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Mushroom as an Anticancer Agent: A Review on Mechanisms, Bioactive Compounds, and Therapeutic Potential

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ABSTRACT:

Cancer remains one of the foremost global health burdens despite advancements in modern medicine. The limitations of conventional therapies, including chemotherapy and radiation, have driven interest toward complementary and alternative medicine. Among the promising candidates, mushrooms—long used in traditional healing systems—have emerged as a powerful source of anticancer compounds. This review highlights the history, classification, and medicinal importance of mushrooms in oncology, emphasizing their rich content of bioactive molecules such as polysaccharides, terpenoids, lectins, and phenolic compounds. These constituents exert their effects by enhancing immunity, promoting apoptosis, and inhibiting angiogenesis. As natural immunocuticals, mushrooms hold potential as both standalone and adjunctive treatments in cancer therapy.

Introduction

Cancer continues to pose a significant threat to global health. While notable progress has been made through conventional treatments like surgery, chemotherapy, radiation, and targeted therapies, success rates vary significantly, and adverse effects often compromise patient immunity and quality of life. The growing demand for safer, effective alternatives has led researchers to explore natural sources, particularly mushrooms, for their anticancer potential.

Mushrooms are nutrient-rich fungi that possess both culinary and medicinal values. They harbor a wide range of biologically active compounds with potent pharmacological properties, particularly in immunomodulation and tumor suppression. Their ability to interact with immune cells—such as macrophages, dendritic

cells, and NK cells—makes them strong candidates in oncology.

Historical and Medicinal Background

The medicinal use of mushrooms can be traced back thousands of years in Eastern cultures. Ancient Chinese, Japanese, and Korean medicinal systems extensively utilized mushrooms for their healing properties. The earliest records indicate cultivation of *Auricularia auricula* around 600 A.D., followed by *Flammulina velutipes* and *Lentinula edodes* (shiitake). Revered for promoting vitality and longevity, mushrooms like *Ganoderma lucidum* (Reishi) and *Tremella fuciformis* became central to traditional therapies. These early uses laid the foundation for modern scientific interest in their pharmacological properties.

Medicinal Mushrooms with Anticancer Activity

**Ganoderma lucidum (Reishi)**

- Contains triterpenoids and β -glucans.
- Induces apoptosis and modulates immune responses.

Lentinula edodes (Shiitake)

- Source of lentinan, a polysaccharide known for enhancing immune function.
- Shown to improve survival rates in gastric cancer patients when combined with chemotherapy.

Coriolus versicolor (Turkey Tail)

- Rich in polysaccharide-K (PSK) and polysaccharopeptide (PSP).
- Used as an adjuvant in cancer therapy in Japan.
- Demonstrates immune system stimulation and tumor inhibition.

Agaricus blazei Murill

- Contains ergosterol and β -glucans.
- Shown to induce apoptosis in leukemia and multiple myeloma cells.

Key Bioactive Compounds in Mushrooms**➤ Polysaccharides**

Polysaccharides, especially β -glucans, are among the most potent and researched constituents found in mushrooms. These molecules enhance the host's immune system by stimulating the activity of macrophages, dendritic cells, and natural killer (NK) cells. Compounds like lentinan, PSK, and Maitake D-fraction modulate the immune system, promote cytokine release,

- Inhibits proliferation of breast, lung, and prostate cancer cells.

and increase antigen presentation. They also trigger apoptosis in cancer cells and inhibit tumor metastasis.

➤ Terpenoids

Terpenoids, including ganoderic acids from *Ganoderma lucidum*, exhibit anti-inflammatory and antitumor activity. These molecules interfere with tumor growth by downregulating pathways responsible for cell proliferation, inducing programmed cell death (apoptosis), and preventing the formation of new blood vessels (angiogenesis). Their dual action makes them effective in halting tumor development and spread.

➤ Lectins

Lectins are proteins that bind specifically to carbohydrate moieties on cell surfaces. In cancer therapy, mushroom-derived lectins show affinity for altered glycoproteins on cancer cells, triggering cell aggregation and apoptosis. *Agaricus bisporus* and other edible fungi have demonstrated significant anti-proliferative activity through this mechanism.

➤ Phenolic Compounds

Phenolic compounds, including flavonoids, phenolic acids, and tocopherols, are powerful antioxidants. They reduce oxidative stress and DNA damage—key contributors to cancer initiation. *Agaricus blazei* and *Phellinus linteus*, among others, are rich in phenolics that support cellular defence mechanisms and prevent carcinogenesis.

Table no.1: Bioactive Compounds Responsible for Anticancer Effects



Compound	Mushroom Source	Mechanism
β -glucans	Reishi, Shiitake	Immune activation, macrophage stimulation
Triterpenoids	Ganoderma	Anti-proliferative, cytotoxic

Lectins	Flammulina, Agaricus	Induce apoptosis, block tumor cell growth
Phenolic compounds	Phellinus, Hericium	Antioxidant, DNA protection

Mechanisms of Anticancer Action

- Induction of apoptosis: Through caspase activation and mitochondrial membrane disruption.
- Inhibition of angiogenesis: Reduction in VEGF and other pro-angiogenic factors limits blood supply to tumors.
- Immune stimulation: Enhanced activity of NK cells, T lymphocytes, and macrophages.
- Antioxidant protection: Prevention of oxidative DNA damage and mutation.
- Modulation of gene expression: Downregulation of oncogenes and upregulation of tumor suppressor genes.

Clinical and Preclinical Evidence

Numerous preclinical studies have demonstrated significant antitumor activity of mushroom extracts in vitro and in animal models. For instance, PSK from *Coriolus versicolor* has been approved in Japan as an adjuvant for cancer therapy and has improved survival in gastric and colorectal cancers. Lentinan from *Lentinula edodes* enhances host immunity and has been used

in clinical settings to improve outcomes in gastric and liver cancers.

Maitake D-fraction has shown synergistic effects with chemotherapy drugs like doxorubicin. In vivo studies further confirm tumor regression, increased survival, and improved quality of life in treated groups.

Future Prospects and Challenges

While medicinal mushrooms offer significant promise, challenges include standardizing active ingredients, ensuring quality control, and conducting large-scale human clinical trials. Future research should explore nanoformulations, novel delivery systems, and bioavailability enhancement. Regulatory frameworks also need to evolve to accommodate such natural therapies.

Conclusion

Medicinal mushrooms represent a unique and multifaceted approach to cancer therapy. Their ability to modulate immune responses, induce apoptosis, and prevent tumor growth positions them as vital agents in integrative oncology. With further research and clinical validation, mushroom-derived compounds could



revolutionize cancer treatment and patient care.

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