

# Ganoderma

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## ABSTRACT

*Ganoderma lucidum* is a versatile mushroom. Polysaccharides and triterpenoids are the main constituents bioactive compounds and have been used as traditional medicinal mushrooms since ancient times. *Ganoderma lucidum* has a long history of medicinal use in Far Eastern countries for over 2000 years due to its healing properties. Recently, *G. lucidum* has been scientifically studied to evaluate its content of bioactive components that affect human physiology and has been exploited for effective components in the pharmacology, nutraceuticals. *G. lucidum* extracts and its bioactive compounds have been used as an alternative to antioxidants and antimicrobials. agents. Secondary metabolites with many medicinal properties make it a potential substitute could be used as an Anti-Tumor, anticancer, antimicrobial, anti-inflammatory and antidiabetic agent. For example, evidence is accumulating on the potential of this mushroom species as a promising antiviral drug for the treatment of many viral diseases, such as more recently coronavirus disease 2019 (COVID-19). Nevertheless, further research studies on the biotherapeutic components of *G. lucidum* are necessary to ensure the safety and efficiency of *G. lucidum*.

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**KEYWORDS:** *Ganoderma lucidum*, bioactive compounds, anticancer, Anti-tumor, Antimicrobial, Antiviral, antidiabetic, COVID-19

## INTRODUCTION

There is a developing fashion amongst purchasers to are looking for out ingredients and nutritional dietary supplements that now no longer most effective offer fundamental dietary wishes however additionally provide extra fitness advantages which can sell durability and general well-being. Functional meals are an critical a part of the developing fashion closer to customized vitamins and a greater holistic technique to fitness and wellness. Functional meals are capable of produce pharmacological

consequences due to the bioactive compounds they contain. In this context, mushrooms were used for their medicinal houses in usual remedy structures for centuries, and medical studies has showed lots of their healing benefits.<sup>[1]</sup> The family Ganodermataceae (Polyporales, Basidiomycota) sticks out morphologically due to the shape of the basidiospores with double-walled and barely to distinctly thick-walled with numerous ornamentation.<sup>[2]</sup>

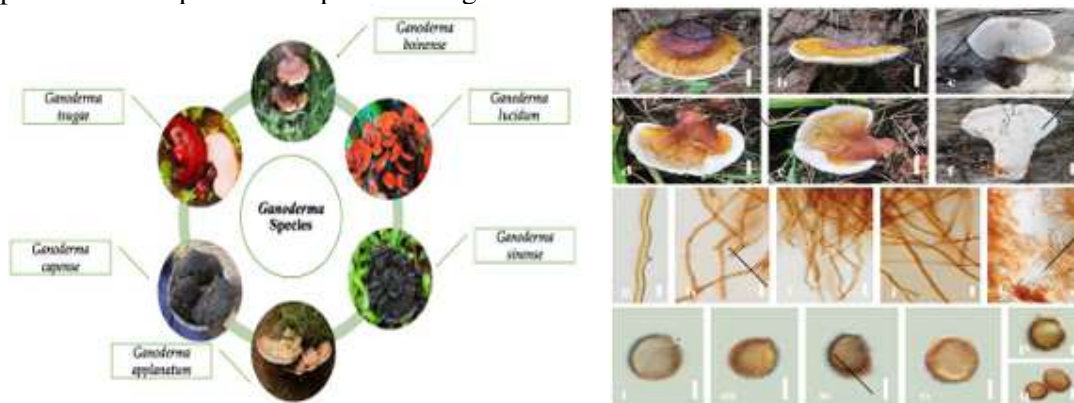


FIGURE 1: VARIOUS TYPES OF GANODERMA

Ganodermataceae is a big and complex have that has been studied for plenty decades, but the species diversity, geographical distribution, species classification, and taxonomy of Ganodermataceae stay uncertain.<sup>[3]</sup> Ganoderma, the foremost genus withinside the Ganodermataceae, is characterised via way of means of a cosmopolitan distribution and is particularly observed in tropical and subtropical regions, such as Africa, America, Asia, and Europe.<sup>[4]</sup>

The name Ganoderma originates from Greek, meaning shiny, glowing skin (“gános”—shiny, glowing, brightness; and “dérma”—skin). However, it does not reflect the morphological features of all species of this genus as not all species have a bright and shiny surface.<sup>[3,5]</sup> The genus Ganoderma changed into first defined in 1881 via way of means of the Finnish mycologist Petter Adolf Karsten and first of all protected best one species, Ganoderma lucidum (Curtis) P. Karst, whose former names had been Boletus lucidus Curtis (1781) and Polyporus lucidus (Curtis) Fr.(1821).<sup>[6]</sup> In 1889, Patouillard accelerated this genus to 48 species, which had been labeled by the presence of pigmented spores, clinging tubes, and a shell-like cap.<sup>[7]</sup> Numerous reviews and research have showed the multidirectional organic activity of extracts from numerous Ganoderma spp. and remoted compounds. The following properties were tested anticancer, immunomodulatory, antioxidant, anti-inflammatory, antiallergic, neuroprotective, hepatoprotective, hypoglycemic, hypotensive, antimicrobial, antiviral, antimalarial.<sup>[8,9]</sup> The maximum critical organizations of compounds observed in Ganoderma spp. consist of triterpenes (Ganoderma triterpenes) and polysaccharides. Until now, greater than three hundred triterpenes and 2 hundred polysaccharides characterised with the aid of using various chemical systems and organic interest were isolated.<sup>[10]</sup>

#### ORIGIN:

#### Synonyms:

English	“ Ganoderma Mushroom ”
Japanese	“ Reishi Mushroom ”
Chinese	“ Lingzhi Mushroom ”
Korean	“ Youngzhi Mushroom ”

Ganoderma lucidum, a species of mushroom withinside the Ganoderma genus of the Ganodermataceae family, is the maximum considerably studied and properly known. This mushroom is known by different names across various countries and cultures. In Japan, it is referred to as “Reishi”, which means “spiritual potency”. In China, it is known as “Lingzhi”, which means “divine mushroom”, while in Korea, it is called “Youngzhi”, meaning “mushroom of immortality”. Traditional medication practices in those nations have applied G. lucidum for plenty years, with ideals in its diverse fitness benefits. In contrast, studies on those mushrooms in Western research dates lower back handiest to the beyond 30 years.<sup>[11,12,13,14]</sup>

#### Taxonomy of G. lucidum:

Domain	Eukaryota
Kingdom	Fungi
Phylum	Basidiomycota
Class	Agaricomycetes
Order	Polyporales
Family	Ganodermataceae
Genus	Ganoderma
Species	G. lucidum (P. Karst) <sup>[12,15]</sup>

However, there's presently ongoing debate in the medical network approximately the perfect medical call for this species. Some authors have proposed opportunity names inclusive of G. lingzhi, G. reishi, G. mannentake, or G. lingzhi var. lucidum.<sup>[11]</sup>

#### Bioactive component of Ganoderma lucidum:

GL bioactive parts have lately received remarkable recognition. Countless bioactive additives were reportedly remoted from the fruiting body, mycelia, and spores of GL. About four hundred one of a kind bioactive compounds from GL were documented.<sup>[16]</sup> The major identified active compounds possessing biological activities include polysaccharides, triterpenoids, nucleotides, sterols, amino and fatty acids, meroterpenoids, sesquiterpenoids, steroids, alkaloids, polysaccharides, volatile oils, proteins, and many more.<sup>[17]</sup> Nevertheless, GL bioactive materials are depending on situations such as the origin, classifications, cultivation process, approach of extraction, etc. GL polysaccharides and triterpenoids are taken into consideration the maximum

bioactive compounds with numerous health benefits and feature expanded request withinside the market.<sup>[18]</sup> The file from the Chinese Pharmacopoeia (2015 edition), confirmed not less than 0.90% polysaccharides and 0.50% triterpenoids are contained withinside the Ganoderma dry fruiting body.<sup>[18,19]</sup> Nevertheless, triterpenoids and polysaccharides have attracted substantial and worthwhile interest because of their numerous significance and excessive content material in fungus.

### Therapeutical effects of *Ganoderma lucidum*:

GL is identified for its medicinal residences instead of its dietary value. It isn't always an suitable for eating mushroom due to the fact it's miles a polypore. It is visible as a mushroom that has a great impact on fitness and consequently received the hobby of many researchers by analysing its bioactive constituents. Several documented works have attested to its antimicrobial, antiviral, and anti-inflammatory outcomes towards many microbial, viral and inflammatory agents. Ganoderma is wealthy in distinct bioactive compounds with healing outcomes and that they include polysaccharides, triterpenoids lipids, lysosomes, proteins, and nucleotides. It incorporates sure factors which includes germanium, calcium, potassium, calcium, and compounds like alkaloids, flavonoids, and coumarins.<sup>[20]</sup>

Diverse medicinal benefits of GL have been established, and they include Anti-Tumor<sup>[21]</sup>, anti-malaria<sup>[22]</sup>, anti-microbial<sup>[23,24]</sup>, anti-inflammatory<sup>[25]</sup>, and antiviral effects.<sup>[26]</sup>

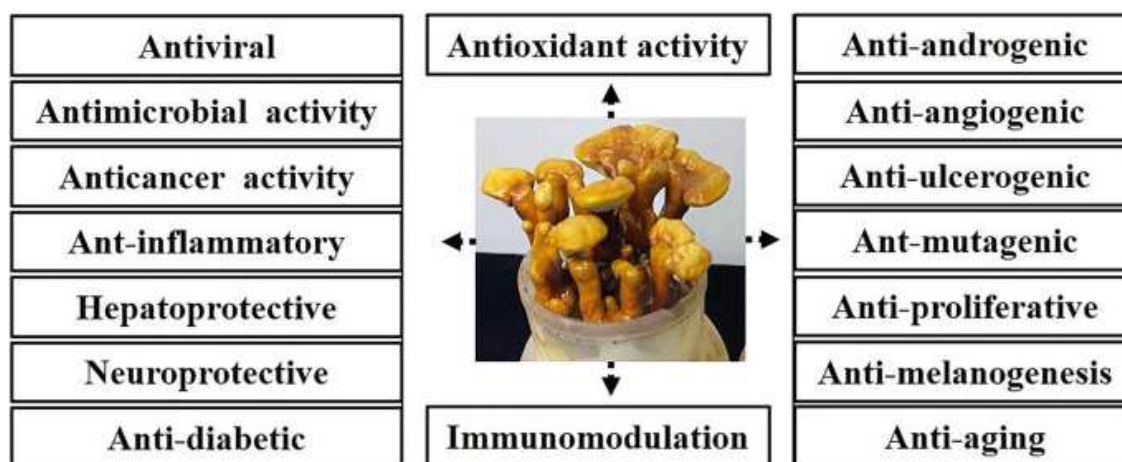


Figure: 2 Therapeutic uses of *Ganoderma lucidum*

### Anti tumor activity:

Ganoderic acids (GAs), a subset of triterpenes have been said in vitro to have antitumor activity, which induced the apoptosis in cervical carcinoma cells.<sup>[27]</sup> Human immune system function has been greatly enhanced by Gas<sup>[28]</sup> Found that GAs prevents the continuing department of human cervical carcinoma cells through preserving the cell cycle on the G2 phase.<sup>[29]</sup> found the increase inhibition of a few tumour cell strains and activation of apoptosis in human leukemia HL-60 cells via way of means of GA-B.<sup>[30]</sup> Additionally expressed the blockage of the Cell cycle regulatory protein CDC20 with the aid of using GA-Y, consequently department and boom of invasive and metastatic human breast most cancers cells were additionally prevented. Generally, most cancers stays the most scientific challenge regardless of the development withinside the early prognosis and chemotherapy of most cancers.<sup>[31]</sup> GL is a general supplement taken via way of means of wholesome folks and most cancers sufferers to improve their immunity in conjunction with traditional therapies. Ganoderma species are wealthy assets of endless bioactive components, together with antitumoral agents.<sup>[32]</sup> GL polysaccharides (GLPs), Ganoderma Triterpenes (GTs), and GL extract possess therapeutic effects on cancers such as prostate cancer<sup>[21]</sup>, Lung cancer<sup>[33]</sup>, glioma<sup>[34]</sup>, cancer of the breast.<sup>[35]</sup> Several research have defined the antitumor activity expressed with the aid of using *G. lucidum* being done via the induction of programmed cell death.<sup>[36]</sup> Furthermore, the remoted materials from the *G. lucidum* had been earlier defined as controllers of autophagy in numerous human cancer Cell lines.<sup>[37]</sup>

### Anti Malaria:

Malaria is a disorder as a result of a few species of Plasmodium and may be correctly dealt with artemisinin. Artemisinin resistance in Plasmodium falciparum has been reported. Evaluated the anti-malaria homes of triterpene remoted from the mycelium of Ganoderma towards *P. falciparum*. The in vitro *P. falciparum* test confirmed that GA-F and spironolactone B triggered half of *P. falciparum* demise with the dose starting from 6.0 to 10.0  $\mu$  mol/L.<sup>[38]</sup>



**Anti-Microbial:**

Antimicrobial activities of GL against various viruses, bacterial and fungal pathogens have been widely reported with some outstanding results.<sup>[8,9]</sup> Microorganisms such as bacteria, viruses, fungi and protozoa have always posed a threat to health. Bioactive compounds and mushroom extracts have shown promise in the search for new antimicrobial agents. Although there are numerous synthetic antimicrobial agents available to treat infectious diseases, drug resistance and toxicity still remain challenging issues, especially when used for a long period of time. Concerned about fewer side effects and safety, most people opt for herbal medicines, nutraceuticals and dietary supplements.<sup>[49]</sup> Therefore, it is time to search for new natural antimicrobial agents and alternatives to serve as alternatives to current drugs.<sup>[50,51]</sup> The primary goal of natural antimicrobial agents is to treat pathogens, stop their growth without damaging normal cells, and protect against microbial resistance.<sup>[52,53]</sup>

**Anti-Inflammatory:**

Inflammation a normal physical response to infection or injury and part host defense and tissue.<sup>[39]</sup> GLP can prevent inflammation, maintain intestinal homeostasis, and regulate intestinal immune barrier function in mice.<sup>[40]</sup> Effects of anti-inflammatory GLPs play an important role care of sensitive skin.<sup>[17]</sup>

**Antiviral Effects:**

The aim of antiviral drugs is to find antiviral agents that can stop the spread of viruses without harming normal cells. Now is the time to search for natural agents that can kill viruses without making them resistant or causing other side effects.<sup>[54,55]</sup> Several experimental studies have shown that *G. lucidum* could be a safe alternative to antiviral drugs.<sup>[56]</sup> Mushrooms are a huge source of bioactive metabolites with little or negligible toxicity. However, the development of antiviral drugs or vaccines for viral infections is a challenging task and currently, a natural source of therapy is a source to improve the immune system and reduce the mortality rate.<sup>[57]</sup> The bioactive components of *Lucidum* play a dynamic role in numerous human diseases and are also measured as a source of current medications.<sup>[50]</sup>

**Cardioprotective effects:**

Reported the presence of  $\alpha$ -tocopherol in *G. lucidum*, which protects mitochondria and reduces cardiac toxicity and mitochondrial dysfunction.<sup>[58]</sup> the beneficial effects of Ganopoly (*G. lucidum* polysaccharide extract) in patients with coronary heart disease (CHD). The same authors showed that a polysaccharide extract of *G. lucidum* resulted in a reduction in blood pressure and serum cholesterol levels.<sup>[59]</sup>

**Antidiabetic Activity:**

It has been shown that *G. lucidum* contains compounds responsible for hypoglycemic effects such as polysaccharides, proteoglycans, proteins and triterpenoids.<sup>[60]</sup> It has been reported that consumption of a spore powder of *G. lucidum* (GLSP) resulted in a reduction in blood glucose levels by promoting glycogen synthesis and preventing gluconeogenesis.<sup>[61]</sup>

**Anticancer Activity:**

Cancer remains one of the most lethal diseases worldwide and represents a major clinical challenge, despite the significant increase in early diagnosis techniques and the advancement of its treatment techniques.<sup>[62]</sup> Hundreds of plant species have been investigated as sources of new therapies (chemopreventive or chemotherapeutic).<sup>[63]</sup> In this sense, mushrooms; e.g., *Ganoderma* species, are rich sources of many biologically active components, including antitumor agents.<sup>[64,65]</sup> For example, polysaccharides and triterpenes are two major groups of compounds extracted from *G. lucidum* that have been reported to possess chemopreventive and/or tumoricidal activities.<sup>[66,67,68]</sup>

***Ganoderma lucidum* against the 2019 Novel Coronavirus (SARS-CoV-2):**

In December 2019, a mysterious pneumonia outbreak began in Wuhan (Hobby Province, China).<sup>[41]</sup> One month later, it turned out that the infectious agent was a new type of coronavirus called SARS-CoV-2 (previously 2019-nCoV).<sup>[42]</sup> The World Health Organization (WHO) declared the pneumonia outbreak that occurred in Wuhan a major public health crisis on February 11, 2020 and gave it the official name Coronavirus Disease-2019 (COVID-19).<sup>[43]</sup> Several symptoms have been reported in COVID-19 patients, including cough, lung damage, fever, fatigue, muscle pain, diarrhea, myalgia, and respiratory symptoms.<sup>[44]</sup> As of April 27, 2021, 147,539,302 cases of SARS-CoV-2-infected pneumonia and 3,116,444 deaths have been reported in China and 223 other countries, areas or territories, of which 103,503 cases were identified in China.<sup>[45]</sup> Natural products are among the most important, if not the most important, sources of technology in the modern pharmaceutical industry due to their advantages, such as their numerous clinical uses and their unique diversity of chemical structures and biological activities.<sup>[46]</sup> In this context, Traditional Chinese Medicine (TCM) is one of the gold mines rich in

untapped natural resources.<sup>[47]</sup> that can be used to treat many diseases challenging humanity, including COVID-19. Previous studies on SARS-CoV and its homology with SARS-CoV-2 may provide opportunities to find natural compounds that inhibit SARS-CoV-2.<sup>[16]</sup> For example, the helicase domain is being investigated as a potential drug target.<sup>[48]</sup>

### Type Of Ganoderma:<sup>[69,70]</sup>

Colour	Taste	Chinese name	Japanese Name	Uses
Blue	Sour	Seishi	Aoshiba	Improve eyesight and liver function, calms nerves
Red	Bitter	Sekishi	Akashiba	Support internal organs; sharpens memory, enhances vitality
Yellow	Sweet	Oushi	Kishiba	Strengthens spleen function
White	Hot (or Pungent)	Hakushi	Shiroshiba	Improves Lungs function, gives courage and strong will
Black	Salty	Kokushi	Kuroshiba	protects Kidneys

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