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Ganoderma Lucidum: A Comprehensive Review on its Phytochemistry and Therapeutic Potential

Chetana Vilas Nirwan[1]; Rakesh Y. Bhute[2]

[1;2]Bhausaheb Mulak College of Pharmacy, Umred.

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Abstract: Ganoderma lucidum, commonly known as Reishi or Lingzhi, is a medicinal mushroom highly valued across Asian traditional medicine systems for its wide-ranging therapeutic properties. This review provides a comprehensive overview of its phytochemistry, pharmacological actions, and potential applications. G. lucidum contains diverse bioactive compounds, including polysaccharides, triterpenoids, amino acids, peptides, alkaloids, sterols and other. Additional constituents support antidiabetic, neuroprotective, antiviral and antimicrobial benefits. The mushroom grows naturally on decaying hardwood in temperate regions but is now widely cultivated due to increasing global demand. Numerous pharmaceutical, nutraceutical, and cosmetic products derived from fruiting bodies, spores, and mycelia are commercially available. Overall, G. lucidum represents a potent medicinal macrofungus with significant therapeutic potential, supporting its traditional uses and encouraging further research into its clinical efficacy and safety.

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I. INTRODUCTION

Ganoderma lucidum is a type of edible mushroom that is used in traditional Chinese medicine.

It is known for its many health benefits, like fighting bacteria, viruses, and helping with blood sugar levels. It is used to help prevent and treat different diseases because of its active components, such as polysaccharides and triterpenes. [12]

Ganoderma lucidum is a popular medicinal mushroom and is known by different names in different countries and cultures.In Japan, it is called "Reishi," which means "spiritual power." In China, it is known as "Lingzhi," meaning "divine mushroom." In Korea, it is called "Youngzhi," which means "mushroom of immortality." [1] The family is called Ganodermataceae. [2]

It is a large, dark-colored mushroom with a shiny exterior and a hard, wood-like texture.

The name "lucidum" in Latin means "shiny" or "bright," which describes the mushroom's shiny surface. [3]&[4]

This mushroom usually grows on the stumps of various different kind of trees, including oak, maple, sweetgum, willow, elm, magnolia, and acacia. It grows, in particularly in temperature climates, across north and south America, Asia, and Europe. [1]

G. lucidum usually has a dark red, reddish brown, or reddish black color and is kidney-shaped, fan-shape, or semicircular in form. Around the margins, yellow or ochre color are more visible. The inner part of the mushroom is usually dark brown to yellowish- brown. [1]

Fig 1 Ganoderma Lucidum Mushroom

In contrast, for growing Ganoderma, people often use planting media like brown rice flour, paddy husk and rubber tree waste.They avoid using pesticides, chemicals or hormones to grow the mushroom. To keep the mushroom's health benefits, it's important to carefully manage sunlight during the growing process. [1]

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The most important compounds that give it health benefits are triterpenoids, polysaccharides, nucleotides, fatty acids, sterols, steroids and other active substances.

Ganoderma lucidum is a large mushroom that is both medicinal and edible. It has many active ingredients and health benefits. It can help moisten the lungs, make breathing easier, and reduce coughing. It also has effects on the immune system, liver protection, detoxification, reducing allergies, fighting cancer, treating inflammation, and managing diabetes. The parts of G. lucidum that grow on trees, dead wood, or cultivation materials form a fruiting body, which has a stalk and a cap. Different types of G. lucidum and different growing environments directly affect the kinds of medicinal compounds it contains. The spores of G. lucidum are used for reproduction and can grow into mycelium when they land in a suitable environment like dead wood. [6]

➢ *Aim*

"Ganoderma lucidum: A Comprehensive Review on its Phytochemistry and Therapeutic Potential"

➢ *Objective*

This article aims to provide a Comprehensive Review of the Phytochemistry and Therapeutic Potential of G. lucidum.

- *The Objectives are Include:*

✓ Examine Ganoderma lucidum mushroom.
✓ Review its phytochemistry and therapeutic potential.
✓ To be use as a medicinal mushroom and a functional food.

II. PLANT PROFILE

A. Identification

Table 1 Common Name

United State	Reshi mushroom (Herbs of Commerce), Ganoderma
China	Ling zhi, ling zhi cao, ling chih, hong ling zhi,chi zhi
Japan	Reishi, mannentake; rokkakureishi (antler form).
Korea	Young ji
Vietnam	Ling chi

Table 2 Taxonomy

Kingdom	**Fungi**
Phylum	Basidiomycota
Class	Agaricomycetes
Order	Polyporales
Family	Ganodermataceae
Genus	Ganoderma
Species	G. lucidum

B. Description

➢ *Morphological Characteristics*

Reishi is made up of spore, a stem, and a cap that resembles a kidney.[23]

Typically, the cap has a dark color , such as reddish black, red, black, deep red, and brown. It has shiny, round, kidney-shaped and occasionally flat surface. The diameter of the cap usually ranges between 30-250 mm. Reishi fruit bodies are yellow-brown when they are undeveloped; as they age, their color changes and become darker. Reishi produces spores that are elliptical or ovoid in shape rather than properly round. They are made up of two layers: the internal and external layers. The internal layer is yellow-brown, lumpy, and typically ranges in size from 6 to 11 mm, while the external layer is colorless, smooth, and flat. [24]

Typically kidney-shaped or irregular, the fruiting bodies of G. lucidum collected from India have a thick margin and a long, corky, hard, dark brown stipe (fruiting bodies without stipe are also found, attached to the base of the tree with a dark, thick pileus-G. applanatum)[14]. The stem, or stipe, is 3–12 cm long. long, 1-2 cm thick, with smooth, cylindrical crust that is dark red-black in color and brown spore prints [15]. The context of the Chinese G. lucidum is cream to buff. [17]

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Fig 2 Different Ganoderma Species.

➢ *Habitat*

Mushroom (G.Lucidum) comes from the class Basidiomycetes that derieved from family Ganodermataceae. The fruiting body of Ganoderma lucidum grows on a variety of deciduous trees found in the Far East, including China, Japan, Korea, and the upper Himalayas. These trees include oak, pyrus, quercus, magnolia, and plums. As the name suggests, the fruiting bodies of these macrofungi can be recognized by the glossy appearance of their growing sites (lucidum is Latin for "shiny"). The fruiting body is striped, half, sometimes semicircular, thick, corky, with yellowish edges. In mature areas, the edges may become brownish. Temperature is considered to Be the most important factor for the growth of mushroom mycelium. Mushroom cultivation is controlled. Reishi can grow at temperatures between 30 and 34oC. However, the optimum temperature is 370°C and the plants grow at a rate of 7-8 mm/day. Due to the widespread use of Ganoderma, efforts to produce Ganoderma have been intensified in countries such as China, Japan, Taiwan, and South Korea to meet market demand.[2]

C. Classification

There are about 2000 classes of G. mushrooms out of which only 6 are known i.e., white, blue, black, purple, yellow and red (Table 3). Among these six are red Reishi (G. lucidum) and black Reishi (G. sinensis) have shown numerous health advantages.[25] The black reishi has a ten-inch diameter and an uneven shape, while the mature species can reach a diameter of six inches. Due to its low polysaccharide content, black reishi is not recommended for use. Although purple reishi is uncommon, it shares content with red reishi. [27]

Table 3 Important Classes of Mushroom Lingzhi with Therapeutic Value.

Colour	Taste	Clinical Use
Black	Salty	Pulmonary diseases
Red	Bitter	Refine memory, Immune modulator
Blue	Sour	Eyesight improvement, Remediate liver
Yellow	Sweet	Spleen function modulator
White	Hot	Kidney function modulator and act as protective agent
Purple	Sweet	Skin health modulator, Anti-infective for ear

➢ *Photographs*

- *Various Images of Ganoderma Lucidum Mushroom in Growing Stages (Fig. 3-9).*

The immunomodulatory properties of G. lucidum can help strengthen the immune system and reduce the harmful effects of cancer treatments like chemotherapy and radiation.

Studies also show that dietary supplements of G. lucidum help reduce leucopenia and neutropenia and increase NK cells and lymphocyte count. Research supports the immune-modulating activities of G. lucidum.

G. lucidum has been found to fight various gram positive and gram negative bacteria.

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It also has properties like anti-fungal, anti-allergic, anti-angiogenic, anti-ulcer, anti-mutagen, anti-proliferative, cardiovascular, and liver-protecting activities.[22]

Fig 3 Naturally Growing G. Lucidum Fruiting Body on Dead Wood

Fig 4 G. Lucidum Fruiting Body Growing on Dead and Decaying

Fig 5 Porus Under Surface of G. Lucidum Fruiting Body

Fig 6 Pinhead Stage of G. Lucidum

Fig 7 G. Lucidum Fruiting Body with Elongated Stipe.

Fig 8 G. Lucidum Young Growing Fruit Body of G. Lucidum with Yellow Colour and White Margin.

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Fig 9 Harvested and Dried G. Lucidum Fruiting Bodies.

➢ *Geographical Source*

G. lucidum is a basidiomycete that typically grows in humid, low-light envirnments on wood. It grows on deciduous plant wood, either dead or living. It`s extensively dispersed throughout regions. In the USA, Europe, and South America, it grows in the subtropical areas. In North America, it is found on the East Coast. In East Asia, it grows on dead Japanese plum trees. In Europe, it grows on various deciduous trees during summer and autumn.[20]

This mushroom grows on stumps of various deciduous trees like elm, willow, maple, oak, acacia magnolia and sweetgum.[1]

III. PHYTOCHEMICAL CONSTITUENTS

➢ *General Nutritional Components*

These mushrooms usually have carbohydrates, proteins, minerals, fiber, and fatty acids. Artificial and wild mushrooms have similar nutritional components.[16] About 90% of their weight is water, and the remaining 10% includes fat (2-8%), fiber (3-32%), protein (10-40%), carbohydrates (3-28%) and ash (8-10%).[18] They also contain copper, zinc, and selenium[19]. Complex compound include fatty acid acids and pro vitamins[20].

Other minerals like potassium, phosphorus, calcium, magnesium, zinc, copper, iron and selenium are also present in the remaining 10% of the mushroom's weight.[2]

➢ *Major Bioactive Components*

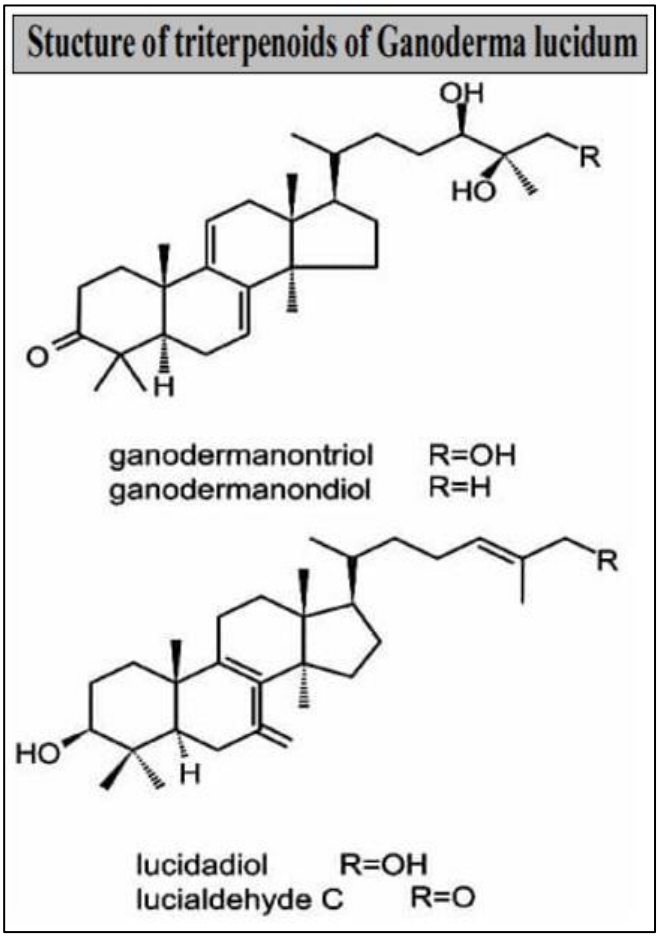
Many reports have shown that G. lucidum has hundreds of bioactive compounds like nucleotides, trace elements, fatty acids, proteins, peptides, triterpenoids, polysaccharides, and nucleotides.

It is an important source of these active compounds.[21]

- *Triterpenoids*

These triterpenoids are found in the fruiting bodies, cultured mycelium, and spores of Ganoderma.
They are typically between 400 to 600 Da in molecular weight and are lipid soluble, making them hard to dissolve in water. They are biosynthesized through the isoprenoid pathways, specifically the Mevalonate pathway, which has four main steps: conversion, construction, condensation, and modification.[6]

At least 140 different triterpenes have been identified in G. lucidum. Most of them are bitter and are in the form of ganoderic acid. A new triterpenoid called ganosporeric acid A was recently found in the ether-soluble fraction of the spores. Six new lanostane-type triterpenes were also identified from the spores, including ganoderic acids. Studies suggest that spores contain more ganoderic acids compared to other parts of the fungus, and the triterpene composition may vary depending on where the fruiting body is grown. Spores also contain triterpene lactones. Figure 10 shows the structure of all ganoderic acid and triterpenoids reported in the literature.



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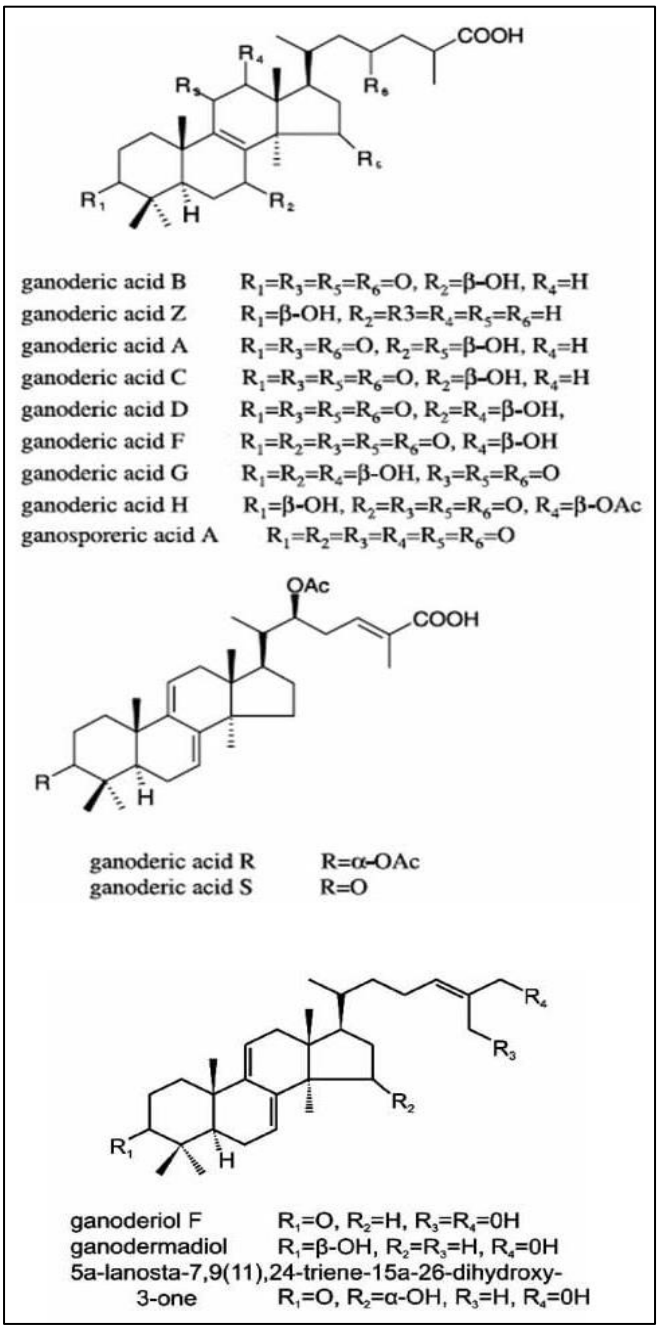

Fig 10 Structure of Triterpenoids of Ganoderma Lucidum.

Known as ganoderic acids, triterpenoids are a significant class of compounds with complex structures that contain carboxyl groups. They are lanostane's oxidative by-product. Their derivatives include ganoderic acid Mk, ganoderic acid S, ganoderic acid Mf, ganoderic acid R, ganoderic acid Mc, and ganoderic acid A, ganoderic acid F, and ganoderic acid H, each of which has a different level of clinical efficacy. Triterpenoids have a promising effect by improving memory. The cytotoxic effects of ganoderic acids on breast and prostate cancer cells have been demonstrated. Hepatoprotective, antihypertensive, anti-cancer, anti-histamine, anti-HIV, and cholesterol-lowering effects are additional actions. [20]

Table 4 Triterpene Compounds with their Selective Clinical Action.

Triterpene	Clinical Action
Ganoderic acid R, S, Mc, Mf	Cytotoxic
Ganoderic acid A, H	Inhibits breast cancer cell growth.
Lucidenic acid C, N, A	Decrease cell growth by inhibiting cell cycle.
Ganoderic acid DM	Inhibit metastasis of prostate cancer cells.
Ganoderic acid E	Cytotoxic.
Ganoderic acid D	Inhibits proliferation of cancer cells
Ganoderic acid T	Inhibits growth of cancer cells.

➢ *Polysaccharides*

Polysaccharides are regarded as an active group of compounds out of 279 active metabolites. Spores have a cell wall that contains a lot of polysaccharides. Additionally, hundreds of polysaccharides are extracted from fruit bodies, mycelium, various liquid media of Linghzi, α-D-glucans, β-D-glucans, and complexes of proteins and polysaccharides. The biological activity of these glucans is determined by their various forms, branching, water solubility, and size. PL-1, PL-3, PL-4, and ganoderans A, B, and C are among the

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various polysaccharides extracted from fruit bodies; SP and PSGL-1-1A are extracted from spores. Polysaccharides' ability to scavenge free radicals shields cells from harm. Additionally, they contain glucans that have cytotoxic effects on cancer cells and immunomodulatory effects. Reishi polysaccharides are used in diabetic patients to prevent cardiac complications. They also stand for defense against gamma-ray-induced destruction. The aqueous extract of reishi fruit bodies contains low molecular weight polysaccharides that have been shown to have immune-boosting properties. [20]

➢ *Alkaloids*

Alkaloids are nitrogen-containing compounds with diverse structures and strong biological activity.They play a key role in organic chemistry and are important in the discovery of new medicines. Ganoderma lucidum contains a small amount of alkaloids, but they are powerful in protecting the liver, improving heart health, lowering cholesterol, and reducing blood fat. Examples include choline, betaine, nicotinic acid, ganoderine A, and ganoderine B. Although their levels are lower than other compounds, specific alkaloids have important biological functions. Seven promising drug candidates, 90 natural products, 37 synthetic compounds, and 26 key intermediates were summarized. These include five types of monoterpene pyridine alkaloids and one type of cyclopenta[c] pyridine alkaloid. Possible genetic pathways were proposed. The chemical structure, biotransformation, synthesis, and biological activity of MTPAs and cyclopenta pyridine derivatives were studied. These derivatives can be made efficiently and with the correct chirality, offering potential in antibacterial, insecticidal, antiviral, anti-inflammatory, and neurological uses. The total synthesis of lucidimines B and C was also developed. These alkaloids were isolated from Ganoderma lucidum.[6]

Table 5 Some Alkaloids in Ganoderma.

No.	Alkaloid	Molecular formula	Source
1	Australine	C14H13NO4	Ganoderma australe
2	Lucidimine A	C16H15NO3	Ganoderma lucidum
3	Lucidimine B	—	
4	Lucidimine C	C16H15NO3	
5	Lucidimine D	C17H17NO4	
6	Lucidimine E	C13H11NO4	Ganoderma lucidum
7	Ganocochlearine A	C14H13NO2	Ganoderma cochlear
8	Ganocochlearine B	C15H15NO2	
9	Ganocochlearine C	C18H17NO3	Ganoderma cochlear
10	Ganocochlearine D	C17H17NO4	
11	Ganocochlearine E	C17H17NO3	
12	Ganocochlearine F	C15H11NO4	
13	Ganocochlearine G	C15H15NO3	
14	Ganocochlearine H	C15H13NO2	
15	Ganocochlearine I	C15H13NO3	

➢ *Amino Acids and Peptides*

About 2.94% of G. lucidum's mass is made up of various amino acids that are vital to human health, including glutamic acid, proline, aspartic acid, and others. Enough energy is supplied by these amino acids to stimulate cell regeneration and support the development of proteins and nucleic acids in the hypha. Different G. lucidum contain different kinds of amino acids, such as glutamic acid, which is nearly twice as abundant in red G. lucidum as it is in common varieties. extracted a peptide from G. lucidum's water extract. Several techniques were used to ascertain the peptide fractions' molecular weight and structure in relation to their antioxidant qualities. Phenylalanine, aspartic acid, proline, histidine, and isoleucine were found to be abundant in the peptide's amino acid composition. It was determined that polypeptides' advantageous antioxidant qualities might result from their particular amino acid composition and low molecular weight. [6]

➢ *Proteins*

Reishi also contains a variety of proteins that have therapeutic benefits; for example, ganodermin showsLZ-8 protein, which exhibits immunomodulatory activity, and antifungal activity. LZ-8 mycelium typically contains protein, which has the molecular weighed around 12 kilo Dalton . In general, this LZ-8 protein demonstrates mitogenic activity. Ganodermin, a different protein with a molecular weight of 15 kilo Dalton, separatedhave antifungal properties from fruit bodies.

➢ *Sterols*

There are various sterols in the reishi mushroom complex, both in the fruit bodies and spores.

These include provitamin D2, also known as ergosterol, and its oxidized form. These sterols usually affect breast cancer cells.[20]

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➢ *Others*

Among the many vitamins found in G.lucidum, are the B and C families. Which are essential water-soluble nutrients for human health. Vitamin B helps prevent pernicious anemia and functions as a coenzyme. Vitamin C helps remove harmful free radicals and prevents gum bleeding. It also contains minerals such as zinc, calcium, magnesium, manganese, germanium, selenium, vanadium, iron, potassium, nickel, and chromium. These elements often form organic compounds that are easy for the body to absorb.[6]

➢ *Uses of Ganoderma Lucidum*

In China, G. lucidum has been widely used as a traditional medicine to support longevity and good health. G. lucidum is valued in traditional Chinese medicine for boosting the spleen, replenishing Qi, and strengthening body resistance. G. lucidum was discovered over 2400 years ago. Long ago, G. lucidum was mentioned in Shen Nong's Materia Medica as having the ability to strengthen bones and muscles, nourish liver qi, enhance vital essence, and improve vision. Furthermore, G. lucidum has been noted in the Compendium of Materia Medica as having the ability to prolong life and preserve spirit.

Studies today show that two key parts of Ganoderma lucidum—polysaccharides and triterpenoids are the main reasons it has been used for health benefits.

These compounds help the immune system and may slow aging. Ganoderma lucidum is listed in both the Chinese Pharmacopoeia and the American Herbal Pharmacopoeia and Therapeutic Compendium.[12]

- Ganoderma lucidum is often taken with other treatments, and its effects have been studied alongside other forms of radiation like UV, fluorescence, and cosmic rays.It has also been used in place of radiation therapy with chemotherapy.[11]
- It is used to help people feel stronger, more energetic, and more active.
- For a long time, plants and mushrooms have been used both for healing and cooking because they contain substances that help keep people healthy and reduce the chance of illness.
- Reishi, or Ganoderma lucidum, has been used in clinical settings to support the immune system, fight viruses, kill harmful cells, fight bacteria, protect the liver, reduce inflammation, and treat brain-related problems.[20]

➢ *Therapeutical Potential*

Numerous components of reishi exhibit antibacterial properties. They inhibit the growth of both gram-positive and gram-negative bacteria. Its extract inhibits the bacteria Helicobacter pylori, which causes stomach ulcers. Additionally, some components exhibit antifungal properties. The mycelial growth of several fungi, including Physalospora piricola and Fusarium oxysporum, is inhibited by a protein called ganodermin that is extracted from the mycelium of this mushroom. Compared to streptomycin, the extracts show a stronger therapeutic effect against Staphylococcus aureus. Methanol extracts exhibit activity against a variety of microorganisms, including Pseudomonas aureus, Staphylococcus aureus, and Escherichia coli [20].

G. lucidum has a broad range of health benefits that cover many body systems, including the respiratory, nervous, circulatory, digestive, endocrine, and muscular systems. This is because the fungus helps to strengthen the immune system, which in turn boosts the body's ability to fight off diseases. Unlike most medicines that are used to treat specific illnesses, G. lucidum works in a more general way. It is also different from typical nutritional supplements, which mainly provide certain nutrients but do not help balance the body's overall metabolism.[6]

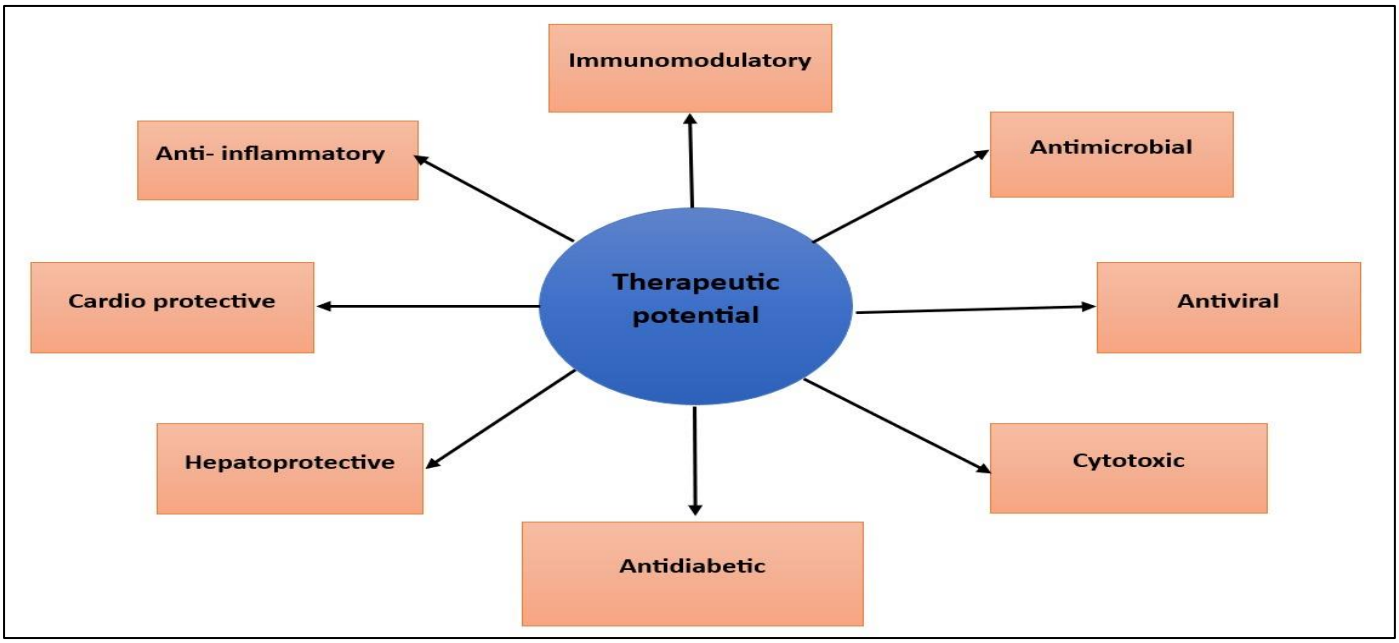

Fig 11 Therapeutical Potential

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➢ *Immunomodulatory Effect*

Numerous compounds found in reishi, such as glucans, different proteins, and triterpenoids, have immunomodulatory properties. The activation of different immune system cells, such as lymphocytes and macrophages, is the mechanism of action behind this. Additionally, reishi aqueous extract stimulates the synthesis of interleukins, different cytokines, interferon, and tumor necrosis factor. This mushroom's spore extract has anti-cancer properties and boosts macrophage production. Many substances work on mast cells to prevent allergic reactions. It has been established that a high concentration of polysaccharides, germanium, and triterpenoids affects and strengthens the immune system.

➢ *Antiviral Effect*

The fruiting bodies of the reishi mushroom contain Ganoderic acid, which helps fight HIV and Epstein-Barr virus.Some substances found in water and alcohol extracts of reishi can stop the influenza virus from multiplying. Polysaccharides found in reishi also show activity against hepatitis B virus. Ganoderma diol, a triterpene, has inhibitory effects on herpes virus.

➢ *Cytotoxic Effect*

Extracts of Ganoderma lucidum help fight many types of cancer cells, including breast and ovarian cancer cells.In animal studies, the reduction in tumor cells is linked to the production of TNF and lymphocytes, which cause cell death and sometimes reduce blood supply to tumors by blocking or destroying blood vessels. Mice treated with oil from Ganoderma lucidum showed increased immunity against cancer cells. The protein LZ-8 found in reishi helps stop leukemia cells from dying. Many studies show the anti-tumor effect of Ganoderma lucidum is due to β-D-glucan, a sugar molecule that activates or regulates the immune system by stimulating T-cells and macrophages.

➢ *Antidiabetic Effect*

The polysaccharide part of reishi shows a blood sugar-lowering effect.

Extracts of this mushroom are more effective than standard diabetes medications in lowering blood glucose levels. It also helps prevent diabetic kidney disease, as shown in preclinical studies.

➢ *Hepatoprotective Effect*

Ganoderma lucidum has a strong protective effect on liver cells.

In studies with mice, the triterpenes in reishi help remove harmful free radicals from the liver. The polysaccharides in reishi help keep levels of certain liver enzymes normal in people with hepatitis. Chronic hepatitis can also be treated with reishi. Extracts of reishi are effective in treating liver failure. In an experiment using mice with liver damage from carbon tetrachloride, continuous treatment with reishi tincture led to improved liver function and cell regeneration.

➢ *Cardio Protective Effect*

Ganoderma lucidum lowers cholesterol and triglycerides and supports heart health by normalizing blood pressure. Two months of continuous use of Ganoderma lucidum extract in people with early-stage high blood pressure showed positive results. It also helps prevent atherosclerosis in rats by reducing lipid levels. A combination of polysaccharides and peptides in the mushroom protects blood vessel lining.

➢ *Anti-Inflammatory Effect*

Reishi extracts also have anti-inflammatory properties and help protect against conditions like colitis. The aqueous extract of reishi also speeds up wound healing. Many studies show that reishi extract reduces various allergic reactions, including asthma, eczema, conjunctivitis, bronchitis, and rheumatism.

➢ *Neurological Effect*

Numerous Chinese and Japanese therapists have proposed that reishi mushrooms may help treat neurological illnesses, insomnia, and a variety of psychiatric conditions. G. lucidum users with Alzheimer's disease have demonstrated notable improvements.[20]

➢ *Marketed Preparation of Ganoderma Lucidum*

Table 6 Marketed Preparation Products

FORMULATIONS	COMPANY
Ganoderma lucidum compound capsules	Chongqing Taiji Industry (Group) Co. Ltd.
Ganoderma lucidum syrups	Guizhou Shunjian Pharmaceutical Co. Ltd.
Ganoderma lucidum spore powder capsules enriched with Se	Guizhou Lingkangshi Biological Technology Co. Ltd.
Ganoderma lucidum spore powder	Yunnan Xianghui Pharmaceutical Co. Ltd.
Broken G. lucidum spore powder oil capsules	FGTZ Biotechnology Company
Broken G. lucidum spore powder	Chengdu Dujiangyan Chunsheng Chinese Herbal Pieces Co. Ltd.
Ganoderma lucidum fruiting body slices	Sichuan Zibo Pharmaceutical Co. Ltd.

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Fig 12 Marketed Preparation Products

Three categories of Ganoderma products exist: spore powder, mycelia, and developmental products based on Ganoderma fruiting bodies. Numerous Ganoderma products have been put on the market, and it's estimated that over 780 products under at least 100 brands are available worldwide. The biggest market for Ganoderma and associated goods is the United States. revealed that fruiting bodies, slices, and spore powders are the most popular products among consumers, with China being the biggest producer and exporter with a capacity of over 110,000 MT/year. China produces less than 5% of the world's total output, despite making up 70% of it. In order to be accepted in foreign markets, the majority of Chinese manufacturing facilities lack internationally recognized GMP (Good Manufacturing Practice) certifications. In China, there are over 200 factories that produce pharmaceuticals and nutraceuticals, and over 100 research institutes that focus on the study of Ganoderma. According to Xie et al. (2002), numerous patented products have been marketed on the basis of the preparation of anti-tumor, liver function accelerant, blood pressure lowering, hypoglycemic activity, cholesterol lowering, immunomodulator, lysozyme as antibiotic, shampoo, and body shampoo. Products like decoction, syrup, tablets, and injection liquids based on Ganoderma were available on the global market in the early 1980s. Ninety Ganoderma product brands were registered and sold abroad at the beginning of the 1990s. Today, though, it ranges from medications, health drinks, and Ganoderma dietary supplements to cosmetics. There are currently many G. lucidum products on the market that are made from various parts of the mushroom. These products do not, however, currently satisfy customers. [10]

IV. CONCLUSION

Ganoderma lucidum is a highly valuable medicinal mushroom recognized for its extensive phytochemical diversity and wide-ranging therapeutic properties. The presence of bioactive constituents such as polysaccharides, triterpenoids, proteins, sterols, alkaloids, amino acids, and essential micronutrients contributes significantly to its pharmacological activities. Scientific investigations support its traditional use as an immunomodulatory, anticancer, hepatoprotective, antidiabetic, antiviral, antimicrobial, cardioprotective, anti-inflammatory, and neuroprotective agent. In addition to medicinal applications, its growing utilization in nutraceutical, pharmaceutical, and cosmetic industries highlights its economic and commercial importance.

However, variations in cultivation conditions, extraction techniques, and product standardization continue to influence the consistency and therapeutic efficacy of available preparations. Therefore, further clinical studies, toxicity assessments, and standardized quality control measures are essential to confirm safety, optimal dosage, and long-term effectiveness. Overall, Ganoderma lucidum represents a

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promising natural therapeutic resource that bridges traditional medicine and modern pharmaceutical research, with strong potential for future development in evidence-based healthcare.

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