



Edible Mushroom For Medicinal Use

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Abstract

Medicinal mushroom has been used for their health benefits for thousands of years. Each mushroom has its own distinct health advantages. A lot of people heard about Medicinal mushroom or you can say Healing mushroom or Functional mushroom. But not all mushroom is like this on other side magic mushroom which are wildy cultivated that gives psychoactive effect. There are approx. 10,000 known species of mushroom, out of that 700 are edible. Like there are numerous mushroom that have been utilized for their medicinal advantage for millennia. Some of them have specific biological effect like, Reishi for immunomodulatory, Lions mane for cognitive behavioral therapy, Chaga mushroom for body manage and regulate stress, Maitaki mushroom for antibacterial. These mushroom are known for their extraordinary medicinal advantage for example safe health offering, creating cell reinforcement, helping a balance blood-sugar level, supporting brain health, supporting sensory system, expanding energy and low risk of depression. Mushroom contain polysaccharide that act as prebiotic. Also contain important minerals like copper, potassium, selenium, etc. Two epidemiological studies found that higher mushroom intake had protective effect on older elder brain and may prevent growth of amyloid protein that related to dementia. On other hand it protects the body from the physiological stress that cause visible sign of ageing. So overall consumption of mushroom is not only having health benefits in diseases but they can be used to stop progression of disease. You can identify if this mushroom species is edible or poisonous by “Yellow stain test” – By scratching at the top of mushroom and if they show yellow color then it is poisonous mushroom.

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INTRODUCTION:

Fungi are eukaryotic life form; i.e., their cells contain film bound and define nuclei. Fungi are developed from upper tip of fiber that make the body of organisms (Mycelium) ⁽¹⁾. The fungi constitute a unique kingdom of heterotrophic organisms. They show a great diversity in morphology and habitat. You probably seen parasites on a damp bread and spoiled organic products. They show an extraordinary variety in morphology and territory. King Fungi contain four classes which provide distinct features: -

1. Phycomycetes (the mycelium of this member is a septate),
2. Ascomycetes/Sac fungi (asexual spores exogenously produce where sexual spore produce endogenously),
3. Basidiomycetes (it's included mushroom, bracket fungi),
4. Deuteromycetes/Imperfect fungi (they don't have sexual state in their life cycle & it reproduce via producing spores)

▪ **Basidiomycetes: -**

Reason why mushroom can fit into this class is because it doesn't produce spore instead of it provide fragmentation. Understanding the fundamental of decay wood basidiomycetes local elements is critical for completely understanding decomposition processes, and for displaying biological system capability and strength to natural change ⁽²⁾. Basidiomycetes are one of the biggest gatherings of edible mushroom and become more important healthful and medicinal properties. Morphological ID of consumable mushroom can now and again cause troublesome; One of the main issues for mushroom raise is the absence of deliberate agreement instrumental to recognize various species, which are sometime morphologically identical ⁽³⁾.

Members of basidiomycetes: -Agaricus (Mushroom); Puccinia (Rust fungus); Ustilago (Smut fungus).

Agaricus is a genus which include common mushroom and field mushroom and a group of mushrooms contain both edible and poisonous species having 400 members in all over world ⁽⁴⁾. The term Agaricus Blazei Murill is basically therapeutic mushroom of brazilian origin. It's generally use against various scope of illness, including disease and chronic hepatitis and also for the development of wellbeing food market ⁽⁵⁾. A genus of saprobic fungus called Agaricus (Basidiomycota) has cultivated edible species like the button mushroom, Agaricus bisporus. The genus has drawn a lot of attention in the field of ecology, nutrition, and medicine but little is known about how diverse it is, particularly in subtropical and tropical region ⁽⁶⁾. Japan is generally famous for its health benefit purpose, so it is presently viewed one of the main palatable and culinary restorative biotechnological species. It was generally used to deal with atherosclerosis, hepatitis, hyperlipidemia, diabetes, dermatitis & cancer. Mushroom are fundamentally basidiomycetous fungi and they popularly known for their important food, low in calories and high in minerals, and it contain essential nutrients; some of them produce substance having expected clinical result, and are called Medicinal Mushroom ⁽⁷⁾.

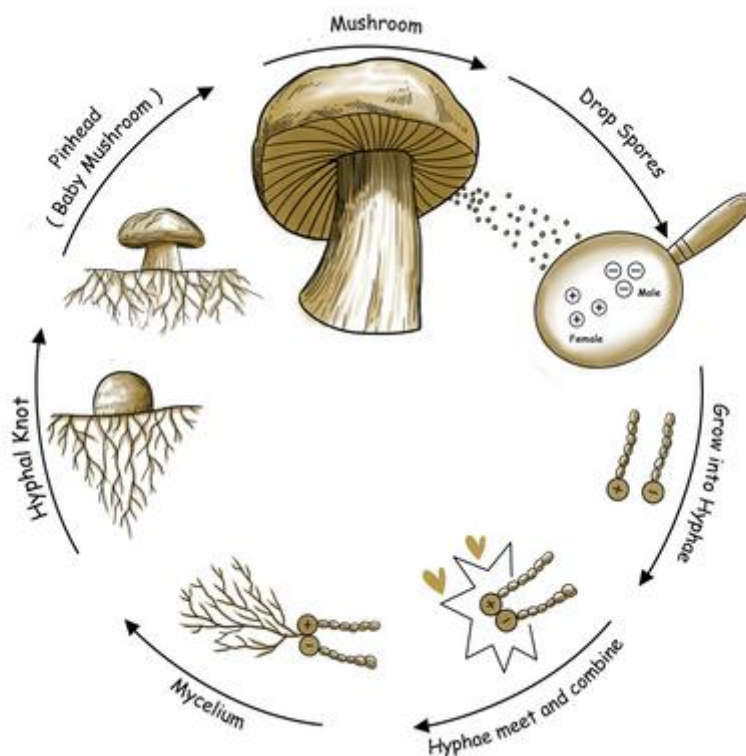
A bioactive mixture from edible mushroom can help in health treatment by making new items ⁽⁸⁾. Agaricus bisporus's prominence in the edible mushroom business, members of the genus Agaricus have been strikingly weak in knowledge of sexuality and the life cycle ⁽⁹⁾.

▪ **Life pattern of Mushroom: -**

Lowered culture is a rapid procedure that yield quality mushroom mycelia, taking into account the option of development that requires more time to investing and to create fruiting bodies ⁽¹⁰⁾. "Mushroom are fascinating type of fungal organism. And they have different kingdom mushroom have life cycle parallel to stages found in plant. Mycelium is primary quote-unquote plant portion of mushroom and having root like filaments as it develops, grown as fruiting body.

A fruiting body is reproducing stage which produce spore which can seem similar to plants seed. Their mainly include three stage of mushroom life cycle, in which initially mycelium is most active highly dynamic stage of mushroom life cycle. And it also supports the health of the surrounding ecosystem. Mushroom are not support immune response but also the health of surrounding ecosystem. When harnessed in form of supplement human being also benefit from significant health supporting power of mushroom mycelium".

In mushroom, this is taken to limits with the event of numerous thousands of mating type. Yet, having gone to such remarkable length to guarantee that practically any two mushrooms in the wild can mate, cell combination and genuine diploidy ⁽¹¹⁾. In them after the grown-ups arose, females were gauged, mated and permitted to oviposit. The quantity of eggs laid expanded as the heaviness of the female expanded ⁽¹²⁾. As opposed to the uncommonness of totipotent cells in creatures, pretty, much every cell framed by a parasite can work as a "undifferential organism". The same type of filamentous hyphae that make up the organism feeding phase, or mycelium, also make up the multicellular fruiting bodies of basidiomycete fungus, and there is seldom any discernible cellular differentiation ⁽¹³⁾.



Life cycle of Agaricus.

Its importance takes a note of that not all mushroom is protective to consume. A few mushrooms found in nature can be toxic or make opposite side impacts. It is ideal to adhere to that you are keen on integrating grow into your eating regimen or involving them for their restorative properties, it is generally really smart to talk with a medical care proficient first.

▪ **Biological Impact:** -

Mushroom have been used medicinally for thousands of years due to their wide range of beneficial health effects. Now, as functional medicine and holistic nutrition have become a more popular, we're witnessing a rise in interest in these wonderful superfoods. It is thought that antibacterial substance is necessary for mushroom to thrive in their natural habitat. Many different types of mushrooms might produce antimicrobial chemical, some of which were shown to be beneficial for people ⁽¹⁴⁾. The disorder has been treated with edible mushroom since the dawn of time because they contain anti-oxidants, fibers, triterpenoids, alkaloids, and other phytochemicals. Active ingredients found in mushroom, such as comatin, have significant impact on diabetes mellitus and obesity by altering cellular activity or biochemical pathway ⁽¹⁵⁾. Edible mushroom are a significant wellspring of supplements and bioactive mixture notwithstanding a developing interest for people by their flavors and culinary highlights. As of late, they have become progressively appealing as useful food sources for their likely valuable consequently, food industry is particularly inspired by developed and wild consumable mushroom ⁽¹⁶⁾. About 130 therapeutic properties of medicinal mushrooms and fungi, such as anticancer, antioxidant, radical scavenging, heart-healthy, anti-hypercholesterolemia, antiviral, and antibacterial, Hepatoprotective, antiparasitic, antifungal, detoxifying, and antidiabetic effects. Most upper Basidiomycetes mushrooms, if not all of them, include fruit bodies with physiologically act. They are regarded as the best source of natural medicines and foods ⁽¹⁷⁾. They are regarded as the best source of natural medicines and foods. They are regarded as functional foods because of their exceptional flavor, scent, and nutritional content. This implies that they benefit the body not just in terms of nutrition but also in terms of better health. Secondary metabolites are a class of bioactive substances found in high concentrations in both medicinal mushrooms and their extract. As they have many properties including anti-diabetic, anti-cancerous, anti-obesity, immunomodulatory, hypocholesterolemia, and anti-aging nature, polysaccharide -glucans or polysaccharide-protein complexes present in mushroom extract have great therapeutic applications in human health. The current review focuses on a thorough explanation of the therapeutic benefits of several medicinal mushrooms ⁽¹⁸⁾. Safety is a relative concept; there is no such thing as absolute safety, and mushroom side

effects can vary from person to person or depending on the ailment being treated. However, it is crucial that the adverse effects of mushroom treatments are supported by science. By being consumed by humans as food or used as traditional medicines for millennia, toxic mushrooms have been clearly separated from non-toxic one⁽¹⁹⁾.

▪ **Type of mushroom which shows a different medicinal resource.**

I. Reishi Mushroom: - (*Ganoderma lucidum*)



Scientific classification⁽²⁰⁾

Domain:	Eukaryota
Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Polyporales
Family:	Ganodermataceae
Genus:	Ganoderma
Species:	<i>G. lucidum</i>

The reishi mushroom is also called as “The **mushroom of immortality** “. Reishi mushroom are a highly medicinal sought-after mushroom. And it’s also associated with wisdom and health for thousands of years. Its traditional Chinese name literally means spirit mushroom.

The term "The king of herbs" refers to *Ganoderma lucidum*. It is a fungus that thrives on several dead and decaying trees, particularly elm, maple, willow, oak, and sweet gum. In China, Japan, along with other Asian nations, *ganoderma lucidum* has a long tradition of use for extending life and promoting a healthy lifestyle. Most people refer to *Ganoderma lucidum* as Reishi⁽²¹⁾.

In China, Japan and Korea in particular, the medicinal fungus *ganoderma lucidum* has been utilized for the prevention and treatment of many illnesses to increase longevity and health. In ancient China, it was referred to as “God’s herb” because it was thought to increase youth, lengthen life, and sustain physical strength⁽²²⁾.

In Asia, *ganoderma* has a long history of usage for the treatment of chronic infectious disorders, such as bronchitis and chronic hepatitis, either alone or increasingly frequently in conjunction with chemotherapy drugs. Preclinical research show that *Ganoderma* has a wide range of antibacterial and antiviral properties, however there is a paucity of information on these effect in humans⁽²³⁾. *lucidum* is a word gotten from the Latin word *lucidus*, and that signifies "sparkly" or "splendid", and portrays the stained look of the mushroom's surface. By and large, *G. lucidum* is a huge, dull mushroom particularly portrayed by a polished surface and a woody surface. The new mushroom is delicate, corklike, level, needs gills on its underside, and deliveries its spores through fine pores⁽²⁴⁾.

The basidiocarp, mycelia and spores of *Ganoderma lucidum* contain roughly 400 different bioactive mixtures, which chiefly incorporate triterpenoids, polysaccharides, nucleotides, sterols, steroids, unsaturated fats, proteins/peptides and minor components which has been accounted for to have various pharmacological impacts including immunomodulation, hostile to atherosclerotic, mitigating, pain relieving, chemopreventive, antitumor, chemo and radio defensive, rest advancing, antibacterial, antiviral , hypolipidemic, hostile to fibrotic, hepatoprotective, against diabetic, against androgenic, against angiogenic, hostile to herpetic, antioxidative and revolutionary searching, against maturing, hypoglycemic, estrogenic movement and against ulcer properties⁽²⁵⁾. Therapeutical administration has been acknowledged as oral, skin application, and powder gulping, cleaning wounds, tea removes with different spices, and tonics for long ailment, and disease treatment, and home-grown soup with ginseng in the wake of drying. Today, *G. lucidum*-based items have

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been by and large isolated into three kinds of items, including fruiting bodies, mycelia, and spore powder. *G. lucidum* mycelia, spores, and fruiting bodies-determined drugs, nutraceuticals, and dietary enhancements as refreshments, teas, powdered separates, containers, oral fluids, and enjoyable tablets are right now accessible and broadly spread on the world market particularly in China, Japan and North America. What's more, different in vivo and clinical examinations have shown that the concentrates, spore arrangements and dietary enhancements of *G. lucidum* have no or minimal incidental effects ⁽²⁶⁾. *Ganoderma lucidum* (reishi) is a promising wellspring of prebiotics because of overflow of a few bioactive mixtures make nourishing and restorative impacts and are available in all pieces of the growth (natural product bodies, mycelium, and spores). Consequently, since antiquated times, *G. lucidum* has been utilized customarily in Chinese medication as "the fortunate fungi" for its ability to mitigate conditions like joint pain, a sleeping disorder ⁽²⁷⁾.

II. Lion's mane mushroom: - (*Hericium erinaceus*)



Scientific classification ⁽²⁸⁾	
Domin	Eukaryota
Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Oder	Russulales
Family	Hericiaceae
Genus	<i>Hericium</i>
Species	<i>H. erinaceus</i>

'The lion's mane mushroom also called as "**mountain-priest mushroom**". They contain some specific compounds in lion's mane mushroom that stimulate nerve and brain cells to grow, and keep them alive longer. Mushroom consumption was also associated with brain cells in the hippocampus being more active and releasing more neurotransmitters.'

Due to its therapeutic and medicinal qualities, the Lion's Mane Mushroom (*Hericium Erinaceus*) has been utilized in traditional medicine for thousands of years. Recently, this functional mushroom has become a rare and in-demand fungus because to its nootropic potential. The remarkable health advantages of lion's mane mushrooms are explained here ⁽²⁹⁾.

H. erinaceus (also known as the Lion's Mane mushroom), a gourmet fungus, has received substantial research into its potential benefits for neurohealth. Lion's mane mushroom aqueous extract contains polysaccharides that may encourage neuronal survival and induce differentiation. And another research tested the effectiveness of consumption of *H. erinaceus*, for treating cognitive impairment, utilizing a cognitive function test on Japanese men and women aged 50 to 80 who had been diagnosed with mild cognitive impairment ⁽³⁰⁾. Antibiotic, anticarcinogenic, antifatigue, antihypertensive, antisenescence, hepatoprotective, nephroprotective, and neuroprotective properties, as well as improvements in anxiety, cognitive function, and depressive symptoms, are among the reported health-promoting properties of the lion mane's mushroom fruit bodies, mycelia, and bioactive pure compounds ⁽³¹⁾.

NGF mRNA expression was increased by *H. erinaceus* extract in a dose-dependent way. It has been suggested that *H. erinaceus* stimulates NGF gene production through JNK signaling since *H. erinaceus* extracts elevated c-fos expression and caused activation of JNK and its downstream substrate c-Jun ⁽³²⁾.

General examination of the freeze-dried mushroom powder showed that it contains high measures of proteins, sugars, and minerals. The outcomes demonstrate that *H. erinaceus* mushrooms might have remedial potential against human leukemia⁽³³⁾. It has been discovered that *H. erinaceus* stimulates the production of neurotrophic factors linked to cell proliferation, such as nerve growth factors. *H. erinaceus* may be a promising alternative medicine for the treatment of depression, even if its antidepressant effects have not been verified and contrasted with those of standard antidepressants. This is because depression has a neurotrophic and neurogenic etiology⁽³⁴⁾.

That includes activities that help improve nerve and brain health. Various mixtures separated from this mushroom actuating the statement of neurotrophic factors, for example, nerve development factors (NGF) have been effectively announced. Erinacines were derived from the mycelia of the mushroom, whereas hericenones were typically found in the fruiting bodies. In previous double-blinded clinical study *H. erinaceus* was administered orally in 50–80-year-old Japanese Patients. After analyzing the impact, hericenones unsuccessful to stimulate to NGF quality articulation in essential refined rodent astroglial cell and 1321 N1 human astrocytoma cell, proposing that hericenones were not the key substances for the neuroprotective exercises of this mushroom. In contrast, rat demonstrated that erinacineA had significant beneficial effect on CNS⁽³⁵⁾.

III. Chaga Mushroom: - (*Inonotus obliquus*)



Scientific Classification⁽³⁶⁾

Domain	Eukaryota
Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Hymenochaetales
Family	Hymenochaetaceae
Genus	<i>Inonotus</i>
Species	<i>I. obliquus</i>

Chaga, also known as *Inonotus obliquus*, is a parasitic fungus that lives on birches and is employed in traditional medicine to treat a variety of illnesses. This species of fungus has only ever been identified in the northern region⁽³⁷⁾.

Most of these decoctions' active ingredients are polysaccharides with different chemical makeups. The majority of them are B-glucans, which have anticancer and immune-stimulating characteristics. B-glucans with a high molecular weight are more efficient than those with a low molecular weight. Polysaccharides from mushrooms stop tumor spread and oncogenesis. Instead of directly attacking cancer cells, they cause the host's immune system to respond⁽³⁸⁾.

"In 1958, logical examinations in Finland and Russia found this mushroom gave an epochal (most important) impact in bosom malignant growth, liver disease, uterine disease, and gastric disease, as well as in hypertension and diabetes⁽³⁹⁾.

Due to its extraordinary antioxidant ability to maintain a healthy equilibrium between the system of oxidation and free radicals in the human body, *I. obliquus* has a great deal of potential to become an organic and dietary antioxidant⁽⁴⁰⁾.

One of the main bioactive ingredients in *Inonotus obliquus*, *Inonotus obliquus* polysaccharide (IOPS), is thought to be present in the plant's extracts and has anticancer, antioxidant, antiviral, hypoglycemic, and hypolipidemic properties. might represent a viable therapy option for type 2 diabetes and cancer⁽⁴¹⁾.

In terms of the hepatitis C virus, it was discovered that fractions of an aqueous extract of *I. obliquus* had the potential to lower the infectious qualities by 100 times in just 10 minutes. Both preventative usage and therapeutic use of fungal extracts revealed their antiviral capabilities⁽⁴²⁾.

The pharmaceutical industry has taken notice of inotodiol, an oxysterol that can only be found in the Chaga fungus, because of its potent antioxidant and anti-allergic properties. Due to its powerful biological actions, inotodiol, an oxysterol present simply in Chaga mushrooms (*Inonotus obliquus*), is of tremendous interest to the food and pharma sectors⁽⁴³⁾.

Inonotus obliquus, often known as the chaga mushroom, has been used in traditional medicine to cure cancer. *I. obliquus* is said to have good bioactive chemicals, according to several research. *I. obliquus* has produced the compound 3hydroxy-lanosta-8,24-dien-21-al, and a high-molecular-weight, water-soluble material that resembles lignin has been shown to block the protease of type-1 human immunodeficiency virus⁽⁴⁴⁾.

This "mushroom" is the hyperplastic conk made of wood and mycelium that forms on Birch after the fungus becomes infected and grows invasively. Concentrates of Chaga have been utilized in some countries for their assumed antibacterial, hepatoprotective, calming, antitumor, and cell reinforcement exercises. Chaga's properties in vitro were found to be mostly antiviral, antioxidative, and anti-inflammatory and not create toxicity⁽⁴⁵⁾.

In the past, the *Inonotus obliquus* (*I. obliquus*) mushroom was used to treat a variety of gastrointestinal conditions. *I. obliquus* extracts have been shown to be effective in the treatment of viral and parasitic infections for a number of years, as evidence has grown. The most encouraging finding was the exhibition that *I. obliquus* extracts' therapeutic potential, their antiviral, antiparasitic, and antioxidant properties, and their ability to halt the progression of diabetes mellitus and cancer⁽⁴⁶⁾.

IV.MAITAKI MUSHROOM: - (*Grifola frondose*)



Scientific Classification⁽⁴⁷⁾

Domain:	Eukaryota
Kingdom:	Fungi
Division:	Basidiomycota
Class:	Agaricomycetes
Order:	Polyporales
Family:	Meripilaceae
Genus:	<i>Grifola</i>
Species:	<i>G. frondosa</i>

A polypore fungus called *Grifola frondosa*, often called hen-of-the-woods or maitake (literally, "dancing mushroom" in Japanese), grows around the base of trees, especially old-growth oaks or maples. Late summer to early fall is the best times to find it. It is indigenous to North America, Europe, and China⁽⁴⁸⁾.

Proteins and glycoproteins, which have demonstrated anticancer, immunomodulation, antioxidant, and other actions, make up the macromolecules in *G. frondosa*. Small chemical molecules with varied bioactivities, including sterols and phenolic compounds, have also been identified from the fungus⁽⁴⁹⁾.

More and more people are becoming aware of maitake as an excellent source of polysaccharide compounds with extraordinary health-promoting potential and if we combine D-fraction and MD- fraction and other extract to maitaki powder than it shows medicinal benefits as immunomodulating agent⁽⁵⁰⁾.

As you seen it's edible because it is an excellent source of protein, carbs, dietary fiber, vitamin D2, and minerals (K, P, Na, Ca, and Mg), as well as having a low-fat content and calorie value, *G. frondosa* is palatable and a nutritious meal. Due to the high levels of trehalose, glutamic, aspartic, and 5'-nucleotide in *G. frondosa*, it has a pleasant, sweet, and umami flavor. Due to its unique and exquisite flavor, *G. frondosa* is utilized as a dry powder food flavoring in addition to being a food ingredient ⁽⁵¹⁾.

Supplements for the diet are frequently used by cancer patients to "boost immune function". In preclinical experiments, a polysaccharide extract from *Grifola frondosa* (maitake extract) shown immunomodulatory properties, suggesting the possibility of therapeutic use ⁽⁵²⁾.

Due to its particular rich, woody flavor and meaty textures, the fruiting body of this fungus is commonly consumed as a daily food item or as a food ingredient in Japan, China, Korea, portions of Europe, and North America. The Chinese folk medicine known as "keisho" also uses this mushroom to treat different skin conditions, improve spleen and stomach conditions, and treat hemorrhoids ⁽⁵³⁾.

Particularly, polysaccharides obtained from mushrooms contain a range of biological properties, primarily anticancer, immunomodulatory, and antioxidant properties. Due to their low toxicity and lack of harmful side effects, polysaccharides have therefore been widely utilised in the realms of functional foods and medicine ⁽⁵⁴⁾.

Using boiling water and enzymatic digestion, polysaccharides from *G. frondosa* were extracted. The link between their physical characteristics and antioxidant activity was investigated. The fruit body of *G. frondosa* was used to create five polysaccharide extracts using various extraction techniques. The MW was shown to play a more significant influence in antioxidant activity in the correlation study between antioxidant activity and polysaccharide concentration, protein content, Mw, or viscosity ⁽⁵⁵⁾.

In clinical study they find out that consuming maitake reduced the severity of several common cold symptoms while simultaneously boosting antibody production in response to influenza vaccination. The ongoing outcomes propose that Maitake might initiate both intrinsic and versatile invulnerable reactions for the counteraction of infection contamination. In conclusion, we anticipate that consumption of maitake boosts the host's defenses and protects against the influenza virus and other pathogenic bacteria and viruses ⁽⁵⁶⁾.

G. frondosa is one of the fungi that has been studied the most for therapeutic and nutritional compounds. Compared to other commonly grown mushrooms, *G. frondosa*'s fungal biomass has a high protein and carbohydrate content and a relatively low-fat content ⁽⁵⁷⁾.

Conclusion: -

Strong antibiotics are produced by mushrooms because they dislike being destroyed by bacteria. They do rot once they have passed their prime following sporulation. However, I would like to make the case to you that the microorganisms on that mushroom are crucial to the health of the forest and the development of trees.

The mushrooms are so potent that they appear, sprout, and then vanish in just five days. Some mushrooms can feed you, while others may have unfavorable effects. Some mushrooms are also therapeutic and may be able to heal you.

The more been studies the more the people are seeing that actually they do numerous thing. On some way it gona be helping to modulate the immune system and that immune system and that means that it's helping to immunity when needed by their modulating effect.

The more studies done; the more individuals realize that they truly do a variety of things. It will inevitably assist in modulating the immune system, which implies that it will support either raising immunity, when necessary, through their modulating impact.

Reference :-

1. Vernon Ahmadjian, Constantine John Alexopoulos, David Moore; *Fungus*; Editors of Encyclopaedia Britannica; 2023.

Available online at: <https://jazindia.com>

2. J.Hiscox , J.O'Leary ,L.Boddy ; *Fungus wars: basidiomycete battles in wood decay* ; Science Direct ; 89; 2018; pg:117-124.
3. Farhat Ahmadi Avin, Subha Bhassu, Vikineswary Sabaratanam ; *Molecular classification and phylogenetic relationships of selected edible Basidiomycetes species* ; Springer link ; 39; 2012; pg:-7355-7364.
4. Bas C; *A short introduction to the ecology, taxonomy and nomenclature of the genus Agaricus*: In L.J.L.D. Van Griensven (ed.); 1991; 21–24.
5. G Hetland¹, E Johnson, T Lyberg, S Bernardshaw, A M A Tryggestad, B Grinde ; *Effect of the medicinal mushroom Agaricus blazei Murill on immunity, infection and cancer* ; Scandinavian journal of immunology; 68(4); 2008; 363-70.
6. Ruilin Zhao, Samantha Karunarathna , Olivier Raspe , Luis A. Parra , Jacques Guinberteau; *Major clades in tropical Agaricus*; Fungal Diversity; 51; 2011; 278-296.
7. F. Firenzuoli,¹ L. Gori, and G. Lombardo; *The Medicinal Mushroom Agaricus blazei Murrill: Review of Literature and Pharmaco-Toxicological Problems*; Evidence-Based Complementary and Alternative Medicine; 5(1); 2007; 3-15.
8. Komist Wistrassameewong, Samantha C. karunarathna , Naritsada Thongklang, Ruilin Zhao, Philippe Callac; *Agaricus subrufescens: A review* ; Saudi Journal of Biology Sciences ; 19(2); 2012; 131-146.
9. Carlene A. Raper, John R. Raper & Robert E. Miller; *Genetic Analysis of the Life Cycle of Agaricus Bisporus*; Mycologia; 64(5); 1972; 1088-1117.
10. Himanshi Rathore, Shalinee Prasad, mandira kapri, Abhay Tiwari; *Medicinal importance of mushroom mycelium: Mechanisms and application*; Journal of Functional Foods; 56; 2019; 182-193.
11. Andrew J. Brown, Lorna A. Casselton; *Mating in mushroom: increasing the chances but prolonging the affair*; A Cell press journal; 17(7); 2001; 393-400.
12. L.O'Connor , C.B.Keil ; *Mushroom Host Influence on Lycoriella mali Life Cycle* ; Journal of economic entomology; 98(2); 2005; 342-349.
13. Nicholas P. Money; *Mushroom stem cells*; BioEssays ,24(10); 2002; 949-952.
14. J.Manjunathan ,V. Kaviyaran ; *Solvent Based Effectiveness of Antibacterial Activity of Edible Mushroom Lentinus tuberregium*; International Journal of Pharma Tech Research ; 2(3) ; 2010 ; 1910-1912.
15. Dubey S.K., Caturvedi V.K., Mishra D; *Role of edible mushroom as a potent therapeutics for the diabetes and obesity*; 3 Biotech; 450; 2019.
16. Eva Guillamon, Ana Garcia –Lafuente, Miguel Lozano, Ana Villares; *Edible mushroom: RoleI the prevention of cardiovascular diseases* ; Fitoterapia ; 81(7) ; 2010 ; 751-723.
17. Solomon Wasser; *Medicinal mushroom science: Current Perspective, advances, evidence, and challenges*; Biomedical journal; 37(6) ;2014.
18. Vivek Kumar Chaturvedi, Sonam Agarwal, Krishna Kumar Gupta, Pramod W. Ramteke & M. PSingh ; *Medicinal mushroom: boon for therapeutic applications* ; 3 Biotech , 334 (2018).
19. Sujogya Kumar Panda, Walter Luyten ; *Medicinal mushrooms: Clinical perspective and challenges* ; Drug Discovery Today ; 27(2), 2022, 636-651.
20. Kirk PM, Cannon PF, Minter Stalpers JA, *Ganoderma*; Dictionary of the Fungi; 10th ed.; 2008; 272. ISBN 978-0-85199-826-8.
21. Najeeb Khatian & Muhammad Aslam; *Effect of Ganoderma lucidum on memory and learning in mice*; Clin Phytosci 5; 4; 2019. <https://doi.org/10.1186/s40816-019-0101-7>
22. M.A oke , F.J Afolabi, O.O. Oyeleke, T.A.Kilani, A.R.Adeosun ; *Ganoderma lucidum: Unutilized natural medicine and promising future solution to emerging diseases in Africa* ; Front Pharmacol ; 13 ; 2022 .
23. Yihuai Gao, Wenbo tang, He Gao, Eli Chan; *Antimicrobial Activity of the Medicinal mushroom Ganoderma*; Food Review International; 21(2); 2005; 843.
24. Aly Farag El Sheikha; *Nutritional Profile and Health Benefits of Ganoderma lucidum “Lingzhi, Reishi, or Mannentake” as Functional Foods: Current Scenario and Future Perspectives*; Foods; 11(7); 2022; 1030.
25. Sanodiya, Bhagwan S.; Thakur, Gulab S et al; *Ganoderma lucidum: A Potent Pharmacological Macrofungus* ; Curr Pharm Biotechnolog ; 10(8); 2009; 17-42.
26. Sanem Bulam, NebahatŞule Üstün, Aysun Pekşen ; *Health Benefits of Ganoderma lucidumas a Medicinal Mushroom*; Turkish Journal of Agriculture ; 7(sp1): 2019 ; 84-93.

27. Aly Farag El Sheikha; *Nutritional Profile and Health Benefits of Ganoderma lucidum “Lingzhi, Reishi, or Mannentake” as Functional Foods: Current Scenario and Future Perspectives*; *Foods*; 11(7) ; 2022 ; 1030-1107.
28. “Reforestation Traditional Methods have to Change “; *The Sierra Forest Voice*; 8(2); 2015.
29. Stephanie Masterman; *Lion's Mane Mushroom*; *Rheal superfood* ;2022. <https://rhealsuperfoods.com/blogs/news/lions-mane-mushroom>
30. Vikineswary Sabaratnam, Wong Kah-Hui, Murali Naidu and Pamela Rosie David; *Neuronal Health – Can Culinary and Medicinal Mushrooms Help*; *Journal of Traditional and Complementary Medicine*; 3(1); 2013; 62–68.
31. Friedman M.; *Chemistry, Nutrition, and Health-Promoting Properties of Hericium erinaceus (Lion's Mane) Mushroom Fruiting Bodies and Mycelia and Their Bioactive Compounds*; *Journal of Agricultural and Food Chemistry*; 2015 ;63(32):7108-23.
32. Mori K, Obara Y, Hirota M, Azumi Y, Kinugasa S et al; *Nerve growth factor-inducing activity of Hericium erinaceus in I321NI human astrocytoma cells*; *Biol Pharm Bull*; 2008 ;31(9):1727-32.
33. Sung Phil Kim, Mi Young Kang, Yong Hee Choi, Jae Ho Kim, Seok Hyun Nam and Mendel Friedman; *Mechanism of Hericium erinaceus (Yamabushitake) mushroom-induced apoptosis of U937 human monocytic leukemia cells*; *Food funct*; 2011; 2 ;348-356.
34. Chong PS, Fung ML, Wong KH, Lim LW; *Therapeutic Potential of Hericium erinaceus for Depressive Disorder*; *International Journal Molicular Science*; 21(1); 2019 ;163.
35. I-chen Li, Li- Ya lee, Tsai-Teng Tzeng, Wan-Ping Chen; *Neurohealth properties of Hericium erinacous Mycelia Enriched with Erinacines*; 2018. <https://doi.org/10.1155/2018/5802634>
36. Babitskaya, VG; Shcherba, VV; Lkonnikova, NV (2000). "Melanin complex of the fungus *Inonotus obliquus*"; *Applied Biochemical Microbiology*; **36** (4); 2000; 377–381.
37. Antoine Géry, Christelle Dubreule, Véronique André, Jean-Philippe Rioult; *Chaga (Inonotus obliquus), a Future Potential Medicinal Fungus in Oncology? A Chemical Study and a Comparison of the Cytotoxicity Against Human Lung*; *Integrative Cancer therapies*; 17(3); 2018; 832–843).
38. Pavel Kalac ; *Health-Stimulating Compounds and Effects*; *Edible Mushrooms*; 2016, 137-153. https://www.researchgate.net/publication/312345102_Health-Stimulating_Compounds_and_Effects
39. Tillotsen, Alan. *Chaga Mushrooms (Inonotus obliquus)*. (https://www.wikidoc.org/index.php/Chaga_mushroom#cite_ref-1)
40. Ye Chang, Ming Bai, Xiao-Bian Xue, Chun-Xin Zou, Xiao-Xiao Huang, Shao-Jiang Song; *Isolation of chemical compositions as dietary antioxidant supplements and neuroprotectants from Chaga mushroom (Inonotus obliquus)*; *Food Bioscience*; 47; 2022; 101623.
41. Yangpeng Lu, Yanan Jia, Zihan Xue, Nannan Li, Junyu Liu and Haixia Chen ; *Recent Developments in Inonotus obliquus (Chaga mushroom) Polysaccharides: Isolation, Structural Characteristics, Biological Activities and Application*. *Polymers (Basel)*; 13(9); 2021 ;1441.
42. Tamara Teplyakova and Tatiana Kosogova ; *Fungal Bioactive Compounds with Antiviral Effect*; *Journal of Pharmacy and Pharmacology* 3 (2015) 357-371
43. Phu Cuong Nguyen, My Tuyen Thi Nguyen, Ba Tai Truong, Dae-Ryeol Kim, Sujin Shin et al; *Isolation, Physicochemical Characterization, and Biological Properties of Inotodiol, the Potent Pharmaceutical Oxysterol from Chaga Mushroom*; *MDPI Antioxidants* 12 (2), 2023; 447.
44. Mi Ja Chung, Cha-Kwon Chung, Yoonhwa Jeong, Seung-Shi Ham et al; *Anticancer activity of subfractions containing pure compounds of Chaga mushroom (Inonotus obliquus) extract in human cancer cells and in Balbc/c mice bearing Sarcoma-180 cells*; *Nutrition Research and Practice*; 4(3); 2010; 177-182.
45. Jasmina Glamočlija, Ana Ćirić, Miloš Nikolić , Ângela Fernandes, Lillian Barros, Ricardo C. Calhelha et al; *Chemical characterization and biological activity of Chaga (Inonotus obliquus), a medicinal “mushroom”* ; *Journal of Ethnopharmacology*; 162 ; 2015 ; 323-332.
46. Konrad A. Szychowski , Bartosz Skóra , Tadeusz Pomianek , Jan Gmiński et al ; *Inonotus obliquus – from folk medicine to clinical use*; *Journal of Traditional and Complementary Medicine* ; 11(4) ; 2021; 293-302.
47. Jim Meuninck - *Basic Illustrated Edible and Medicinal Mushrooms*; Rowman & Littlefield, 2015; 13-14.
48. Jim Meuninck; *Basic Illustrated Edible and Medicinal Mushrooms*, pp. 13-14, Rowman & Littlefield, 1 Jun 2015.
49. Jian-Yong Wu, Ka-Chai Siu, and Ping Geng; *Bioactive Ingredients and Medicinal Values of Grifola frondosa (Maitake)*; *Foods*; 10(1); 2021; 95.

50. Mayell M.; *Maitake extracts and their therapeutic potential*; Altern Med Rev; 6(1); 2001; 48-60.
51. Jian-Yong Wu, Ka-Chai Siu, and Ping Geng et al; *Bioactive Ingredients and Medicinal Values of Grifola frondosa (Maitake)*; Foods; 10(1); 2021; 95.
52. Deng, G., Lin, H., Seidman, A. et al; *A phase I/II trial of a polysaccharide extract from Grifola frondosa (Maitake mushroom) in breast cancer patients: immunological effects*; J Cancer Res Clin Oncol 135; 2009; 1215–1221
53. Amila A. Dissanayake, Chuan-Rui Zhang, Gary L. Mills, Muraleedharan G. Nair; *Cultivated maitake mushroom demonstrated functional food quality as determined by in vitro bioassays*; Journal of Functional Foods; Volume 44, May 2018, 79-85.
54. Jixian Zhang, Dongming Liu, Chaoting Wen, Jun Liu et al; *New light on Grifola frondosa polysaccharides as biological response modifiers*; Trends in Food Science & Technology; 119 ;2022; 565-578.
55. Yina Fan, Xiangyang Wu, Min Zhang, Ting Zhao et al; *Physical characteristics and antioxidant effect of polysaccharides extracted by boiling water and enzymolysis from Grifola frondosa* ; International Journal of Biological Macromolecules; 48(5) ; 2011 ; 798-803.
56. Catherine Ulbricht, Wendy Weissner, Ethan Basch, Nicole Gi et al; *Maitake Mushroom (Grifola frondosa): Systematic Review by the Natural Standard Research Collaboration*; Journal of the Society for Integrative Oncology, 7(2); 2009; 66-70.
57. Jian-Yong Wu, Ka-Chai Siu and Ping Geng ; *Bioactive Ingredients and Medicinal Values of Grifola frondosa (Maitake)* ; Foods 2021, 10(1); 2021; 95.