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Therapeutic Applications, Nutritional Composition, and Their Future Perspectives of Wild Mushrooms

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Abstract

Considering the current situation, relatively little research has been conducted on wild mushrooms to date. Many species of wild mushrooms are found in nature. Discovering new species of these hidden mushrooms, properly identifying them, exploring new compounds hidden in them, and writing new literature would be novel research in the future. In this way, the properties and diversity of wild mushrooms can be further explored. Wild mushrooms can be a valuable new source of pharmacologically active substances, nutraceuticals, and cosmeceuticals, which could be exploited for diverse medical applications in the future, particularly those requiring accurate pharmacogenetic fingerprints. The purpose of the present review study is to compile the information on wild mushrooms discovered by our scientists and researchers from different places and to discuss their medicinal and nutraceutical properties. So accurate data and guidance can be obtained in future research work.

Contents

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1 Introduction

Macrofungi (mushrooms), with their natural fineness, have always held a unique place in this biological world. From the tropics to the poles, from the top of the mountains to the depths of the ocean, the expansion of the wild mushroom is ubiquitous. They can colonize, multiply, and survive in a wide range of habitats, including water, air, soil, foam, dung, litter, hair, paints, textiles, and others. Notably, mushrooms are an attractive group of organisms that play an important role in human life apart from their use in medicine, the agriculture sector, textile manufacturing, food processing, bioremediation, biofertilizers, and geochemical cycles (Srivastava, 2021).

Mushrooms have been utilized in traditional remedies for thousands of years. Some of them can produce bioactive molecules, while others are nutraceuticals. There are many health benefits to mushrooms, including wound healing, stress reduction, rheumatoid arthritis, asthma, diabetes, liver disease, diaphoretic, epilepsy, heart ailments, skin diseases, insomnia, cholesterol reduction, allergies, cholera, colds, diarrhea, dysentery, anesthesia, gall bladder illness, and vermicides (Chugh et al., 2022; El-Ramady et al., 2022). These are an important source of protein found in nature, having a protein level that is higher than that of most vegetables but lower than that of most meats and milk.

2 Nutritional Aspects of Mushrooms

There are over 200 genera of wild mushrooms and some species are useful to humans, primarily due to their edible characteristics. Rural communities in numerous nations treasure wild fungi with medicinal characteristics; however, this is of secondary importance. There are two main groups of edible wild fungi: those with widely consumed species (e.g. *Boletus* and *Cantharellus*) that are often exported in significant quantities and those whose species are commonly consumed (usually in little amounts) but seldom traded beyond national borders. Edible mushrooms have a high nutritional content, which is why they are eaten for their nutritional and therapeutic properties.

There is increasing interest in edible mushrooms as the need for novel types of food varieties is increasing day by day, and the demand for alternative sources of income is increasing in rural communities as well (Pilz & Molina, 2002). More individuals than ever are "foraging" mushrooms in Asia, Europe, and North America, restoring mushroom traditions that have been diluted by urbanization and posing new challenges for long-term production.

Harvesting commercially important wild species such as matsutake (*Tricholoma spp*. morels (*Morchella spp*.), truffles (*Tuber spp*.), *Lactarius species* (e.g., *L. deliciosus*) and boletes (*Boletus spp*.) are a lucrative industry in many nations and a vital source of earnings for collectors and their families (DeRoman et al., 2006).

3 Therapeutic Potential of Mushrooms

Hippocrates, the founder of medicine, famously said, "Let food be your medicine and medicine be your food," summarising the connection between sickness and diet. This adage applies to mushrooms because of their enormous medicinal value, which serves as the foundation of mycology in medicine. The improved ability to create medical mushrooms via artificial means has greatly enhanced their usage as traditional medicinal ingredients for the treatment of numerous diseases and associated health issues. Many traditional uses have been confirmed and new applications developed, especially in China, Japan, and Korea, as a result of a large number of scientific studies on medicinal mushrooms.

The main medicinal uses of mushrooms include their antioxidant, antidiabetic, anticancer, antiallergic, cardiovascular protector, immunomodulating, anticholesterolemic, antiviral, antibacterial, antifungal,

antiparasitic, detoxification, and hepatoprotective effects; They also prevent the growth of tumors and inflammation. Mushrooms have more than 100 different medicinal properties (Finimundy et al., 2013).
In general, polysaccharides, fats, proteins, minerals, alkaloids, glycosides, volatile oils, terpenoids, phenolics, flavonoids, tocopherols, carotenoids, lectins, folates, enzymes, ascorbic acid, and organic acids are the bioactive compounds released by various types of mushroom species. These bioactive compounds are also found in fruit bodies, cultured mycelium, and cultured broth. For modern medicine, polysaccharides are crucial, and β-glucan is the most well-known and versatile metabolite with a broad range of biological activities (Patel & Goyal, 2012).

Medicinal mushrooms produce molecules that are light in weight and are useful as drugs. Nowadays, science should focus on the properties of these molecules. Apoptosis, angiogenesis, metastasis, cell cycle regulation, and signal transduction cascades are among the processes reduced to low molecular weight secondary metabolites target.

It is estimated that 80% of all medications used in 1990 were natural compounds or analogs. A variety of medications, including antimicrobials drugs (penicillin, tetracycline, and erythromycin), antimalarial drugs (quinine, artemisinin), antiparasitic drugs (avermectin), fats-controlling drugs (lovastatin and analogs), immunosuppressor for transplant (rapamycin, cyclosporin), and anticancer medicine (taxol, doxorubicin), referred to as "blockbuster medicines," revolutionized the world. Many of the medications listed above were developed using fungus elements (Li & Vederas, 2009).

Antimicrobial activity

Multiple drug resistance has arisen in human pathogenic microorganisms so far, possibly as a result of the use of commercial antimicrobial medications to treat infection, due to which the demand for new antimicrobial agents is increasing (Karaman et al., 2003).

Antimicrobial activity has been found in the mycelia and fruiting body extracts of a variety of mushrooms against a wide range of pathogenic microbes. The antibacterial activity of petroleum ether, chloroform, acetone, and water extracts obtained from the mushroom *Osmoporus odoratus* is beneficial against *Staphylococcus aureus, Streptococcus pyogenes, Bacillus subtilis, Escherichia coli,* and *Pseudomonas aeruginosa*. As an antibacterial agent, Osmoporus odoratus water extract is comparable to ampicillin instead of chloramphenicol in action against organisms. By Ramesh & Pattar (2010), was Demonstrated significant antimicrobial activity against *B. subtilis, S. aureus, E. coli, P. aeruginosa* and *C. albicans* using six wild mushrooms found in the Western Ghats of Karnataka, India (*L. perlatum, C. cibarius, C. vermiculris, R. formosa, M. oreades, P. pulmonarius*). The most promising species as antibacterial agents are *Russula botrytis, Russula delica,* and *Fistulina hepatica*. In general, the mushroom extracts examined demonstrated considerable antibacterial action against the pathogens tested. This suggests that mushrooms can be used as medicine for many diseases.

A. bisporus shows potential activity against gram-positive microbes and, to some extent, against gram-negative microbes. It is also effective against *Bacillus subtilis* due to its narrow-spectrum activity. In Bangladesh, Chowdhury et al. (2015), evaluated the antimicrobial activity of edible mushrooms and found an inhibition zone from 7-20 mm for all bacteria and fungi. The lowest concentrations of extracts that were found to be effective ranged from 1 mg/ml to 9 mg/ml. Antimicrobial activity was highest for *Lentinula edodes*, followed by other species. Compared to the other microbial specimens, *Saccharomyces cerevisiae* was more susceptible, whereas *Pseudomonas aeruginosa* was highly resistant. *Auricularia auricular judae* extract was used in a study to examine how it affected various bacteria and fungus. As a result of this research, a crude extract of *Auricularia auricular-judae* was found to have promising antimicrobial properties (Cai et al., 2015).

Antioxidants activity

The oxidation process is critical for the energy production required for physiological functions in diverse living organisms. The scavenging of freely accessible radicals is a lipid oxidation inhibition technique commonly used to assess antioxidant capacity. Oxygen is important in biological systems because of its oxidation capabilities, which include nutrition consumption, electron transport for ATP synthesis, and xenobiotic elimination (Hemnani & Parihar, 1998). Hydroxyl radical [OH], Superoxide radical [O_2-], and H_2O_2 are all reactive forms of oxygen that can nick DNA, which can disrupt critical enzymes and structural proteins and cause lipid peroxidation or autooxidation. Mushrooms have been found to have antioxidant properties that are capable of inhibiting the effects of the destructive oxidative process in organisms. Phenolics, flavonoids, glycosides, polysaccharides, tocopherols, ergothioneine, carotenoids, and ascorbic acid were identified as antioxidant components detected in fruit bodies, mycelium, and broth.

Methanolic and aqueous extracts of *Ganoderma lucidium* showed impressive free radical scavenging activity, according to (Jones & Janardhan 2000). Tyrosinase derived from *Agaricus bisporus* has the potential to protect cellular DNA from oxidative damage and is a valuable source of bioactive substances. 23 different varieties of mushrooms naturally found in various regions of India were evaluated by Puttaraju et al. (2006), to determine their antioxidant potential. The principal chemical compounds in *Ganoderma lucidium* are triterpenoides, according to (Paterson, 2006). *Ganoderma lucidum* has antioxidant properties due to camptothecin.

Phytochemicals like phenolics, flavonoids, ergosterol, and carotenes of *Russula griseocarnosa* have been shown to possess antioxidant properties (Chen & Seviour, 2007). Antioxidants like phenolics and ascorbic acid, which are abundant in mushrooms, are very beneficial for health. The methanol extract of *P. rimosus* effectively reduced the ferric ion in the FRAP and cleaved DPPH. Mushroom *Inonotus obliquus* with antioxidant activity has long been used as a traditional and multifunctional medicinal mushroom. Darker mushrooms in each *Morchella species'* population showed stronger radical scavenging activity and phenol content than light-colored mushrooms, according to (Jander & Masaphy 2010).

Several authors tested the antioxidant activity of *Agaricus bisporus, Pleurotus ostreatus, Boletus edulis,* and *Cantharella cibarius* mushroom extracts, isolated successively using cyclohexane, dichloromethane, ethanol, methanol, and water. Free radical scavenging, total phenolic compound determination, reducing power, and total flavonoid content determination were all used to assess antioxidant activity. The study found that acetone extracts from *Russula cyanoxantha* showed stronger antioxidant activity than the other mushroom extracts tested. Furthermore, the extracts examined demonstrated effective reducing power. Numerous studies have found that fungi's antioxidant activity is closely linked to their polyphenol phenol content (Smolskaite et al., 2015). Shiitake (*Lentinula edodes*), which is renowned for its medicinal and nutritional benefits, is one of the most widely farmed mushrooms. The drying method has a significant effect on the chemical constituents and antioxidant properties of shiitake. According to the findings, hot air drying at 50 degrees Celsius produced antioxidant activity and high total phenolic content (Zhang et al., 2013).

Anticancerous properties

Cancer is a major cause of mortality globally scale. Anti-cancer medications on the market have not been shown to be successful in treating cancer, which leads to a variety of complications and side effects in the clinical care of various cancer types. Some highly regarded mushrooms and their active components have been shown to have anti-cancer potential. Medicinal mushroom extracts have been used for a variety of clinical trials in cancer therapy, to see how beneficial they are in stopping the growth of cancer. So that commercial production of these medicinal mushrooms can be increased.

Individually and as adjunctive treatments for cancer, their potential has been revealed. Polysaccharides, lipids, alkaloids, proteins, glycosides, ash, volatile oils, phenolics, tocopherols, carotenoids, folates, ascorbic acid enzymes, and organic salts are among the bioactive substances found in mushrooms. Lentinan, krestin, lectin, calcaelin, hispolon, psilocybin, illudinS, Hericium polysaccharide A and B (HPA and HPB), ganodericacid, laccase, schizophyllan, and other active components in mushrooms are provided anti-cancer potential. The most effective compounds obtained from mushrooms are polysaccharides that have anticancer and immunomodulatory effects. Because of its broad spectrum of biological activity, the polysaccharide b-glucan is the most versatile metabolite (Chen & Seviour 2007).

Tumor cells are not directly killed by mushroom polysaccharides. In mice with tumors, these compounds cause a 50% decrease in tumour size and extension of survival time, since they prevent body stress (Wasser, 2002). To combat certain cancers, fungi metabolites can inhibit molecular targets in malignant cells. Molecules with a high molecular weight tend to fight cancer better than those with a low molecular weight. Their mechanism of action is different in both groups. There are a lot of polysaccharides and protein-bound polysaccharides among high-molecular-weight compounds. A number of different mechanisms may be used by these compounds to influence the immune system, including upregulating or downregulating the response it. There is another class of chemical compounds characterized by low-molecular-mass molecules capable of penetrating the cell membranes and interacting with signal-transduction pathways within cells (Lull et al., 2005).

The majority of these compounds are sesquiterpenes (which are part of the metabolism of Basidiomycetes), steroids, triterpenes, and sterols, as well as polyketides (produced by Actinomycetes in abundance). According to Patel & Goyal (2012), cancer-fighting mushrooms are from the species *Phellinus, Agaricus, Pleurotus, Ganoderma, Antrodia, Clitocybe, Trametes, Schizophyllum, Inonotus, Funlia, Albatrellus, Lactarius, Fomes,* and *Russula*. As reactive oxygen species inducers, mitotic kinase inhibitors, anti-mitotic, angiogenesis inhibitors, and topoisomerase inhibitors, the anticancer compounds lead to apoptosis, ultimately blocking the growth of cancer cells.

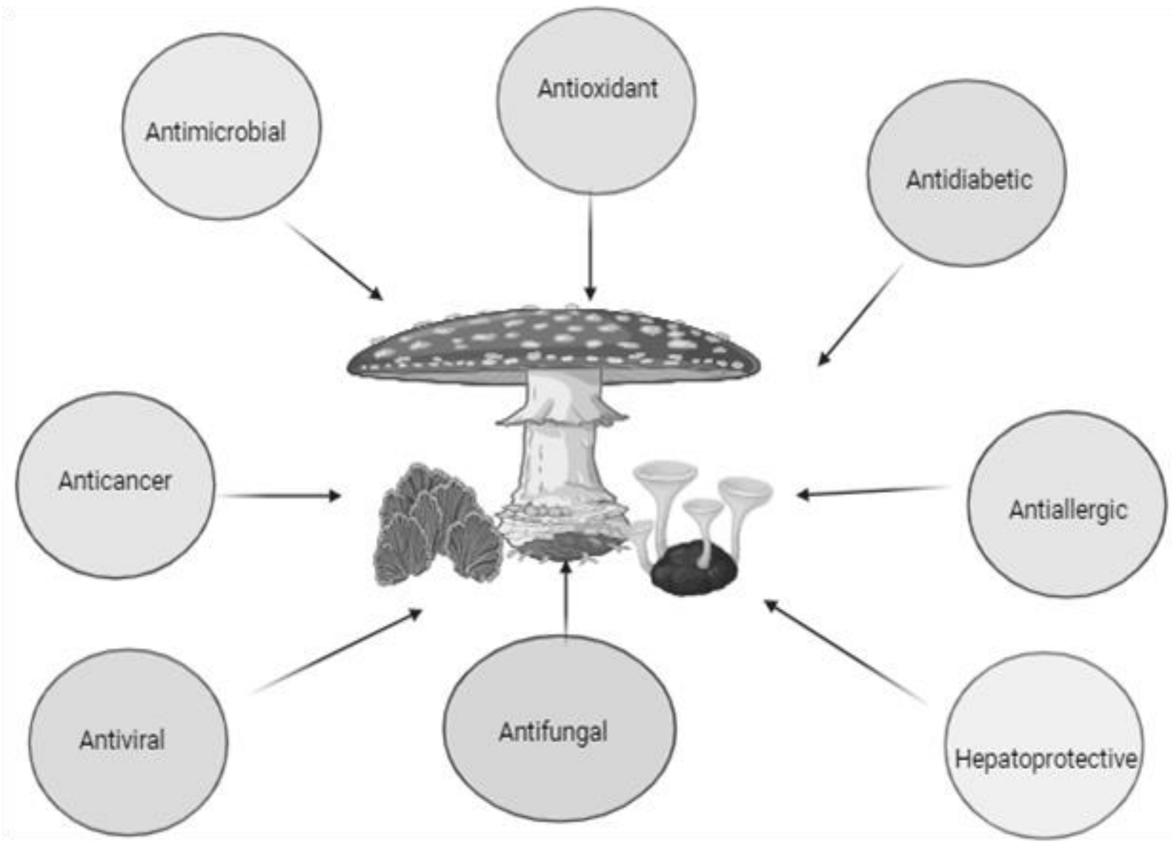

Figure 3. Effects and Health Benefits of Wild Mushrooms

Cardiovascular disease

Cardiovascular diseases are one of the leading causes of mortality in the Western world and transition countries. Lipid and lipoprotein metabolism, hemostatic function, oxidative damage, homocysteine metabolism, and blood pressure variations are among the etiological risk factors that are specifically affected by food (Mensink et al., 2003). There are four well-accepted and widely used tests of cardiac health: LDL (low-density lipoprotein) and HDL (high-density lipoprotein), triacylglycerol, and homocysteine. Diabetes and high levels of low-density lipoprotein (LDL) are important risk factors in cardiovascular disorders. Mushrooms are abundant in fiber, protein, and micronutrients and low in calories, which play an ideal role in preventing heart disease. The cholesterol metabolic routes associated with the hypocholesterolemic impact of edible mushrooms are elucidated. Edible mushrooms' fatty acid profile appears to help lower serum cholesterol levels (Barros et al., 2007).

Polyunsaturated fatty acids were detected in significant amounts in some edible mushrooms after analyzing the fatty acid profile. The presence of unsaturated fatty acid trans-isomers is linked to the biggest impact on increasing the blood total cholesterol to high-density lipoprotein ratio, which increases the risk of cardiovascular disease. Mushrooms do not contain unsaturated fatty acid trans-isomers (Barros et al., 2007). Dietary fiber consumption may impact plasma lipid concentrations, lowering the risk of cardiovascular disease. It has been demonstrated that soluble dietary fibers lower levels of LDL and total cholesterol and promote a healthier lipid profile. Glucans, a type of solvable dietary fiber, have the potential to lower cholesterol and triglyceride absorption by forming sticky gels.

Hepatoprotective activity of mushroom

The liver, which plays a crucial role in the metabolism of proteins, carbohydrates, and fats, is the largest and most complicated organ in the human body. The waste products of metabolism, such as ammonia, are detoxified in the liver. The liver destroys the remnants of red cells and recycles their components. It produces bile as well as lipoproteins and plasma proteins, including clotting factors. Several mechanisms operate in the liver to maintain blood glucose levels, including the storage of sugars as glycogen and the conversion of glycogen into glucose when necessary.

The liver is involved in drug removal and detoxification, and liver damage can result from a variety of xenobiotics, including alcohol and many drugs, as well as starvation, infection, and anemia. Liver damage is a common condition that is defined by a steady progression from steatosis to chronic hepatitis, cirrhosis, fibrosis, and hepatocellular cancer in the majority of cases (Mroueh et al., 2004). By minimizing exposure to toxic contamination such as medications during disease, an important part of the liver's function is to process chemical waste and detoxify it. To treat liver diseases, alternative medications need to be developed. Mushrooms contain secondary metabolites like phenols, steroids, terpenes, and essential cell wall components that protect the liver from dysfunction. Extracted some fungi have been shown to possess remarkable antioxidant potential in the hepatic, evaluated in terms of scavenging free radicals. Chatterjee et al. (2011), investigated the protective effects of an ethanolic extract of a wild edible fungus (*Calocybe indica*) against CCl_4-induced liver damage in mice.

The findings indicate that ethanolic extracts of *C. indica* restored the liver antioxidant status in mice after chronic CCl_4 hepatotoxicity was induced. According to Soares et al. (2013), a variety of mushrooms contain hepatoprotective properties against toxic chemical injury. The mushroom extracts may contain phenols, triterpenes, polysaccharides, and peptides that are responsible for their hepatoprotective effects. Wu et al. (2013), demonstrated that amanitin-induced acute liver damage could be prevented by using *Ganoderma lucidum* aqueous extracts. These beneficial effects may be attributed to GLE's antioxidant properties.

The bioactive effects of medicinal and edible mushrooms on liver function were initially studied by feeding animals whole mushrooms or non-purified extracts. The hepatoprotective effects of aqueous extracts of *Flammulina velutipes, Lentinula edode, Tremella fuciformis, Tricholoma lobayens,* and *Grifola frondosa* were tested in rats with paracetamol-induced hepatic injury.

Enzymatic testing revealed that paracetamol causes acute liver injury, as a result, a significant increase in aspartate aminotransferase (AST) and alanine transaminase (ALT). Rats given 100 mg/kg of extracts from *Ledodes* and *G frondosa*, were found to have a highly substantial hepatoprotective effect, the extracts significantly decreased the acute elevation of AST/ALT values induced by paracetamol. Although only the 300 mg/kg dose of T lobayense mycelial aqueous extract showed hepatoprotective activity. Chemically induced liver injury has been evaluated using bilirubin concentrations. Besides excreting bilirubin in the bile, the liver also releases other normal functions such as hemoglobin breakdown. The low amount of bilirubin in the serum showed that the *Lentinus edodes* extract reduced the severity of paracetamol-induced liver damage (Wasser, 2014).

Antidiabetic properties

Type 1 diabetes mellitus is caused by impaired insulin secretion, type 2 diabetes mellitus is caused by increased cellular resistance to insulin, or both types of diabetes mellitus. As a result, an unusually high amount of blood glucose, commonly known as hyperglycemia, develops, causing catastrophic damage to the body's organs. Diabetes has become the third most common chronic condition, after cancer and heart disease, in recent years. Diabetes is becoming more common, and by 2035, the number of people with the disease is expected to reach 592 million (Guariguata et al., 2014). Uncontrolled diabetes causes both acute and chronic consequences, including retinopathy, amputation, neuropathy, and organ malfunction affecting the eyes, nervous system, kidneys, vascular damage, and heart, all of which increase the risk of cardiovascular disease. Several diabetic treatment medications are currently available on the market. Biguanides, Sulfonylureas, tolbutamide, glinides, troglitazone, phenformin, repaglinide, and rosiglitazone, are examples of oral antidiabetic medicines.

Most of these are drugs, very toxic, and have a negative effect on the patient's body. As a result, they have a low success rate in preventing diabetes complications. Some of these medications may raise the risk of hepatic damage, kidney tumors, and acute hepatitis. A wide range of mushroom species is effective in lowering blood sugar levels.

Pleurotus pulmonaryius (grey oyster mushroom) is considered one of the prominent mushroom candidates with these anti-diabetic properties. Researchers Rushita et al. (2013), evaluated the hypoglycemic potential of methanolic extracts of *Pleurotus citrinopileatus* mycelium in type - II diabetes-induced rats. *P. citrinopileatus* was found to have good anti-diabetic efficacy in this investigation, and hence has a lot of potential as a natural health product ingredient. *Pleurotus ostreatus* was examined for its anti-diabetic efficacy in normal and alloxan-induced hypoglycemic mice. The vanadium-rich fungus *Grifola frondosa* has hypoglycemic properties. *Trametes pubescens*, a medicinal fungus, has a fruiting body that lowers blood glucose levels while increasing insulin action (Im et al., 2016).

A medicinal mushroom, *Lentinula edodes* (shiitake mushroom), improved glucose levels in plasma, as well as immune function. *Tremella mesenterica* (Yellow brain mushroom). Its medicinal properties are primarily attributed to a heteropolysaccharide acid and several sugars, including glucose, found in its fruit bodies. It is primarily the polysaccharides and β-glucans found in mushrooms that promote pancreatic tissue regeneration by increasing insulin secretion by the β-cells, thereby decreasing blood glucose levels. Studies have shown that it improves insulin sensitivity in peripheral tissues (Kaur et al., 2015).

Anti-aging property

Aging is a progressive process that causes all body organs to malfunction and have a lower reserve capacity. In anti-aging research, the aim is to slow, prevent, or reverse the aging process. A patented anti-aging product derived from *Ganoderma lucidum* spores is now available. *Ganoderma lucidum* isolates contain two novel anti-aging compounds, ganodermasidase A and B, which regulate the expression of UTH1 oxidative stress-responsive genes and extend the replicative life of Saccharomyces cerevisiae (Krupodorova et al., 2015). An extract of *Auricularia auricular* (AAP I-a) reduces oxidative stress in mice induced with d-galactose.

An industrial paste of polysaccharides is used to make products that combat the effects of aging on the skin, including antiaging creams and lotions. Polysaccharides (AAP I-a) inhibit the growth of associated enzymes that cause skin aging. Thus, it helps in slowing down the aging process through hyaluronidase, tyrosinase, elastase. Furthermore, polysaccharides restore skin elasticity and stimulate collagen synthesis (Zhang et al., 2011). Recent research has discovered that the medicinal mushroom *Tricholoma malobayense* contains several bioactive components with anti-aging properties. When polysaccharide (TLH-3) isolated from the *Tricholo malobayense* and used on d- galactose-stimulated aging rats, the result was found to have anti-aging properties (Ding et al., 2016).

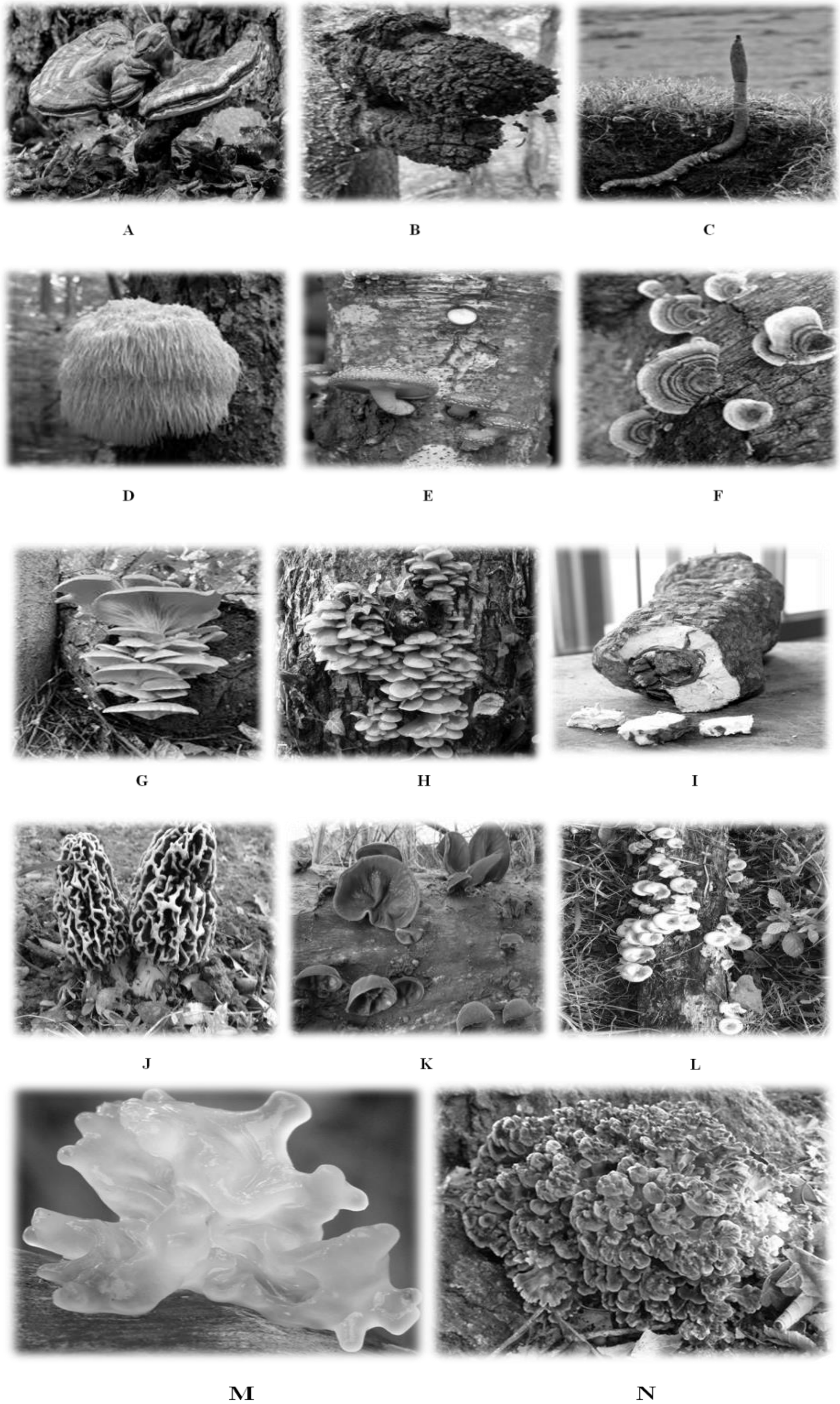

Figure 4. List of some edible and medicinal macrofungi: A - *Ganoderma lucidum;* B - *Inonotus obliquus;* C - *Ophiocordyceps sinensis;* D - *Hericium erinaceus;* E - *Lentinula edodes;* F - *Trametes versicolo;* G - *Oyster mushroom;* H- *Flammulina-velutipes;* I - *Wolfiporia extensa;* J - *Morchella esculenta;* K - *Auricularia auricula-judae;* L - *Lentinus squarrosulus;* M - *Tremella fuciformis;* N - *Grifola frondosa* sources: www.first-nature.com, MushroomExpert.Com, https:// www.iNaturalist https://www.sciencedirect.com (Photo courtesy of daniel winkler 2008), https://healing-mushrooms.net

Table 3
List of biological activities of some wild medicinal mushrooms and their active constituents (Wu et al., 2021; Wu et al., 2022; Gebreyohannes & Sbhatu, 2023; Panya et al., 2024)

S.No.	Scientific name	Common Name	Bioactive components founds	Health-promoting benefit
1	*Ganoderma lucidum*	Lingzhi mushroom / *Reishi*	Triterpenoid, Vitamins, Fatty acids, Polysaccharides - (1–6)-α/β-glucans, (1–3)-α/β-glucans, lectins	Antimicrobial, Anticancer Antiviral, Antioxidant, Immunomodulatory effect, Hepatoprotective, Anti-asthmatic, Antidiabetic, ardioprotective, Antiaging
2	*Inonotus obliquus*	Chaga	Phenolic acids, Flavonoids, Styrylpyrones, Quinones, Polysaccharides, Fatty acids, Triterpenoids, Steroids	Antimicrobial, Anticancer Antiviral, Antioxidant, Antilipidemic effect, Immunomodelling, Hepatoprotective, Antiglication effect, Cardioprotective, Antiaging
3	*Ophiocordyceps sinensis*	Cordyceps sinensis/ Caterpillar fungus/ Keeda jadi/ Yartsa gunbu	Cordymin, Cordycepic acid (D-mannitol), Polysaccharide, Alkaloid, Saponins, Polyunsaturated fatty acids (PUFA), Ergosterol, Tocopherol	Antimicrobial, Anticancer Antiviral, Antioxidant, Immunomodulatory effect, Hepatoprotective, Anti-asthmatic, Antidiabetic, ardioprotective, Antiaging, Anticonvulsant activity
4	*Hericium erinaceus*	Lion's mane/ yamabushitake/ Bearded tooth fungus	Hericenones, Erinacines, Beta-glucans, Polysaccharides, Sterols, Fatty acids, Lactone, linoleic acid, Hexadecanoic acid, Benzaldehyde	Anticancer, Antioxidant, Immunomodulatory effect, Neurotonic, Hypoglycemic effects Anti-asthmatic, Antiaging
5	*Lentinula edodes*	Shiitake	Glycoproteins, β-Glucan Polysaccharides, Terpenoids Phenols, Steroids	Antimicrobial, Anticancer Antiviral, Antioxidant, Antiaging, Immunomodulatory, Hypocholesterolemic effect, Helps in Reducing blood pressure
6	*Trametes versicolor*	Turkey Tail/ Cloud mushroom	Polysaccharide (1,3)(1,6)-β-D-glucans), henolic acids, flavonoids, lignans, vanillic, protocatechuic, Fatty acids, Vitamin B	Antimicrobial, Antidiabetic, Antioxidant activity, Antitumor, Immunoregulatory, Prevent obesity
7	*Pleurotus ostreatus,*	Oyster mushroom, Hiratake, Dhingri mushroom	Esters, lactones, Aldehydes, Selenium Content, Heterocyclic Metabolites (sulphorus, nitrogenous), Phenolic Compounds, Terpenoids Polysaccharide (1,3)(1,6)-β-D-glucans), Concanavalin A, Chlorogenic acid, Ferulic acid, α-tocopherol, Linoleic acid, Ergosterol, Fatty acids	Antimicrobial, Anticancer, Antitumor Antioxidant, Immunomodulatory, Prebiotic activity, Hypocholesterolemic Effect, Anti-inflammatory activity
8	*Flammulina velutipes*	Velvet foot /Winter mushroom	Phenolic compounds (homogentisic acid, chlorogenic acid, Ferulic acid, pyrogallol), Polysaccharide, Flavonoids, *Terpenoids,* Steroids, Fatty acids, *Proteins*	Antioxidant, Anticancer, Hypolipidemic effect, Cardioprotective, improves brain health, enhances immunity, promotes skin health, Hepatoprotective, Memory improvement

S.No.	Scientific name	Common Name	Bioactive components founds	Health-promoting benefit
9	*Wolfiporia extensa*	China root/ Poria/ Tuckahoe/ Hoelen	Polysaccharides, Fatty acids, Triterpenoids, Sterols, Enzymes	Antitumor, Anti-oxidation, Anti-diabetes, Anti-inflammatory, Anti-aging, Hepatoprotective, Immunomodulation, Anti-hemorrhagic fever
10	*Morchella esculenta*	Yellow morel/Sponge morel/ Gucchi	Phenolic compounds, Polysaccharides, Organic acids, Tocopherols, Galactomannans, Vitamins, Minerals, Fatty acids, Ergosterols	Antioxidant, Antimicrobial, Antitumor, Antiinflammatory, Antiallergenic, anti-obesogenic, Neuro-protective
11	*Auricularia auricula-judae*	Jelly ear/ *Wood Ear/ Judas Ear*	Polysaccharides, Proteins, Vitamins, Polyphenols, oleic acid, Phthalic acid, Ester, Cyclohexane, Fatty alcohol, Phthalate	Antimicrobial, Antioxidant Antimalarial, Anticancer, Antidiabetic, Anti-Inflammatory, Antifertility Insecticidal, Cholesterol-lowering, Hepatoprotective
12	*Lentinus squarrosulus*	*Glombang*	Polysaccharides, Phenolic compounds, polyphenols, flavonoids, Alkaloids, Glucans, Lectins, Proteins	Antimicrobial, Antidiabetic Antioxidant, Antifungal, Anticancer, Cholesterol-lowering,
13	*Tremella fuciformis*	Snow fungus/ white jelly mushroom/ *silver ear fungus*	Polysaccharides, fatty acids, Phenols, Flavonoid, Catechins, Dietary fiber, trace elements,	Anti-oxidation, Anti-tumor, Anti-aging, Anti-inflammatory, Anti- cancer, Hypoglycemic, Imunomodulatory, Neuroprotection, Hypolipidemic, Obesity combating
14	*Grifola frondosa*	Hen-of-the-woods/Maitake/ Hui-shu-hua	Polysaccharides, Glycoprotein, Amino acids, Sugar, Fatty acid, Ergrosterol, *α-Tocopherol*, Polyphenolics, Flavonoids, Ascorbic acid	Antitumor, Antioxidant, Anti-viral, Antibacterial, Antidiabetic, Anti-Hypertension, Immunomodulation

4 Cultivation of Mushrooms

Commercial wild mushroom harvesting continues today, with commercial mushroom producers providing the majority of the world's supply. Around 1100 AD, the Chinese began cultivating shiitake (*Lentinula edodes*) mushrooms, which had been domesticated for centuries. Americans and Europeans are most familiar with white button mushrooms (*Agaricus* spp.) as they were domesticated in France in 1650. The United States began commercial production in the 1880s. In 1997, *Agaricus* was the most commonly cultivated mushroom crop in the United States, making up 99 percent of the total. There are over 300 edible mushroom species, but only 30 have been domesticated, and just 10 are economically produced. Around 70% of the world's mushroom crop is made up of button, oyster, and shiitake mushrooms. Asia continues to be the largest producer and consumer of mushrooms, but the United States has been increasing its consumption rapidly in recent years, which could provide opportunities for mushroom growers (Patel et al., 2014).

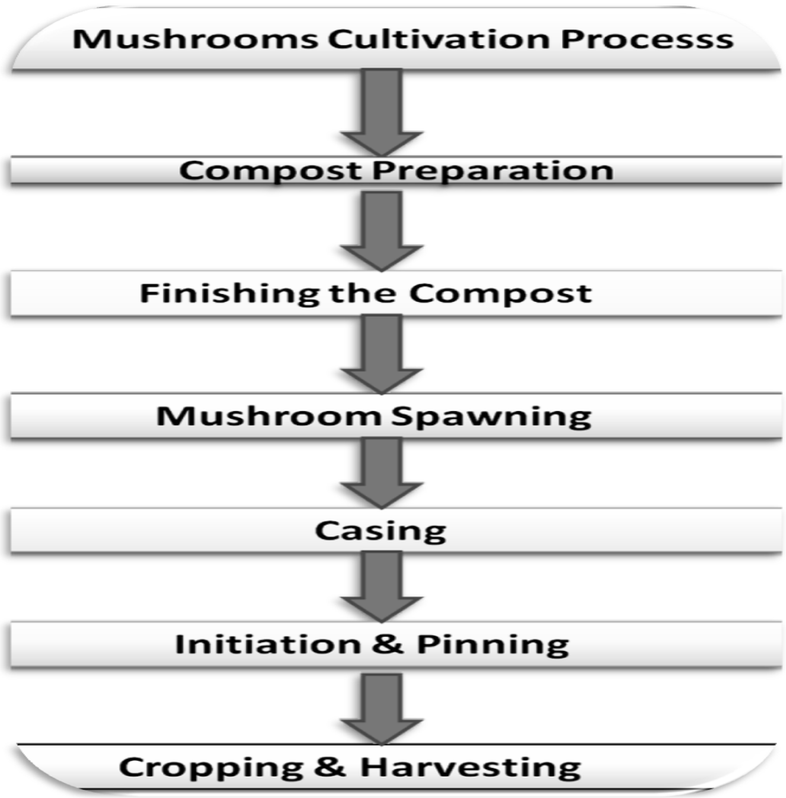

Figure 5. Mushroom Cultivation Process

5 Future Prospects

Considering the current situation, relatively little research has been conducted on wild mushrooms to date. Many species of wild mushrooms are found in nature. Discovering new species of these hidden mushrooms, properly identifying them, exploring new compounds hidden in them, and writing new literature would be novel research in the future. In this way, the properties and diversity of wild mushrooms can be further explored.

The total number of macro-fungi discovered to date is estimated to be only 7% to 10 %. Like animals and plants, fungi are endangered by human activity. They are neglected organisms that are poorly protected. Due to habitat destruction, deforestation, unorganized harvesting, climate change, urbanization trends, and population growth, many macro-fungi are becoming extinct or facing extinction threats. Therefore, ethnobotanical significance must be adequately investigated, conserved, and documented, as well as scientifically validated.

In the future, more research on wild mushrooms is needed to explore the nano-biofortification, bioactive compounds present in mushrooms, their healing properties, and the health benefits found in wild edible mushrooms that can lead to a healthier lifestyle in the future.

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