



**EDIBLE MUSHROOMS AS
NATURAL BIOFACTORIES:
NUTRITIONAL VALUE,
BIOACTIVE COMPOUNDS,
AND ANTIDIABETIC
PROSPECTS OF PLEUROTUS
SPP.**



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Edible Mushrooms as Natural Biofactories: Nutritional Value, Bioactive Compounds, and Antidiabetic Prospects of *Pleurotus* spp.

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Abstract

Mushrooms are macrofungi that have unique fruiting bodies and are important for ecology, medicine, and nutrition. Among them, edible mushrooms have drawn more attention because of their varied bioactive chemicals and high nutrient makeup. Oyster mushrooms, or *Pleurotus*, are one of the most extensively grown and consumed groupings in the world due to their capacity to grow quickly, adapt to a variety of agroclimatic situations, and use agricultural wastes as substrates. Oyster mushrooms are good for health-conscious diets since they are low in calories, fat, and cholesterol and high in dietary fiber, vitamins, minerals, and vital amino acids. Because of its bioactive components, *Pleurotus* species have important therapeutic qualities in addition to their nutritional value. These qualities include antioxidant, anticancer, antibacterial, immunomodulatory, and antidiabetic effects, attributed to bioactive constituents such as β -glucans, phenolic compounds, flavonoids, terpenoids, and polysaccharides. These characteristics demonstrate their potential for usage in pharmacological, nutraceutical, and functional food applications. Furthermore, growing oyster mushrooms is a sustainable method of recycling trash and producing biofertilizer. This paper highlights the significance of oyster mushrooms as a valuable food resource and a prospective natural source of bioactive compounds by summarizing their taxonomy, cultivation methods, nutritional makeup, and medicinal potential.

Keywords- Oyster mushroom, functional foods, bioactive compounds, antioxidant activity, mushroom cultivation.

1. Introduction

Fungal organisms include mushrooms, rusts, smuts, puffballs, truffles, morels, and yeasts, as well as many lesser-known organisms. More than 700,000 fungi species have been described; however, some estimates suggest that 1.5 million species may exist [1]. Mushrooms belong to the kingdom of Fungi, a group very distinct from plants, animals

and bacteria. Fungi lack the most important feature of plants: the ability to directly use solar energy via chlorophyll. As a result, fungi are food-dependent, absorbing nutrients from the dead and organic material in which they live so they are called saprophytes [2]. Mycelium, the fungus's living body, is composed of a tiny web of threads (or filaments) known as hyphae. Sexually compatible hyphae will fuse and begin to form spores under certain conditions. Mushrooms are larger spore-producing structures (larger than about 1 mm) [3].

Mushrooms are a type of fungus that has a distinct fruiting body that can be either epigeous or hypogeous, large enough to be seen with the naked eye and picked by hand [4]. They can be saprophytic, parasitic, or mycorrhizal in nature. The majority of these three categories are saprophytic, and they play an important role in the biodegradation and bioremediation of recalcitrant substances [5]. Notably, approximately 14,000 mushroom species have been reported to date, with an additional 126,000 species yet to be discovered. Scientist reported that over 2000 mushroom species are edible, while over 400 are poisonous. Out of the more than 2000 edible species, 5-6 are grown on a large scale, 40 are produced commercially, and 80 are cultivated experimentally [4]. The Pharaohs considered mushrooms to be a delicacy, and the Romans considered mushrooms to be "Food of God," served only on special occasions. The Chinese considered mushrooms to be a healthy food and an elixir of life. On religious occasions, the Mexicans used mushrooms as hallucinogens [6].

Mushrooms are primitive organisms known as fungi (macro fungi). The fleshy, spore-bearing fruiting body of a fungus, often developed above ground, on soil, or on its food supply, is known as a mushroom or toadstool. Almost all agricultural and forestry waste can be used as a substrate for mushrooms because they are saprophytic fungi that grow on dead organic materials of vegetative origin [2]. Mushrooms have received a lot of attention because of their biological activities, which include antioxidative, antitumor, antiviral, anticomplementary, anticoagulant, antidiabetic, hypolipidemic, hepatoprotective, immunostimulant, and immunological activities, making them suitable for use in food, cosmetics, biomedicine, agriculture, environmental protection, and wastewater management. Mushrooms are classified into four types: edible, poisonous, medicinal, and miscellaneous. To stay healthy and fit, people all over the world are turning to low-calorie foods that provide maximum health benefits [5].

1.1 Overview of Edible Mushrooms

The soft and edible fruit bodies of numerous species of macro fungi are edible mushrooms. They can grow underground (hypogeous) or above ground (epigeous), and can be harvested by hand [7]. Certain fungal species are edible mushrooms, which are either picked wild or cultivated [4]. Markets frequently stock easily farmed and common wild mushrooms, and others that are more difficult to come by (such as the valued truffle, matsutake, and morel) can be picked on a smaller scale by individual collectors [5]. Less than 25 species are generally regarded as food, out of the more than 2000 species that are thought to be edible, and only a handful have been domesticated and artificially

farmed. Edible mushrooms have long been recognized not only as a delicacy, but also as a food source in human diets [8].

Mushrooms contain a large number of biologically active secondary metabolites with high medicinal value, such as anti-diabetic, antiviral, anti-thrombotic, anti-inflammatory, anti-microbial, and anti-tumor properties [9]. Mushrooms have anti-oxidant, anti-microbial, anti-inflammatory, anti-tumor, anti-diabetic, and other medicinal properties. They're also used to treat cardiovascular disease (CVD), neurological disease (ND), and reproductive problems (RDs) [10]. They are abundant in dietary fibers, natural antibiotics, chitin, pectin, phenolic compounds, flavonoids, and a variety of other secondary metabolites, with cell wall-glucans being especially well known for their immunomodulatory and antibacterial properties [11]. Antibacterial compounds with a broad spectrum of activity are found in both the fruiting body and mycelium of mushrooms. Different mushroom extracts have been demonstrated to be effective against a wide range of bacteria in several investigations [9]. *Pleurotus* sp. contains bioactive substances that make it a medicinally important mushroom.

1.2 The Genus *Pleurotus* (Oyster Mushrooms)

Pleurotus is a genus of gilled mushrooms which includes one of the most widely eaten mushrooms. *Pleurotus* spp. is generally referred as the oyster mushroom. Oyster mushroom is regarded as one of the commercially important edible mushrooms throughout the world. *Pleurotus* mushrooms are an oyster mushroom species that was originally produced in Germany during World War I [3].



Figure 1. Fruiting body of *Pleurotus membranaceus*.

The genus *Pleurotus* comprises about 40 species that are commonly referred to as "oyster mushrooms". *Pleurotus* genus includes *P. ostreatus*, *P. sajor caju*, *P. florida*, *P. flabellatus*, *P. highbing*, *P. cystidiosus*, *P. sapidus*, *P. eryngii*, *P. tuberegium*, *P. ulmarium*, *P. pulmonarius*, *P. citrinopileatus*, *P. geesteranus*, *P. membranaceus* [7].

1.3 Cultivation of Oyster Mushrooms

Many fungal species are harvested wild or cultivated to make edible mushrooms. Cultivated mushrooms, as well as the more common wild mushrooms, are frequently available in markets; private gatherers may collect porcini or other ectomycorrhizal mushrooms on a smaller scale [12]. As a cultivated mushroom, the oyster mushroom has many advantages: quick mycelial growth, high saprophytic colonization potential, simple and economical cultivation techniques, and a variety of species suitable for cultivation under various climatic conditions. Mushrooms are mainly grown on waste products such as sawdust, compost, straw, and rubbish. According to reports, mushroom farming began in France around 1630, and since then, a number of tests and research have been done to monitor various mushroom growth characteristics. As a result of its medicinal benefits and its ability to grow at a wide range of temperatures and with a variety of agro-based residues, oyster mushroom production has risen around the world. It can also adapt to a variety of agro-climatic situations and grow on a variety of agricultural wastes. The substrates on which the mushrooms were grown can also be utilized as a biofertilizer to improve soil fertility, as animal feed, and as a biogas feed. As a result, mushroom growing is considered to be environmentally benign, as it has no negative impact on the environment when compared to other crop cultivation methods [8].



Figure 2. Mushroom Bag.

Mushroom cultivation is influenced by a variety of parameters, including temperature, humidity, and sterility of the substrates, all of which act alone or in combination. Temperatures of 20° to 30° C and humidity levels of 55-70 % are ideal for the growth of oyster mushrooms for a period of 6-8 months per year. During the summer months, the cultivation methods can be carried out by giving the extra humidity essential for the plant's growth and development. Mushrooms are cultivated in suitable environment, such as natural caves or a well-controlled growing chamber, and require numerous phases. Mushrooms produce a number of enzymes that break down complex organic substances like cellulose and lignin into soluble products that are absorbed by the hyphae during mycelia development on their substrate [13].

Any type of cereal grain, including wheat, jowar, bajra, or rye, as well as agricultural wastes such as maize cobs, wooden sticks, rice straw, sawdust, spent tea leaves, etc., can be used to make mushroom spawn. Cereal grains, which serve as the spawn substrate, should be disease-free and free of defects, ageing, and insect pest damage. The majority

of cereal grains make excellent spawn production substrate. Saw dust-based substrates are preferable to cereal grains for the growth of mushrooms [1].

They have recently received a lot of attention as a source of bioactive metabolites for the development of drugs and nutraceuticals. Secondary metabolites such as phenolic compounds, flavonoids, terpenoids, sterols, ascorbic acid, ergothioneine, and carotenoids have been discovered in some of them. They are high in dietary fibers, natural antibiotics, chitin, pectin, phenolic compounds, and flavonoids, of which cell wall β -glucans are well known for their immunomodulatory and antibacterial properties [9].

1.4 Nutritional and Health Benefits of Oyster Mushrooms

Mushrooms provide a high protein diet with a low calorific value, making them ideal for heart patients because they include all of the amino acids required by the human body. Mushrooms have a high-water content (93-95%) as compared to lean beef (70%) and fresh vegetables (92%). Mushrooms are noted for their high mineral content, which includes phosphorus, potassium, calcium, iron, and copper, as well as 56 percent carbohydrate, 30% protein, 10% ash, and 2% fat by dry weight. They're also high in vitamin B and vitamin D [1].

Oyster mushroom is also low in calories, salt, fat, and cholesterol while being high in protein, carbohydrate, fiber, vitamins, and minerals. This mushroom's nutritional characteristics make it an excellent dietary meal. Other essential elements found in edible mushrooms include niacin, vitamin D, proteins, selenium, potassium, and riboflavin. Mushrooms also contain a considerable quantity of fiber, which aids in proper meal digestion [8]. Edible mushrooms have very few calories because they contain less fat and carbohydrate and are also cholesterol-free [5]. Edible mushrooms, commonly known as the meat of the vegetable world, can be used to make a range of delectable dishes and can also be used to enhance flavor. Some people choose to use mushrooms in stews instead of beef [13]

Aside from its nutritional value, mushrooms have therapeutic effects, particularly as an anticancer agent. Other properties claim that mushrooms can be utilized as an ingredient in the treatment of headaches, chest discomfort, stomach pain, colds, smallpox, dropsy, and fever when coupled with other plants [8]. Aside from their delicious flavor, mushrooms have a favorable chemical composition that includes a high amount of functional proteins, a low total fat level, and a high proportion of polyunsaturated fatty acids (PUFA), making them ideal for low-calorie diets. Edible mushrooms have a high nutritional value in terms of vitamins (B1, B2, B12, C, D, and E). Mushrooms also have a low glycemic index and a high mannitol content, which is especially beneficial for diabetics. Mushrooms have a low sodium (Na) concentration, which is beneficial for hypertensive patients, as well as a high potassium (K) and phosphorus (P) content, which is an important orthomolecular aspect. Mushrooms are an important source of home remedies in Asia for a variety of diseases caused by oxidative stress [12].

2. Medicinal properties of mushroom

2.1 Anticancer property of Mushroom

Mushroom is a reservoir of pharmacologically important macromolecules like β -glucan, α -glucan, resveratrol, concanavalin A, Cibacron blue affinity protein, p -hydroxybenzoic acid, ergosterol, linoleic acid, lentinan, lipopolysaccharides, triterpenes etc. [14].

2.2 Antioxidant property of Mushroom

Mushroom have high antioxidant properties and thus protect against cancer, HIV-1 AIDS, and other viral diseases; they are antimutagenic, anti-tumoral, and can be used to treat cardiovascular disorders [7]. According to scientific evidence, high levels of antioxidants can help prevent oxidative stress caused by free radicals, which can lead to cell damage, cancer cell generation, and brain cell ageing [15]. Oxidative stress, which is caused by an imbalanced metabolism and an excess of reactive oxygen species (ROS), results in a variety of disorders, including metabolic disease, heart disease, severe neural disorders such as Alzheimer's and Parkinson's, premature ageing, and some cancers. Oxidative stress can occur as a result of the presence of oxidation agents, a decrease in antioxidant levels, or both. As a result of the oxidation process, reactive oxygen species (ROS) and free radicals are produced as harmful byproducts. Edible mushrooms have gained popularity as a commercial source of antioxidants in recent years. They could be used directly to boost antioxidant defences through dietary supplementation, lowering the level of oxidative stress [12].

2.3 Antimicrobial Properties of Mushrooms

Antimicrobial resistance (AMR) defined as the ability of microorganisms to survive and be viable under the influence of antimicrobial agents. Several types of antimicrobial agents are present such as antibiotics, disinfectants, and food preservatives that can be used against microorganisms to reduce their capacity to grow, inhibit their multiplication or even kill them. Antimicrobial resistance (AMR) is now recognized as a major worldwide health issue [16]. AMR is caused by changes in bacteria that render antibiotics ineffective allowing illnesses to persist in the body, increasing the chance of infection spreading to others, according to the World Health Organization (WHO). Antimicrobial misuse, incorrect dose practices, a scarcity of current innovative antibiotics, and antimicrobial resistant bacteria have all led to the development of resistance and its spread. Antimicrobial drugs have a critical role in reducing the global burden of infectious illnesses. As a result, given the evidence of rapid global dissemination of resistant clinical isolates, discovering novel antimicrobial medicines is critical [9].

2.4 Antidiabetic Properties of Mushrooms

Diabetes mellitus is a metabolic condition that causes insulin secretion to be inadequate [17]. Insulin is a hormone produced by the pancreas β -cells that regulates blood glucose levels. Insulin secretion either stops or becomes insensitive to insulin action as a result of pancreatic β -cell disruption, causing glucose levels to rise over normal levels. This condition is known as hyperglycemia, and if it lasts for a long time, it is known as diabetes mellitus [18]. Diabetes is linked to a number of other disorders, including cancer, hypertension, renal failure, glaucoma, and others. In general, adipose tissue, skeletal muscles, and to a lesser extent, the liver play a vital part in energy balance by regulating glucose with the help of insulin, and their function is interrupted if their tissue develops insulin resistance [19].

Free radicals produced by oxidative stress and metabolic stresses can play a significant role in diabetes mellitus development. Diabetes mellitus is classified into two types: type 1 and type 2. Diabetes type 1 is caused by the death of pancreatic β -cells by the immune system, resulting in inadequate insulin secretion. Type 1 diabetes is also known as insulin-dependent diabetes mellitus because it necessitates the use of insulin to control blood glucose levels. Diabetes type 1 is most common in children and adolescents (about 15 years old) and accounts for around 10% of all diabetes occurrences. Insulin-dependent diabetes mellitus is another name for type 2 diabetes. Type 2 diabetes accounts for 90% of all diabetes cases [17]. The peripheral tissue becomes resistant to insulin action in this kind of diabetes. Adults (about 20 years of age) are more likely to get this kind of diabetes [20]. Obesity is a key factor in the development of type 2 diabetes. α -amylase is a key player in the control of diabetes. We know that α -amylase is a carbohydrate hydrolyzing enzyme that releases glucose molecules following hydrolysis [21].

If we inhibit this enzyme, we may be able to lower the glucose level. Metformin, sulfonylurea, glibenclamide, and other synthetic medicines are available on the market. However, these medications have some negative effects that can lead to another problem. People are continuously looking for any natural drug that has no or fewer side effects as a result of these negative impacts. People from Asian nations such as India and China have utilized mushrooms to treat diabetes since ancient times due to their antidiabetic characteristics. Their bioactive components serve a critical function in diabetes management [19].

Diabetes mellitus is a chronic metabolic condition characterized by an excessive rise in plasma glucose levels as a result of unbalanced insulin production and/or sensitivity to the hormone's action on cellular receptor signaling. Modifications in glucose, lipid, and protein metabolism accompany these metabolic alterations. The majority of diabetes type 2 problems in individuals are caused by hyperglycemia. Inhibition of complex polysaccharide breakdown by pancreatic α -amylase and glucose absorption limiting by blocking intestinal α -glucosidase enzyme are two efficient techniques for diabetes type-2 management [22].

Commercial medications for α -glucosidase inhibition in the treatment of diabetic illness include acarbose, miglitol, and voglibose. [23]. Chronic inhibition of α -amylase and α -glucosidase may be beneficial in the treatment of type 2 diabetes and obesity. The medications now used to treat diabetic patients as reversible inhibitors of α -amylase and α -glucosidase have side effects such as abdominal distension, meteorism, bloating, flatulence, and possibly death [18]. The alpha amylase enzyme inhibitors restrict the body from digesting and absorbing dietary carbohydrates. They are beneficial in the treatment of diabetes mellitus type II. The ant nutrition α -amylase inhibitors regulate the rate of carbohydrate digestion and absorption. Obesity and diabetes management could also benefit from it [24]. Polysaccharides, proteins, alkaloids, sterols, lectin, terpenoids, and phenolic compounds are some of the high molecular weight substances found in mushrooms [11]. *Ganoderma lucidum* is well-known for its anti-diabetic properties [20].

3. Conclusion

In addition to giving significant nutritional and therapeutic advantages, mushrooms—particularly *Pleurotus* species—offer sustainable production from agricultural waste. Their abundant bioactive content supports a variety of therapeutic actions, including antidiabetic and antioxidant properties that help control metabolic diseases and hyperglycemia. Oyster mushrooms have great potential as functional foods and natural supplements because of their health-promoting qualities and ease of preparation. Their use in welfare-oriented agriculture, medicine, and nutrition will be strengthened by ongoing study.

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