

## Biological Activity of The Medicinal Mushroom *Ganoderma Lucidum* Against Various Diseases

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Edible mushrooms have long been popular among consumers due to their unique flavor and aroma, as well as their potential medical benefits. Because of their therapeutic properties, mushrooms are not only frequently found in kitchens but are also utilized as ingredients in traditional herbal remedies. For thousands of years, Asian nations have utilized the macro fungus *Ganoderma lucidum* (*G. lucidum*) as a traditional medicinal mushroom and for its health advantages. Its main secondary bioactive components, polysaccharides and triterpenoids, are the reason it is being employed as a nutraceutical and functional food. It has a number of biologically active substances with antibacterial, antifungal, anticancer, anti-inflammatory, and antioxidant qualities that strengthen the immune system.

Numerous biological actions, including immunomodulatory, antineurodegenerative, antidiabetic, anti-inflammatory, anticancer, and antibacterial properties, are exhibited by polysaccharides. In addition to their anticancer and antiangiogenic properties, triterpenoids have hepatoprotective, antihypertensive, hypocholesterolemia, and antihistaminic properties. Extracts of *G. lucidum* have been shown to contain more than 100 triterpenoid components. However, in vitro and in vivo investigations have validated a number of *Ganoderma* therapeutic properties. In light of this, the following details concerning different biological functions are provided:

### Antioxidant activity

Numerous in vitro antioxidant tests validated the polysaccharide and polysaccharide complexes that were isolated from *G. lucidum* for their antioxidant capacity. A redox imbalance brought on by high levels of free radicals damages the body's tissues oxidatively. One important contributing element to the onset and progression of illnesses is oxidative stress-induced damage to proteins, lipids, and DNA. The polysaccharides that were separated from *G. lucidum* have antioxidant properties and shield tissues from the

harmful effects of reactive oxygen species. They also aid in maintaining the body's oxidative state.

The triterpenoids of *G. lucidum* have antioxidant properties in addition to polysaccharides. Dong et al. (2019) employed the triterpenoids' capacity to scavenge two radicals, DPPH and ABTS, to assess their antioxidant activity. Some triterpenoids were isolated by Wang et al. Using the ABTS technique, two of them, Lingzhin E and Lingzhin F, demonstrated antioxidant activity. Zheng et al. (2020) extracted the triterpenoids using ethanol maceration and assessed their antioxidant activity using the DPPH technique, which is dependent on the terpenoids' concentration.

### Antibacterial activity

Terpenes, lectins, polysaccharides, and other substances that affect the bacterial cytoplasmic membrane are regarded as antimicrobials. Both gram-positive and gram-negative bacteria can be inhibited by the chemicals present in *G. lucidum*. For example, 15 gram-positive and gram-negative bacterial species can be inhibited by an aqueous extract of *G. lucidum*. Some substances, such triterpenoids and ganomycin, have been shown to exhibit broad-spectrum antibacterial action. According to Robles-Hernández et al. (2021), *G. lucidum* culture fluids exhibit antibacterial action against bacterial plant diseases.

Furthermore, *G. lucidum* derived peptides shown enhanced antibacterial activity against *Salmonella typhi* and *Escherichia coli*. This is most likely caused by two mechanisms: the stimulation of intracellular protein leakage in bacterial cells and the inhibition of action and production of reactive oxygen species (Mishra et al., 2018).

### Antifungal activity

Publications on *G. lucidum* antifungal properties are quite rare. The so-called ganodermin antifungal protein, which *Physalospora piricola*, *Fusarium oxysporum*, and *Botrytis cinerea* cannot develop mycelially, was effectively identified by Wang and Ng (2006). *Penicillium* sps., *Aspergillus Fumigatus*, *Aspergillus niger*, *Aspergillus flavus*, and

*Mucor indicus* were tested against methanolic and aqueous extracts. According to Sridhar et al. (2011), there was strong action against *Mucor indicus*.

#### **Antitumor activity**

For survival, a tumour requires a steady flow of nutrients. Blood and lymph vessels are the means by which invasive cancer cells proliferate. Therefore, angiogenesis-inhibiting drugs must be utilised. Targeting elements including cell adhesion, invasion, and migration can also regulate metastasis. Because chemotherapy slows angiogenesis, fewer blood vessels that nourish the tumour are formed, which lowers the tumor's food supply. It has been demonstrated that *G. lucidum* polysaccharides and triterpenes have anticancer and chemopreventive properties. Different extracts or isolated chemicals from *G. lucidum* have been shown in numerous studies to function as carcinostatics on a variety of cancer cell lines, including those from the lung, colon, pancreatic, liver, breast, skin, and prostate.

#### **Antiviral activity**

According to the findings of multiple investigations, *G. lucidum* may be a viable option for the creation of different antiviral medications. According to the genetic sequencing, *G. lucidum* has the ability to combat a wide range of viruses, including the highly hazardous and virulent H1N1 strain of flu, as well as herpes, influenza, Epstein-Barr, and hepatitis. It has been claimed that a number of isolated chemicals from *G. lucidum*, including ganoderic acid beta, lucidumol B, ganodermanondiol, ganodermanontriol, and ganolucidic acid A, have inhibitory effects on the activity of the HIV protease (Min et al., 1998). To establish the foundation for the use of *G. lucidum* isolates as anti-HIV drugs, much more study is required. Triterpenoids, however, seem to be the most significant substance with anti-HIV properties.

#### **Neuro-protective activity**

One of the most prevalent chronic progressive neurodegenerative diseases is Alzheimer's disease (AD). This sickness does not currently have an effective treatment. The primary goals of current Alzheimer's therapy are symptom relief and cognitive enhancement. Acetylcholinesterase (AChE) inhibition is one method of treating AD by regulating the amount of the neurotransmitter acetylcholine in the brain. The majority of the therapies involve medication, which lessens symptoms but has numerous adverse effects. Compounds from *G. lucidum* must be effective in

treating AD as part of alternative therapies. According to Zhang et al. (2011), a combination of triterpenoid drugs decreases fatigue and increases neuronal survival. Furthermore, studies have indicated that using *G. lucidum* as an adjuvant for neurological conditions over an extended period of time may slow the progression of Alzheimer's disease.

#### **Conclusion**

This review studied the neuro-protective, antibacterial, antifungal, anticancer, antiviral, anti-inflammatory, and antioxidant properties of the chemicals that were identified from *G. lucidum*. Triterpenoids and polysaccharides are the two chemical families that have been the subject of the majority of research on *G. lucidum* bioactive properties. Ganoderic acids, one of the triterpenoids, are believed to have anticancer action because they have been demonstrated to be cytotoxic to a range of cancer cell lines, including breast, lung, liver, colon, etc. Because of their immunomodulatory properties, GLPs are linked to anticancer action in addition to ganoderic acids. The molecular weight, degree of branching, and water solubility of polysaccharides are likely the primary factors influencing their properties. Several GLPs have been isolated using various techniques based on their structure over the past thirty years.  $\alpha$ - or  $\beta$ -(1 $\rightarrow$ 3)-, (1 $\rightarrow$ 6)-glucans, and heteropolysaccharides with various sugar combinations are the most frequently isolated polysaccharides from *G. lucidum*.

The creation of novel medications and other functional foods requires a thorough grasp of the nutritional and medicinal functions of *G. lucidum* extracts. It is still necessary to conduct additional research on the separated compounds of *G. lucidum*, concentrating on certain elements of the bioactive chemicals. To ascertain the precise levels for additional clinical research, these defined components must be accessed through in vitro and in vivo investigations. Additional research and newly acquired knowledge may make it easier to create novel pharmacological formulations and nutraceuticals from *G. lucidum*.

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