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REVIEW ON MUSHROOM CULTIVATION AND ITS MEDICINAL USES

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ABSTRACT

This paper's goal is to examine and assess the body of research on the production and culture of mushrooms, as well as its many health advantages and possible applications. The relevant literature was gathered using a methodical approach. 26 research articles in all, published between 1970 and 2022, were chosen and used for this review. Mushroom cultivation has emerged as a sustainable agricultural practice with significant economic and therapeutic potential. Edible and medicinal mushrooms such as Agaricus bisporus (white button), Pleurotus ostreatus (oyster), and Ganoderma lucidum (reishi) are widely cultivated across the globe for their nutritional value and bioactive compounds. The cultivation process involves low-cost substrates like agricultural waste, making it eco-friendly and resourceefficient. Medicinal mushrooms are rich in polysaccharides, triterpenoids, antioxidants, and immune-modulating compounds, which have demonstrated therapeutic effects against various diseases, including cancer, diabetes, cardiovascular disorders, and microbial infections. Scientific research has validated the immunostimulatory, anti-inflammatory, and anti-tumor properties of many mushroom species.

Keywords: Cultivation, Sustainable, Economic, Therapeutic, Antioxidant

INTRODUCTION

The majority of fungal species, due to their apical growth characteristics, are more suited for growth across and through solid surfaces, particularly in land habitats, although many also thrive in aquatic environments. Fungi have an essential function in the soil ecosystem by breaking down decomposing organic materials, but they can also spread widely among humans, animals, and other living organisms, resulting in illness and deterioration. On one hand, fungi significantly contribute to biotechnology, particularly in the manufacture of wines, beers, and spirits. Many edible mushrooms form the basis of various commercial processes. The well-being of humans has been significantly impacted by mushrooms, which are among the most varied organisms on Earth. In fungal taxonomy, mushrooms refer to the fleshy, spore-producing fruiting bodies that emerge from the ground or from

the fungus's food substrate. Mushrooms are classified within the Basidiomycetes class and the Agaricales order. Throughout history, many cultures have used mushrooms for culinary and medicinal purposes, appreciated for their rich flavor, nutritional benefits, and numerous health-promoting properties. Over time, improved and more effective methods have been developed to substantially enhance mushroom cultivation. The sexual reproduction process occurs in both Basidiomycetes and Ascomycetes, starting at the subterranean mycelial stage and culminating in the large, visible fruiting bodies, or mushrooms, that grow above ground. These mushroom structures, which vary in shape and color, primarily serve to spread spores or reproductive units. The final aspect of spore release demonstrates the most significant differences between the two groups. Ascomycetes are commonly known as "sac fungi" because they produce sac-like structures (asci) within the mushroom mass that actively release spores into the air for wind dispersal.(88)

PSYCHOACTIVE, MEDICINAL, POISONOUS, AND EDIBLE MUSHROOMS

An important aspect is the increasing awareness that numerous mushrooms possess a treasure trove of fascinating medicinal compounds. Some mushrooms are sought after by food enthusiasts, while others are shunned due to their reputation for harboring some of the most lethal toxins .

Mushrooms have been recognized as a unique and nutritious food source since the beginning of human history. The Romans regarded mushrooms as the "Food of God," while the Greeks considered them a source of strength for their warriors in battle. Traditionally, mushrooms were gathered from their natural habitats, but over time, efforts have been made to cultivate them in controlled environments. Over 2,000 edible mushroom species are deemed acceptable for human consumption, yet only a few are widely cultivated on a commercial scale globally. In India, just five types of mushrooms are predominantly cultivated: Agaricus bisporus, species of Pleurotus, Volvariella volvacea, Calocybe indica, and Lentinula edodes.

The capability of mushrooms to transform essential inputs into nutrient-rich, high-protein meals has earned them recognition as one of the world's premier natural resources. They provide a significant nutritional supply in case of a large population increase that leads to food shortages of nutrient-dense options, as they are a rich source of vitamins and minerals. The button mushroom (Agaricus bisporus), paddy straw mushroom (Volvariella spp.), and oyster mushroom (Pleurotus spp.) are the three varieties of mushrooms currently being cultivated globally. The majority of Agaricus bisporus cultivation occurs on a commercial level. Most processed mushroom varieties are internationally traded. The numerous significant health benefits of mushrooms, which have traditionally been appreciated for their culinary and nutritional importance, are now being increasingly acknowledged. Consequently, they are utilized not only as functional foods but also as dietary supplements, nutraceuticals, and products for mycotherapy.

Fresh mushrooms contain a moisture content ranging from 85% to 90%, a protein level of 3%, a carbohydrate content of 4%, a fat percentage of 0.3-0.4%, a mineral and vitamin content of 1%, along with certain health benefits such as reducing cholesterol, cancer prevention, and stimulating hair growth. Edible mushrooms are rich in vitamins like niacin, riboflavin, vitamin D, vitamin C, and the vitamin B complex. The FAO has recommended edible mushrooms to assist developing countries, where a large portion of the population mainly depends on cereal crops, in meeting their protein requirements. Cultivating mushrooms is an environmentally friendly and economically viable, albeit laborintensive, agricultural enterprise.

Mushrooms are considered organic vegetables. They can be cultivated in compact spaces through vertical growth without requiring arable land. By providing a rapid-yield nutritious food source and a consistent income stream, mushroom farming can enhance livelihoods and reduce the likelihood of poverty. Numerous commercial mushroom farms exist in various regions globally. Mushrooms can be easily grown on organic substrates high in cellulose, hemicellulose, and lignin, such as sawdust, leaves, and other agricultural byproducts. Over half of Bangladesh's population suffers from malnutrition, which raises significant concerns regarding their nutritional health. Due to their fast production rate and higher protein output per unit area compared to other crops, mushrooms have the potential to help mitigate the hardships of hunger. To advance national health, it is crucial to promote crop diversification and dietary changes. The demand for and consumption of mushrooms continue to grow, with most mushroom producers and sellers being small business proprietors. Mushrooms can also be used to dye wool and other natural fibers. The chromophores in mushrooms yield bright, vibrant colors, allowing mushroom dyes to produce any hue in the color spectrum. Prior to the invention of synthetic dyes, mushrooms were the primary source used in textile coloring. Tinder fungi are mushrooms that have been employed to ignite fires. The criminic and oyster mushrooms are utilized for environmental cleanup. Mycelium plays a role in what is known as myco-remediation, where it breaks down pollutants such as petroleum, fertilizers, pesticides, explosives, and various types of industrial, medical, and agricultural waste.

MUSHROOM CULTIVATION AND PRODUCTION

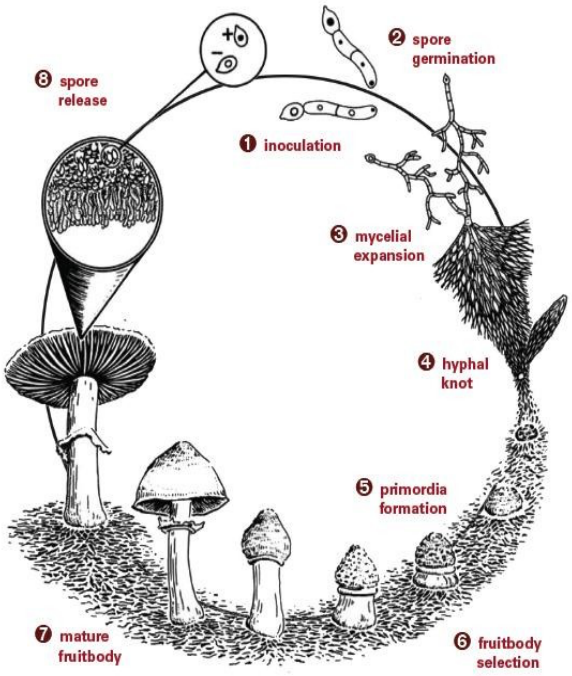
Mushrooms were first cultivated in India during the 1970s; however, advancements in environmental control technology and a deeper understanding of cropping systems have led to a significant rise in mushroom production. In 2010, button mushrooms accounted for 89% of all mushrooms produced in India, followed by oyster mushrooms (6%), milky mushrooms (1%), and other varieties (4%). Currently, India produces a total of 94,676 metric tons of white button mushrooms from both seasonal and technologically advanced cultivation methods, which represent approximately 73% of the country's overall mushroom output.

In 2017, the mushroom industry in the United States generated revenues of $1.22 billion, reflecting an 8% increase in value since 2007. The total weight of mushroom production was 929 million pounds, marking a 2% decline from the previous year, but a 12% increase over the last decade. Pennsylvania continues to be the leading state, producing around 60% of all mushroom sales, a figure that has remained constant for the past ten years. While production values are on the rise, the industry is also experiencing consolidation; the number of Agaricus and specialist mushroom growers decreased by 32% between 2007 and 2017. Producers have ramped up output by acquiring existing businesses, expanding their operations, and both building new production facilities and enhancing their current ones.

Although Europe initiated commercial mushroom production at the start of the 20th century, Bangladesh has only recently begun its own cultivation efforts. The country has twenty varieties of mushrooms, with 5-6 being toxic and found in the wild. The oyster mushroom (Pleurotus spp.) and white button mushroom (Agaricus bisporus) are the two species most suitable for farming. Owing to its favorable climate, low production costs, availability of growth substrates, and high market value, Bangladesh is recognized as one of the most ideal locations globally for mushroom cultivation. Despite the considerable potential for mushroom production in Bangladesh, several challenges related to cultivation and marketing need to be addressed before production can be significantly increased.

While Europe initiated commercial mushroom production around the beginning of the 20th century, Bangladesh has only recently entered the field. In the country, twenty varieties of mushrooms grow in the wild, with about 5 to 6 of them being toxic. The oyster mushroom (Pleurotus spp.) and the white button mushroom (Agaricus bisporus) are the two types considered most suitable for cultivation. Thanks to its favorable climate, low production costs, easy access to growth substrates, and high market demand, Bangladesh is among the top countries globally for mushroom farming. Despite the substantial potential for mushroom production in Bangladesh, several challenges in cultivation and marketing need to be addressed before increasing output can take place. Due to negative perceptions and misconceptions about mushrooms being Halal, they have not

gained significant attention as a food source in Bangladesh. Even though the techniques for growing mushrooms are a relatively new innovation, integrating this unconventional crop into the existing agricultural framework could enhance the social and economic conditions of rural and urban farmers. In 2014, the Bangladeshi government established the Mushroom Development Institute (MDI), previously known as the National Mushroom Development and Extension Centre (NAMDEC), in Saver, Dhaka, to provide training and encourage mushroom cultivation.



SOCIO-ECONOMIC STATUS OF MUSHROOM GROWERS

Mushroom production is mainly carried out by local individuals and specialists globally. A study conducted on mushroom cultivators in the Savar upazila indicated that a significant majority of participants in mushroom farming are women (82.6%). Additionally, the research found that 31.4% of farmers pursue mushroom cultivation as a supplemental source of income, while 68.6% consider it their primary job. Small-scale mushroom farming was observed to require relatively minimal investment, which contributes to lower daily yields; 80% of farms produced only 1–5 kg, while the other 20% yielded between 5–10 kg.

MEDICINAL ADVANTAGES OF MUSHROOMS

- Edible fungi have been highly regarded for their significant health benefits and are often used in traditional medicine. ○ The health-promoting effects of medicinal mushrooms are primarily attributed to specific bioactive compounds such as polysaccharides, triterpenoids, low-molecular-weight proteins, glycoproteins, and substances that modulate the immune system [28].
- Research has shown that mushrooms can enhance the immune system, promote overall wellness, lower cancer risk, inhibit tumor development, help in regulating blood sugar levels, combat bacteria, fungi, and viruses, reduce inflammation, and aid in detoxifying the body.
- Thanks to their low fat content, higher levels of unsaturated fatty acids, and absence of cholesterol, mushrooms are an excellent addition to a heart-healthy diet.
- It has been observed that mushrooms, which are low in sodium but high in potassium, contribute to improved blood circulation and balance of salt in the body,

making them beneficial for individuals with hypertension [28].

- Due to their low-calorie, low-starch, and low-sugar profile, mushrooms are popular among those with diabetes and obesity. ○ The fermentable dietary fiber present in mushrooms serves as nourishment for beneficial microorganisms within the human digestive system and promotes normal bowel function.
- Kresin, a commonly utilized cancer treatment in pharmaceuticals, is a compound that reduces tumor activity.
- Ergothioneine, an antioxidant found in Flammulina velutipes and Agaricus bisporus, plays a crucial role in maintaining the health of the eyes, kidneys, bone marrow, liver, and skin while also slowing down the aging process.
- The antioxidants abundant in mushrooms help neutralize free radicals in the body, thus delaying cellular aging.
- This helps them function as an anti-aging agent [28].
- Mushrooms contain various polysaccharides (such as beta-glucans) and minerals that strengthen and regulate the human immune system [28].
- The therapeutic potential of mushrooms is widely recognized.
- All forms of edible mushrooms, which account for 6% of those proven to have medicinal properties, can be found in health tonics, tinctures, teas, soups, and herbal remedies [30] [29].
- Due to their health benefits, edible mushrooms have become vital components in the formulation of certain pharmaceutical products
- Shiitake (Lentinula edodes) and Reishi (Ganoderma lucidum) mushrooms are particularly known for their health benefits and are believed to possess anti-tumor and antiviral properties, including activities against HIV and hepatitis B, as well as the ability to reduce serum cholesterol levels in the blood [27]. ○ Historically, they have been used in Asian cultures to promote and maintain health, as well as treat various ailments, while this approach has gained popularity more recently in the West.
- Medicinal mushrooms (MMs) are reported to offer a wide array of pharmacological effects such as prebiotic, antibacterial, anti-inflammatory, immunomodulatory, antidiabetic, cytotoxic, and antioxidant properties.
- They also exhibit hepatoprotective, anticancer, antiallergic, and antihyperlipidemic effects [29].
- These activities stem from many bioactive metabolites found in the mycelium, particularly in the fruiting body, with their biological effects varying based on their chemical composition and distribution, which can differ among various fungal species.
- Given the growing interest in utilizing natural products as adjuncts to standard treatments, extensive research has been conducted and is ongoing to identify and characterize mycochemicals and clarify their actions and mechanisms.

ECOLOGICAL ADVANTAGES OF FUNGI

All ecological processes rely on biodiversity [31]. The ongoing decline in biodiversity and the rapid onset of environmental and global changes put ecosystem health and resources at risk [31] [28]. It is widely recognized that increased fungal diversity enhances tree growth and directly influences "food supply," "biochemicals," "natural medicines," and "pharmaceuticals" [31] . Fungi play a crucial ecological role in decomposing organic matter and recycling essential nutrients within the soil [17] [31]. As noted by Perez-Moreno et al. (2002), one of the most important mutualistic interactions between fungi and plants is the mycorrhizal association, which aids in the exchange and communication of nutrients and minerals.

Every organism on Earth holds unique ecological significance. Due to their interconnections within specific ecosystems, all living entities have roles in maintaining ecological stability. By participating in the decomposition of organic waste, mushrooms support distinct nutrient cycles across various ecosystems. Many plants and trees engage in symbiotic mycorrhizal relationships with certain fungi. Various wildlife, including insects (like beetles, flies, gnats, springtails, and centipedes), slugs, squirrels, and deer, rely on wild mushrooms for their nourishment [29]. On the other hand, parasitic fungi can negatively affect ecosystem health by spreading diseases, inhibiting growth, and reducing the fertility of many wild plant species. Other ecological functions of wild fungi include maintaining soil quality, bioremediation, and lessening pollution.

Many ecological roles performed by mushrooms remain unknown to this day [29].

The black-cap mushroom, Coprinus comatus, is notably liquid-like and rapidly transforms into a black fluid that can be utilized for writing. Shaped fruiting bodies of Polyporus fomentarius and P. ignitarius can be crafted into flower pots [29]. The capacity of microbes, plants, and animals to produce light in darkness is well-established. Numerous fungi exhibit luminescent fruiting bodies or mycelium, or both, depending on the species. Those in the timber industry, including woodworkers and forestry professionals, are familiar with these glowing phenomena, particularly in dark forests. Provided that conditions remain conducive to growth and the environment is moist, decaying wood can emit light when combined with Armillaria mellea mycelium. Another luminescent fungus is Fomes annosus. Both the mycelium and fruiting bodies of this fungus, typically found in mines, display vibrant colors. Light is also generated by Pleurotus japonicus.

CONCLUSION

This review highlighted the importance of mushroom cultivation and production, along with their diverse benefits and therapeutic potentials. Mushrooms serve various roles and offer numerous advantages, including economic, medicinal, ecological, environmental, and nutritional benefits. Globally, the production of mushrooms is on

the rise, significantly impacting the economies of countries involved in their cultivation. Both small-scale and large-scale farming practices exist worldwide for mushroom cultivation, which brings with it a range of positive and negative consequences. Moreover, mushrooms are vital to ecosystems that are threatened by climate change. It is essential to conduct further research into mushroom cultivation and production, as well as their benefits and therapeutic potential. A significant portion of the literature reviewed focused on mushroom cultivation and production, benefits, and therapeutic potential outside of the Neotropics, indicating a need for more research on mushrooms within the Neotropic region.

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