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Bioactive Potential and Antimicrobial Activity of Extracts from Three Oyster Mushroom Species

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KEYWORDS

Antimicrobial, Bioactive compounds, Extracts, Solvent, oyster mushrooms.

ABSTRACT:

The bioactive compounds contained in oyster mushrooms have numerous nutritional and health benefits. Antimicrobial resistance and infectious diseases are major public health problems worldwide. In this study, we examined bioactive potential and antimicrobial activity of extracts from three oyster mushroom species. Fresh oyster mushroom samples of Pleurotus ostreatus, Pleurotus florida, and Pleurotus sajor caju were collected from growers in Gujarat, India. They were sun-dried for four days and powdered. Ten grams of powder from each species were extracted with 300 ml of double-distilled water, methanol, and ethanol at 70% using a Soxhlet apparatus, depending on the boiling point of each solvent. Qualitative and quantitative Phytochemical tests for the screening of bioactive chemical constituents in the mushroom samples were carried out using the standard procedure. Antimicrobial activity was evaluated by agar well diffusion against Escherichia coli, Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa, Candida albicans, and Candida parapsilosis using extracts prepared at a concentration of 100 mg/ml, and tested in volumes of 25, 50, and 100 µl. The results showed the presence of a diversity of bioactive compounds with the intensity of the reactions classified as strongly positive, positive and absent. Each solvent has its own particularity in the process of extracting phytochemical compounds. Pleurotus sajor caju contains the highest content of tannins, alkaloids and flavonoids (2.7 mg/ml, 100.7 mg/g, 0.6 mg/g). Pleurotus ostreatus contains the highest concentrations of phenols, saponins and glycosides (48.15 GAE/g, 1.5 mg/g, 5.05 mg/g). Pleurotus florida contains the highest concentration of steroids which is 2.35 mg/g. Methanol and ethanol extracts of oyster mushrooms exhibited inhibition zones ranging from 3.9 to 4.8 mm, whereas double distilled water extracts showed comparatively lower activity. Oyster mushroom extracts possess dose-dependent antimicrobial properties and theirs extracts are powerful broad-spectrum antimicrobial agents. The methanol extracts of Pleurotus ostreatus and Pleurotus sajor caju were more potent. The choice of solvent significantly influences the antimicrobial activity of oyster mushrooms.

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INTRODUCTION

Oyster mushrooms are saprophytic mushrooms belonging to the family Pleurotaceae and the genus *Pleurotus*. There are more than 70 different species in this group (Bertha, et al., 2024; Afroz, Dilip Kumar, & Saikia, 2017). They are the second most cultivated mushroom in the world and play a key role in the global mushroom market (Garuba, et al., 2023; Mehmet, ¸Sule, & Sevda, 2023). They are cultivated on various agricultural wastes (Somnath & Bishwanath, 2023). These mushrooms are rich in phenolic compounds, flavonoids, polysaccharides and various other secondary metabolites. The consumption of oyster mushrooms helps for human health as they contain several secondary metabolites which help in the prevention of diseases, because they contain antimicrobial, antioxidant, anticancer, antibiotic and antiviral properties (Izham, Avin, & Raseetha, 2022; Cardoso, et al., 2021; Adebayo, et al., 2018).

Research has shown that mushrooms possess phytochemicals with important nutritional values, antimicrobial properties, and powerful antioxidants. The use of oyster mushrooms in the manufacture of medicines will help a lot because their phytochemical profile has shown that they have hematological, antiviral, antitumor, antibiotic, antibacterial, antifungal and anticancer properties (Ahmed, et al., 2024; Nuhu, et al., 2018). The increase in antimicrobial resistance against a large number of antibiotics has limited the treatment of diseases caused by pathogenic bacteria and fungi, highlighting the need to find alternative therapies from oyster mushrooms. The antimicrobial properties of oyster mushrooms could offer an interesting alternative to antibacterial and antifungal drugs (Thakur, et al., 2025; Bozdeveci, Avci, Alpay Karaoğlu, Can, & Pekşen, 2022; Cardoso, et al., 2021). Pathogenic bacteria and fungi are responsible for infectious diseases that can cause death (Hameed, Ceyhan, & Akpınar, 2025; Varela, et al., 2021). Several studies have demonstrated that different oyster mushroom species possess bioactive compound and antimicrobial properties (Gangwar, et al., 2024 ; Kaisun Nesa, et al., 2022; Kothiyal & Keerti, 2022). Oyster mushrooms are little known in Gujarat state in India, and few studies have been carried out in the area. Our research adds insight into three Pleurotus species, clarifying their distinct bioactive and antimicrobial profiles for food and pharmaceutical applications. This study aimed to determine bioactive potential and antimicrobial activity of extracts from three oyster mushroom species.

MATERIALS AND METHODS

Mushroom strains

Pleurotus ostreatus, *Pleurotus florida* and *Pleurotus sajor caju* were obtained at Madhuvanti organic farm at Junagath and Shreenathji Organic Mushroom Products & Organic Mushroom Farm at Rajkot.

Oyster mushroom extraction

The mushroom samples collected were dried in the sun for 4 days. After that, each mushroom was cut into small pieces and then crushed to obtain a powder. The powder obtained was used for the preparation of the different extracts. Three different extracts were prepared. These are methanol, ethanol and double distil water. 10 g of powder was separately extracted with each 300 ml of ethanol, methanol at 70 % and double distilled water by using a soxhlet extractor for 4 hours at a temperature below the boiling point of the solvents. Using Whatman number 1 filter paper, the extract was filtered and the residual solvent was further removed by evaporation at 40 °C for 6 hours using a rotatory evaporator. The extracts obtained were stored in a sterile bottle under refrigeration condition (4 °C) before using for further analysis (Kothiyal & Keerti, 2022; Pandimeena, Prabu, Sumathy, & Kumuthakalavalli, 2015).

Bioactive compound determination

Qualitative and quantitative Phytochemical tests for the screening of bioactive chemical constituents in the mushroom samples were carried out using the standard procedures as describe by (Prasad Vijay, et al., 2023; Ikon, et al., 2019; Odangowei Inetiminebi, Oluchi Oguoma, Chukwudi Adigwe, & Bumein Anthony, 2021; Gayathri, Gomathi, Ambikapathy, & Panneerselvam, 2023).

Antimicrobial activity

Antimicrobial activities were carried out on commercial antibiotics namely chloramphenicol, streptomycin and ketoconazole. Subsequently on double distilled water, ethanol and methanol extracts of *Pleurotus ostreatus*, *Pleurotus florida* and *Pleurotus sajor caju*. A Total of four test bacterial species and 2 yeasts were tested to

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evaluate antimicrobial activity of commercial antibiotics and oyster mushrooms extracts. The Gram-positive bacteria were *Staphylococcus aureus* MTCC-2408 and *Bacillus subtilis* MTCC-736 while the Gram-negative bacteria were *Escherichia coli* MTCC-1650 and *Pseudomonas aeruginosa* ATCC27853. The different yeasts were *Candida albicans* HF0532-438 and *Candida parapsilosis*. The pathogens were obtained from the Department of Microbiology, Silver oak University, Ahmedabad.

Agar well diffusion techniques were adopted for the study. Mueller Hinton agar plates were inoculated with 0.1 ml of an overnight broth culture of each bacterial isolate (equivalent to 3 x 10^7 CFU/ml according to the McFarland standard) in a sterile Petri dish. The seeded plates were gently rocked for uniform distribution of the isolates and allowed to set. Wells with an 8 mm diameter were created on the plates using a standard sterile cork borer. Equal volumes (100 µl) of the test extracts were transferred into the wells using a micropipette. The experiments were carried out in triplicate. The plates were then incubated at 37°C for 24 hours, and observations were made until a marked decline in the potency of the extracts to inhibit the growth of the test isolates was observed. The zones of inhibition were measured in millimeters (mm), and the average values were calculated and recorded. For control purposes, Chloramphenicol and Streptomycin were used as standard antibiotics against selected Gram-positive and Gram-negative bacteria cultures, respectively. Ketoconazole was used as a control for the antifungal assay. (Gashaw, Fassil, & Redi, 2020; Gangwar, et al., 2024).

RESULTS

Bioactive compound determination

Qualitative phytochemical present in oyster mushroom

We took a closer look at the phytochemical profiles of *Pleurotus ostreatus*, *Pleurotus florida*, and *Pleurotus sajor caju* using double distilled water, ethanol, and methanol at 70%. The findings showed a variety of bioactive compounds, with reactions categorized as strongly positive, positive, or absent. *P. ostreatus* stood out with its impressive levels of carbohydrates, proteins, and steroids, highlighting its nutritional benefits. On the other hand, *P. florida* showcased its antioxidant capabilities thanks to its flavonoids and phenolics, while *P. sajor caju* was rich in tannins and alkaloids, which may enhance its antimicrobial properties. Water was particularly effective in extracting proteins, tannins, and saponins, while ethanol and methanol proved to be more efficient for alkaloids, flavonoids, and glycosides. The efficiency of extraction really depended on the solvent used.

Table 1: Qualitative phytochemical of *Pleurotus ostreatus*

Phytochemical constituents		***Pleurotus ostreatus***		
		Double distilled water extract	**Ethanol extract**	**Methanol extract**
Test for carbohydrates	Fehling's test	++	++	++
	Benedict' s test	++	++	++
	Mollish test	++	+	+
Test for proteins	Millon's test	++	+	+
	Test of biuret	++	++	++
Test for amino acid		++	+	+
Test for alkaloid	Mayer test	+	+	+
	Dragendorff test	+	+	+
	Wagner's test	+	+	+

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Test for terpenoid		+	++	++
Test for glycosides	Libermann Buchard's test	+	+	+
	Keller kiliani test	+	+	+
Test for phenolic compounds	Ferric chloride test	+	+	+
	Test lead acetate test	+	+	+
Test for flavoids	Ferric chloride test	++	++	++
	Alkaline reagent test	+	+	+
Test for steroids		++	+	+
Test for tannins		++	+	+
Test for saponins		++	++	+

++: Strongly positive; + Positive; - Absent

Table 2: Qualitative phytochemical of *Pleurotus florida*

Phytochemical constituents		***Pleurotus florida***		
		Double distilled water extract	**Ethanol extract**	**Methanol extract**
Test for carbohydrates	Fehling's test	++	++	++
	Benedict' s test	++	++	++
	Mollish test	+	+	+
Test for proteins	Millon's test	++	+	+
	Test of biuret	++	++	++
Test for amino acid: Ninhydrin test		+	+	+
Test for alkaloid	Mayer test	++	++	++
	Dragendorff test	++	++	++
	Wagner's test	++	++	++
Test for terpenoid		+	+	+
Test for glycosides	Libermann Buchard's test	-	+	-
	Keller kiliani test	++	++	+
Test for phenolic compounds	Ferric chloride test	++	++	++
	Test lead acetate test	+	+	-
Test for flavonoids	Ferric chloride test	++	++	+

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Alkaline reagent test	++	++	+
Test for steroids	++	+	+
Test for tannin	+	+	++
Test for saponin	++	+	+

++: Strongly positive; + Positive; - Absent

Table 3: Qualitative phytochemical of *Pleurotus sajor saju*

Phytochemical constituents		***Pleurotus Sajor caju***		
		Double distilled water extract	**Ethanol extract**	**Methanol extract**
Test for carbohydrates	Fehling's test	++	++	++
	Benedict' s test	+	++	++
	Mollish test	++	++	+
Test for proteins	Millon's test	++	++	++
	Test of biuret	++	+	++
Test for amino acid		+	+	+
Test for alkaloid	Mayer test	++	++	++
	Dragendorff test	++	++	++
	Wagner's test	+	+	++
Test for terpenoid		+	+	+
Test for glycosides	Libermann Buchard's test	+	+	+
	Keller kiliani test	+	+	+
Test for phenolic compounds	Ferric chloride test	+	+	+
	Test lead acetate test	+	+	+
Test for flavoids	Ferric chloride test	++	++	++
	Alkaline reagent test	++	++	++
Test for steroids		-	+	+
Test for tannin		++	++	++
Test for saponin		++	+	+

++: Strongly positive; + Positive; - Absent

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Table 4: Quantitative phytochemical

Phytochemical constituents	Oyster mushrooms species		
	Pleurotus ostreatus	***Pleurotus florida***	***Pleurotus sajor caju***
Tannins (mg/ml)	1.5	0.27	2.7
Alkaloid (mg/g)	5.5	2.92	100.7
Flavonoids (mg/g)	0.5	0.028	0.6
Terpenoid (mg/g)	0.9	0.74	0.82
Steroid (mg/g)	2.15	2.35	1.05
Phenol (mg of GAE/g)	48.15	46.74	30.15
Saponin (mg/g)	1.5	0.91	0.88
Glycosides (mg/g)	5.05	3.41	3.01

Quantitative phytochemical result of oyster mushroom

The quantitative phytochemical analysis of three mushroom species: *Pleurotus ostreatus*, *Pleurotus florida*, and *Pleurotus sajor caju*. Among them, *P. sajor caju* stands out with the highest levels of tannins, alkaloids, and flavonoids, suggesting it has strong antimicrobial properties. On the other hand, *P. ostreatus* boasts the highest amounts of phenols, saponins, and glycosides, which are known for their antioxidant benefits. Meanwhile, *P. florida* takes the lead in steroid content, measuring at 2.35 mg/g. There are significant differences among these species, particularly in their tannin, alkaloid, and phenol levels ($p < 0.001$). Additionally, *P. florida* shows a unique flavonoid profile, while *P. ostreatus* is particularly rich in antioxidants. These results underscore the unique therapeutic and nutritional potential of each species

Antimicrobial activity of oyster mushroom

Antimicrobial activity of Pleurotus ostreatus

The highest inhibition zones are observed at concentrations of 100 µl. The inhibition zones ranged from 3.9 to 4.7 mm. The double distilled water extract obtained the largest inhibition zone of 4.7 mm in *E. coli*. The smallest inhibition zone was obtained in the methanol extract in *C. parapsilosis*. Progressive decreases in the inhibition zones were observed at concentrations of 50 and 25 µl, revealing the role of high concentrations in antimicrobial tests. The diameters of the inhibition zones are in most cases greater than 4 mm at 100 µl concentration as well as at the lowest concentration (25 µl) indicating the potent antimicrobial effect of the extracts. *Staphylococcus aureus* shows the highest diameters of the inhibition zones at almost all concentrations indicating a high sensitivity to the extracts. *Candida parapsilosis* had the smallest inhibition diameters, suggesting lower sensitivity than other organisms. *Pleurotus ostreatus* is a broad-spectrum antimicrobial agent as its extracts are effective against Gram-positive, Gram-negative bacteria and fungal species. A high inhibition diameter means that the microorganism is more sensitive and has a strong ability to fight bacteria and fungi. Low inhibition indicates resistance or a lack of sensitivity of the microorganism.

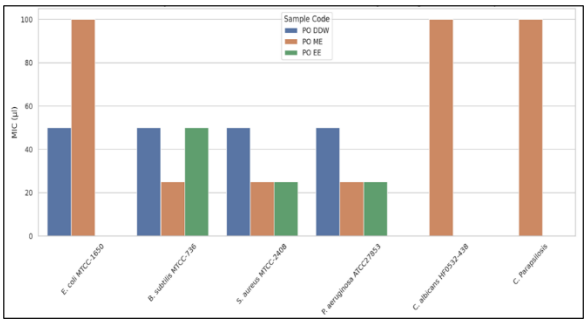

Figure 1: Minimum Inhibitory Concentration of *Pleurotus ostreatus* by test organism and extracts

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The Minimum Inhibition Concentration (MIC) value varied with both solvent and organism. The double distilled water and methanol extract showed variations in MIC in the pathogen *E. coli*. The methanol extract showed the highest MIC which is 100 µl indicating lower antimicrobial efficacy while double distilled water extract had a lower MIC (50 µl) indicating better inhibition for this organism. *B. subtilis* exhibited similar MIC of 50 µl in both double distilled water and ethanol extracts. However, the methanol extract exhibited a MIC of 25 µl suggesting better activity for this organism. *S. aureus* maintained a constant MIC in the double distilled extract. Methanol and ethanol extracts exhibited lower MIC (25 µl) indicating stronger inhibition of the extracts. *P. aeruginosa* showed an MIC of 50 µl in the double distilled water extracts. The methanol and ethanol extracts had similar MIC (25 µl) indicating relatively better inhibition. *C. albicans* showed a very high concentration of 100 µl in the methanol extract, indicating weak antifungal activity. The extract with the lowest MIC performs best because it can effectively stop microbial growth even at low concentrations.

Antimicrobial activity of Pleurotus Florida

The different inhibition zone diameter values ranged from 4 to 4.6 mm. The largest inhibition zone (4.6 mm) was observed for *S. aureus* in the double distilled water extract at a concentration of 100 µl. Overall, inhibition increased with extract concentration, with 100 µl producing the widest zones, followed by 50 µl and 25 µl. *Staphylococcus aureus* exhibited the most significant zone of inhibition at all concentrations, thus displaying a robust response. In contrast, *C. albicans* and *C. parapsilosis* exhibited the smallest zones of inhibition than the bacterial strains, indicating weak antifungal activity. *E. coli* and *B. subtilis* showed consistent responses at different concentrations. The antimicrobial compounds of *Pleurotus florida* are more effective at higher concentrations (100 and 50 µl). Regarding sensitivity, bacteria seem to be more affected by the antimicrobial properties of *Pleurotus florida* extracts than fungal strains, as evidenced by the observed wider zones of inhibition. Among the bacteria tested, *S. aureus* stood out for its higher sensitivity. Antimicrobial effect is effectively dependent on the concentration of the extract. The ethanol extract exhibited the most potent antimicrobial activity across all concentrations and pathogens.

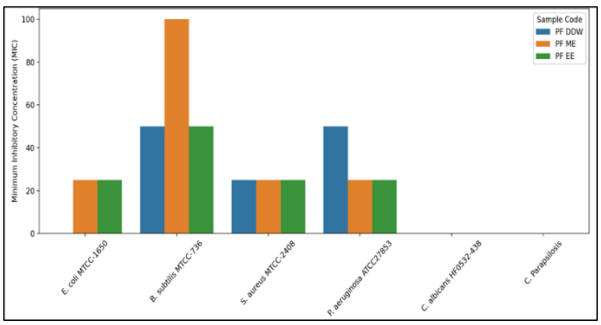

Figure 2: Minimum inhibition concentration of *Pleurotus florida* by test organism and extracts

The MIC values of *Pleurotus florida* extract varied with both the type of solvent and the test organism. Each extract had a different MIC value depending on the extract used. *B. subtilis* had the highest MIC (100 µl) with the methanol extract followed by 50 µl with the double distilled water extract. *P. aeruginosa* had a MIC of 50 µl in the double distilled extract. *E. coli* and *S. aureus* exhibited lower MIC values, indicating that these extracts were more effective in inhibiting growth. The methanol extract appeared to exhibit higher MIC values than the other extracts, indicating that it was less effective in stopping bacterial growth in most situations. Double distilled water and ethanol extracts showed stronger antimicrobial properties, as the MIC values were lower for some tested pathogens. The choice of extract and target pathogen strongly influences the antimicrobial efficacy of *Pleurotus florida*. The ethanol extract stands out as the most effective extract while *E. coli* proves to be the most vulnerable organism. This extract-organism combination constitutes the most potent pairing observed. There is no significant difference between the MIC values of the three extracts for the tested organisms.

Antimicrobial activity of Pleurotus sajor caju

The diameters of the inhibition zones of *Pleurotus sajor caju* range from 4.1 to 4.8 mm. The most significant inhibition was observed at 100 µl concentration (4.3 to 4.8 mm) for all organisms. Followed by 50 µl concentration (4.2 to 4.7 mm) then 25 µl (4.1 to 4.5 mm). Thus, the antimicrobial efficacy of *Pleurotus sajor caju* depends on the concentration used, higher concentrations resulted in stronger activity. *E. coli* and *P. aeruginosa* showed the widest inhibition zones at all concentrations: at 100 µl concentration (4.8 mm) in the double distilled water extract, 4.6 mm in the methanol extract and 4.4 mm

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in the ethanol extract; at 50 µl concentration (4.7, 4.5 and 4.4 mm). Furthermore, *B. subtilis* and *S. aureus* exhibited moderate inhibition with smaller inhibition zones than *E. coli* and *P. aeruginosa*. Fungal strains (*C. albicans* and *C. parapsilosis*) exhibited smaller inhibition zones, suggesting that they are less susceptible to the extract. *Pleurotus sajor caju* extract exhibited a distinct antimicrobial effect that varied with concentration. Higher concentrations resulted in stronger activity. The extracts exhibited broad-spectrum antimicrobial activity, effectively blocking the growth of Gram-positive, Gram-negative bacteria and fungi. *Pleurotus sajor caju* extracts are natural antimicrobial agents that are used in the fight against bacterial infections.

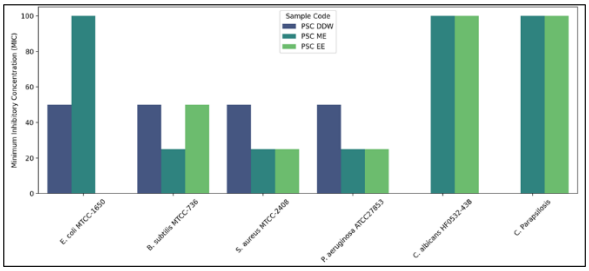

Figure 3: MIC of *Pleurotus sajor caju* by test organism and extracts

Concerning the MIC of *Pleurotus sajor caju* methanol and ethanol extracts were found to be more effective against bacteria, particularly *B. subtilis*, *S. aureus* and *P. aeruginosa*, with lower MIC (25 µl). All species had difficulty combating fungal strains (*C. albicans* and *C. parapsilosis*) with MIC equal to 100 µl. The methanol extract was more effective against the bacteria tested, while the fungal strains were found to be quite resistant to all extracts. *E. coli* in methanol extract has the highest MIC which means that it is not very effective, on the other hand in the double distilled water extract has a MIC of 50 indicating a better effectiveness than methanol. *B. subtilis* in the double distilled water and ethanol extract has similar MIC (50 µl) indicating moderate activity. However, it has a MIC of 25 µl (lower) in the methanol extract. This indicates that the methanol extract exerts a strong inhibitory effect on this pathogen. Regarding *S. aureus*, it has an MIC of about 50 µl in the double distilled water extract and 25 µl in the methanol and ethanol extracts suggesting similar efficacy. *P. aeruginosa* had an MIC of 25 µl in the methanol and ethanol extracts indicating high efficacy, an MIC of 50 µl in the double distilled water extract. *Candida albicans* and *C. parapsilosis* had an MIC of 100 µl in the methanol and ethanol extracts indicating low antifungal activity.

CONCLUSION

Our work focused on bioactive potential and antimicrobial activity of extracts from three oyster mushroom species. Through various analytical methods, we have established the qualitative and quantitative analysis of *Pleurotus ostreatus*, *Pleurotus florida* and *Pleurotus sajor caju* on methanol, ethanol and double distilled water extracts. Agar well diffusion technique was adopted to determine antimicrobial activity on the different extracts against pathogens. The results revealed that oyster mushrooms contain almost all the secondary metabolites who are essential for life. Oyster mushrooms are broad-spectrum antimicrobial agents. Antimicrobial activity was dose dependent. Alcohol solvents allow better extraction of bioactive compounds responsible for antimicrobial activity. Methanol extracts of *Pleurotus ostreatus* and *Pleurotus sajor caju* were the most potent. Methanol, ethanol, and double distilled water extracts of *Pleurotus ostreatus*, *florida*, and *sajor caju* are potent antimicrobial agents. This study highlighted the potential of oyster mushrooms as a source of antimicrobial agents, exploitable for pharmaceutical, medicinal, nutritional, agricultural and many other applications.

REFERENCES

1. Adebayo, E. A., Martınez-Carrera, D., Morales, P., Sobal, M., Escudero, H., Meneses, M. E., . . . Bonilla, M. (2018). Comparative study of antioxidant and antibacterial properties of the edible mushrooms Pleurotus levis, P. ostreatus, P. pulmonarius and P. tuber-regium. *International Journal of Food Science and Technology*, 1316–1330.
2. Afroz, M., Dilip Kumar, S., & Saikia, A. (2017). Antioxidant properties of some common oyster mushrooms grown in North East India. *Indian Phytopath, LXX*(1), 98-103.
3. Ahmed, R., Hasan Mazumder Niloy, M. A., Shafiqul Islam, M., Selim Reza, M., Yesmin, S., Bin Rasul, S., & Khandakar, J. (2024). Optimizing tea waste as a sustainable substrate for Oyster mushroom (Pleurotus Ostreatus) Cultivation : a comprehensive study on

biological efficiency and nutritional aspect. *Frontiers in Sustainable Food Systems*, 1- 10.

4. Baraza, L. D., Neser, W., Cheruiyot Jackson, K., Fredrick, J. B., Dennis, O., Wairimu, K. R., . . . Heydenreich, M. (2016). Antimicrobial Coumarins from the Oyster Culinary Medicinal Mushroom, Pleurotus ostreatus (Agaricomycetes), from Kenya. *International Journal of Medicinal Mushrooms, XVIII*(10), 905–913.
5. Bertha, G.-P., Mario, C., Isabel, M.-R., Rodríguez-Jasso, R. M., Araceli, L., José Luis, M., & Belmares, R. (2024). Bioavailability in edible mushroom Pleurotus species : Revue article. *Journal of Agricultural, Food Science & Biotechnology, II*(1), 130- 139.
6. Bozdeveci, A., Avci, S., Alpay Karaoğlu, Ş., Can, Z., & Pekşen, A. (2022). Do Different Substrates Affect Antioxidant Properties and Antimicrobial Activity of Pleurotus ostreatus? *Journal of Anatolian Environmental and Animal Sciences*, 537-545.
7. Cardoso, R. V., Carocho, M., Fernandes, Â., Pinela, J., Stojkovi, D., Sokovi´, M., . . . Barros. (2021). Antioxidant and Antimicrobial Influence on Oyster Mushroom (Pleurotus ostreatus) from Substrate Supplementation of Calcium Silicate. *Sustainability*, 1-14.
8. Gangwar, R., Salem, M. M., Kumar Maurya, V., Bekhit, M. M., Singh, N., Fattah Amara, A. A., . . . Ibrahim, M. A. (2024). Exploring time-killing and biofilm inhibition potential of bioactive proteins extracted from two varieties of Pleurotus ostreatus . *Frontiere in Microbiology*, 1- 17.
9. Garuba, T., Olabanj, I., Awogboro, O. M., Olahan, G., Atunwa, S., Ahmed, O., . . . Sabiu, S. (2023). Haematological, Serum Biochemical and Histopathological Changes in Acute and Sub-Chronic Aqueous Extract of Oyster Mushroom in Male Wistar Rats. *Journal of Scientific Research, XV*(1), 201-213.
10. Gashaw, G., Fassil, A., & Redi, F. (2020). Evaluation of the Antibacterial Activity of Pleurotus spp. Cultivated on Different Agricultural Wastes in Chiro, Ethiopia. *International Journal of Microbiology*, 1-9.
11. Gayathri, G., Gomathi, S., Ambikapathy, V., & Panneerselvam, A. (2023). Physico-Chemical and Qualitative, Quantitative Chemical Compounds Analysis of Pleurotus florida in Thanjavur, Tamilnadu, India. *International Journal of Life science and Pharma Research, XIII*(2), L8-L17.
12. Hameed, B., Ceyhan, D. İ., & Akpınar, A. (2025). Antimicrobial activity against some human pathogenic microorganisms of silk spiders; Agelena labyrinthica (Agelenidae) and Holochnemus pluchei (Pholcidae). *Journal of Natural Fibers, XXII*(1), 1-8.
13. Ikon, G., Udobre, E., Etang, U., Ekanemesang, U., Ebana, R., & Edet, U. (2019). Phytochemical Screening, Proximate Composition and Antibacterial Activity of Oyster Mushroom,Pleurotus ostreatus Collected from Etim Ekpo in Akwa Ibom State, Nigeria. *Asian Food Science Journal, VII*(2), 1-10.
14. Izham, I., Avin, F., & Raseetha, S. (2022). Systematic Review: Heat Treatments on Phenolic Content, Antioxidant Activity, and Sensory Quality of Malaysian Mushroom: Oyster (Pleurotus spp.) and Black Jelly (Auricularia spp.) . *Frontiers in Sustainable Food Systems*, 1-16.
15. Kaisun Nesa, L., Mayeen Uddin, K., Faruque Mohammad, R. I., Rohit, S., Fahadul, I., Saikat, M., & Talha Bin, E. (2022). Nutritional Value, Medicinal Importance, and Health-Promoting Effects of Dietary Mushroom (Pleurotus ostreatus). *Journal of Food Quality*, 1-9.
16. Kothiyal, G., & Keerti, S. (2022). Antimicrobial and phytochemical screening of selected wild mushrooms naturally found in Garhwal Himalayan region,Uttarakhand, India. *Journal of Advanced Biotechnology and experimental Therapeutics, X*(2), 417-432.

17. Mehmet, A., ¸Sule, ˙. I., & Sevda, K. (2023). Evaluation ofAntimicrobial, Antioxidant, Cytotoxic andDNAProtective Effects of Oyster Mushroom: Pleurotuspulmonarius (Fr.) Quel. *Arabian Journal for Science and Engineering*, 7273-7283.

18. Nuhu, A., Ruhul, A., Asaduzzaman, K., Ismot, A., Mi Ja, S., Min Woong, L., & Tae Soo, L. (2018). Nutritional Analysis of Cultivated Mushrooms in Bangladesh – Pleurotus ostreatus, Pleurotus sajor - caju, Pleurotus florida and Calocybe indica. *Mycobiology, XXXVI*(4), 228-232.

19. Odangowei Inetiminebi, O., Oluchi Oguoma, L. M., Chukwudi Adigwe, P., & Bumein Anthony, B. (2021). Phytochemical Properties and In-vitro Antimicrobial Potency of Wild Edible Mushrooms (Pleurotus ostreatus) obtained from Yenagoa, Nigeria. *The Journal of Phytopharmacology, X*(3), 180-184.

20. Pandimeena, M., Prabu, M., Sumathy, R., & Kumuthakalavalli, R. (2015). Evaluation of phytochemicals and in vitro anti-inflammatory, anti-diabetic activity of the white oyster mushroom, pleurotus florida. *International Research Journal of Pharmaceutical and Applied science, X*(1), 16-21.

21. Prasad Vijay, K., Damini Kallyanrao, G., Sameer Khamroddin, S., Kavita Nilesh, Y., Abhijit Sampatrao, K., & Manohar Janardhan, P. (2023). Pharmacognostic, Chemical Characterization Studies on Oyster Mushroom (Pleurotus ostreatus). *Pharmacognosy Research, 15*(3), 514-523.

22. Somnath, R., & Bishwanath, C. (2023). Morphological and molecular characterization of four Pleurotus spp. and evaluation of their antioxidant properties. *Journal of Mycopathological Research, VI*(1), 31-43.

23. Thakur, P., Jandaik, S., Guleria, S., Sharma, A., Sharma, R., & Singh, R. (2025). Exploring the Potential of Spent Pleurotus eryngii (Agaricomycetes) Substrate to Cultivate Pleurotus. *International Journal of Medicinal Mushrooms, XXVII*(2), 47–57.

24. Varela, M. F., Stephen, J., Lekshmi, M., Ojha, M., Wenzel, N., Sanford, L. M., . . . Kumar, S. (2021). Bacterial Resistance to Antimicrobial Agents. *Antibiotics*, 1-22.