallucinogen produced by over 100 species of mushrooms worldwide, binds with high affinity to several serotonin receptors, including 5-HT_{1A}, 5-HT_{2A}, and 5-HT_{2C}, which are located in various brain regions such as the cerebral cortex and thalamus. Daniel & Haberman (2017) provide an in-depth review of psilocybin's potential against various mental health conditions, including depression, anxiety disorders, obsessive-compulsive disorder, alcohol use disorder, and tobacco use disorder. Various substances extracted from macro fungi, particularly mushrooms, such as ceramides, lentinan, schizophyllan, omega-3, 6, and 9 fatty acids, carotenoids, and resveratrol, are increasingly being incorporated into cosmetics (Hyde et al., 2010; Camassola, 2013).

Conclusion

The study has revealed a rich array of bioactive components, including polysaccharides, peptides, fatty acids, and phenolic compounds, each associated with various therapeutic activities. The study identified 37 distinct bioactive compounds, demonstrating a wide spectrum of biological effects such as treatment for phobic disorders, antiseborrheic and antiacne properties, cholesterol antagonism, and regulation of lipid metabolism. The results suggest that *Pleurotus florida* holds considerable promise as a source of functional compounds with diverse health benefits. These findings support the potential of these mushrooms for use in developing novel therapeutic interventions and highlight the need for further research to elucidate the mechanisms underlying their efficacy and to explore their clinical applications more comprehensively.

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