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THE FOOD AND MEDICINAL BENEFITS OF OYSTER MUSHROOM (*PLEUROTUS OSTREATUS*): A REVIEW

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ABSTRACT: The oyster mushroom (*Pleurotus ostreatus*) is a culinary mushroom. Mushrooms are considered a potential source of many essential nutrients and therapeutic bioactive compounds. *Pleurotus ostreatus* is a macro fungus that belongs to the class Basidiomycetes and the family Pleurotaceae, known as the oyster mushroom. It is the most important commercially cultivated mushroom in the world. Mushroom contains rich nutrients such as proteins, carbohydrates, vitamins, amino acids, lipids and fibers. It is used as food and medicine. Mushroom contains more bioactive compounds such as peptides, polysaccharides, liposaccharides, glycoprotein, lectin, triterpenoid, fatty acids, essential amino acids and nucleosides. They are used traditionally as a medicine for different diseases. These mushrooms have been reported to be antioxidant, anticancer, antimicrobial, anti-inflammatory, antidiabetic, antihypertensive, antihypercholesterolemic, antiatherogenic, anti-hyperglycemic and immunomodulating. This review gives information on the traditional uses, chemical composition and nutritional benefits of oyster mushrooms. These studies reveal that *Pleurotus ostreatus* is a source of medicinally active compounds with various pharmacological effects. These studies will be helpful to create interest in *Pleurotus ostreatus* and may be useful in developing a new reaction for further research.

INTRODUCTION: The oyster mushroom was firstly described in 1775 by Dutch naturalist Nikolaus Joseph Freiherr von Jacquin (1727-1817). In 1871 German mycologist Paul Kummer transferred the Oyster mushroom to the genus *Pleurotus*. (A new genus that Kummer himself had defined in 1971), given its currently accepted name *Pleurotus Ostreatus*. It has long been cultivated in Asia, Japan, and the Chinese¹.

All around the world 2000 species of mushrooms are edible. A small number of species are known to be poisonous. *Pleurotus ostreatus* is nutritious, edible, and cultivated commercially for its nutritional and medicinal value². They are healthy food, low in calories and fat, and rich in carbohydrates, vitamins, protein, chitin, and minerals³.

It is used as food and medicine. Other oyster mushroom species include *Pleurotus ostreatus*, *Pleurotus Sajor-Caju*, *Pleurotus cystidiosus*, *Pleurotus tuber-region*, *Pleurotus flabellate*, *Pleurotus pulmonarias*, *Pleurotus citrinopileatus*, *Pleurotus Florida*, *Pleurotus sapidus*, *Pleurotus eryngii*, *Pleurotus tuberregium* are present. The *Pleurotus ostreatus* is cultivated on different types

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of lignocellulose materials like sawdust, straw, rice, coffee residue, hull, tea leaves, and cotton waste. These mushrooms have a delicate taste, texture, and unique flavor⁴. It is a food supplement not only for its flavor, taste, and nutritive value but also for its medicinal properties. Numerous edible mushrooms have been found, in addition to their nutritional profile, to be medically active in different therapies. The reason is linked to their richness in bioactive compounds, such as phenolic compounds, polyketides, terpenes, steroids, beta-carotene, and vitamins A and C⁵.

Mushrooms are a good source of dietary fibers due to the presence of polysaccharides ((1→3)-β-D-glucans and mannans) and chitin (a straight chain (1→4)-β-linked polymer of N-acetylglucosamine) in their cell walls⁶. The use of oyster mushrooms in cosmetology and dermatology is another issue. Due to the presence of antioxidants, anti-aging, anti-wrinkle, whitening, and moisturizing components oyster mushroom extracts can be used to produce various cosmetics and cosmeceuticals⁷. The Oyster mushroom name originates from the Latin *Pleurotus* - sideways, oyster- the shape of the cap⁸. *Pleurotus ostreatus* is commonly known as the oyster mushroom, a macro fungus of the phylum Basidiomycota that belongs to the Family Pleurotaceae.

Taxonomical Classification¹⁰:

| Sr. no. | Taxonomic | Taxon |
|---------|-----------|----------------------------|
| 1. | Domain | Eukaryota |
| 2. | Kingdom | Fungi |
| 3. | Phylum | Basidiomycota |
| 4. | Subphylum | Agaricomycotina |
| 5. | Class | Agariomycetes |
| 6. | Subclass | Agaricomycetides |
| 7. | Order | Agaricales |
| 8. | Family | Pleurotaceae |
| 9. | Genus | <i>Pleurotus</i> |
| 10. | Species | <i>Pleurotus ostreatus</i> |

Morphological Description¹¹:

| Sr. no. | Part | Observation |
|---------|--------------|--|
| 1. | Cap (pileus) | 5.6-11.2 diameter, Whitish to grey color, convex, smooth, soft, maturing to a shell shape. |
| 2. | Gills | White, broad decurrent gills |
| 3. | Spores | Spores are whitish to lilac grey in mass, cylindrical to oblong in shape |
| 4. | Stipe | 4.7-7.2 cm in length, 1.3-2.2cm in diameter, Cream, and smooth surface |
| 5. | Odor | Mild |

It is also called 'dhingri' or abalone. Mushroom is defined as the fleshy spore-bearing fruiting body of the fungus that could either be epigenous or hypogynous when produced. It can be seen as vulnerable and picked by hand⁹.

Chemical Constituents: Phytochemical constituents of the *Pleurotus ostreatus* include Alkaloids, Saponin, Quinones, Triterpenoid, Phenolic compounds, Steroids, flavonoids, and Tannins¹². Angus Nnamdi Oli *et al.* observed that the carpophore of the mushroom is also a potential source of lignin and phenol-degrading enzymes. It contains secondary metabolites such as Ergothioneine, carotenoids, and Ascorbic acid. It contains high bioactive polysaccharides, which are functional food. They are a good source of prebiotics and contain short-chain sugars such as galactose, glucose, fructose and N-acetylglucosamine¹³. It is composed of different minerals such as Zinc, Potassium, Sodium, Iron, and Calcium¹⁴. It contains volatile oil compounds used as flavoring agents, called 1-octane-3-ol. It is the major contributor. It is a good source of Beta-glucans¹⁵.

Ethnobotanical uses: Oyster mushrooms have a great potential to produce value-added backed products. Nutritionally the *Pleurotus ostreatus* is a source of vitamins B1 (Thiamin) B2 (Riboflavin), B3 (niacin), B9 (folic acid), and ascorbic acid. *Pleurotus ostreatus* decreases cholesterol levels in experimental animals. It is a rich source of protein, vitamins, carbohydrates, amino acids, minerals, lipids, and fiber. Internal polysaccharides and exopolysaccharides isolated from *Pleurotus ostreatus* also showed high antioxidant properties¹⁶. Oyster mushroom is used for mycoremediation¹⁷. It is used to produce an instant soup premix and is also used in various vegetables, health drinks, cakes, sausages, and bakery products¹⁸. It is used for making chicken nuggets¹⁹. *Pleurotus ostreatus* have a great potential to produce health-promoting novel value-added derived products. It is used as a nutraceutical²⁰. Aqueous extract of *Pleurotus ostreatus* is also used for fermentation of yogurt²¹.

Medicinal uses: *Pleurotus ostreatus* are used to treat lower and high blood pressure. It is an Immune system supporter, lowering high blood pressure, building strong bones, regulating

cholesterol levels, anti-cancer properties, Anti-inflammatory properties, defending against neurodegenerative diseases and protecting the heart against cardiovascular disease²².

Pharmacological Activities: *Pleurotus ostreatus* contains several bioactive compounds that exhibit great pharmacological activities like Immunomodulation, Antiplasmodial, Hypo-lipidemic, Antioxidant, Antimicrobial, Anti-atherogenic, Anticancer, Antihyperglycemic, Atherosclerosis, Antihypercholesterolemic, Anti-inflammatory, Antitumor, Antifungal, Antiviral, Anti-diabetic, Inhibit HIV-1 reverse transcriptase, Eye health, Inhibition of protein synthesis, a proteolytic enzyme, Antibacterial²³.

Immunomodulation: F.M. Refaie *et al.* studied the assessment of Immunomodulatory effect and toxicity produced in mice. They isolate hot water polysaccharopeptides from the Oyster mushroom mycelium. The acute toxicity and polysaccharopeptides were not lethal after 24 h. In mice given intraperitoneally 854 mg/kg or less. Polysaccharopeptides were administered intraperitoneally in mice at doubling doses thrice weekly for five consecutive weeks. Eventually, animal weight is gained by 39.56% and thus mortality rate will be reduced²⁴.

Anticancer: Anjana Shree K. G. *et al.* studied the antioxidant and antitumor activity. It was found in the water-soluble polysaccharides (POPS-1) of *Pleurotus ostreatus*. They chose the two organic extracts of *Pleurotus ostreatus* obtained using methanol and ethyl acetate solvents. An ethyl acetate extract shows higher total phenolic content than methanol. The antitumor activity was studied by using melanoma cancer cells A375 and estimated by MTT assay. As per research, *Pleurotus ostreatus* shows higher antitumor activity in ethyl acetate extract than the methanol extract²⁵.

The Oyster mushroom is used for its high bioactive substances. The mushroom DNA contains an unmethylated CpG pattern with antitumor and immunomodulatory activities. The DNA was isolated from the fruit body *Pleurotus ostreatus*. The effect of oyster mushroom DNA on natural killer activity was studied *in-vitro* by using a nonspecific cytotoxicity assay. As per research, the

application of *Pleurotus ostreatus* could be a buildup of natural killer cytotoxic activity and increase mice's lifespan with solid Ehrlich carcinoma²⁶.

Different colors of *Pleurotus ostreatus* show antioxidant and anticancer activities. They prepared the methanolic extract of oyster fungus. The extracts of dark grey and the pink strain showed a better suppressive effect against the expansion of human colon cancer cell HT-29 life span rates 39.9% and 40.7% than the yellow strain, and the yellow strain showed the three times highest radical scavenging activity than the dark grey strain²⁷.

Antiplasmodial Activity: N-Hexane extract of the mushroom treats malarial infections and thus shows antiplasmodial activity. This study infers the cytotoxic properties and antiplasmodial activity of the *Pleurotus ostreatus* n-Hexane extract. Cytotoxic and antiplasmodial assays were done *in-vitro* by using the mammalian HeLa cell lines. A growth inhibition assay was done by using *Plasmodium falciparum*. As per research, the oyster mushroom species suggested in the diet are useful for the prevention of malaria infection²⁸.

Antihypercholesterolemic and Antioxidant Activity: Ramalingam Anandhi *et al.* studied the Antihypercholesterolemic and antioxidant effects of an extract of the *Pleurotus ostreatus*. They chose the male albino rats of the Wistar strain for this study. They prepared the ethanolic extract of *Pleurotus ostreatus*. In rats, one intraperitoneal injection of triton WR- 1339 (300 mg/kg body weight) was induced to supply hypercholesterolemia. This increased low-density lipoprotein, glucose, total cholesterol, triglycerides, blood serum levels of lipid profile, and low-density lipoprotein. Then for 7 days gave the Chrysin which is a major constituent of mushroom extract orally to the hypercholesterolemic rats. This resulted in a decrease in the lipid profile, level of glucose, and hepatic marker enzyme and an increase in enzymatic and non-enzymatic antioxidant factors. The Chrysin treated hypercholesterolemic rats. As shown, Chrysin is the major component of *Pleurotus ostreatus* for the protection of hypercholesterolemia and hepatic marker enzyme levels²⁹.

Anti-inflammatory activity: *Pleurotus ostreatus* show Anti-inflammatory activity. For this study, Wister rats are used. The anti-inflammatory activity was studied by using the suspension of freeze-dried powder of Oyster mushroom, and Acetone extract of *Pleurotus ostreatus*. The anti-inflammatory activity was studied by using *in-vitro* and *in-vivo* assays. They found at the dose of suspension of freeze-dried and powder of *Pleurotus ostreatus* shows long-lasting activity at both early and late phases of carrageenan-induced rat paw edema. The acetone extracts of *Pleurotus ostreatus* show the most inhibition of edema. As per research, the edible mushroom shows an anti-inflammatory effect, therefore it is suggested as a functional diet during inflammatory conditions³⁰.

Atherosclerosis: Mohamad Hamdi Zainal Abidin et al. Studied the therapeutic properties of *Pleurotus ostreatus* for atherosclerosis. This review reported the advantages of *Pleurotus* species for treating and preventing atherosclerosis. It is used to reduce hypertension, oxidative stress, and hypercholesterolemia. They have studied the comparison between 10 different types of *Pleurotus* species. It is used directly in food or mycelium or extracts from fruiting bodies. As per the study, the *Pleurotus ostreatus* is more potent to cure atherosclerosis due to the presence of a large amount of anti-atherosclerotic compounds such as lovastatin, Chrysin, and ergothioneine³¹.

Antihyperglycemic: *Pleurotus ostreatus* shows Antihyperglycemic action and its effect on DNA damage, chromosome aberrations and sperm abnormalities in streptozotocin-induced diabetic rats. For this study, 5 groups of male albino rats are selected. The primary group included normal animals (control), the second group was diabetic (hyperglycemia), and the third, fourth, and fifth groups included hyperglycemic animals. They are orally treated with Amaryl, high mushroom, and low mushroom extracts for 30 days. The mushroom treatment is compared with the Amaryl standard treatment. After 30 days increase in blood sugar level, genetic changes, and sperm abnormalities in hyperglycemic animals compared to normal animals. The treated hyperglycemic animals with Amaryl had a decrease in blood sugar level and sperm abnormalities. Then DNA fragmentation was decreased in mushroom groups as compared to the

Amaryl groups. The diabetic animals are treated with mushroom extracts and decreased sperm abnormalities and chromosome aberration than Amaryl. As per research, the treatment of a high level of the mushroom extract is better than the treatment of a low level of mushroom extract for the reduction of genetic abnormalities, blood sugar levels, and sperm abnormalities in hyperglycemic rats. The treatment with *Pleurotus ostreatus* extracts reduces the high glucose level in hyperglycemic rats than the Amaryl treatment. Hence, the mushroom extracts are more efficient for decreasing sperm abnormalities and genetic alteration in diabetic conditions³².

Antiatherogenic Activity: Sergey I. Piskov et al. studied the effect of various pre-treatment conditions on the antiatherogenic potential of freeze-dried oyster mushrooms. They studied the antiatherogenic properties under the content of lovastatin, catalase, antioxidant, thrombolytic, and anti-inflammatory properties. They found that the above-mentioned properties show different effects on the pre-treatment freeze-dried products. As per the research in this article, lovastatin obtained from the raw material was ground to pieces with a size of > 0.5 cm, UV disinfection, blanched, treated with hot air and cryostabilization with a 1.5 pectin solution. The catalase activity of the product does not depend on the degree of grinding, UV disinfection, blanching, and cryostabilization.

The antioxidant properties' critical conditions include lactoperoxidase inhibition and absorption, ozonation, and cryoprotection with a 1.5 % lactose and sucrose solution. The anti-inflammatory activity was best preserved after UV disinfection and cryoprotection with a 10% lactose solution. Thrombolytic properties were obtained when the mushrooms were ozonated and cryoprotected using a 5% sorbitol solution. As per the research, the *Pleurotus ostreatus* is a valuable functional product for antiatherogenic properties³³.

Antimicrobial Activity: Mustafa N. Owaid et al. studied the antimicrobial activity of the mycelia of oyster mushrooms. They chose the four species of oyster mushrooms *Pleurotus ostreatus* (white and gray strain), *Pleurotus salmoneostramineus* (pink strain), and *Pleurotus cornucopiae* (bright yellow strain). This research is an in-vitro study of anti-

bacterial activity and anti-yeast effects of *Pleurotus* species. As per research, the liquid filtrate of *Pleurotus salmoneostramineus* shows high antimicrobial activity than other filtrates among *Candida parapsilosis* ATCC 22019 *Pseudomonas aeruginosa* ATCC 27853. Mycelia of *Pleurotus cornucopiae* inhibits colonies of the yeast *Candida parapsilosis* ATCC 22019 and bacterium *Enterococcus faecalis* ATCC 29212 by 29.19% and 5.21%. *E. Coli* ATCC 25922 is sensitive to the mycelia of *Pleurotus salmoneostramineus*³⁴.

Hypolipidemic Activity: Nuhu Alam *et al.* studied the hypolipidemic activity of *Pleurotus ostreatus* in hypercholesterolemic rats. They have performed research on female rats. They fed a diet containing a 5% powder of *Pleurotus ostreatus* fruiting bodies to hypercholesterolemic rats. After a mushroom diet, they show reduced triglyceride, plasma total cholesterol, lipid, low-density lipoprotein, high-density lipoprotein and phospholipid ratios of 52.75, 30.18, 34.15, 59.62, 50% and 23, 89.

It reduces the weight of hypercholesterolemic rats. It has no adverse effect on bilirubin, albumin, blood urea nitrogen, creatinine, potassium, sodium, calcium, inorganic phosphate, magnesium, enzyme profile, and chloride. Feeding mushrooms increased the cholesterol and total lipid in feces.

The *Pleurotus ostreatus* increased alpha-lipoprotein but reduced plasma beta and pre-beta- lipoprotein because plasma lipoprotein fraction, separated by agarose gel electrophoresis. As research, they suggested the 5% *Pleurotus ostreatus* provided health benefits to the lipid profile in hypercholesterolemic rats³⁵.

Murlidhar S. Talkad *et al.*, 2015 studied the establishment of enzyme inhibitory activities of lovastatin isolated from *Pleurotus ostreatus*. They report the presence of statins in fruiting bodies and fermentation processes from Oyster fungus. For this study, lovastatin was extracted from *Pleurotus ostreatus*. It shows anti-oxidant activity when compared with standard quercetin. As per research, the *Pleurotus ostreatus* have a great antioxidant and enzyme inhibition for Acid Phosphatase, Alpha-Amylase, and membrane stability studies, hence as a health promoter and environmental restoration is gaining more importance³⁶.

Nutritional Benefits of Oyster Mushroom:

Proximate Composition: Igile, G.O *et al.* described the oyster mushroom is grown on rubber sawdust in Calabar Nigeria for proximate composition and they found Oyster mushroom fruit body is rich in final harvest as compared to the first harvest such as carbohydrates (45.82 mg/100g), Protein (22.45 mg/100mg), Fiber (11.65 mg/100), Fat (4.77 mg/100g), Moisture (11.96 mg/100g), Energy (316.01 mg/100g)². G. M. Icon *et al.* described the Moisture (78.28 g/100, Ash (16.68 g/100), Crude protein (28.40 g/100), Fat (12.46 g/100), Crude fiber (19.55 g/100), Carbohydrate (52.74 g/100) are present in *Pleurotus ostreatus*⁹.

Protein and Amino Acid: *Pleurotus ostreatus* are a good source of protein. Different kinds of proteins digestible and non-digestible were analyzed in caps and stipes of *Pleurotus ostreatus* in different phases of development. According to the average diameter of the cap. The crude and digestible protein content of caps was highest in the second phase. In the remaining phases, crude protein was lower³⁷. The protein content of *Pleurotus ostreatus* is also significantly affected by the method of drying, as oven-dried *Pleurotus ostreatus* recorded a less protein content (24.99%) than open sun-dried mushrooms (27.14%)³⁸. The *Pleurotus ostreatus* consists of essential and non-essential amino acids and the richest amino acids are Glutamic acid (53.3), arginine (27.6), aspartic acid (31.4), alanine (28.6), leucine (25.7), threonine (17.1), cysteine (3.8), glycine (17.1), histidine (12.4), isoleucine (16.2), lysine (22.9), methionine (3.8), phenylalanine (15.2), proline (15.2), serine (18.1), tyrosine (13.3), and valine (21.0)¹⁶.

Mineral Elements: Igile, G.O *et al.* studied the *Pleurotus ostreatus* grown on rubberwood sawdust in Calabar Nigeria. They found various mineral elements and variations in the first and final harvest. It contains different minerals such as Iron (49.65 mg/100g), phosphorus (977 mg/100g), sodium (14.33 mg/100g), calcium (34.29 mg/100g), potassium (1172.14 mg/100g), Magnesium (14.66 mg/100g), copper (0.67 mg/100g), zinc (3.65 mg/100g), manganese (1.61 mg/100g), selenium (6.11 mg/100g), chloride (19.61)².

Vitamins: G.M. Ikon et al. determine the vitamin constituent from *Pleurotus ostreatus*. It is collected from Nigeria. They found the six different vitamins, including total and Soluble vitamin C (82.46), vitamin A was the main constituent (295.72), whereas Thiamin (10.1), Riboflavin (10.43), Niacin (10.12)⁹. Igile, G.O et al. describe the vitamin composition of *Pleurotus ostreatus*. It is grown on rubberwood sawdust in Calabar. They found different vitamins are present such as vitamin A (84.75), vitamin C (28.92), vitamin D (2.86), vitamin B1 (1.89), vitamin B2 (2.26), vitamin B6 (1.81), Niacin (26.83), Folic acid (0.44), Pantothenic acid (92.31)². G.M. Ikon et al. studied the different functional properties present in oyster mushrooms. The properties such as water absorption capacity, oil absorption capacity, and bulk density. emulsion capacity, Foaming capacity⁹.

Lipids: The main fatty acid present in oyster mushrooms is linoleic acid³⁹.

Carbohydrates: The carbohydrate contents of *Pleurotus ostreatus* are significantly affected by the method used to dry them: oven-dried *Pleurotus ostreatus* recorded a higher carbohydrate value (43.64%) than open sun-dried mushrooms (39.99%)⁴⁰.

CONCLUSION: *Pleurotus ostreatus* may provide significant functional food as well as medicine due to its high nutritional value. *Pleurotus ostreatus* is widely used for nourishment, and medicinal benefits and is specially used as an antioxidant, anticancer, antimicrobial, antibacterial, antidiabetic, cardiovascular diseases, antihypertensive, antihypercholesterolemic, glycoprotein. Therefore, it should be created awareness amongst the consumer regarding the proper utilization of this golden drug for the future. In the last decade, the *Pleurotus ostreatus* has been used as a source of treatment and in diet food supplements. Most of the explorations have shown that nutraceutical therapy is an encouraging source of new therapeutics against many life-threatening diseases. Whereas bioactive molecules isolated from *Pleurotus ostreatus* may represent an important advance for their characterization as a source of drugs, more clinical data are needed to determine the medicinal benefits of *Pleurotus*

ostreatus. This review article will be useful for academic purposes as it contains detailed information on pharmacological activities and the nutritional benefits of *Pleurotus ostreatus*.

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